ENVIRONMENTAL EARTH SCIENCES
THE KNOW AND THE HOW

PROJECT NO. **210074**

INDOOR AMBIENT AIR VAPOUR INVESTIGATION AT FORMER SOUTH MELBOURNE GASWORKS

ENVIRONMENTAL EARTH SCIENCES VIC
REPORT TO CITY OF PORT PHILLIP
NOVEMBER 2012
VERSION 2

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EXECUTIVE SUMMARY

Environmental Earth Sciences VIC was requested by City of Port Phillip to be the assessor in support of a Section 53V Environmental Audit of the former South Melbourne Gasworks ("the site"). The site operated as a gasworks from 1873 to 1955, with some aspects remaining functional until 1971. The site was redeveloped and the majority has been used as a recreational reserve (Gasworks Park) since the 1980's by the City of Port Phillip with one corner being occupied by the South Port Nursing Home.

Environmental Earth Sciences has undertaken vapour sampling of ambient indoor air in buildings at Gasworks Park and South Port Nursing Home. The aim was to assess the potential for vapour intrusion into buildings on-site from buried gasworks waste. Works were conducted in accordance with a Sampling and Analysis Plan (SAP), which was developed and approved through discussions with the Environmental Auditor, Peter Nadebaum (GHD Pty Ltd). The scope of works consisted of:

- site inspection to evaluate building characteristics that might influence vapour sampling and potential cross contaminating indoor sources of vapours;
- two rounds of indoor ambient air sampling events, using USEPA Method TO-15, in winter and summer seasonal conditions including:
    - a total of 13 sampling locations in Gasworks Park (including an outdoor background sample) and two in South Port Nursing Home (including one in the kitchen and one in west wing room 3 [during round 1 winter sampling], and one in the kitchen and one in west wing room 1 [during round 2 summer sampling]);
    - samples were collected via passivated summa canisters over either an 8-hour (Gasworks Park) or 24-hour period (South Port Nursing Home); and
    - site specific meteorological conditions were monitored using a mobile weather station during sampling.
- laboratory analysis of samples for USEPA TO15 comprehensive 84 Component Suite; and
- comparison of laboratory results against published initial screening criteria and production of this report.

Detectable concentrations of vapours measured at the site by Environmental Earth Sciences were low and appear largely due to indoor cross contaminating sources noted to be within the building such as paints, solvents, thinners, glues, resins etc. Only benzene, naphthalene and trimethylbenzene concentrations in three separate locations exceeded initial screening criteria, and only benzene exceeded the exposure adjusted criteria. Environmental Earth Sciences consider that the concentrations are attributable to indoor sources rather than from as a result of gasworks waste at the site.

The vapour intrusion exposure pathway appears to be mitigated by the following factors:

- building design, including ventilation, building height and subsurface penetrations;
- radial flow of impacted groundwater outwards away from buildings due to drawdown from sewers;
- the low likelihood of gasworks waste buried in soil beneath or in close proximity to original gasworks buildings; and
- natural site setting with depth to groundwater greater than 7m in sandy clay soils.

Based on the results of this assessment, Environmental Earth Sciences consider that any sub-surface vapour intrusion at the site appears to be negligible and unlikely to result in a chronic unacceptable health risk to building users. On this basis, remedial options and / or management systems are not considered necessary at this time to manage vapour intrusion into site buildings. This conclusion is provisional upon site land use and buildings remaining unaltered.

This executive summary must be read in conjunction with the whole of the report proper. Limitations and assumptions used to reach the conclusions contained within the report and have not been included in this executive summary. This report must be read in conjunction with the attached "Environmental Earth Sciences General Limitations".

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1 INTRODUCTION

The site was formerly the manufacturing area of the South Melbourne Gasworks (SMG), and operated from 1871 to 1965, with some aspects remaining functional until 1971. The site was redeveloped and the majority has been used as an open space recreational reserve since the 1980's by the City of Port Phillip (CoPP) with one corner being occupied by the South Port Nursing Home.

The site is currently managed in accordance with two Interim Contamination Management Plans (ICMPs); one applicable to the South Port Nursing Home and the other to the Gasworks Park. The ICMPs are subject to changes and amendments pending further investigation, remediation and/or management.

The site is currently undergoing a two stage 53V audit commissioned by the CoPP to assess the potential risk of harm posed by the site. The first stage of the 53V audit was undertaken by Dr. Peter Nadebaum of GHD in December 2008 and involved undertaking a '*preliminary assessment of available information regarding risks associated with groundwater and soil contamination to determine what further investigation and remediation works would be required to complete the audit*'.

The findings of the first stage were documented in a report developed by GHD "*Section 53V Environmental Audit – Interim Report*" (2008). As detailed in the audit report, further environmental investigation and monitoring works are required to address the higher risk issues identified at the site, determine requirements for remediation and the sites suitability for future land uses. One of the issues identified by the Auditor as requiring further assessment was potential for vapour intrusion into buildings on-site from gasworks waste.

Environmental Earth Sciences prepared a scope and methodology for environmental investigational works at the former SMG in accordance with information provided within the tender document Sections 3.1 to 3.4 (*Specification*), and in reference to the Auditor's comments detailed in the Interim Audit Report (December 2008).

This scope and methodology was refined once a detailed review of existing site environmental reports was undertaken. The development of a Sampling and Analysis Plan (SAP) was finalised following extensive discussions with GHD.

The work reported upon in this document has been undertaken in accordance with discussion between Environmental Earth Sciences, the Environmental Auditor and the CoPP.

2 OBJECTIVE

The objective of this indoor ambient air investigation was to provide a direct assessment of the potential health risks from vapour intrusion to existing building users of the South Port Nursing Home and Gasworks Park.

3 SITE IDENTIFICATION

3.1 Site location

The site is currently owned by CoPP in conjunction with the State of Victoria. CoPP currently operate as the 'Committee of Management' for the site. The site is situated in Albert Park and is bounded by: Graham Street to the south; Pickles Street to the west; Richardson Street to the north; and Foote Street / Bridport Street to the east (refer to Figure 1 and Figure 2).

The site covers an area of 3.43 hectares (ha) and includes Gasworks Park and South Port Nursing Home.

3.2 Site history

The site operated as a gasworks from 1873 with a short period of closure during the depression, from which some sections of the plant never reopened. Gas manufacture, continued up until 1971 with the Gas and Fuel Corporation of Victoria becoming the registered proprietor of all properties on-site in 1955.

The City of South Melbourne and Government of Victoria acquired the manufacturing plant in 1979, capping the site and redeveloping it into Gasworks Park. Gas and Fuel Corporation of Victoria still operate a small depot in the northern corner of the former gasworks site (i.e. Alinta site), however this is not part of the area under investigation. South Port Nursing Home was constructed on city owned land to the northeast of the site in 1981.

For further detail regarding site history please refer to Environmental Earth Sciences (2011b).

3.3 Current site uses

Gasworks Park incorporates 2.67 ha of the site, consisting of grassed and landscaped areas, playground, BBQ facilities and small wetlands, all linked by gravel access tracks. A number of community based events are held within the grounds of Gasworks Park including monthly farmer's market, dog training, school holiday activity programs and private and public functions.

Eleven buildings exist within the Gasworks Park, including historic gasworks buildings retained as part of the site redevelopment and a few buildings, including administration buildings have been constructed since the redevelopment. Current buildings within Gasworks Park are detailed below and locations are provided in Figure 2:

- Gasworks Park Building 1 – *Main Theatre and Foyer;*
- Gasworks Park Building 2 –*Theatre Workshop;*
- Gasworks Park Building 3 – *Theatre Rehearsal Room;*
- Gasworks Park Building 4 – *Gasworks Administration Offices;*
- Gasworks Park Building 5 – *Café;*
- Gasworks Park Building 6 – *Theatre Dressing Room;*
- Gasworks Park Building 7 – *Gatehouse Building;*

- Gasworks Park Building 8 – *Visual Arts Studio 3 (also known as the Garden Studio);*
- Gasworks Park Building 9 – *Visual Arts Studio 1;*
- Gasworks Park Building 10 – *Ceramics Studio;*
- Gasworks Park Building 11 – *Arts and Craft Studio; and*
- Gasworks Park Building 12 - *Sculpture Studio.*

The South Port Nursing Home site covers an area of 0.54 ha and is situated in the east corner of the former SMG (refer to Figure 2). The South Port Nursing Home occupies the majority of the South Port Site (fronting Richardson Street) and includes a brick building (i.e. nursing home), open space grassed and paved areas and landscaped gardens.

