

AIR QUALITY REPORT

146 – 152 JOHNSON STREET, CASINO, NEW SOUTH WALES



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APPENDIX A – FIGURES

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Figure 2: Lot Boundary and Sample Locations

Figure 3: Proposed Development

Figure 4: Conceptual Site Model

APPENDIX B – LABORATORY RESULTS

APPENDIX C – RADIELLO PASSIVE SAMPLER

ABBREVIATIONS

AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment and Conservation Council
AS	Australian Standard
BGS	Below Ground Surface
BH	Bore Hole
BTEXN	Benzene, Toluene, Ethylbenzene, Xylenes and Naphthalene
BTOC	Below Top of Casing
C ₆ -C ₃₆	Hydrocarbon chain length fraction
COPC	Contaminants of Potential Concern
CSI Aus	Contaminated Site Investigations Australia
EPA	Environment Protection Authority
ESA	Environmental Site Assessment
GPR	Ground Penetrating Radar
HDPE	High Density Polyethylene
HIL	Health Investigation Level
HSL	Health Screening Level
IP	Interface Probe
LNAPL	Light Non-Aqueous Phase Liquid
MAH	Monocyclic Aromatic Hydrocarbon
NATA	National Association of Testing Authorities
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PID	Photoionisation Detector
RPD	Relative Percentage Difference
QA	Quality Assurance
QC	Quality Control
RAP	Remediation Action Plan
SAQP	Sampling Analysis and Quality Plan
SVB	Soil Vapour Bore
TDS	Total Dissolved Solid
TOC	Top of Casing
TPH	Total Petroleum Hydrocarbon
TRH	Total Recoverable Hydrocarbon
USCS	Unified Soil Classification System
UST	Underground Storage Tank
VOC	Volatile Organic Compound
XRF	X-Ray Fluorescence Analyser

1 Introduction

Contaminated Site Investigations Australia Pty Ltd (CSI Aus) was commissioned by Damon Moloney of Abode2 (on behalf of the site owner), to conduct an air quality assessment of the vacant property, located at 146 - 152 Johnston Street, Casino, New South Wales (the site).

A development application (DA) is to be submitted to Richmond Valley Council for a mixed use commercial/medium density residential development. The site borders an active service station to the west and it has been requested by Richmond Valley Council (RVC) that an air quality report be prepared for the proposed development. This report focusses on the site as a whole and the proposed site plan for the new dwellings.

This report outlines the findings of the Air Quality assessment.

1.1 Objectives

The objective of the Air Quality Report is to identify potential contamination of ambient air by volatile compounds emanating from the active service station, and make an assessment of the sites' suitability for residential use, or if further investigation is required. This objective will be met via desktop research of government sources, a site visit and walk-over, air sampling and subsequent laboratory analysis.

1.2 Scope of Works

The following scope of works was undertaken by CSI Aus, in accordance with NSW EPA guidelines and RVC's request:

- Desktop assessment of site location, history and setting.
- Review of previous consulting reports, namely;
 - o *Easterly Point Environmental (May 2023) Ref. 23034.1**
 - o *Ask Acoustics & Air Quality – Trinity Consultants Australia Pty Ltd (July 2020) Ref207401.0025.R01V01.docx*
- Site visit and walk-over (see photos in report);
- Collection of three primary samples to assess for contaminants of potential concern (COPC);
- Chain of Custody documentation;
- Analysis of samples via a NATA accredited laboratory; and
- Preparation of this Air Quality Monitoring Report.

Notes: Dispersion modelling has not been conducted as part of this assessment.

* it is noted that further onsite work has been conducted by Easterly Point Environmental since that version of the DSI report.

1.3 Summary of Previous Work

The two previous reports relating to the site have not identified contamination, or issues that require further investigation. Both reports conclude that the site is suitable for its proposed use. The air quality report was thorough in its compound list which is generally reserved for industrial sites or mining lease approval. The report found no exceedances of the criteria with a mention of cumene and odour from fuel sales.

2 Site Information

2.1 Site Identification

The site is located on the eastern edge of the township of Casino, in an area of mixed residential, open space and commercial/industrial land uses. Agricultural land uses occur within 500 m to 1,000 m of the site, including grazing, cropping, and orchards. General site information is presented in Table 2.1 below, and a Site Layout Plan is included as Figure's 1 and 2 in Appendix A.

Table 1: General Site Information

Table 1 General Site Information	
Site Address:	146-152 Johnston Street, Casino, NSW & Lots 155,156, 157 & 158 in DP 834821
Land Description:	Flat and vacant property, grass covered
Site Area:	3,200 m ²
Site Owner:	Momentum
Municipality	Richmond Valley Council
Current Zoning:	E1 Local Centre
Current Site Use:	Vacant
Proposed Site Use:	Community Housing, residential with access to soil and ground floor commercial space.
Nearest Active Fuel Station:	Adjacent - bordering western boundary
Adjoining Land Uses:	North: Residential properties East: Clark Street and beyond, residential properties South: Johnston Steet (Bruxner Hwy) West: Active Service Station and beyond, residential properties

2.2 Detailed Site Investigation

Further information pertaining to the site is presented in Easterly Point Environmental report dated May 2023 with Ref 23034.1. This information has been reviewed by CSI Aus and is considered factual, directly usable for this assessment and in line with the guidelines for reports prepared by contaminated land consultants.

2.3 Site Visit and Observations

A Site visit and walk-over was conducted by Dane Egelton of CSI Aus on 9 and 10 August, 2023. The site was free of evidence of previous construction or use. The location of Easterly Point Environmental test pits were visible on the site surface.

The active service station has a diesel vent pipe within 2 metres of the boundary to the site. Another petrol vent pipe was located approximately 30 m from the boundary.

There were no visual or olfactory indicators of industrial activities that would potentially cause contamination of the site soils or underlying groundwater. Note; soil and groundwater was not assessed during this Air Quality Assessment.

PHOTOGRAPH 1 CURRENT SITE LAYOUT AND SETTING – VIEW FROM BRUXNER HWY LOOKING NORTH



3 Regulatory Framework and National Legislation

The Australian and NSW regulatory framework operates around a “polluter pays” system for contamination events. It is understood that the site is not contaminated.

3.1 Protection Of the environment Operations Act 1997 (POEO)

The *Protection of the Environment Operations Act 1997* sets the statutory framework for managing air quality in NSW, including establishing the licensing scheme for major industrial premises and offences and penalties for a range of air pollution issues. It is supported by the *Protection of the Environment Operations (General) Regulation 2022*, which provides for

- the administration of the licensing scheme
- economic incentives for licensed businesses and industry to reduce pollution, including emissions to air, through load-based licensing.

This would apply to the neighboring service station site, but not the site being assessed.

3.2 POEO (Clean Air) Regulation 2022

The Protection of the Environment Operations (Clean Air) Regulation contains provisions to regulate emissions from;

- wood heaters (Part 2)
- fires (Part 3)
- motor vehicles (Part 4)
- industry (Parts 5, 6 and 7)
- petrol and other liquid fuel (Parts 8 and 9)

This would apply to the neighboring service station site, but not the site being assessed.

3.3 National Environmental Protection Measure (Ambient Air Quality) Measure (NEPM)

The NSW Government is a signatory to the National Environment Protection (Ambient Air Quality) Measure (Air NEPM). The NEPM sets standards for six key air pollutants:

1. carbon monoxide,
2. nitrogen dioxide,
3. sulfur dioxide,
4. lead,
5. ozone and
6. particles (particulates). Particles included are:
 - PM₁₀ – particles smaller than 10 micrometres in diameter
 - PM_{2.5} – particles smaller than 2.5 micrometres in diameter

These parameters are not considered to be relevant to the proposed development or previous site use. The current land zoning is “E1 Local Centre” which promotes business, retail, community and residential uses. There are no industrial or mining related activities near the site.

3.4 National Environment Protection (Air Toxics) Measure

This guideline outlines the reference methods for monitoring of Air Toxics. It also outlines monitoring investigation levels in Table 2 of the measure and summarised below in Section 5.2 Table 3.

3.5 Approved Methods for Sampling and Analysing Air Emissions

This regulation is deferred to the Contaminated Land Management Regulation which outlines a list of approved USEPA methods including Method 18 – Volatile Organic Compounds by Gas Chromatography using GC/MS. This is the method used by the NATA accredited laboratory commissioned for the sample analysis. See Section 4.4 and Appendix C.

3.6 Consultants Reporting on Contaminated Land

These guidelines provide a reporting framework and information to ensure that reports prepared by consultants on the management of contaminated land contain the right information in a suitable format to inform and explain management decisions, document outcomes, and provide for efficient review by regulators, the site auditor and other interested parties. Primarily it relates to the work completed by Easterly Point Environmental which involved soil sample collection and analysis. It is understood that the site is not contaminated with volatile organic compounds (VOCs).

4 Contaminants

4.1 Possible Sources of Contamination (Airborne)

The site has not previously been developed and potential sources of air contamination are offsite and neighboring to the property. Therefore, the following potential sources of ambient air contamination have been identified.

- Fuel sales from adjacent active service station
 - Volatile compounds in air from refuelling vehicles at bowsers
 - Fuel tank vent pipes
 - Refuelling of underground storage tanks has vapour recovery which minimises exposure
- Air pollution from the Bruxner Highway (Johnston Street) fronting the site.

4.2 Contaminants of Potential Concern

Based on the review of the Detailed Site Investigation report prepared by East Coast Environmental and the sites position adjacent to a service station, contaminants of potential concern are considered to be limited to:

- Volatile Organic Compounds (VOCs).

The key components of fuel that pose a human health risk via inhalation include: Benzene, Toluene, Ethylbenzene, and Xylene.

4.3 Sampling Rationale

The passive samplers were positioned across the site to assess the variation of VOC concentrations away from the two primary source areas (Highway and bowser).

The duplicate location AA01 had two samples at slightly different heights to assess the vertical distribution of VOC's. This was done to assess if there were higher concentrations at ground level or the first floor of proposed future buildings.

See figures 2 and 3 in Appendix A at the end of this report.

4.4 Sample Method

The Radiello sampling system is a passive sampler which works on gaseous molecules passing through the diffusive body followed by absorption onto the internal cartridge. Due to the Radiello's cylindrical design it has a much larger surface area compared to that of traditional passive samplers. This large surface area allows for greater uptake rates of target compounds to enable lower reporting limits to be achieved.

The Radiello VOC solvent desorption cartridge (RAD130) consist of a stainless steel net cylinder, with 3x8µm mesh grid opening and 4.8mm diameter, packed with 350mg of graphitized charcoal (Carbograph 4). This cartridge is then placed in the diffusive body made from 1.7mm thick microporous polyethylene with an average porosity of 25µm to protect the sampling cartridge.

The sampling start date and time and end date and times are recorded on the barcoded labels and chain of custody forms for submission to the laboratory. See Appendix C for further information.