The South Melbourne Gas Regulator site (i.e. Alinta Site) covers an area of 0.22 ha, is situated on the corner of Pickles and Richardson Streets and is not included within the investigational area. This area is covered by bitumen hard stand while a brick building occupies the northern portion of the site, which was a historical part of the original SMG infrastructure. The building housed the regulator station, which controlled pressure in the gas distribution pipes.

The total area of investigation including the Gasworks Park South Port Nursing Home is 3.21 ha.

3.4 Proposed future land use

The CoPP has advised that the future land use of Gasworks Park is likely to remain '*Open Space Parkland'*, and the South Port Nursing Home site is to remain a community nursing home, but may be developed into another community use sometime in the future.

4 REGIONAL SETTING

4.1 Surrounding area features

SMG is surrounded by low density residential housing to the north and northeast to east across Richardson and Bridgeport Streets. High density residential units are present across Pickles Street to the west, while to the south high density resident units are currently under construction.

4.2 Climate

The Melbourne region experiences a Mediterranean climate with cool wet winters and hot dry summers. The nearest long-term operating weather station to the site is the Melbourne regional office (station 086071) which commenced recordings in 1855 and is located approximately 2.7km north of the site (BOM, 2012a). A summary of the mean climate observations for the Melbourne region have been presented in Table 1 below.

A review of meteorological observations for the period from 1981 to 2011 for the Melbourne Regional weather station (BOM, 2012a) indicated variable annual rainfall between 360mm and 844mm with an average annual rainfall of 603mm. This variability is in part due to a drought in Victoria between 2001 and 2009 with annual rainfall varying between 397mm and

622mm with an average of 451mm. This is 189mm less than the average rainfall prior to the drought. In addition annual minimum and maximum temperatures increased by approximately 1°C during the drought compared to pre-drought conditions.

TABLE 1 MEAN CLIMATE OBSERVATIONS FOR THE MELBOURNE REGION

Item	Mean Minimum	Mean Maximum	Annual Average	July[1]	January[1]	February[1]
Minimum temperature	6.0 °C (July)	14.6 °C (February)	10.2 °C	6.0 °C	14.3 °C	14.6 °C
Maximum temperature	13.5°C (July)	25.9 °C (January)	19.9 °C	13.5°C	25.9 °C	25.8 °C
Cumulative monthly rainfall	47.5 mm (July)	66.4 mm (October)	650.0 mm	47.5 mm	47.6 mm	48.0 mm
Number of clear days	2.5 days (June)	6.2 days (February)	48.6 days	2.6 days	6.1 days	6.2 days
Number of cloudy days	9.7 days (February)	18.1 days (May)	179.4 days	17.3 days	11.2 days	9.7 days
Wind speed at 9am	8.7 km/h (April)	12.6 km/h (October)	10.4 km/h	10.4 km/h	10.0 km/h	9.1 km/hr
Wind speed at 3pm	12.5 km/h (May)	15.8 km/h (September)	14.2 km/h	14.1 km/h	14.8 km/h	14.3 km/h
Relative humidity at 9am	62.0% (Oct &Dec)	80.0 % (June)	69.0 %	79 %	63 %	66 %
Relative humidity at 3pm	47.0 % (Jan& Dec)	63.0 % (June)	53.0 %	61.0 %	47.0 %	48.0 %

Note(s):

1. July, January and February averages have been presented as these were the months during which the vapour monitoring was undertaken.

There is a clear indication of the drought breaking between 2009 and 2010 with annual rainfall increasing from 465mm to 780mm. Annual rainfall was recorded as 832mm in 2011. Since the breaking of the drought a number of unseasonal weather phenomena have been documented including:

- widespread, heavy and persistent rainfall was recorded across southeast Australia between 27 February and 5 March 2012 (BOM, 2012b);
- on 11th January, and into the morning of the 12th January 2012, southeast Australia experienced very cold temperatures for January (BOM, 2012c);
- Victoria experiencing unprecedented warm weather in early August 2011 (noting that late June/early July is typically the coldest time of year in southeast Australia) (BOM, 2011a); and
- extreme rainfall across the Melbourne Metropolitan area, between the 4 and 6 February 2011. Daily rainfall totals between 100 and 200mm was widespread in the eastern and southeastern suburbs of Melbourne and was the equivalent of what most stations would usually observe in an entire summer season (BOM, 2011b).

4.3 Topography

Surface topography at the site is relatively flat, sloping slightly from east to west. Regionally, land slopes towards Port Phillip Bay. Recorded site surface elevations range from 2.105 to 2.670 metres Australian Height Datum (mAHD). Site surface topography is defined by fill material and does not represent natural conditions.

There is a regional gentle slope towards Port Phillip Bay located approximately 350m south of the site (Figure 1), which is the nearest surface water body to the site.

4.4 Geology

According to the Geological Survey of Victoria (GSV 1974) *Melbourne 1:63,360 map sheet*, outcropping geology beneath the site is the Recent Holocene aged (0 to 10,000 years old) Port Melbourne Sand (PMS), consisting of raised beach ridges of well sorted sand, shelly sand, minor silty or clayey sand. The PMS discontinuously underlies the fill material, and has been identified in lenses up to 2.6m thick in the southern portion of Gasworks Park.

Regionally, the PMS is underlain by Pliocene age (late Tertiary – 5.3 million years old [MYO] to 1.8MYO) Brighton Group sediments, consisting of red-brown, yellow and white cross-bedded sands and silty sands (with clay). Where PMS does not exist on the site, the fill material directly overlies the Brighton Group sediments.

4.5 Soil

The soils of the local area are described in van de Graaff (1996) as comprising dark loams, clays and local sands. These features are consistent with the local geology as described above, being PMS sands and silty/clayey sands. Previous site investigations have confirmed the natural soils on-site to consist of sands, clayey sands and sandy clays.

4.6 Hydrogeology

Interpretation from previous groundwater investigations and monitoring events has identified several potential aquifer units on-site. Groundwater flow systems are likely to be present in the following geological units:

- although the PMS may be a water bearing zone, it is not considered to constitute an aquifer beneath the site due to its limited capacity to store and transmit water caused by its shallow intermittent distribution;
- Brighton Group sediments, considered to contain the watertable aquifer beneath the site, located between seven and nine metres below ground surface (mgbs); and
- Dargile Formation, which forms the basement aquifer/ aquitard beneath most of Melbourne.

Groundwater flow within the Brighton Group sediments has been confirmed as being controlled by the local sewer system which borders the site on three sides, with all groundwater from the watertable aquifer beneath the site ultimately discharging to the sewers (Environmental Earth Sciences 2011a).

5 IDENTIFIED CHEMICALS OF POTENTIAL CONCERN

A number of environmental investigations have been conducted previously at both South Port Nursing Home and Gasworks Park and have identified impacts from buried gasworks waste in both in soil and groundwater. Volatile and semi-volatile contaminants of potential concern (CoPC) identified on-site from gasworks waste with the potential to generate vapour include:

- polycyclic aromatic hydrocarbons (PAHs), particularly the volatile naphthalene;
- monocyclic aromatic hydrocarbons (MAHs), including benzene, toluene, ethylbenzene and xylene;
- volatile fraction of total petroleum hydrocarbons (TPH) (C_6-C_{16}); and
- phenolic compounds.

6 DATA QUALITY OBJECTIVES

The aim of quality assurance and quality control (QA/QC) is to deliver data that is:

- representative of what is sampled;
- precise;
- accurate; and
- reproducible.