PHOTOGRAPH 2 RADIELLO PASSIVE SAMPLER ONSITE (AA01 + AA01 DUP)



4.4.1 Sample Details

- Map coordinates (Australian Map Grid, latitude, longitude)
 1. AA01 = 506104.94m E, 6807446.13m S
 2. AA02 = 506131.14m E, 6807469.20m S
 3. AA03 = 506159.46m E, 680744.70n S
- Site elevation = ~24m
- Sample intake height
 1. AA01 = 1.5m & 2.3m
 2. AA02 = 1.5m
 3. AA03 = 1.5m
- Date monitoring established; 9 August 2023 @ 9:22am
- Date monitoring completed; 10 August 2023 @ 9:59 am
- Exceptions to AS/NZS 3580.1.1:2007; Assessment of VOC's from hydrocarbons
- Description of surrounding land use = Residential, highway, fuel station.
- Instrument details = Passive radial sampler (Radiello)
- Sources impacting on the site = Highway pollution and fuel sales next door.
- Distance from the kerb for roadside monitoring = 9m (AA01) – 40m (AA02)

4.5 Analysis Method

Analysis for VOCs on Radiello solvent desorption tubes is performed by environmental laboratories using NATA accredited methods. This is done by desorbing the cartridge in carbon disulphide and analyzing the solvent extract by GC/MS. Concentrations of target VOC's are then calculated to airborne levels based on the exposure time of the Radiello sampler and the validated uptake rates published in the Radiello technical manual.

The Radiello passive sampler has been in use in Australia since the late 1990's and has a proven record of repeatable, accurate and representative data from both indoor and ambient air applications. See Appendix C for further information.

4.6 Sample Transportation

Samples were sent via Australia post on the day of sample collection. This type of sample media does not require cooled transport or other preservation. See Appendix B for the laboratory report and COC documentation.

5 Guidelines & Criteria

The ambient air analytical results have been assessed with regard to the suitability of the site for the proposed E1 Local Centre development. The following receptors have been identified as requiring protection:

- Human Health - Future occupants of the commercial and residential development

The adopted guidelines associated with the protection of each identified receptor are detailed in the following sections. The guidelines have been sourced from the National Environment Protection Measure - Assessment of Site Contamination, as amended in 2013 (NEPM). The NEPM presents a range of guidelines applicable for the protection of receptors associated with land uses.

It is emphasised within the NEPM that the purpose of the guidelines is to provide a basis whereby the chemical profile for a site may be screened to identify conditions that may warrant further consideration of risks to human health or the environment. Therefore, the guidelines do not represent values above which remedial action or other site management measure would be required. Rather, the adopted guidelines provide an appropriate basis for identifying conditions which do not warrant any further consideration.

5.1 Human Health Criteria

The adopted criteria for this assessment is the NEPM Air Quality guidelines and the Qld Environmental Protection (air) Policy 2019. They have similar threshold values for the compounds of interest and are a conservative approach to human health and cancer risk from exposure. See Table 3 below.

TABLE 3 Assessment Criteria				
Element / Compound 1,2,3	Health-based Investigation levels ($\mu\text{g}/\text{m}^3$)			
	NEPM (1:)	Workplace Guidelines (2:)	WHO (3:)	Qld EPA (Air) Policy (4:)
VOC's				
Benzene	9.6	3,200	3,200	5.4
Toluene	376	191,000	260	400
Ethylbenzene	-	434,000	-	2.74
Xylene	867	442,000	442,000	950

- Notes:**
- 1: NEPM – 2011 Air Toxics Annual Average
 - 2: Safe Work Australia Occupational health and safety guidelines for workers (8-hour daily exposure)
 - 3: WHO – World Health Organisation.
 - 4: Environmental Protection (Air) Policy 2019 (Qld Gov) – Health and Wellbeing environmental value.

5.2 Data Quality Objectives

Data quality objectives (DQOs) were developed to define the type and quality of data required to achieve the potential soil contamination assessment and, if required, remediation investigation objectives. Development of the DQOs was based on guidelines in the US EPA *Guidance for the Data Quality Objectives Process* (2000), and

with reference to relevant guidelines published by the NSW EPA (1997 and 1998), ANZECC 2000, and NEPC 2013, which define minimum data requirements and quality control procedures.

The DQO process comprises a seven-step planning approach. Using this approach, CSI Aus has developed the sampling design for data collection activities that support the objectives of the soil investigation and facilitate decision-making. Table 4 below lists the seven steps and identifies the sections within this report that addresses those steps.

TABLE 4 Data Quality Objectives Process	
DQO Step	Discussion and Detailed description
1. Define the problem	The site is adjacent to an active service station and fronted by a highway. Council has requested that air quality be assessed prior to DA approval.
2. Identify the decision	If identified COPC are detected in surface soils exceed Tier 1 or Tier 2 Risk Assessment Criteria. If the 95% UCL does <u>not</u> exceed Tier 1 and/or Tier 2 Risk Assessment Criteria a human health pathway is considered to not exist.
3. Identify the inputs of the decision	Correct collection of air samples, sample preservation and use of a NATA accredited laboratory. Air samples collected from three locations selected judgmentally across the site. Analysis of air samples for VOC's including BTEX. Tier 1 Assessment.
4. Define the investigation boundaries	The property boundary as outlined in Section 2 Table 1.
5. Develop a decision rule – analytical approach	Acceptable limits for analytical approach are presented in Data Quality Indicators Table 5 below. The analytical method can achieve detection limits below Tier 1 Risk Assessment Criteria.
6. Specify tolerable limits on decision errors	The limits on decision errors expressed as per cent error for the investigative activities should be no greater than 10 per cent. The aggregate sampling and analysis error may be greater, but error resulting from sampling procedures or the nature of the sample matrix is not quantifiable. By implementing statistically valid sampling plan and adopting the 95% UCL to compare against the Tier 1 / 2 Risk Assessment Criteria we have adopted a 5% level of significance, i.e. adopting a 5% probability we will make the wrong decision (Type 1 / Type 2 error). The data must fall within the range of DQIs to be considered reliable.
7. Optimise the design for obtaining data	Presented in Sections 4, 5 & 6 of this report. A review of previous work conducted on the site including an air quality assessment and a detailed site investigation. Physical data was obtained by passive air sampling (Radiello).

5.3 Data Quality indicators

Quality Assurance and Quality Control QA/QC is tested by review of data against Data Quality Indicators (DQIs) to ensure data precision, accuracy, representativeness, comparability and completeness. A summary of DQIs for samples to be collected as part of the investigation are presented in the table below:

TABLE 5 Data Quality Indicators

Data Quality Objectives	Frequency	Data Quality Indicator
Precision		
Duplicate samples	1 per 10 samples	RPD <50%
Accuracy		
Laboratory control samples	1 per day	General analytes recovery of 70–130%
Analysis blank	1 per day	Non-detect
Representativeness		
Samples analysed within specified holding times	Soil Samples	<30 days Within specific analyte holding times
Samples transported under COC conditions	N/A	All samples will be transported under chain of custody documentation
Reliability of field measured data	N/A	
Comparability		
Industry best practise for all sample media	All samples, all analytes	Experienced staff
Consistent sampling techniques	All samples all analytes	Same staff and method for the project
Appropriate laboratory reporting limits	All samples, all analytes	-
Completeness		
Appropriate sample design to meet objectives	N/A	-

5.4 Field Data QA/QC Acceptance Criteria

For all samples, field sample QA/QC was be conducted in accordance with industry best practice for air sampling and consist of the following:

NEPM Air Toxics (2011) and NEPM schedule B indicate an acceptable RPD range of 30-50%, and that the variation can be expected to be higher for organic analysis than inorganics, and for low concentrations of analytes.

Field and Laboratory Quality Control/Quality Assurance (QA/QC) procedures were conducted in accordance with NEPC (2013), and;

USEPA TO-15 Analysis by GC/MS - Section 1.6. *“Solid adsorbents can be used in lieu of canisters for sampling of VOCs, provided the solid adsorbent packings, usually multisorbent packings in metal or glass tubes, can meet the*

performance criteria specified in Compendium Method TO-17 which specifically addresses the use of multisorbent packings. The two sample collection techniques are different but become the same upon movement of the sample from the collection medium (canister or multisorbent tubes) onto the sample concentrator. Sample collection directly from the atmosphere by automated gas chromatographs can be used in lieu of collection in canisters or on solid adsorbents.”

All air samples were collected using individually sealed new sample media provided by the laboratory. Clean nitrile gloves were used when handling the Radiello cartridges between sample vial and diffusive body. See Figure 2 in Appendix A for sample locations. See Appendix C for more information on the Radiello passive sampler.

The acceptance criteria for QA/QC samples are detailed in Table 5 above:

5.5 Laboratory QA/QC

- At least one analysis blank per batch
- Duplicate analysis at a rate of one per batch or one per ten samples, whichever is smaller
- Laboratory Control Samples at a rate of one per batch

The nominated laboratory must comply with the minimum QA procedures documented in Schedule B(3) in NEPC (2013) National Environmental Protection (Assessment of Site Contamination) Measure and include, but not be limited to:

- Matrix spikes, and
- Surrogate Spikes

A review of SGS’s quality report in Appendix B indicates that all QA procedures were satisfactory and no significant outliers were reported.

In the event the acceptance criteria are not met, the variation is taken into consideration and its implications assessed in regard to the context of the investigation.

6 Conceptual Site Model (CSM)

National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (NEPC 2013) identifies a conceptual site model (CSM) as a representation of site related information regarding contamination sources, receptors and exposure pathways between those sources and receptors. The development of a CSM is an essential part of all site assessments. See figure 4 in Appendix A for a visual representation of the CSM.

NEPC (2013) identified the essential elements of a CSM as including:

1. Known and potential sources of contamination and contaminants of concern including the mechanism(s) of contamination;
 - For the site being investigated, the potential sources of airborne contamination would be fuel sales and urban pollution from vehicles using the Bruxner Highway.
2. Potentially affected media (soil, sediment, groundwater, surface water, indoor and ambient air);

- Affected media assessed in this investigation is limited to ambient air and weather parameters.
- Human and ecological receptors;
 - Human receptors would be likely given that the proposed future use is commercial and residential with access to soil.
 - Ecological receptors have limited significance as the site does not have significant contaminating activities close to an ecosystem with sensitive or dependant species.
 - Potential and complete exposure pathways;
 - Direct contact with contaminated soil (complete pathway once developed for residential use).
 - Ingestion or dermal contact with contaminated groundwater/surface water (potential - unlikely)
 - Inhalation of vapours from volatiles in soil or groundwater (incomplete and unlikely).
 - Migration of contaminated groundwater to surface water discharge point (unlikely).
 - Any potential preferential pathways for vapour migration.
 - No known VOC contamination of soils and therefore a low risk of vapour intrusion.
 - Data Gaps
 - None considered for this assessment.

7 Results

The results for air sample analysis have been summarised in Table 6 below. Laboratory certificate of analysis and QA/QC assessment is provided at the end of this report in Appendix B. A discussion of results is presented below in section 7.2.