Development of data quality objectives (DQOs) for each project is a requirement of the *National environment protection (assessment of site contamination) measure* (NEPC 1999). This is based on a DQO process formulated by the USEPA for contaminated land assessment and remediation. This has not been formally adopted by EPA Victoria or the contaminated land industry; however, it provides sound guidance for a consistent approach in understanding site assessment and remediation. The DQOs are defined in a series of seven steps as outlined in Appendix C.

Further discussion on the QAQC protocols and outcome are presented in Section 12 and Appendix C of this report.

7 IDENTIFIED RECEPTORS AND EXPOSURE PATHWAYS

Previous environmental works have identified volatile CoPCs in soil and groundwater, which have the potential to partition into the air in the vadose zone and can move as vapour into buildings, ambient air, confined spaces or excavations on-site. Note that historical soil and groundwater concentrations reported at the site are not indicative of those which could result in acute health risks or explosive risk. Volatilisation of CoPCs from secondary sources (i.e.

soil and groundwater) has the potential to impact upon site receptors through the inhalation of vapour.

Vapour poses a risk when it is able to concentrate within areas where there is an impediment to surficial venting such as excavations and maintenance trench and beneath buildings. On this basis, vapour intrusion to on-site buildings is considered to be a potentially complete exposure pathway (note that potential exposures to on-site sub-surface workers is outside the scope of this assessment).

Vapour emission in open spaces areas is able to dissipate and so diminish the potential for emissions which could result in a chronic health risk. As such, these areas present a negligible exposure pathway for vapour inhalation and have therefore have not been assessed further.

Groundwater impacted with volatile organic CoPCs is generally not migrating off-site due to groundwater discharge to encircling sewers (Section 4.6). Volatile organic CoPCs in groundwater are not complete captured by the Richardson Street sewer resulting in a small plume of organic CoPC beneath approximately 17 residences off the eastern corner of the site (detected in groundwater monitoring wells GW07,GW08, GW37 and GW38). It is concluded that this impacted groundwater is later captured by the Bridport Sewer as the groundwater migrates south (Environmental Earth Sciences 2011a).

The concentrations of volatile CoPCs in this off-site plume are considered low enough that they do not pose a risk of vapour intrusion in these residences, according to CRC CARE Technical Report no. 10 (Friebel and Nadebaum, 2011). Therefore off-site receptors are not considered further in this assessment.

Given the site location and setting, along with the current and proposed future use, potentially complete exposure pathways considered in this assessment are presented below:

- recreational park users (adults and children) who occupy the Gasworks Park buildings and/or visitors to the South Port Nursing Home;
- commercial workers in the Gasworks Park buildings or South Port Nursing Home; and
- aged-care residents of the South Port Nursing Home.

Based on the potentially complete exposure scenarios list above, the most sensitive human receptor is considered to be an occupant of the South Port Nursing Home given the likely extended exposure time (up to 24 hours per day).

8 SAMPLING AND ANALYSIS PLAN

A SAP was developed by Environmental Earth Sciences to assess these identified exposure pathways and receptors. All sampling locations, methods and laboratory analysis were approved by the Environmental Auditor, Peter Nadebaum (GHD Pty Ltd), prior to the commencement of field works through the following documents:

- Environmental Earth Sciences, 2010. Report number 210074 - *'Sampling and analysis plan for the former South Melbourne Gasworks, Albert Park, Victoria'*;
- GHD 31/26548/189319Letter '*Gasworks Site Environmental Audit Sampling and Analysis Plan*', dated 10 November 2010;

- SAP discussion between Environmental Earth Sciences, CoPP and GHD on 2 December 2010
- Environmental Earth Sciences, Letter 210074L2 - '*Revised vapour intrusion investigation sampling and analysis plan for the South Melbourne Gasworks, Albert Park, Victoria*' dated 4 January 2011;
- GHD 31/26548/191401Letter '*Gasworks Site Environmental Audit Sampling and Analysis Plan*', dated 12 January 2011;
- Environmental Earth Sciences, Letter 210074L5 – '*Response to auditor's comments regarding the revised vapour SAP for the former South Melbourne Gasworks, Albert Park, Victoria'* dated 28 January 2011;
- site walkover and designation of sampling locations with the Environmental Auditor, Peter Nadebaum on 6 June 2011; and
- correspondence (*via-email*) with the Audit team between 12-15 July 2011.

8.1 Sample location selection

The rationale behind the selection of sampling locations is based on identified exposure pathways and receptors, and minimising potential cross contaminating indoor sources. Site inspections were undertaken to assess building design and identify potential cross contaminating sources located within buildings. Based on the site inspection, sampling locations were finalised to account for:

- building design;
- ventilation;
- access; and
- potential indoor cross contaminating sources.

Inspection checklists, adopted from Appendix E of Oregon DEQ, (2010) *Guidance for assessing and remediating vapour intrusion in buildings,* are located in Appendix A of this report.

All efforts were made to remove or distance potential contamination sources from sampling locations and minimise ventilation of buildings. The following potential sampling locations were discarded after the site inspection as they were determined as not being amenable to sampling due to potential indoor contaminating sources or access issues:

- substation (low exposure risk and physical access constraints); and
- darkroom studio (painted immediately prior to sampling Round 1).

The proposed substation sample was reallocated to the theatre dressing room, and the darkroom studio sample was reallocated to the theatre stage and performance area. This location was selected as performers may spend some time in there for rehearsals and performances.

The following locations were also excluded from the investigation due to a low-risk of exposure from short occupancy duration:

- ticket sales office and bar area has low exposure risk of two to three hours on performance nights only;

- Angela Roberts – Bird gallery has low exposure risk as site users are only in the room for 30 minutes to one hour at a time; and
- theatre foyer / gallery is low exposure risk, as site users are not confined to this area for any extent of time.

To assess potential cross contamination from external ambient air, the SAP included a background sample located outside in the southeastern corner of the site. This location was selected as it is upwind to the site for the prevailing coastal winds which travel north from the coast across the site.

8.2 Sampling conditions and methodology

The sampling methodology selected was time-integrate low-flow active sampling of ambient air. This methodology was chosen as time-integrated sampling reduces the potential for bias and can provide a relatively direct assessment of the potential risks to occupants or receptors identified in Section 6.

Key limitation of any ambient sampling methodology is the potential for other sources of the CoPC to be located within the building or to occur from background off-site sources. Measures to eliminate or monitor these potential effects have been included in this investigation including:

- sample location selection (as discussed in Section 8.2.1);
- collection of QC samples including a background sample and a field duplicate sample; and
- reduction of the potential for cross contamination between sampling events by decontaminating and cleaning sampling equipment by ALS.

8.3 Laboratory analysis

Laboratory analysis of 84 volatile compounds was undertaken by Australian Laboratory Services (ALS), who are National Association of Testing Authorities (NATA) accredited for analysis of volatile organic compounds (VOCs) in air (USEPA Air Toxics methods TO15)]. Methods USEPA TO14 and/or TO15 are recommended in the National Environment Protection (Air Toxics) Measure (NEPM) for Benzene, Toluene & Xylenes for ambient air, ALS methods comply with this NEPM (NEPC, 2004).

9 FIELD INVESTIGATION

The investigation was conducted in general accordance with:

- NSW Government Department Environment Climate Change and Water (DECCW), 2010, *Vapour intrusion: Technical practice note*;
- Oregon Department of Environmental Quality (DEQ), 2010, *Guidance for assessing and remediating vapour intrusion in buildings*, State of Oregon Department of Environmental Quality;
- National Environment Protection Council (NEPC), 2010, *Draft National Environment Protection (Assessment of Site Contamination) Measure (NEPM)*;

- ITRC (Interstate Technology and Regulatory Council), 2007, *Vapour Intrusion Pathway: A Practical Guideline*. (VI-1). Washington, D.C.: Interstate Technology and Regulatory Council, Vapour Intrusion Team. www.itrcweb.org;
- ITRC (Interstate Technology and Regulatory Council), 2007, *Vapour Intrusion Pathway: Investigative Approaches for Typical Scenarios*. (VI-1A). Washington, D.C.: Interstate Technology and Regulatory Council, Vapour Intrusion Team. www.itrcweb.org;
- DTSC (Department of Toxic Substances Control), 2011, *Guidance for the evaluation and mitigation of subsurface vapour intrusion to indoor air (Final Guidance)*. California Environmental Protection Agency;
- Victorian Government Gazette, 2001, State Environment Protection Policy (SEPP) *Air Quality Management*. No. S240, Gazette 21/12/2001; and
- other relevant Victorian guidelines and legislation.

9.1 Site inspection

Site inspections of the Gaswork Park and South Port Nursing home buildings were undertaken individually by Environmental Earth Sciences field staff on 18 and 26 May 2011. A final site inspection was then undertaken by Environmental Earth Sciences field staff in conjunction with the Environmental Auditor, Peter Naddebaum, Auditor's assistant Kate Fairway of GHD, and Darren Pendergast of the CoPP on 6 June 2011.

These inspections were undertaken to evaluate the building characteristics that might influence vapour sampling such as physical layout, building use, building material, ventilation and condition. Additionally, potential indoor sources of vapour that may affect or interfere with the proposed sampling were identified, and where possible, relocated away from sampling locations immediately prior to sampling (although remaining within the building). The field observations were logged on forms sourced from Appendix E of Oregon DEQ, (2010). The completed forms are located in Appendix A of this report. Potential indoor sources of vapours that were noted included:

- new carpet in the administration offices four weeks prior to Round 1;
- recent painting of the indoor surfaces:
    - within the theatre/administration complex four weeks prior to Round 1;
    - darkroom studio immediately prior to Round 1;
    - gatehouse building two weeks prior to Round 2; and
    - reception area in administration offices prior to Round 2.
- commercial building paints such;
- artistic acrylic, oil-based and water-based paints;
- solvents and thinners including but not limited to acetone, turpentine, methylated spirits and ethanol;
- acetylene canisters for oxyacetylene welding;
- gas heaters and wood-fire heaters;
- variety of artistic and industrial glues such as adhesive spray, grip adhesive and PVA glues;
- copier / printer with toner and printer cartridges;

- cleaning products including bleach and disinfectants; and
- various other chemicals including metal primers (penetrol), citronella, smoke fluid, resins, varnish; enamels and plumb-weld PVC plumbing fluid.

As detailed in Section 3.2, all existing buildings investigated were historic gasworks buildings retained as part of the site redevelopment, with the exception of the administration offices and the South Port Nursing Home buildings.

Buildings were generally noted as being constructed slab on grade with either wooden floors or carpet as a covering layer and brick walls. Buildings were all single level without any basements, with the exception of the gatehouse building which had an open plan mezzanine level. Most original Gasworks buildings were also noted to have air vents at the top of the buildings.

The following buildings were noted as having portions open to outdoor air i.e. well ventilated and subject to outdoor ambient air influences:

- ceramics studio;
- theatre workshop; and
- café (during summer the café is opened up).

9.2 Vapour sampling

9.2.1 Frequency and environmental condition during sampling

Two ambient air sampling events were undertaken during different seasonal conditions including:

- Round 1- cloudy skies and low temperatures (winter conditions) between 17-19 July 2011; and
- Round 2 - clear skies and high temperatures (summer conditions) between 29 January and 01 February 2012.

To obtain maximum concentrations in the Gasworks Park building ventilation was reduced by closing windows and doors, turning off any heating/cooling and sampling over the weekend when buildings were largely unoccupied. Access to South Port Nursing Home was only available during weekdays, therefore sampling was undertaken separately on the Monday immediately after sampling in Gasworks Park. Unfortunately due to incorrect sampling equipment being provided by the laboratory, sampling of South Port Nursing Home was delayed by one day in the sampling Round 2.

SouthPort Nursing home is fully occupied by residents and carers every day of the week and the common area is kept at a constant temperature of 21^{o}C, although the bedrooms each have their own heater. Sampling was undertaken in a vacant bedroom with the windows and door closed to reduce ventilation and chance of interference by residents.

To monitor site-specific weather conditions, an Envirodata Weathermaster 2000 monitoring station was set-up in the southeast corner of the site (adjacent to the background ambient sample) during sampling of Gasworks Park buildings. The weather station was then established in the garden of South Port Nursing Home during sampling of this building. The weather station recorded, temperature, wind speed and direction, relative humidity, precipitation and evaporation. As it did not record barometric pressure mean sea level

pressure data was obtained from the Bureau of Meteorology for the Melbourne station (BOM, 2012).

The weather data recorded by the mobile station and data obtained from the Bureau of Meteorology confirms that weather during both rounds of sampling conformed with the required cloudy skies and low temperatures (winter conditions) or clear skies and high temperatures (summer conditions). A cool change came through between sampling of Gasworks Park and South Port Nursing Home in sampling Round 2, hence conditions were not optimal although considered by Environmental Earth Sciences to be acceptable for the purposes of this assessment (the controlled internal climate of the nursing home remained constant during sampling and so barometric fluctuations are expected to represent negligible bias).

A summary of the weather data collected during both rounds of sampling is presented in Table 2 with the full data sets presented in Appendix D.

TABLE 2 SITE SPECIFIC WEATHER STATION DATA

Weather Parameters over sampling period	Round 1		Round 2	
	Gasworks Park[1]	SouthPort[2]	Gasworks Park[3]	SouthPort[4]
Temperature (°C)	11.3-14.8	10.0-15.0	23.5-31.2	12.0-24.1
Wind speed (km/hr)	0- 6.1	0-2.8	1.4-5.00	0-7.4
Avg. wind direction	NE changing to NW	NW swinging E at 4pm and then mostly S. at 9pm	Mostly South swinging between SW and SE	Mostly SE, swinging between SW and SE
Relative humidity (%)	60.5-74.7	53.6-96.1	38.9-62.8	42.6-74.9
Total rainfall (mm)	2.8	1.6	0	12.6
Total evaporation (mm)	0.542	0.755	2.3	5.1
Barometric pressure (hPa)[3]	Started at 1030 & steadily fell to 1023.7	Started at 1020.4 & steadily fell to 1015.7[4]	Started at 1006.3 & steadily fell to 997.6	Started at 1016 & increased to 1018.4 (10.00pm) before falling to 1015

Note(s):

1. data collected from between 8.30am-5.30pm on 17 July 2011;
2. data collected from between 8.30am on 18 July 2011 to 6.30am on 19 July 2011;
3. data collected from between 9.00am-6.00pm on 29 January 2012;
4. data collected from between 1.30pm on 31 January 2012 to 1.00pm on 1 February 2012;
5. data obtained from the Mean Sea Level Pressure from Bureau of Meteorology; and
6. Ppressure increased slightly from 1015.7 hPa to 1017.2 hPa for the final four hours of sampling – 4.30am-8.30 am on 18 July 2011;

The weather station continuously logged data even when dismantled resulting in some unnecessary measurements. Therefore the relevant time periods when the station was set-up and recording reliable data include:

- Gasworks Park Round 1 - between 8.30am-5.30pm on 17 July 2011;
- South Port Nursing Home Round 1 – between 8.30am on 18 July 2011 to 6.30am on 19 July 2011;

- Gasworks Park Round 2 - between 9.00am-6.00pm on 29 January 2012;
- South Port Nursing Home Round 2 – between 1.30pm on 31 January 2012 to 1.00pm on 1 February 2012.

9.2.2 Sample locations, position and duration of sampling

A total of 13 sampling locations were selected in Gasworks Park and two in South Port Nursing Home, which are presented on Figure 2 and include:

- background sampling location (outside, up-wind in the south east corner of Graham and Foote Streets);
- café;
- theatre;
- theatre rehearsal room;
- theatre workshop;
- theatre dressing room;
- administration office;
- gatehouse building (used as site office/tea room for off-site construction works during Round 1 sampling, vacant for Round 2 sampling);
- arts and craft studio;
- sculpture studio;
- ceramic studio;
- visual arts studio 1 and Garden Studio (Visual Arts studio 3) (2 samples); and
- SouthPort Nursing home (2 samples - one in kitchen/communal living area and one in either the west wing bedroom 3 or west wing bedroom 1).