TABLE 6 Soil Analytical Results Summary								
Analyte	Criteria 1,4	Concentrations in $\mu\text{g}/\text{m}^3$						
		PQL	AA01	AA01 Dup	AA02	AA03	RPD	
Benzene	5.4 - 9.6	<1	1.4	1.5	1.0	1.0	7%	
Toluene	376 - 400	<1	3.4	3.7	1.8	1.7	8%	
Ethylbenzene	2.74	<1	<1	<1	<1	<1	0%	
m+p Xylenes	867- 950	<1.1	1.1	1.2	<1.1	<1.1	9%	
Total BTEX	-	<2.5	5.8	6.4	2.8	2.6	10%	
Fuel Compounds without criteria								
2-Methylpentane	NA	<1.0	7.1	8.2	2.3	2.6	14%	
Cyclohexane	NA	<1.3	1.6	1.4	<1.3	<1.3	13%	
n-Hexane	NA	<1.1	4.1	4.7	2.2	2.3	14%	

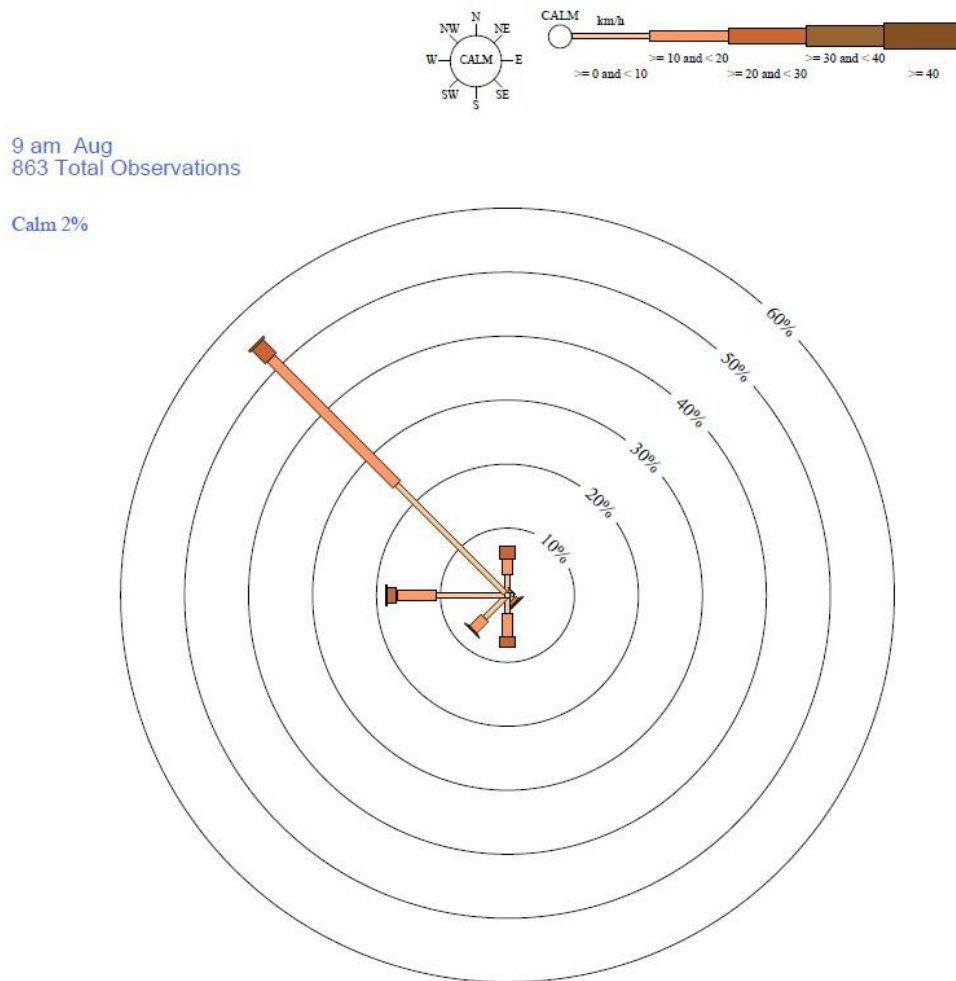
Notes: RPD = Relative percentage difference

7.1 Weather Data

This section presents the data collected from the bureau of meteorology online database, relevant to Casino airport (Station 58208).

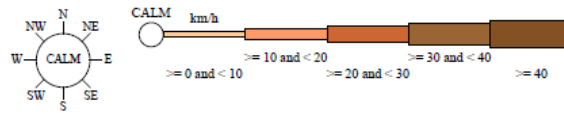
7.1.1 Wind Rose for August (Casino Airport)

As can be seen in the graph below, the prevailing winds in August are from the northwest. This wind direction essentially pushes fuel vapours from the bowlers towards the highway and does not directly impact the proposed buildings on the site. A westerly wind direction would have the greatest impact to the site in terms of fuel vapours and potential odour. As seen below the westerly average for August is approximately 18% of the time.



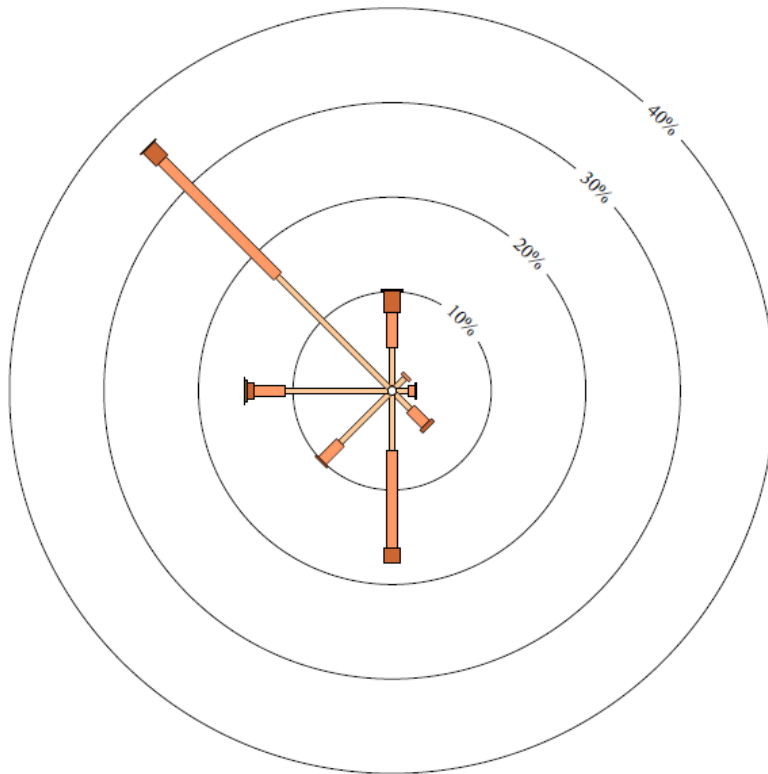
7.1.2 Wind Rose For 9am Annual (Casino)

The annual 9am wind direction for Casino is predominantly from the northwest with 35% of the total being from this direction. The westerly wind direction is averaged to 15%. With approximately 17% of the wind direction coming from the south – in which case potential air pollution would originate from the highway.



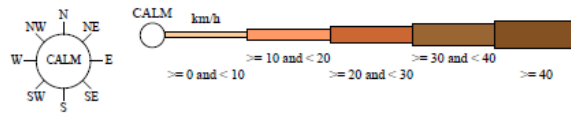
9 am
10213 Total Observations

Calm 2%



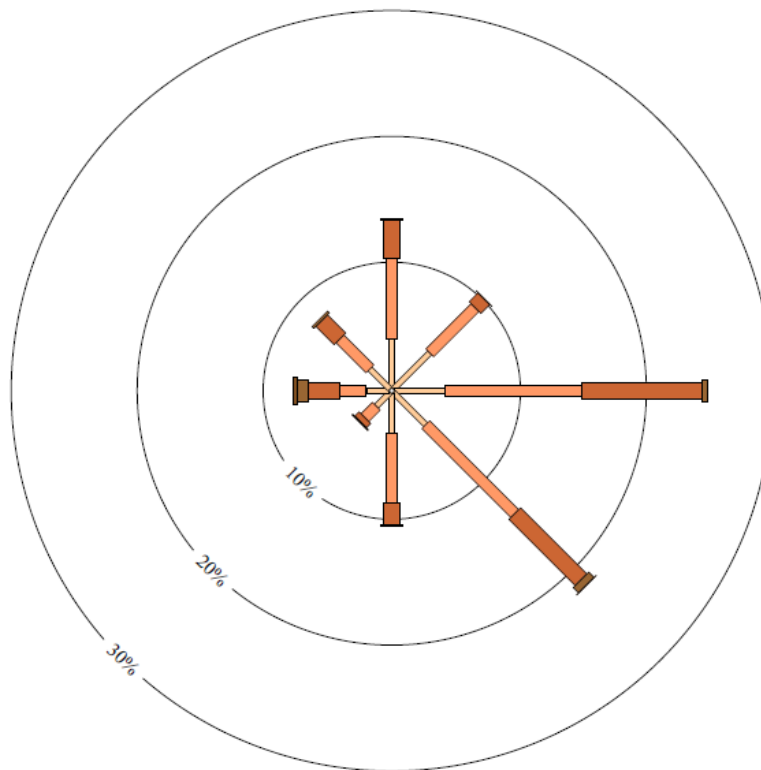
7.1.3 Wind Rose for 3pm Annual (Casino)

The afternoon wind direction for Casino is predominantly (>50%) from the east and south-east which would push potential air pollutants from the service station away from the site. The wind data collected from annual and monthly readings indicates that the potential for odors emanating from the service station and onto the neighbouring site is not likely to be frequent or sustained over an annual period.



3 pm
10178 Total Observations

Calm 1%



7.1.4 Actual Data from Casino Airport During Sample Exposure Period

See Table 7 below presenting the half hourly data measured at Casino on the day that passive samplers were exposed to ambient air onsite.

Date	Time	Direction Degrees	Speed km/hr	Direction	Comments
9/08/2023	9:00:00 AM	250	16.6	SW	Generally blowing from the bowzers towards the proposed development
9/08/2023	9:30:00 AM	210	20.5	SSW	"
9/08/2023	10:00:00 AM	210	16.6	SSW	"
9/08/2023	10:30:00 AM	210	16.6	SSW	"
9/08/2023	11:00:00 AM	190	20.5	SSW	"
9/08/2023	11:30:00 AM	180	22.3	S	Pollution source is expected to be limited to the Bruxner highway
10/08/2023	12:00:00 PM	170	20.5	SSE	"
10/08/2023	12:30:00 PM	170	25.9	SSE	"
10/08/2023	1:00:00 PM	170	24.1	SSE	"
10/08/2023	1:30:00 PM	170	24.1	SSE	"
10/08/2023	2:00:00 PM	140	22.3	SE	"
10/08/2023	2:30:00 PM	170	20.5	SSE	"
10/08/2023	3:00:00 PM	180	20.5	S	"
10/08/2023	3:30:00 PM	140	16.6	SE	"
10/08/2023	4:00:00 PM	150	16.6	SE	"
10/08/2023	4:30:00 PM	140	14.8	SE	"
10/08/2023	5:00:00 PM	130	13	SE	"
10/08/2023	5:30:00 PM	120	7.6	SE	"
10/08/2023	6:00:00 PM	240	5.4	WSW	Air movement from fuel station towards the site
10/08/2023	6:30:00 PM	250	7.6	WSW	"
10/08/2023	6:59:59 PM	250	5.4	WSW	"
10/08/2023	2:54:59 AM	250	1.8	WSW	Calm wind conditions between 7pm and 9am
10/08/2023	9:00:00 AM	320	3.6	NW	Air movement from fuel station towards the site
10/08/2023	9:30:00 AM	290	1.8	WNW	"
10/08/2023	10:00:00 AM	340	11.2	NNW	Air movement from existing residential development
10/08/2023	10:30:00 AM	360	13	N	"

7.2 Discussion

There are no known onsite sources of contamination or airborne pollutants. As can be seen from the summary table 6 presented above, there were no exceedances of air quality criteria for the compounds tested. The air quality data shows typical urban area concentrations of VOC's that would be expected in any Australian town of similar population size. It is noted that on the western side of the property which borders the service station, there were higher levels of compounds found in fuel vapour. Although above the detection limit, these values reported are in the parts per billion range and below human health criteria values. The positioning of the western sample and duplicate was within the proposed carpark to understand potential worst case scenario concentrations. The rear and eastern sample locations (AA02 and AA03) had non detection or lower concentration for all compounds.

The Wind Rose data collected from the nearby Casino airport shows that the annual wind direction percentages are similar to those collected on the day of sampling and the August averages. This indicates that the time of the sampling is representative of average annual conditions with a mixture of wind directions over the exposure period.

The air quality data collected in this assessment indicates that the site is suitable for its proposed development. It is possible that occasional fuel odours will be detectable on the site if wind direction and speed conditions are conducive. The lateral distance of 40 m between fuel bowsers and the proposed residential dwellings and the prevailing north-west wind direction reduces odour occurrence and exposure.

Fuel sales are often influenced by the 8-9am school drop off and 3-4pm pick-up with these times typically being the busiest. The afternoon wind direction is predominantly away from the site which eliminates fuel odors from the service station at these times on average. The refueling of UST's on the service station is not expected to increase vapour emissions as these vehicle are equipped with vapour collection systems.

The collection of a duplicate sample from differing heights provided a dual purpose.

1. Good assessment of quality control between primary and duplicate in the same location; and
2. Assessment of vertical concentration gradient between ground level (Dup) and first floor (AA01).

Ground level (1.5m) was observed to have the higher concentrations for most compounds.

7.3 Quality Assurance and Quality Control (QA/QC)

CSI Aus has completed a review of the Quality Assurance (QA) steps and Quality Control (QC) results, according to the data quality objectives defined in Section 5.6 and the following documents:

- NEPC, National Environment Protection (Assessment of Site Contamination) Measure, National Environment Protection Council (1999).
- US EPA Guidance on Environmental Data Verification and Data Validation (2002).

This included examining holding times, laboratory accreditation, sample preservation methods, a review of field quality control sample results and a review of laboratory quality control sample results.

SGS Australia (Notting Hill, Victoria), was the chosen NATA accredited laboratory for Radiello analysis. The primary sample was identified as AA01 and the duplicate was identified as AA Dup. As be seen from Table 7 below, all relative percentage difference (RPD) values met the +/-30% acceptance criteria.

TABLE 7 RPD Values	
Compound	Relative Percentage Difference (%)
Benzene	7%
Toluene	8%
Ethylbenzene	0%
m+p Xylenes	9%
Total BTEX	10%

Based on the DQI criteria being met, all data collected in this investigation is considered to be representative of site conditions at the time of sampling and satisfactory for use in this assessment.

8 Concluding Comments

CSI Aus has undertaken an Air Quality Assessment that has focussed on the potential contaminants arising from the sale of fuel on the neighbouring property. There are no onsite sources of contamination or airborne pollutants. A desktop review of previous consultant reports and a site visit did *not* identify previous 'high risk' activities on the site that are likely to have contaminated surface soils or pose a risk to air pollution. Analytical results from air samples collected around the site did *not* report any exceedances of the human health criteria for residential use or commercial use. The distance between source and receptor is considered to be sufficient for local village land use and the proposed development.

Additional investigation of the site for contamination or air quality is *not* considered to be warranted and the land is as usable as any other parcel in an urban area with similar zoning.

9 Limitations

The findings of this report are based on the objectives and scope of work outlined above. CSI Aus performed the services in a manner consistent with the normal level of care and expertise exercised by members of the environmental assessment industry. No warranties or guarantees, express or implied, are made. Subject to the scope of work, CSI Aus' assessment is limited strictly to identifying typical environmental conditions associated with the subject property and does not include evaluation of any other issues.

This report does not comment on any regulatory obligations based on the findings, for which a legal opinion should be sought. This report relates only to the objectives and scope of work stated, and does not relate to any other works undertaken for the Client.

The report and conclusions are based on the information obtained at the time of the assessment. Changes to the subsurface conditions may occur subsequent to the investigation described herein, through natural process or through the intentional or accidental addition of contaminants, and these conditions may change with space and time.

The site history, and associated uses, areas of use, and potential contaminants, were determined based on the activities described in the scope of work. Additional site history information held by the Client, regulatory authorities, or in the public domain, which was not provided to CSI Aus or was not sourced by CSI Aus under the scope of work, may identify additional uses, areas of use and/or potential contaminants. The information sources

referenced have been used to determine site history and desktop information regarding local subsurface conditions. While CSI Aus has used reasonable care to avoid reliance on data and information that is inaccurate or unsuitable, CSI Aus is not able to verify the accuracy or completeness of all information and data made available.

Further chemicals or categories of chemicals may exist at the site, which were not identified in the site history, and which may not be expected at the site. The absence of any identified hazardous or toxic materials on the

subject property should not be interpreted as a warranty or guarantee that such materials do not exist on the site. If additional certainty is required, additional site history or desktop studies, or environmental sampling and analysis, should be commissioned.

The results of this assessment are based upon site inspection and fieldwork conducted by CSI Aus personnel and information provided by the Client. Samples were collected at specific locations and should be considered to be an approximation of the condition of the sample. All conclusions regarding the property area are the professional opinions of CSI Aus personnel involved with the project, subject to the qualifications made above.

While normal assessments of data reliability have been made, CSI Aus assumes no responsibility or liability for errors in any data obtained from regulatory agencies, information from sources outside of CSI Aus. CSI Aus accepts no responsibility for any loss or damage suffered howsoever arising to any person or corporation who may use or rely on this document for a purpose other than that described above.

No part of this report may be reproduced, stored or transmitted in any form without the prior consent of CSI Aus.

CSI Aus is not an asbestos consultant. The investigation detailed in this report has been limited to the identified contaminants of concern listed in the report and does not include any assessment of the presence of asbestos, condition of asbestos or broken fragments of asbestos in soils at the site.

APPENDIX A – FIGURES



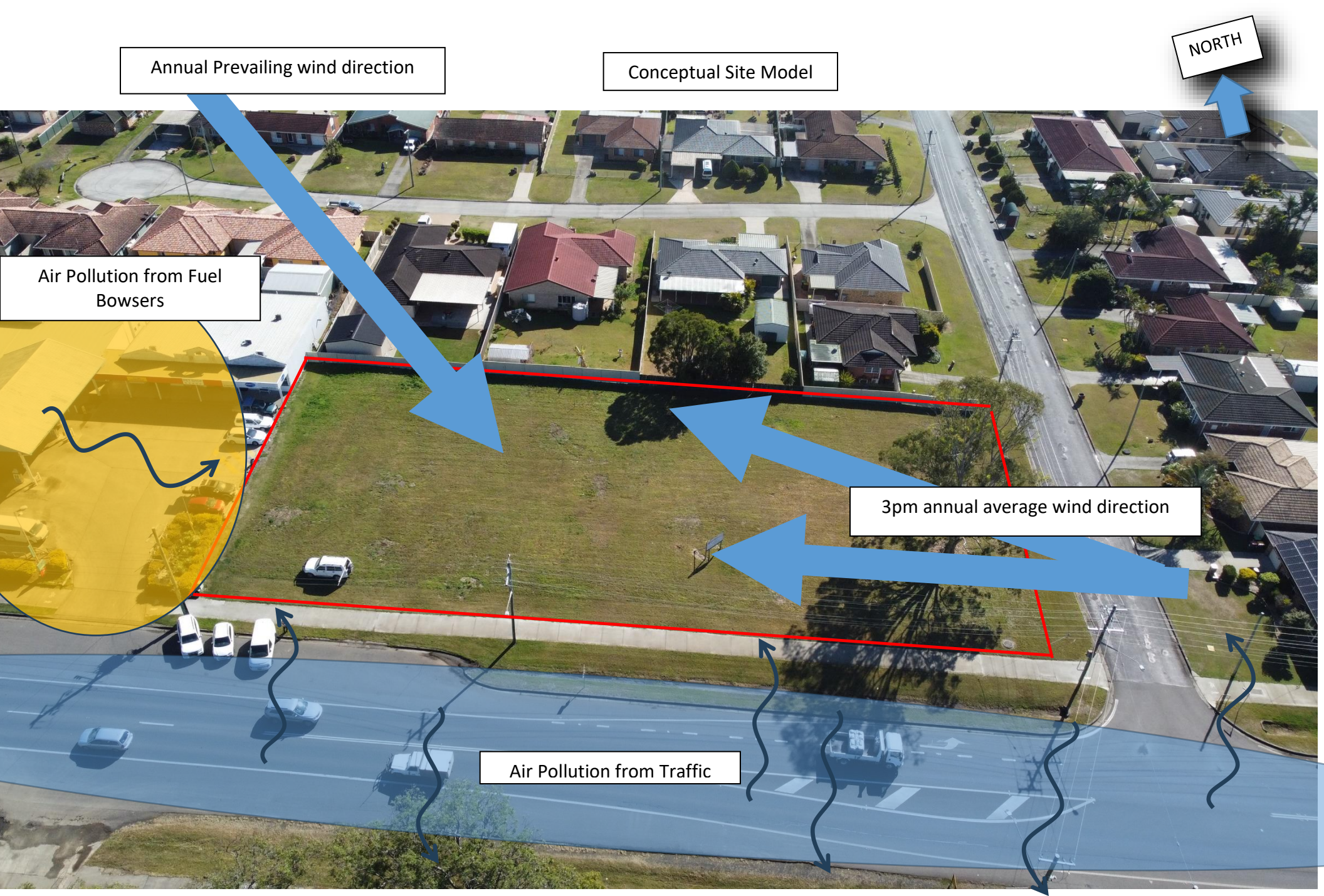
Report Number	2334
Project ID	Johnson Street, Casino
Date	1 September 2023

**Figure 1:
Site Location**



Report Number	2334
Project ID	Johnson Street, Casino
Date	1 September 2023

**Figure 2:
Site & Sample Locations**



Report Number	2334
Project ID	Johnson Street, Casino
Date	1 September 2023

**Figure 4:
Conceptual Site Model**

APPENDIX B – LABORATORY REPORTS

SGS Notting Hill Bottle Map for Air Samples

SGS Notting Hill Bottle Map for Air Samples																	
Temperature	RT	Ice Brick		Ice		Ice Pack		Esky		Bag		Box	1	Orange Case			
Name + Date	RAKSHA 17/08/23 10:00am			Sample Type													
Sample ID	Tray #	Canister	Radiello Tube	Other	Gas Bag	Isocyanate Tube	1.4 Canister (TO15)	6L Canister (TO15)	Thermal Radiello Tube (TO17_RAD)	ATD Tube (TO17)	Radiello Tube (MA5_RAD)	Waterloo Sampler (MA5_WL_LU)	Carbon Tube (MA5_ST)	XAD Tube (MA5_ST)	Silica Gel Tube (MA5_ST)	Puffs (TO13)	Number of labels to be printed per sample ID
1	01496		✓								✓						1
2	01497		✓								✓						1
3	01498		✓								✓						1
4	01499		✓								✓						1
5																	
6																	
7																	
8																	
9																	
10																	

Comments:

Sroc
↓



SAMPLE RECEIPT ADVICE

ME337640

CLIENT DETAILS

Contact Dane Egelton
Client CSI AUSTRALIA
Address PO BOX 389
ALSTONVILLE NSW 2477

Telephone 0499 859 528
Facsimile (Not specified)
Email dane@csiaus.com.au

Project **2334**
Order Number **2334**
Samples 4

LABORATORY DETAILS

Manager Adam Atkinson
Laboratory SGS Melbourne EH&S
Address 10/585 Blackburn Road
Notting Hill Victoria 3168

Telephone +61395743200
Facsimile +61395743399
Email Au.SampleReceipt.Melbourne@sgs.com

Samples Received Thu 17/8/2023
Report Due Thu 24/8/2023
SGS Reference **ME337640**

SUBMISSION DETAILS

This is to confirm that 4 samples were received on Thursday 17/8/2023. Results are expected to be ready by COB Thursday 24/8/2023. Please quote SGS reference ME337640 when making enquiries. Refer below for details relating to sample integrity upon receipt.