Sampling ports within Gasworks Park buildings were positioned in the centre of the most highly occupied room, in the lowest level (i.e. ground floor; nearly all buildings were only one storey) within the '*breathing zone'*, approximately 1.0 to 1.5 metres above floor level of each building.

One sampling location within South Port Nursing Home was positioned within the kitchen of the open plan communal area within the '*breathing zone'*. The second sampling location was positioned at 30-50 cm above the head end of a bed in a vacant room. In sampling Round 1 the bedroom available was Room 3 in the West Wing, in sampling Round 2 the bedroom was Room 1 in the West Wing.

Most potential indoor cross contaminating sources were not allowed to be removed from the buildings, however, they were re-located as far from the sampling ports as practicable prior to sampling and re-instated post-sampling. To assess potential outdoor cross contaminating sources a background sample was attached to the weather station at approximately 1.5 m height in the south east corner of the site.

Samples within Gasworks Park buildings were collected over an 8 hour period, corresponding to an average exposure across a normal working day. Samples within South Port Nursing Home were collected over a 24 hour period (corresponding to an average exposure for a day).

9.2.3 Sampling methodology and analytical schedule

The sampling methodology selected was USEPA Method TO-15, which involves sampling of ambient air over a defined period of time. Vapour samples were collected via SUMMA® canisters, which are a stainless steel vacuum vessel. The canister interior is electro-polished and chemically deactivated, creating a chemically inert surface. Canisters are completely evacuated into a vacuum prior to use, allowing the negative pressure to draw air in. Canisters are evacuated by the laboratory to a vacuum pressure of approximately 30 inches Hg, however, the canister loses vacuum during storage therefore is less than 30 inches Hg in the field. Flow controllers, calibrated in the laboratory, were sent with the canisters to allow the canisters to collect the samples over a set time period. Calibration certificates are presented in Appendix C.

The pre-set flow controller (i.e. 8- or 24-hour) was fitted to the canisters prior to sampling. Start time and vacuum gauge reading was recorded prior to deployment in the field. Flow-rates and vacuum gauge readings were monitored for the duration of sampling for samples in Gasworks Park. Field observations confirm that the volume of air sampled was a linear function of the canister vacuum (i.e. the canister should have half the initial vacuum remaining mid-way through sampling). This monitoring was not possible in South Port Nursing Home due to access issues.

At the conclusion of the proposed sampling period, the sample port was closed, final vacuum pressure recorded and canisters couriered to ALS for analysis for VOCs. Samples were extracted from the canisters and analysed for the USEPA TO15 comprehensive 84 component Suite.

9.2.4 Field observations during sampling

As the resident artists had individual access to their respective studios and South Port Nursing Home is operational at all times access to the site buildings could not be completely controlled. Therefore a few of the sampling locations were accessed as follows:

- construction workers accessing the gatehouse building, which was being used as site offices/tearooms for off-site construction works during sampling Round 1;
- artist accessing sculpture studio and using spray-paint in sampling Round 1, however completed works outside studio when requested and kept all doors and windows closed;
- artist accessing sculpture studio and briefly (maximum of 30 minutes) welding using oxyacetylene torch during sampling Round 2, however all doors and windows were kept closed upon request;
- artist accessing visual arts studio 2 which is connected to visual arts studio 1 during sampling Round 2; and
- artist accessing ceramic studio for administrative reasons (no artistic work) for two one hour periods during sampling Round 2, however all doors and windows were kept closed when requested.

These activities may have influenced sampling conditions through increased ventilation and potential introduction of cross contaminating indoor/outdoor sources. As the sampling plan was designed to assess “worst case scenario”, even with potential interference the results are still valid, although potentially not as conservative as originally planned. Given that people accessing the buildings for artistic activities is one of the exposure scenarios listed in Section 6, these results may be more representative of actual site conditions.

During setting up of samples the following VOC odours were noted:

- odours from recently painted rooms were noted in gatehouse and reception area in administration offices in sampling Round 2; and
- odour from paints, thinners, solvents, resins, varnish, glues etc. in arts and craft studio, visual arts studio 1 and theatre workshop in both sampling rounds.

At the direction of the Auditor these locations were still sampled despite the potential for cross contamination from indoor sources.

10 APPLICATION OF RELEVANT GUIDELINES AND ADOPTED CRITERIA

10.1 SEPP (Prevention and Management of Contamination of Land)

The State Environment Protection Policy (SEPP) (2002) — *Prevention and Management of Contamination of Land* provides the framework for the protection of land and associated beneficial uses throughout Victoria. The policy allows for a consistent approach to the prevention of contamination of land and clean-up of polluted land in Victoria, and sets environmental quality indicators and objectives for each beneficial use. The SEPP defines certain land use categories and associated beneficial uses of land to be protected.

The beneficial uses of land to be protected are dependent on the proposed land use. The investigation process requires that site contamination to be assessed in the context of beneficial uses of soil that need to be protected.

Based on our discussions with CoPP, we understand that the future land-use of both Gasworks Park is likely to remain 'Recreation / Open Space', and the Southport Nursing home site is to remain a nursing home, classified as 'Sensitive Use – Other' under the SEPP (2002). Therefore, the relevant beneficial uses to be protected include:

- modified and highly modified ecosystems;
- human health;
- buildings and structures;
- aesthetics; and
- production of food, flora and fibre.

The relevant beneficial uses to be protected for vapour intrusion is human health, therefore aesthetics, ecosystems, buildings and production of food, flora and fibre are not considered in this report.
A protected beneficial use may not apply at a site where background concentrations of a substance are greater than the relevant guideline. Therefore, it is important to determine the concentrations of substances which occur naturally in the region of the site through collection and analysis of a background sample.

10.1.1 Human health

The various guidance documents adopted for sourcing indoor ambient air criteria include the following:

1. World Health Organization (WHO) Regional Publications, European Series, 2000, *Air quality guidelines for Europe.* No.91;
2. World Health Organization (WHO), International Programme on Chemical Safety (ICPS), 1997, *Xylenes. Environmental Health Criteria.* No. 190.;
3. World Health Organization (WHO) Regional Publications, European Series, 2010, *Guidelines for indoor air quality, selected pollutants*, Geneva;
4. Agency for Toxic Substances and Disease Registry (ATSDR), 1994;2005;2010 *Toxicological Profiles*, US Department of Health and Human Services, Atlanta, Georgia
5. United States Environmental Protection Agency (US EPA), *Toxicological Reviews in support of summary information on the Integrated Risk Information System (IRIS),* Office of Research and Development, National Centre for Environmental Assessment, Washington, DC;
6. California Environmental Protection Agency (CalEPA), *Regional Screening Level for Resident Air Supporting Table, April 2012*
7. Ministry of Environment (MoE), 2007, *Development of Ontario Air Standards for Trimethylbenzenes (1,2,3-Trimethylbenzene, 1,2,4- Trimethylbenzene and 1,3,5-Trimethylbenzene),* Ontario, Canada; and
8. Friebel, E, and Nadebaum, P., 2011, *Health screening levels for petroleum hydrocarbons in soil and groundwater . Part 1:Technical development document,* CRC CARE Technical Report no. 10, CRC for Contamination Assessment and Remediation of the Environment, Adelaide, Australia.

The initial screening criteria are presented in Table 3.