Sample counts by matrix	4 Radiello Tube	Type of documentation received	COC
Date documentation received	17/8/2023	Samples received in good order	Yes
Samples received without headspace	Yes	Sample temperature upon receipt	Ambient
Sample container provider	SGS	Turnaround time requested	Standard
Samples received in correct containers	Yes	Sufficient sample for analysis	Yes
Sample cooling method	N/A	Samples clearly labelled	Yes
Complete documentation received	Yes	Number of eskies/boxes received	1 Box

Unless otherwise instructed, water and bulk samples will be held for one month from date of report, and soil samples will be held for two months.

COMMENTS

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SAMPLE RECEIPT ADVICE

ME337640

CLIENT DETAILS

Client **CSI AUSTRALIA**

Project **2334**

SUMMARY OF ANALYSIS

No.	Sample ID	VOC in Air Radiello List
001	AA01 01496	48
002	AA01 Dup 01497	48
003	AA02 01498	48
004	AA03 01499	48

The above table represents SGS' interpretation of the client-supplied Chain Of Custody document.
The numbers shown in the table indicate the number of results requested in each package.
Please indicate as soon as possible should your request differ from these details .
Testing as per this table shall commence immediately unless the client intervenes with a correction .

CLIENT DETAILS

Contact Dane Egelton
 Client CSI AUSTRALIA
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 ALSTONVILLE NSW 2477

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 Facsimile (Not specified)
 Email dane@csiaus.com.au

Project **2334**
 Order Number **2334**
 Samples 4

LABORATORY DETAILS

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 Laboratory SGS Melbourne EH&S
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 Notting Hill Victoria 3168

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 Email Au.SampleReceipt.Melbourne@sgs.com

SGS Reference **ME337640 R0**
 Date Received 17/8/2023
 Date Reported 23/8/2023

COMMENTS

Accredited for compliance with ISO/IEC 17025 - Testing. NATA accredited laboratory 2562 (14420/22793/24472).

Sampling performed by client

SIGNATORIES



Susan WAN
 Senior Chemist

VOC in Air Radiello List [MA5] Tested: 18/8/2023

PARAMETER	UOM	LOR	AA01 01496	AA01 Dup 01497	AA02 01498	AA03 01499
			RADIELLO TUBE	RADIELLO TUBE	RADIELLO TUBE	RADIELLO TUBE
			10/8/23 9:59 ME337640.001	10/8/23 9:58 ME337640.002	10/8/23 9:54 ME337640.003	10/8/23 9:52 ME337640.004
1-Methoxy-2-propanol	µg/m³	-	<1.2	<1.2	<1.2	<1.3
1-Methoxy-2-propyl acetate	µg/m³	-	<1.1	<1.1	<1.1	<1.1
1,1,1-Trichloroethane	µg/m³	-	<1.1	<1.1	<1.1	<1.1
1,2-Dichloropropane	µg/m³	-	<1	<1	<1	<1
124-Trimethylbenzene	µg/m³	-	<1.4	<1.4	<1.4	<1.4
12-Dichloroethane	µg/m³	-	<0.88	<0.88	<0.89	<0.89
14-Dichlorobenzene	µg/m³	-	<1.3	<1.3	<1.3	<1.3
2-butoxyethanol	µg/m³	-	<1.2	<1.2	<1.2	<1.2
2-Methylpentane	µg/m³	-	7.1	8.2	2.3	2.6
2-ethylhexanol	µg/m³	-	<1.6	<1.6	<1.6	<1.6
3-Methylpentane	µg/m³	-	2.1	2.5	<0.98	<0.98
Benzene	µg/m³	-	1.4	1.5	1.0	1.0
Bromochloromethane	µg/m³	-	<0.97	<0.97	<0.98	<0.98
Butanol	µg/m³	-	<0.92	<0.92	<0.93	<0.93
Butyl acetate	µg/m³	-	<1.1	<1.1	<1.1	<1.1
Carbon tetrachloride	µg/m³	-	<1	<1	<1	<1
Chlorobenzene	µg/m³	-	<1	<1	<1	<1
Cyclohexane	µg/m³	-	1.6	1.4	<1.3	<1.3
Cyclohexanone	µg/m³	-	<1	<1	<1	<1
Ethyl-tert-butyl ether	µg/m³	-	<1.1	<1.1	<1.1	<1.1
Ethyl acetate	µg/m³	-	<0.87	<0.87	<0.88	<0.88
Ethylbenzene	µg/m³	-	<1	<1	<1	<1
Isobutanol	µg/m³	-	<0.88	<0.88	<0.89	<0.89
Isooctane	µg/m³	-	<1.2	<1.2	<1.2	<1.3
Isopropylbenzene	µg/m³	-	<1.2	<1.2	<1.2	<1.2
m&p-Xylenes	µg/m³	-	1.1	1.2	<0.98	<0.98
Methylcyclohexane	µg/m³	-	<1	<1	<1	<1
Methylcyclopentane	µg/m³	-	1.8	2.0	<0.98	<0.98
Methylethylketone	µg/m³	-	<0.86	<0.86	<0.87	<0.87
Methylisobutylketone	µg/m³	-	<1	<1	<1	<1
Methyl methacrylate	µg/m³	-	<1	<1	<1	<1
Methyl-ter-butyl ether	µg/m³	-	<1	<1	<1.1	<1.1
n-decane	µg/m³	-	<1.6	<1.6	<1.6	<1.6
n-Heptane	µg/m³	-	<1.2	<1.2	<1.2	<1.2
n-Hexane	µg/m³	-	4.1	4.7	2.2	2.3
N-Octane	µg/m³	-	<1.3	<1.3	<1.3	<1.3
Naphthalene	µg/m³	-	<2.7	<2.7	<2.7	<2.8
N-Nonane	µg/m³	-	<1.4	<1.4	<1.4	<1.4
n-Propylbenzene	µg/m³	-	<1.2	<1.2	<1.2	<1.2
N-Undecane	µg/m³	-	<2.8	<2.8	<2.9	<2.9
o-Xylene	µg/m³	-	<1	<1	<1.1	<1.1
Styrene	µg/m³	-	<1.1	<1.1	<1.1	<1.1
Tetrachloroethylene	µg/m³	-	<1.2	<1.2	<1.2	<1.2
Toluene	µg/m³	-	3.4	3.7	1.8	1.7
Trichloroethylene	µg/m³	-	<0.99	<0.99	<0.99	<1
Trichloromethane	µg/m³	-	<0.91	<0.91	<0.91	<0.92
Xylenes	µg/m³	-	1.1	1.2	<1.1	<1.1
Total BTEX	µg/m³	-	5.8	6.4	2.8	2.6

METHOD

METHODOLOGY SUMMARY

MA5 This method is used for the analysis of volatile organic compounds which have been sampled from air by the use of solvent desorption VOC Radiello. Extraction of analytes is achieved by desorption in carbon disulfide which is, in turn, analysed by GC/MS using direct injection.

FOOTNOTES

*	NATA accreditation does not cover the performance of this service.	-	Not analysed.	UOM	Unit of Measure.
**	Indicative data, theoretical holding time exceeded.	NVL	Not validated.	LOR	Limit of Reporting.
***	Indicates that both * and ** apply.	IS	Insufficient sample for analysis.	↑↓	Raised/lowered Limit of Reporting.
		LNR	Sample listed, but not received.		

Unless it is reported that sampling has been performed by SGS, the samples have been analysed as received. Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calculated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the "Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.

Note that in terms of units of radioactivity:

- a. 1 Bq is equivalent to 27 pCi
- b. 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

The QC and MU criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here: www.sgs.com.au/en-gb/environment-health-and-safety.

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STATEMENT OF QA/QC PERFORMANCE

ME337640 R0

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Project **2334**
Order Number **2334**
Samples 4

LABORATORY DETAILS

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Facsimile +61395743399
Email Au.SampleReceipt.Melbourne@sgs.com

SGS Reference **ME337640 R0**
Date Received 17 Aug 2023
Date Reported 23 Aug 2023

COMMENTS

All the laboratory data for each environmental matrix was compared to SGS' stated Data Quality Objectives (DQO). Comments arising from the comparison were made and are reported below.

The data relating to sampling was taken from the Chain of Custody document.
This QA/QC Statement must be read in conjunction with the referenced Analytical Report.
The Statement and the Analytical Report must not be reproduced except in full.

All Data Quality Objectives were met (within the SGS Melbourne EH&S laboratory).

SAMPLE SUMMARY

Sample counts by matrix	4 Radiello Tube	Type of documentation received	COC
Date documentation received	17/8/2023	Samples received in good order	Yes
Samples received without headspace	Yes	Sample temperature upon receipt	Ambient
Sample container provider	SGS	Turnaround time requested	Standard
Samples received in correct containers	Yes	Sufficient sample for analysis	Yes
Sample cooling method	N/A	Samples clearly labelled	Yes
Complete documentation received	Yes	Number of eskies/boxes received	1 Box

SGS holding time criteria are drawn from current regulations and are highly dependent on sample container preservation as specified in the SGS "Field Sampling Guide for Containers and Holding Time" (ref: GU-(AU)-ENV.001). Soil samples guidelines are derived from NEPM "Schedule B(3) Guideline on Laboratory Analysis of Potentially Contaminated Soils". Water sample guidelines are derived from "AS/NZS 5667.1 : 1998 Water Quality - sampling part 1" and APHA "Standard Methods for the Examination of Water and Wastewater" 21st edition 2005.

Extraction and analysis holding time due dates listed are calculated from the date sampled, although holding times may be extended after laboratory extraction for some analytes. The due dates are the suggested dates that samples may be held before extraction or analysis and still be considered valid.

Extraction and analysis dates are shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria. If the sampled date is not supplied then compliance with criteria cannot be determined. If the received date is after one or both due dates then holding time will fail by default.

VOC in Air Radiello List

Method: MA5

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
AA01 01496	ME337640.001	LB065370	10 Aug 2023	17 Aug 2023	06 Feb 2024	18 Aug 2023	06 Feb 2024	23 Aug 2023
AA01 Dup 01497	ME337640.002	LB065370	10 Aug 2023	17 Aug 2023	06 Feb 2024	18 Aug 2023	06 Feb 2024	23 Aug 2023
AA02 01498	ME337640.003	LB065370	10 Aug 2023	17 Aug 2023	06 Feb 2024	18 Aug 2023	06 Feb 2024	23 Aug 2023
AA03 01499	ME337640.004	LB065370	10 Aug 2023	17 Aug 2023	06 Feb 2024	18 Aug 2023	06 Feb 2024	23 Aug 2023

Surrogate results are evaluated against upper and lower limit criteria established in the SGS QA/QC plan (Ref: MP-(AU)-[ENV]QU-022). At least two of three routine level soil sample surrogate spike recoveries for BTEX/VOC are to be within 70-130% where control charts have not been developed and within the established control limits for charted surrogates. Matrix effects may void this as an acceptance criterion. Water sample surrogate spike recoveries are to be within 40-130%. The presence of emulsions, surfactants and particulates may void this as an acceptance criterion.

Result is shown in **Green** when within suggested criteria or **Red** with an appended reason identifier when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

No surrogates were required for this job.

Blank results are evaluated against the limit of reporting (LOR), for the chosen method and its associated instrumentation, typically 2.5 times the statistically determined method detection limit (MDL).

Result is shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria.

VOC in Air Radiello List

Method: MA5

Sample Number	Parameter	Units	LOR	Result
LB065370.001	1-Methoxy-2-propanol	µg/m³	-	<1.2
	1-Methoxy-2-propyl acetate	µg/m³	-	<1.1
	1,1,1-Trichloroethane	µg/m³	-	<1.1
	1,2-Dichloropropane	µg/m³	-	<1.0
	124-Trimethylbenzene	µg/m³	-	<1.4
	12-Dichloroethane	µg/m³	-	<0.9
	14-Dichlorobenzene	µg/m³	-	<1.3
	2-butoxyethanol	µg/m³	-	<1.2
	2-Methylpentane	µg/m³	-	<1.0
	2-ethylhexanol	µg/m³	-	<1.6
	3-Methylpentane	µg/m³	-	<1.0
	Benzene	µg/m³	-	<0.9
	Bromochloromethane	µg/m³	-	<1.0
	Butanol	µg/m³	-	<0.9
	Butyl acetate	µg/m³	-	<1.1
	Carbon tetrachloride	µg/m³	-	<1.0
	Chlorobenzene	µg/m³	-	<1.0
	Cyclohexane	µg/m³	-	<1.3
	Cyclohexanone	µg/m³	-	<1.0
	Ethyl-tert-butyl ether	µg/m³	-	<1.1
	Ethyl acetate	µg/m³	-	<0.9
	Ethylbenzene	µg/m³	-	<1.0
	Isobutanol	µg/m³	-	<0.9
	Isooctane	µg/m³	-	<1.2
	Isopropylbenzene	µg/m³	-	<1.2
	m&p-Xylenes	µg/m³	-	<1.0
	Methylcyclohexane	µg/m³	-	<1.0
	Methylcyclopentane	µg/m³	-	<1.0
	Methylethylketone	µg/m³	-	<0.9
	Methylisobutylketone	µg/m³	-	<1.0
	Methyl methacrylate	µg/m³	-	<1.0
	Methyl-ter-butyl ether	µg/m³	-	<1.0
	n-decane	µg/m³	-	<1.6
	n-Heptane	µg/m³	-	<1.2
	n-Hexane	µg/m³	-	<1.0
	N-Octane	µg/m³	-	<1.3
	Naphthalene	µg/m³	-	<2.7
	N-Nonane	µg/m³	-	<1.4
	n-Propylbenzene	µg/m³	-	<1.2
	N-Undecane	µg/m³	-	<2.8
o-Xylene	µg/m³	-	<1.0	
Styrene	µg/m³	-	<1.1	
Tetrachloroethylene	µg/m³	-	<1.2	
Toluene	µg/m³	-	<0.9	
Trichloroethylene	µg/m³	-	<1.0	
Trichloromethane	µg/m³	-	<0.9	

Duplicates are calculated as Relative Percentage Difference (RPD) using the formula: $RPD = | \text{OriginalResult} - \text{ReplicateResult} | \times 100 / \text{Mean}$

The RPD is evaluated against the Maximum Allowable Difference (MAD) criteria and can be graphically represented by a curve calculated from the Statistical Detection Limit (SDL) and Limiting Repeatability (LR) using the formula: $MAD = 100 \times \text{SDL} / \text{Mean} + \text{LR}$

Where the Maximum Allowable Difference evaluates to a number larger than 200 it is displayed as 200.

RPD is shown in **Green** when within suggested criteria or **Red** with an appended reason identifier when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

NOTE: The RPD reported is calculated from the unrounded data for the original and replicate result. Manual calculation of the RPD from the rounded data reported may give a different calculated RPD.

No duplicates were required for this job.

Laboratory Control Standard (LCS) results are evaluated against an expected result, typically the concentration of analyte spiked into the control during the sample preparation stage, producing a percentage recovery. The criteria applied to the percentage recovery is established in the SGS QA /QC plan (Ref: MP-(AU)-[ENV]QU-022). For more information refer to the footnotes in the concluding page of this report.

Recovery is shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria.

VOC in Air Radiello List

Method: MA5

Sample Number	Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB065370.002	14-Dichlorobenzene	µg/m³	-	0.9	1	60 - 140	89
	Benzene	µg/m³	-	1.0	1	60 - 140	100
	Chlorobenzene	µg/m³	-	0.9	1	60 - 140	90
	Ethylbenzene	µg/m³	-	0.9	1	60 - 140	93
	m&p-Xylenes	µg/m³	-	2.0	2	60 - 140	99
	o-Xylene	µg/m³	-	0.9	1	60 - 140	90
	Toluene	µg/m³	-	1.0	1	60 - 140	98

Matrix Spike (MS) results are evaluated as the percentage recovery of an expected result, typically the concentration of analyte spiked into a field sub-sample during the sample preparation stage. The original sample's result is subtracted from the sub-sample result before determining the percentage recovery. The criteria applied to the percentage recovery is established in the SGS QA/QC plan (ref: MP-(AU)-[ENV]QU-022). For more information refer to the footnotes in the concluding page of this report.

Recovery is shown in **Green** when within suggested criteria or **Red** with an appended reason identifier when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

No matrix spikes were required for this job.

Matrix spike duplicates are calculated as Relative Percent Difference (RPD) using the formula: $RPD = |OriginalResult - ReplicateResult| \times 100 / Mean$

The original result is the analyte concentration of the matrix spike. The Duplicate result is the analyte concentration of the matrix spike duplicate.

The RPD is evaluated against the Maximum Allowable Difference (MAD) criteria and can be graphically represented by a curve calculated from the Statistical Detection Limit (SDL) and Limiting Repeatability (LR) using the formula: $MAD = 100 \times SDL / Mean + LR$

Where the Maximum Allowable Difference evaluates to a number larger than 200 it is displayed as 200.

RPD is shown in **Green** when within suggested criteria or **Red** with an appended reason identifier when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

No matrix spike duplicates were required for this job.

Samples analysed as received.

Solid samples expressed on a dry weight basis.

QC criteria are subject to internal review according to the SGS QA/QC plan and may be provided on request or alternatively can be found here: https://www.sgs.com.au/~media/Local/Australia/Documents/Technical Documents/MP-AU-ENV-QU-022_QA_QC_Plan.pdf

- * NATA accreditation does not cover the performance of this service.
- ** Indicative data, theoretical holding time exceeded.
- *** Indicates that both * and ** apply.
- Sample not analysed for this analyte.
- IS Insufficient sample for analysis.
- LNR Sample listed, but not received.
- LOR Limit of reporting.
- QFH QC result is above the upper tolerance.
- QFL QC result is below the lower tolerance.
- ① Majority of surrogate recoveries are within acceptance criteria.
- ② RPD failed acceptance criteria due to sample heterogeneity.
- ③ Results less than 5 times LOR preclude acceptance criteria for RPD.
- ④ Recovery failed acceptance criteria due to matrix interference.
- ⑤ Recovery failed acceptance criteria due to the presence of significant concentration of analyte (i.e. the concentration of analyte exceeds the spike level).
- ⑥ LOR was raised due to sample matrix interference.
- ⑦ LOR was raised due to dilution of significantly high concentration of analyte in sample.
- ⑧ Reanalysis of sample in duplicate confirmed sample heterogeneity and inconsistency of results.
- ⑨ Recovery failed acceptance criteria due to sample heterogeneity.
- ⑩ LOR was raised due to high conductivity of the sample (required dilution).
- ⑪ Majority of spike recoveries are within acceptance criteria.
- † Refer to relevant report comments for further information.

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APPENDIX C – RADIELLO PASSIVE SAMPLER



radiello®

Centro di Ricerche Ambientali - Padova



ENGLISH 02-2003

how does the diffusive sampler work?

The diffusive sampler is a closed box, usually cylindrical. Of its two opposite sides, one is "transparent" to gaseous molecules which cross it, and are adsorbed onto the second side. The former side is named diffusive surface, the latter is the adsorbing surface (marked with **S** and **A** in the figure).

Driven by the concentration gradient dC/dl , the gaseous molecules cross **S** and diffuse towards **A** along the path l , parallel to the axis of the cylindrical box. The molecules, which can be trapped by the adsorbing material, are eventually adsorbed onto **A** according to the diffusive

$$\frac{dm}{dt} = D S \frac{dC}{dl} \quad [1]$$

where dm is the adsorbed mass during time dt and D is the diffusion coefficient. Let C be the concentration at the diffusive surface and C_0 the concentration at the adsorbing surface, the integral of [1] becomes

$$\frac{m}{t} = D \frac{S}{l} (C - C_0) \quad [2]$$

If the concentration at the adsorbing surface is negligible, the equation can be approximated to

$$\frac{m}{tC} = D \frac{S}{l} = Q \quad \text{and then} \quad C = \frac{m}{tQ} \quad [3]$$

Q is the **sampling rate** and has the dimensions of a gaseous flow (if m is expressed in μg , t in minutes and C in $\mu\text{g}\cdot\text{l}^{-1}$, Q is expressed in $\text{l}\cdot\text{min}^{-1}$).

Therefore, if Q is constant and measured, to calculate the ambient air concentration you need only to quantify the mass of analyte trapped by the adsorbing material and to keep note of the time of exposure of the diffusive sampler.

To improve the analytical sensitivity the collected mass m should be increased by enlarging Q . As D is a constant term, one can only try to improve the S/l ratio, namely the **geometrical constant** of the sampler. Unfortunately, in the common axial symmetry sampler, if S is enlarged, the adsorbing surface **A** must be enlarged too, in order to keep the two parallel surfaces at a fixed distance. Since the analytes can be recovered from the axial sampler only by solvent extraction, any increase of **A** lead to a proportional increase of the extraction solvent volume, thus the improvement of Q is canceled out by the effect of dilution.

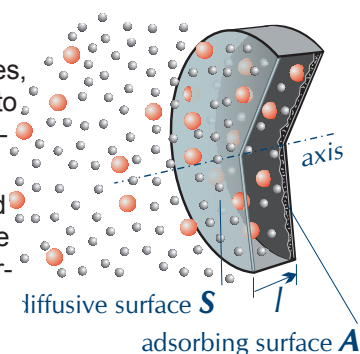
The value of distance l could also be reduced, but under the critical value of about 8 mm the diffusion law is no longer valid in the case of low air velocity values, since adsorption rate becomes higher than supplying rate of analyte molecules at the diffusive surface.