TABLE 3 INITIAL SCREENING CRITERIA

Analyte	Screening Criteria (µg/m^3)	Source
Benzene	1.7	WHO 2000, Air Quality Guidelines for Europe, Second Edition, European series No 91, World Health Organisation (WHO), Geneva
Toluene	5,000	USEPA 2005, Toxicological Review of Toluene in support of summary information on the Integrated Risk Information System (IRIS), United States Environmental Protection Agency (USPEA), Office of Research and Development, National Centre for Environmental Assessment, Washington Office, Washington, DC
Ethylbenzene	265	ATSDR 2010, Toxicological Profile for Ethylbenzene, Agency for Toxic Substances and Disease Registry (ATSDR), US Department of Health and Human Services, Atlanta, Georgia
Xylenes	870	WHO 1997, Xylenes, Environmental Health Criteria 190, International Programme on Chemical Safety (ICPS), World Health Organisation (WHO), Geneva
Acetone	30,000	ATSDR 1994, Toxicological Profile for Acetone, Agency for Toxic Substances and Disease Registry (ATSDR), US Department of Health and Human Services, Atlanta, Georgia

Analyte	Screening Criteria ($\mu g/m^3$)	Source
2-Butanone (MEK)	5,000	USEPA 2003, Toxicological Review of Methyl Ethyl Ketone (MEK) in support of summary information on the Integrated Risk Information System (IRIS), United States Environmental Protection Agency (USPEA), Office of Research and Development, National Centre for Environmental Assessment, Washington Office, Washington, DC
Cyclohexane	6,000	USEPA 2003, Toxicological Review of Cyclohexane in support of summary information on the Integrated Risk Information System (IRIS), United States Environmental Protection Agency (USPEA), Office of Research and Development, National Centre for Environmental Assessment, Washington Office, Washington, DC
Dibromochloromethane	Not established	ATSDR 2005, Toxicological Profile for Bromoform and Chlorodibromomethane, Agency for Toxic Substances and Disease Registry (ATSDR), US Department of Health and Human Services, Atlanta, Georgia
Dichloromethane	600	USEPA 2011, Toxicological Review of Dichloromethane in support of summary information on the Integrated Risk Information System (IRIS), United States Environmental Protection Agency (USPEA), Office of Research and Development, National Centre for Environmental Assessment, Washington Office, Washington, DC
Ethyl acetate / 4-Ethyltoluene / n-Heptane	Not established	No appropriate published criteria available.
Ethanol	100,000	CalEPA/OEHHA 1999, Health & Environmental Assessment of the Use of Ethanol as a Fuel Oxygenate, Volume V: Potential Health Risks of Ethanol in Gasoline, Lawrence Livermore National Laboratory
n-Hexane	700	USEPA 2005, Toxicological Review of n-Hexane in support of summary information on the Integrated Risk Information System (IRIS), United States Environmental Protection Agency (USPEA), Office of Research and Development, National Centre for Environmental Assessment, Washington Office, Washington, DC
Isopropyl alcohol	7,000	CalEPA 2012, Regional Screening Level for Resident Air Supporting Table, April 2012, California Environmental Protection Agency (CalEPA), Sacramento
Naphthalene	10	WHO 2010, WHO Guidelines for Indoor Air Quality, Selected Pollutants, World Health Organisation (WHO), Geneva
Propene	3,000	OSRTI 2012, Provisional Peer Reviewed Toxicity Values for Superfund (PPRTV), Office of Superfund Remediation and Technology Innovation (OSRTI), United States Environmental Protection Agency (USEPA), Washington DC
n-Propylbenzene	1,000	CalEPA 2012, Regional Screening Level for Resident Air Supporting Table, April 2012, California Environmental Protection Agency (CalEPA), Sacramento
Styrene	260	WHO 2000, Air Quality Guidelines for Europe, Second Edition, European series No 91, World Health Organisation (WHO), Geneva
Trimethylbenzene	220	MoE 2007, Development of Ontario Air Standards for Trimethylbenzenes (1,2,3-Trimethylbenzene, 1,2,4-Trimethylbenzene and 1,3,5-Trimethylbenzene, Ministry of Environment, Ontario, Canada

No reliable reference concentration was identified for the following analytes: ethyl acetate, 4-ethyltoluene and n-heptane. Whilst this assessment utilises chronic reference concentrations (RfC) as the exposure is environmental, a review of time-weighted-averages (TWAs) was conducted for these analytes to gain an understanding of the potential chronic toxicity of these chemicals.

No TWA could be determined for 4-ethyltoluene while the Occupational Safety & Health Administration (OSHA) noted threshold limit values (TLVs) of 1,468mg/m^3 and 2,086mg/m^3 for ethyl acetate and n-heptane, respectively. The reported concentrations of these analytes at the site is greater than five-orders-of-magnitude lower than the respective TWA. A general rule of thumb is that the reference concentration should be between two- to three-orders-of-magnitude lower than the TWA given the application of more conservative correlation factors for the protection of population health. On this basis, the absence of chronic human health screening criteria for these analytes is not considered to adversely affect the outcomes of this assessment.

10.1.2 Aesthetics (odour)

Odour threshold limits for this assessment were predominately sourced from either WHO sources (Environmental Health Criteria), toxicology publications as in the case of trimethylbenzene, or values published by the regulatory agencies including the OHSA in the United States. In the absence of published criteria from these sources, industry sources were utilised from reputable sources including 3M who supply respirators, and Air Liquide via material safety data sheets (MSDS) as specialist gas manufacturers.

The odour screening criteria adopted in this assessment are presented in Table 4.

TABLE 4 ODOUR THRESHOLD LIMITS

Analyte	Screening Criteria (mg/m^3)	Source
Benzene	4.8 – 15	WHO 1993, Benzene, Environmental Health Criteria 150, International Programme on Chemical Safety (ICPS), World Health Organisation (WHO), Geneva
Toluene	9.4	WHO 1986, Toluene, Environmental Health Criteria 52, International Programme on Chemical Safety (ICPS), World Health Organisation (WHO), Geneva
Ethylbenzene	2.2	WHO 1996, Ethylbenzene, Environmental Health Criteria 186, International Programme on Chemical Safety (ICPS), World Health Organisation (WHO), Geneva
Xylenes	4.35	WHO 1997, Xylenes, Environmental Health Criteria 190, International Programme on Chemical Safety (ICPS), World Health Organisation (WHO), Geneva
Acetone	9.5	WHO 1998, Acetone, Environmental Health Criteria 207, International Programme on Chemical Safety (ICPS), World Health Organisation (WHO), Geneva
2-Butanone (MEK)	5.9	WHO 1992, Methyl Ethyl Ketone, Environmental Health Criteria 143, International Programme on Chemical Safety (ICPS), World Health Organisation (WHO), Geneva
Cyclohexane	88 – 1,050	USDL 2012, Occupational Safety and Health Guideline for Cyclohexane, Occupational Safety & Health Administration (OHSA), United States Department of Labor, Washington DC, < http://www.osha.gov/ >, accessed 18 October 2012
Dibromochloromethane	Not known	
Dichloromethane	88 – 177	USDL 2012, Substance Safety Data Sheet and Technical Guidelines for Methylene Chloride, Occupational Safety & Health Administration (OHSA), United States Department of Labor, Washington DC, < http://www.osha.gov/ >, accessed 18 October 2012

Analyte	Screening Criteria (mg/m^3)	Source
Ethyl acetate	14	USDL 2012, Occupational Safety and Health Guideline for Ethyl Acetate, Occupational Safety & Health Administration (OHSA), United States Department of Labor, Washington DC, < http://www.osha.gov/ >, accessed 18 October 2012
n-Heptane	626	USDL 2012, Occupational Safety and Health Guideline for Heptane, Occupational Safety & Health Administration (OHSA), United States Department of Labor, Washington DC, < http://www.osha.gov/ >, accessed 18 October 2012
4-Ethyltoluene	Odourless	Air Liquide 2012, Material Safety Data Sheet for 4-Ethyl Toluene, Scott Speciality Gases, Air Liquide America Specialty Gases, < http://www.alspecialtygases.com >, accessed 18 October 2012
n-Propylbenzene	Odourless	Air Liquide 2012, Material Safety Data Sheet for Propyl Benzene, Scott Speciality Gases, Air Liquide America Specialty Gases, < http://www.alspecialtygases.com >, accessed 18 October 2012
Propene	30	3M 2010, Respirator Selection Guide, 3M Occupational Health and Safety Division, St Paul
Isopropyl alcohol	55	USDL 2012, Occupational Safety and Health Guideline for Isopropyl Alcohol, Occupational Safety & Health Administration (OHSA), United States Department of Labor, Washington DC, < http://www.osha.gov/ >, accessed 18 October 2012
Ethanol	154	DHSS 2012, Ethyl Alcohol, Hazardous Substance Fact Sheet, Division of Epidemiology, Environmental and Occupational Health, New Jersey Department of Health and Senior Services (DHSS), Trenton < http://nj.gov/health/eoh/ >, accessed 18 October 2012
n-Hexane	233 – 466	USDL 2012, Occupational Safety and Health Guideline for n-Hexane, Occupational Safety & Health Administration (OHSA), United States Department of Labor, Washington DC, < http://www.osha.gov/ >, accessed 18 October 2012
Naphthalene	0.0075 – 0.42	WHO 2010, WHO Guidelines for Indoor Air Quality, Selected Pollutants, World Health Organisation (WHO), Geneva
Styrene	0.2 – 0.34	WHO 1983, Styrene, Environmental Health Criteria 26, International Programme on Chemical Safety (ICPS) , World Health Organisation (WHO), Geneva
Trimethylbenzene	10.7 – 12	MoE 2007, Development of Ontario Air Standards for Trimethylbenzenes (1,2,3-Trimethylbenzene, 1,2,4-Trimethylbenzene and 1,3,5-Trimethylbenzene, Ministry of Environment, Ontario, Canada

With the exception of naphthalene which was reported in one sample from the workshop at the lower range of sensitivity (refer Table 6), the values presented in Table 4 are orders of magnitude greater than measured site concentrations (note the difference in units). Whilst odour characterisation can be problematic given the inherent subjectivity and range of population sensitivity, no reports of offensive odour associated with the contaminant source have been documented by site receptors or trained contaminated land specialists (gasworks odour tends to be described as phenolic and / or sulfurous). This point includes naphthalene, which has a unique and distinctive odour.

Where odour was noted during the site investigation, this was associated with artistic use of the buildings which have been documented in the assessment as background sources of VOCs within the building. It is unlikely that the VOCs reported at the site would be considered noxious given the low concentrations reported.

11 LABORATORY ANALYSIS

The schedule for laboratory analysis was defined by Environmental Earth Sciences' letters 210074L2 and 210074L5 dated 4 January and 28 January 2011 (2011c; 2011d) respectively.

All samples were analysed for the USEPA TO15 comprehensive 84 Component Suite. The results were measured and reported in parts per billion volume (ppb_v), with the results calculated and reported in micrograms per cubic meter ($\mu g/m^3$) (calculation from ppb_v was based on molecular weight, a temperature of 25°C and atmospheric pressure of 101.3kPa).

In extreme sampling conditions such as measuring emissions from a furnace or pressure vessel, the vapour concentration ($\mu g/m^3$) should be corrected to account for actual conditions during sampling. As this is not the case for this investigation as any correction using meteorological data from the weather station would result in a negligible change to the reported concentration.

12 QUALITY ASSURANCE AND QUALITY CONTROL

12.1 Field quality assurance (QA) and quality control (QC)

Measures were undertaken to mitigate the key limitation of the selected sampling methodology by minimising the potential for cross contamination from indoor sources by:

- sample location selection (as discussed in Section 8.2.1);
- collection of QC samples including a background sample and a field duplicate sample; and
- relocation of potential indoor cross contaminating sources away from sampling locations as far as practicable and as directed by the Auditor.

The canister vacuum reading before and after sampling was recorded to ensure that the canister was leak-free upon receipt and that the flow controller collected the sample over the specified period of time. All canisters recorded an initial vacuum reading of greater than 25 inches of mercury (if vacuum is less than 21 inches of mercury indicates improper handling during shipping). This information was recorded on chain of custody (COC) documentation.

The integrity of the sample was maintained through proper handling during shipping, checking of vacuum gauges, adherence to holding times, use of appropriate sampling equipment and documentation through COC.

12.2 Laboratory QAQC

QC is achieved by utilising NATA accredited laboratories, using standard methods supported by internal duplicates, the checking of high, abnormal or otherwise anomalous results against background and other chemical results for the sample concerned.

QA was achieved by confirming field or anticipated results based upon the comparison of field observations with laboratory results. In addition, the laboratory undertook additional duplicate analysis as part of their internal QA program.

Field duplicate results were generally within the acceptable range of reproducibility and all duplicates and standards were within the acceptable reproducibility range as defined by the ASTM Standard guide for soil gas monitoring in the vadose zone (ASTM, 2006).

Assurance of quality data includes:

- ALS has certified that the canister was leak-free and clean below the resolution limit for the VOCs of concern (refer to Appendix C for documentation).
- ALS provided flow controllers that were clean and calibrated to collect a sample over the specified time frames;
- ALS undertook the required laboratory QC samples including mass spectral tuning, initial calibration, continuing calibration verification, laboratory control spike, and method blank;
- ALS checked the initial vacuum reading prior to issue of canisters; and final vacuum reading upon receipt of completed sample at the laboratory, with all readings recorded on the COC documentation
- ALS issued fully NATA endorsed Certificates of Analysis consistent with USEPA TO14/TO15 method requirements;
- quality assurance reporting is based on automated compliance checking against USEPA QC criteria;
- adherence to holding time requirements with analysis of canister samples for VOCs completed within 30 days from collection.

Full laboratory transcripts and chain of custody forms are presented in Appendix B, while further discussion on QA/QC is provided in Appendix C.

12.3 QA / QC outcomes

Details of the QA / QC undertaken for this project are presented in Appendix C. In summary, assurance of quality data from ambient vapour sampling has been based on development of an approved sampling and analysis plan and site management plan, appropriate field methodology, careful selection of laboratories and assessment of data against the Measurement Data Quality Indicators (MDQI's).

The QA / QC data reported by ALS for the documented vapour samples were determined to be of sufficient quality to be considered acceptable to comply with the Environmental Earth Sciences quality protocols for the project. This report has therefore concluded that the QA / QC data set and field duplicate results are free of systematic, method biases and field sampling errors, and the data is representative of the site conditions. It can be confidently stated that the MDQI's for this project have been met and the data set is considered to be reliable.

13 RESULTS AND DISCUSSIONS

All detectable vapour results for both rounds of sampling have been presented in Table 5 and Table 6.

13.1 Weather impacts

Strong winds can cause increased rates of vapour intrusion into buildings. Comparing the winds measured during sampling (Table 2) to average data obtained from Bureau of Meteorology (Table 1) it can be determined that the wind speed during sampling was significantly lower than the average wind speed for both sampling rounds. Therefore, there is the potential that an increase in vapour drawn into buildings may have occurred during the sampling period due to wind, however, this addition is likely to be negligible.

Data obtained from the Bureau of Meteorology indicate that barometric pressure mostly decreased during sampling events. These conditions result in increased vapour intrusion as the pressure draws vapour from soil into the buildings giving a conservative 'worse-case scenario'.

The cool change came through between sampling of Gasworks Park and South Port Nursing Home in sampling Round 2 (as evident by the drop in barometric pressure). This change in barometric pressure may have resulted in an increase in flux into the South Port Nursing Home. However, given the concentrations measured between sampling rounds were comparable in each building, the affect of barometric pressure changes at the site are likely to be negligible.

13.2 Building design

13.2.1 Building height

In winter taller buildings generally have a significant "stack effect" caused by thermal convection currents. Air inside the building is heated, and hot air rises, causing a net upward flow, pressure in the upper floors, and a vacuum in the lower floors. This pressure differential may contribute to vapour intrusion from the subsurface and increase the potential for vapour intrusion into upper floors (ITRC, 2007).

This effect would impact the gatehouse building, theatre, ceramic studio, sculpture studio and visual arts studio 1 and 2 more than other lower buildings on the site. The buildings being one level, however, are not so tall that thermal convection currents would make a significant impact on vapour intrusion.

13.2.2 Slab-on-grade design

The buildings have mostly been identified as having by slab-on-grade construction with brick walls, all noted as being in good condition. There was no visual evidence suggesting perimeter cracks or gaps between the wall the slab and/or cracks within the slab to act as conduits for vapour intrusion. Australian building standards, however, do not have the air tightness and efficiency requirements that colder regions such Europe and Northern America enact through air leakage standards.