Cannot we improve Q then?

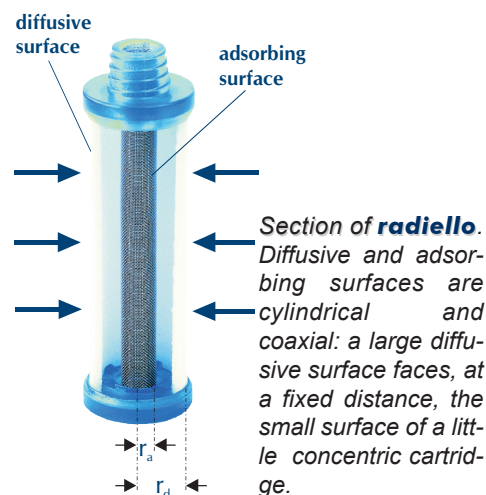
The answer is to improve the sampler geometry to a **radial** design.

From this idea the **radiello** sampler has been developed, its cylindrical outer surface acting as diffusive membrane: the gaseous molecules move axially parallel towards an adsorbent bed which is cylindrical too and coaxial to the diffusive surface.

When compared to the axial sampler, **radiello** shows a much higher diffusive surface without increase of the adsorbing material amount. Even if the adsorbing surface is quite smaller then the diffusive one, each point of the diffusive layer faces the diffusion barrier at the same distance.



In the diffusive sampler, the adsorbing and the diffusive surfaces are two opposing plane of a closed box. Driven by the concentration gradient, the gaseous molecules (coloured in the figure) pass through the diffusive surface and are trapped from the adsorbing surface.



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As $S=2\pi rh$ (where h is the height of the cylinder) and the diffusive path is as long as the radius r , we can then express equation [1] as follows

$$\frac{dm}{dt} = D 2\pi h r \frac{dC}{dr} \quad [4]$$

The integral of equation [4] from r_d (radius of the diffusive cylindrical surface) to r_a (radius of the adsorbing surface) becomes

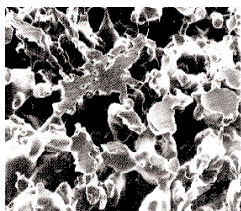
$$\frac{m}{t C} = D \frac{2\pi h}{\ln \frac{r_d}{r_a}} = Q \quad [5]$$

the ratio

$$\frac{2\pi h}{\ln \frac{r_d}{r_a}}$$

is the geometrical constant of **radiello**. The calculated uptake rate [5] is therefore proportional to the height of the diffusive cylinder and inversely proportional to the logarithm of the ratio of diffusive vs adsorbing cylinder radii.

The microporous sintered polyethylene diffusive barrier of **radiello** photographed at the electron microscope; the path length is much longer than the barrier thickness due to the tortuosity of the pores.



While r_a can be easily measured, r_d can only be calculated by exposure experiments. In fact, in order to obtain a sample device of small dimensions which respect of the diffusion laws, the diffusive barrier has been designed with a thick tubular microporous layer. The actual diffusive path length is therefore much longer than the distance among the diffusive and adsorbing surfaces due to the tortuosity of the path through the pores. A diffusive cylinder of external diameter 8 mm, thickness 1.7 mm and average porosity of 25 μm , coupled to an adsorbing cartridge with radius 2.9 mm creates a diffusive path of 18 mm instead of the straight line path estimation of $(8-2.9) = 5.1$ mm.

The sampling rate Q is function of diffusive coefficient D , which is a thermodynamic property of each chemical substance. D varies with temperature (T) and pressure (p); therefore also the sampling rate is a function of those variables according to

$$Q = f(T, p)$$

Q values that will be quoted in the following have been measured at 25 °C and 1013 hPa. As a consequence, they should be corrected so as to reflect the actual sampling conditions.

The correction of Q for atmospheric pressure is usually negligible since its dependence is linear and very seldom we face variations of more than 30 hPa about the average value of 1013 hPa. In the worst case, if corrections for pressure are ignored you make an error of $\pm 3\%$, usually it is within $\pm 1.5\%$.

On the other hand, Q depends exponentially on temperature variations, therefore more relevant errors can be introduced if average temperatures very different from 25 °C are ignored. Moreover, when chemiadsorbing cartridge are used kinetic effects (variations of reaction velocities between analyte and chemiadsorbing substrate) can be evident, apart from thermodynamic ones (variation of D).

As an example, when volatile organic compounds are sampled onto activated charcoal an experimental variation of $\pm 5\%$ of Q is measured corresponding to a variation of T of ± 10 °C from 25 °C, but when nitrogen dioxide is sampled on triethanolamine the variation of Q increases up to 21% for a similar variation of temperature.

It is therefore very important to know the average temperature in order to ensure accuracy of experimental data. See page B3 how you can perform on-field temperature measurements.

Even if some cartridge adsorb large quantities of water if exposed for a long time in wet atmosphere, generally this does not affect sampling by **radiello**. Some consequences, nevertheless, can sometimes be felt on the analysis. As an example, a very wet graphitised charcoal cartridge could generate ice plugs during cryogenic focusing of thermally desorbed compounds or blow out a FID flame.

It is therefore important to protect **radiello from bad weather. See page B1 how this can be easily done.**



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why is radiello so special?

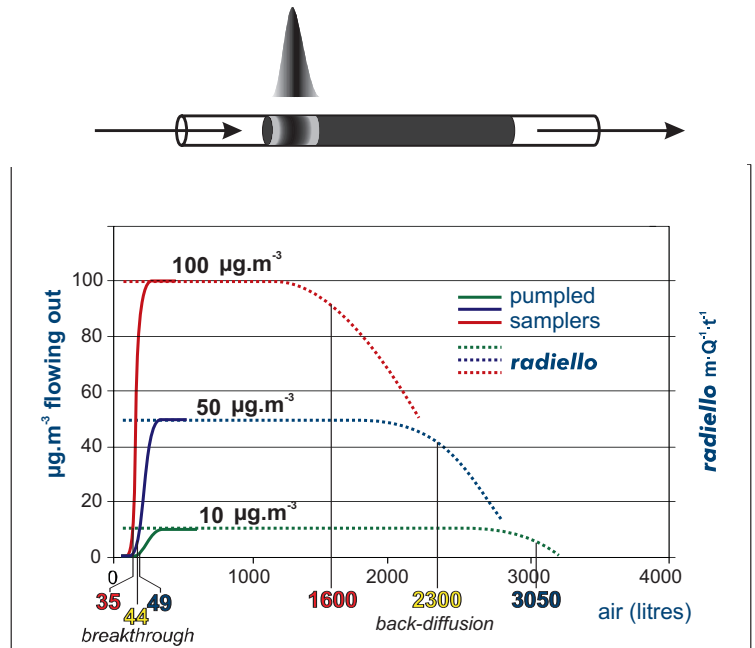
The diffusive sampling does not involve the use of heavy and encumbering pumping systems, does not have energy power supply problems, does not require supervision, is noiseless, is not flammable and does not represent an explosion hazard, can be performed by everybody everywhere and with very low costs.

Moreover, it is not subject to the breakthrough problem, which can be serious when active pumping is performed.

In pumped sampling the adsorbed compound behaves as a chromatographic peak (top): air flow displaces it along the adsorbent bed and its concentration is distributed as a gaussian function. Eventually, the compound comes out from the opposite end. When its concentration in the outlet air is 10% of the concentration in the sampled air we say that the **breakthrough** has been reached, or, with a misleading expression, that the tube has been saturated. Any further pumping leads to a loss of analyte and a consequent underestimation of the environmental concentration. The extent of this phenomenon depends weakly on the concentration of target compound but rather on the value of air flow, the overall sampling volume and the chemical compound involved.

In the graph the case of benzene is displayed, sampled at 25 °C onto an activated charcoal adsorbent bed of the same volume of a code 130 **radiello** cartridge. The breakthrough is reached after 35, 44 or 49 liters of sampled air depending on benzene concentration in air (10, 50 or 100 µg.m⁻³ respectively).

An apparently similar phenomenon is shown by **radiello** also. In this case, however, we cannot speak of breakthrough, since no actual air flow is involved, but rather of **backdiffusion**. This consists of a decrease of the value of $m \cdot Q^{-1} \cdot t^{-1}$ (which is equal to the measured concentration, see eqn. [3] on page A1). This term is constant and equal to the actual concentration until the adsorbed mass of analyte is far from the maximum amount allowed by the adsorbing medium capacity. The extent of backdiffusion depends on concentration and exposure time but a decrease of 10% in the $m \cdot Q^{-1} \cdot t^{-1}$ term is observed along with equivalent sampling volumes of magnitude bigger than those seen before: 1600, 2300 and 3050 liters at the concentration of 10, 50 and 100 µg.m⁻³.



Why diffusive sampling has not been so extensively adopted up to now?

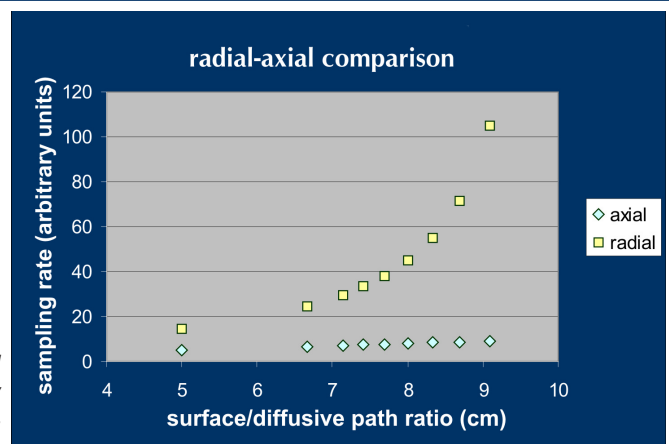
This is due to the fact that the traditional axial symmetry sampler has generally poor sensitivity and reproducibility because of the limits set by its geometry. On one side, uptake rate values are generally low, on the other, they often vary depending on environmental conditions.

These limitations have been overcome by **radiello**.

By virtue of radial symmetry, uptake rate is:

- ✓ **high**, since it does not vary linearly but exponentially with the ratio diffusive surface vs diffusive path length (see eqn. [5]). With the same dimensions, radiello's uptake rate is at least three times higher than for any axial diffusive sampler;

For a traditional axial symmetry sampler the uptake rate increases linearly with the ratio of diffusive surface vs diffusive path length, while for the radial symmetry sampler, the corresponding increase is exponential. This means that, let the diffusive surface vs diffusive path length ratio be 8:1, for the axial sampler the uptake rate value is 8 (regardless of dimensions) while for the radial one it is 45.



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- ✓ **constant**, due to the great adsorbing capacity of the adsorbing cartridge;
- ✓ **reproducible**, by virtue of the stiffness of the diffusive wall and the cartridge and of the close tolerances characterizing all the components of **radiello**;
- ✓ **invariable with air speed**, due to the tortuosity of the diffusive path inside the microporous diffusive cylindrical surface;
- ✓ **precisely measured**, because it is not calculated but experimentally measured in a controlled atmosphere chamber in a wide range of concentration, temperature, relative humidity, air speed conditions and with or without interferences....



Moreover, **radiello**

- ▶ is able to work properly also with bad weather conditions due to the water-repellent diffusive body
- ▶ has blank values lower than three times the instrumental noise due to the complex conditioning procedures of the bulk adsorbing (or chemiadsorbing) materials and to the repeated quality controls along the whole production
- ▶ has low detection limits and high adsorbing capacities that allow exposure time duration from 15 minutes to 30 days and concentration measurements from 1 ppb to over 1000 ppm
- ▶ offers high precision and accuracy over a wide range of exposure values



- ▶ allows thermal desorption and GC-MS analysis without interferences
- ▶ is suited to the sampling of a vast range of gaseous pollutants
- ▶ is tough and chemically inert, being made of polycarbonate, microporous polyethylene and stainless steel
- ▶ is indefinitely reusable in all of its components apart from the adsorbing cartridge; the latter can be recovered if thermal desorption is employed
- ▶ it comes from the efforts of one of the main European scientific research institutions that produces it directly by high technology equipment and continuously submits it to severe tests and performs research and development in its laboratory in Padova



All the images in the manual concern the Environmental Research Center of Padova of the Fondazione Salvatore Maugeri-IRCCS



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the components of radiello

The essential parts of **radiello** are the adsorbing cartridge, the diffusive body, the supporting plate and the adhesive label with the bar code indication. Apart from the adsorbing cartridge, if not differently stated, all of the other components can be used for a lot of sampling experiments.

The adsorbing cartridge

Depending on the polluting compound to be sampled, several different kinds of adsorbing or chemiadsorbing cartridges have been developed. Their dimensions are nevertheless the same for all: 60 mm length and 4,8 or 5,8 mm diameter.

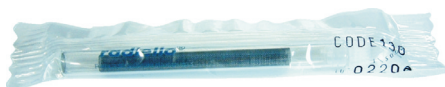
They are contained in glass or plastic tubes wrapped up in a transparent polyethylene thermowelded bag.

The code number, printed onto the bag along with the lot number and expiry date indicates the kind of cartridge.

Apart from the thermal desorption cartridges, all of the other kinds are for single use only.

Available in 20 pieces per package only.

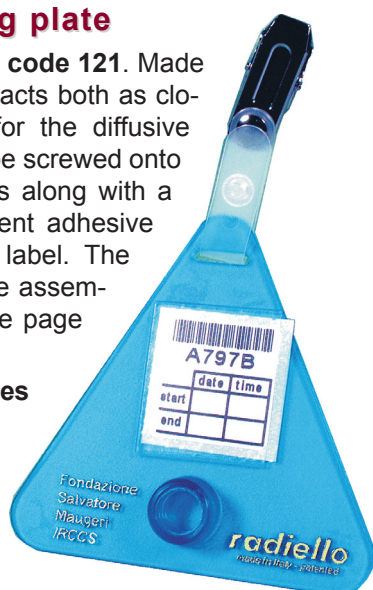
The cartridge has to be introduced into the diffusive body.



The supporting plate

It is identified by the **code 121**. Made of polycarbonate, it acts both as closure and support for the diffusive body, which has to be screwed onto the thread. It comes along with a clip and a transparent adhesive pocket to hold the label. The three parts are to be assembled before use (see page A6).

Available in 20 pieces per package only.



code 121

The diffusive body

Four kinds of diffusive bodies are available, with like outer dimensions: 60 mm height and 16 mm diameter.

The **white** diffusive body, **code 120**, of general use, is made of microporous polyethylene 1.7 mm thick and average porosity $25 \pm 5 \mu\text{m}$. Diffusive path length is 18 mm.

The **blue** diffusive body, **code 120-1**, has the same properties of the white one but is opaque to light: it is suited to the sampling of light-sensitive compounds.

The **yellow** diffusive body, **code 120-2**, should be used whenever the sampling rate must be reduced; it is made of microporous polyethylene 5 mm thick and average porosity $10 \pm 2 \mu\text{m}$. Diffusive path length is 150 mm.

The **permeative** diffusive body, **code 120-3**, is a 50 μm thick silicone membrane strengthened by a stainless steel net. It is employed for anaesthetic gases and vapours sampling.

Available in 20 pieces per package only.

The diffusive body has to be screwed onto the supporting plate.



code 120



120-1



120-2



120-3

code 190



The label

Self-adhesive, with printed barcode number. Since each barcode number has been printed in only one copy, it allows an unmistakable identification of the sampling tube on field and in the laboratory for the subsequent analysis.

Each package of 20 adsorbing cartridges contains also 21 labels.

If the labels are ordered separately, they are shipped in 198 pieces per package only.



how to use radiello before sampling

Before using **radiello**, you have to assemble to the supporting plate the clip, necessary to suspend it, and the adhesive label pocket.

assembling the supporting plate

1 insert the clip strip in the slot, with the peg facing upwards

2 ply the strip and insert the peg into the hole

3 peel off the transparent pocket

user tip
assemble the supporting plate in your lab before the sampling campaign: on the field they are uselessly time-consuming.

and stick it onto the plate in a central position; 4 if you prefer, the pocket can be applied to the rear of the plate, but BE CAREFUL, always with the label insertion slot on the side (otherwise, it starts raining the label can get wet)

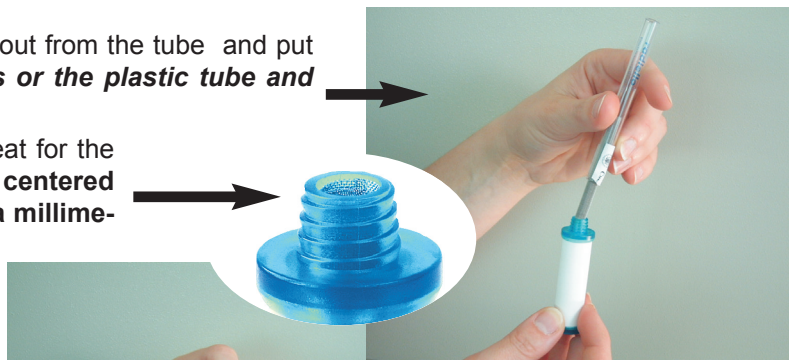
on-field to start the sampling

1 open the plastic bag, draw the cartridge out from the tube and put it in the diffusive body. **Keep the glass or the plastic tube and stopper in the original plastic bag.**

The lower part of the diffusive body holds a seat for the central positioning of the cartridge. **A correctly centered cartridge should not stick out even by half a millimeter. If it is not so, the cartridge is not correctly positioned and is out of axis.**

As a consequence, when the diffusive body is screwed onto the supporting plate the cartridge is bent, the geometry of the sampler is disturbed and the results obtained become unreliable.

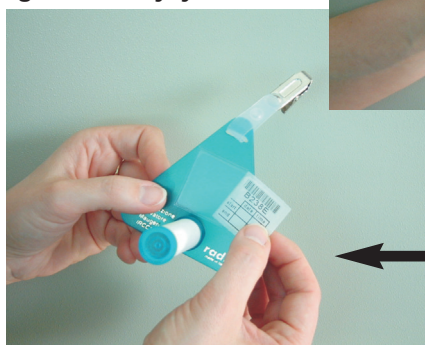
To place the cartridge centrally you need only to shake the diffusive body.



2 keeping the diffusive body in a vertical position, screw it onto the supporting plate

user tip

Do not touch the cartridge with your fingers if possible, particularly if it is impregnated with reactive



BE CAREFUL: do not hold the diffusive body horizontally when you screw it onto the plate, otherwise the cartridge could come out from its seat and stick out. Insert a label in the pocket without peeling it off. Keep note of the date and time and expose **radiello**. Sampling has started.

3



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user tip

even if you can write date and time of the sampling start and end on the adhesive label, we suggest you to keep note of these parameters also separately: after a week exposure with bad weather conditions, your writings could become illegible!

DO NOT USE MARKING PENS to write on the label: they contain solvents that are sampled by **radiello**!



4

Place the cartridge into the tube, peel off the label and stick it onto the tube such that the barcode is parallel to the axis of the tube.

If you have performed the sampling of different polluting compounds at the same time, **BE CAREFUL NOT TO MIX UP THE TUBES**: place the exposed cartridge in its original tube, identified by the code printed on the plastic.

after the sampling

Keep note of the date and time of the end of exposure.

IMPORTANT

Always stick the label such that the barcode is parallel to the axis of the tube: any other position will compromise the barcode automated reading by the optic reading device.

radiello maintenance

When exposed outdoors or in a workplace environment, the diffusive body may get dirty from airborne dust. Fine particles (PM₁₀) are especially harmful to yellow diffusive bodies since they can obstruct the pores. When the diffusive bodies are dirty you can wash them as explained in the following.

Immerse the diffusive bodies in a beaker with a soapy solution (e.g. dish detergent) and sonicate them for 20 minutes. As the diffusive bodies float, you may make them sink by putting a smaller beaker on them, with water inside enough to dip it a few centimeters.

Rinse the diffusive bodies with plenty of water and then deionized water, let them finally dry in the air.

IMPORTANT: NEVER USE SOLVENTS TO CLEAN THE DIFFUSIVE BODIES!!!

After four or five washings, diffusive bodies need replacing: repeatedly adsorbed dust may have penetrated the pores such deeply to be undisturbed by washing.

The following table shows the advised washing schedule:

PM ₁₀ concentration (µg.m ⁻³)	<30	40	>50
Washing after days of exposure	45	30	15



radiello-ready-to-use

The ready-to-use version may be advantageous when you do not have plenty of time to assemble all of the components on field. It can be purchased as it is or in separate parts to be assembled by the customer.

In the **as-it-is version** the adsorbing cartridge is already contained in a diffusive body closed with a polycarbonate screw-thread cap. The whole is closed in a polypropylene airtight container. Just before use draw the diffusive body out of the container and fit it to the special snapping vertical adapter fixed to the supporting plate. After the end of exposure, the diffusive body with its content is placed again in the polypropylene airtight container to be shipped to the laboratory for analysis.

The **ready-to-use as-it-is radiello** (polycarbonate cap, glass or plastic tube, special vertical adapter, barcode label and polypropylene container comprised for each type) is available for the sampling of the following compounds:

codice	campionamento di	contains
123-1	VOCs	white diffusive body and cartridge code 130
123-3	NO ₂ , SO ₂ and HF	blue diffusive body and cartridge code 166
123-5	ozone	blue diffusive body and cartridge code 172
123-6	hydrogen sulfide	blue diffusive body and cartridge code 170
123-7	ammonia	blue diffusive body and cartridge code 168
123-8	HCl	white diffusive body and cartridge code 169

IMPORTANT: in the **ready-to-use** version
the supporting plate is not provided.

If you prefer **to assemble it by yourselves**, you should order:

- ✓ diffusive bodies (of the required type, see following chapters)
- ✓ adsorbing cartridges (of the required type, see following chapters)
- ✓ polycarbonate caps, **code 124-1**
- ✓ special snapping adapters, **code 122-1**
- ✓ polypropylene containers, **code 124-2**
- ✓ supporting plates, **code 121.**

on top:
to the right, **radiello-ready-to-use**

to the left, the diffusive body with the polycarbonate cap and the adsorbing cartridge inside

in the center: the special snapping

adapter

near here: the supporting plate with the vertical snapping adapter

user tip

the **read-to-use** version of **radiello** is very useful in the workplace sampling campaigns but is not advised if very low concentrations in outdoor or domestic environments are to be measured