13.2.3 Ventilation

The conceptual model for vapour transport assumes that vapour is drawn into the building through openings by the pressure difference between the soil and the interior of the building. The pressure differential is induced by a combination of wind and stack effects due to building heating and mechanical ventilation (ITRC 2007).

Most of the original gasworks buildings were noted as having ventilation duct near the roof, limited mechanical heating and cooling and large gaps between walls and doors. The more modern South Port Nursing Home and administration offices (Gasworks Park) have more mechanical heating and cooling, however, lower ventilation potential being in better condition with less gaps. In winter it is expected that vapour intrusion and accumulation in buildings is higher than during summer as ventilation is reduce and the buildings heated.

13.2.4 Sub-surface structures and confined spaces

There is likely some subsurface services beneath buildings that may act as a conduit for soil vapour intrusion, however, none of the buildings on-site were completed below grade with a basement or partial basement that might be prone to vapour intrusion.

In addition most of the buildings are open plan, occasionally with smaller rooms such as toilets, kitchenettes or storage areas. There were no identified confined spaces such as basements, crawl-spaces or attics for vapour to concentrate.

13.2.5 Vapour intrusion potential

Overall the potential for vapour intrusion is considered to be low due to building design based on:

- no basements or buildings at a depth below grade;
- no confined spaces such as basement or, crawl-spaces;
- good condition slab-on-grade construction;
- single level building design;
- minimal mechanical heat/cooling in original gasworks buildings; and
- moderate to high ventilation (particularly for original Gasworks buildings).

13.3 Background sources

A number of VOCs were detected during the vapour sampling, most of which were not identified as site-based CoPCs (i.e. not identified in soil and / or groundwater contamination at the site). The source of such VOCs is considered to originate from background sources and so the potential origins of these VOCs must be considered.

There were a number of potential indoor sources of VOCs identified during the site inspection and sampling, including paints, solvents, thinners, glues, resins etc. It is therefore considered the following detected chemicals may be attributed to background sources:

- ethanol, toluene, ethyl acetate, heptane, hexane, acetone, propene and dichloromethane – common to solvents, thinners, enamel, lacquer and paints in art supplies; and
- hexane and ethyl acetate – VOCs associated with glues.

Trimethylbenzenes, benzene, toluene, ethylbenzene and xylenes are also found in the chemicals stored and used in buildings on-site, but have also been detected in soil and/or groundwater from gasworks waste. Therefore the source of any vapours detected is more ambiguous.

External sources of indoor VOCs in ambient air are largely associated with known urban air pollutants from auto-exhausts due to low efficiency of combustion. VOC that may be generated include: n-pentane, naphthtalene, isopentane, benzene, toluene, ethylbenzene, meta- and para-xylenes and 1,2,4-trimethylbenzene (Brown, 2002).

The ambient background sample in Round 1 (winter) reported detectable concentrations of toluene, hexane and propene in background conditions, which may have contributed to the concentrations detected in ambient air inside site buildings. The background sample in Round 2 (summer) reported non-detectable concentrations, indicating detectable concentrations inside buildings are not representative of background conditions.

13.4 Screening criteria

All detectable vapour concentrations were low, and below adopted screening criteria with the following exceptions:

- benzene concentrations in the Gasworks Park sculpture studio in both rounds of sampling;
- trimethylbenzenes in Gaswork Park visual arts studio 1 in Round 2 sampling (summer); and
- naphthalene in theGaswork Park theatre workshop in Round 2 sampling (summer).

It is also important to note that the screening criteria for benzene and for naphthalene (in most samples) are below the method detection limit (MDL).

In accordance with DECCW *Vapour Intrusion* guidelines (2010), where partial exposure can be demonstrated (the receptor is only exposed for part of the day) the nominated health guideline value may be divided by the fraction of the day that the exposure occurs. This assumes that the receptor is not exposed at other locations at the site. In the commercial use in Gasworks Park the exposure is assumed to only occur for eight hours a day during weekdays therefore the applied initial screening criteria can be multiplied by four (168 hours per week ÷ 40 hours of total exposure). Only benzene concentrations in the Gaswork Park sculpture studio in both rounds of sampling still exceed these adjusted criteria.

TABLE 5 ROUND 1 DETECTABLE RESULTS (µg/m^3) – WINTER

Analyte	Screening Criteria	Time adjusted criteria[9]	Gasworks Park												South Port Nursing Home		4981 Background Sample
			4974 Visual Arts Studio 1	4768 Visual Arts 2	4985 Cafe	4989 Dressing Room	4983 Rehearsal Room	4780 Theatre	4977 Sculpture Studio	4992 Bookshop	4982 Admin/ Office	4772 Ceramic Studio	4736 Theatre Workshop	4987 Arts & Craft Studio	4777 SPNH-Bedroom	4760 SPNH-Communal	
Sampling Date	-	-	17/07/11	17/07/11	17/07/11	17/07/11	17/07/11	17/07/11	17/07/11	17/07/11	17/07/11	17/07/11	17/07/11	17/07/11	18/07/11	18/07/11	17/07/11
Dichloromethane	600[1]	na	23	<4.2	<4.3	<4.3	<4.2	<4.2	<4.0	<4.2	<4.4	14	<4.2	<4.2	<5.3	<3.7	<4.6
Benzene	1.7[2]	6.8	<3.4	<3.9	<4.0	<4.1	<4.0	<3.9	**9.8**	<4.0	<4.1	<4.1	<4.0	<4.0	<5.0	<3.5	<4.3
Toluene	5,000[3]	na	50.3	37.5	<4.8	<4.8	<4.8	7.9	86	17.4	<4.9	<4.9	10	6.1	13.6	26.4	7.9
Ethylbenzene	265[4]	na	<4.7	<5.4	<5.5	<5.6	<5.5	<5.4	6.5	<5.4	<5.6	<5.7	<5.5	<5.5	<6.9	<4.8	<5.9
Xylenes	870[5]	na	28.2	<15.9	<16.3	<16.5	<16.3	<16.0	35.4	<16.0	<16.6	<16.8	<16.2	<16.2	<20.4	<14.2	<17.4
Acetone	30,000[6]	na	<2.6	<2.9	<3.0	<3.0	<3.0	39.3	<2.8	<3.0	<3.1	<3.1	<3.0	<3.0	<3.8	<2.6	<3.2
Cyclohexane	6,000[7]	na	5.1	<4.2	<4.3	<4.3	<4.2	<4.2	14.6	<4.2	<4.4	<4.4	<4.2	<4.2	8.2	14.9	<4.6
Dibromochloromethane	-	na	32.2	<10.5	<10.8	<10.9	<10.8	<10.6	<10.2	<10.6	<11.0	<11.1	<10.7	<10.7	<13.5	<9.4	<11.5
Hexane	700[8]	na	19	28.7	22.7	25.4	20.2	18	62	31.9	<4.6	23.2	95	22.6	109	263	26.6
Propene	3,000[9]	na	9.6	5.2	3.4	3.7	3.3	3.6	8.7	2.9	<2.3	4.3	4.3	4.4	9.3	10.7	2.7
Ethanol	100,000[10]	na	2,960	<2.2	1,030	170	<2.2	112	24.7	<2.2	24.7	61.8	25.5	<2.2	333	500	<2.4

Note(s):

1. USEPA (2011), Toxicological Review of Dichloromethane in support of summary information on the Integrated Risk Information System (IRIS);
2. WHO (2000), Air Quality Guidelines for Europe, Second Edition, European series No 91;
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10. CalEPA/OEHHA 1999, Health & Environmental Assessment of the Use of Ethanol as a Fuel Oxygenate, Volume V: Potential Health Risks of Ethanol in Gasoline;
11. - indicates that no criteria have been established; and
12. values that exceed initial screening criteria are shaded in grey; values that exceed time adjusted criteria are highlighted in bold.

TABLE 6 ROUND 2 DETECTABLE RESULTS (µg/m^3) – SUMMER

Analyte	Screening Criteria	Time adjusted criteria[12]	Gasworks Park												South Port Nursing Home		
			4763 Visual Arts Studio	4747 Garden Studio	4973 Cafe	4782 Dressing Room	4983 Rehearsal Room	4740 Theatre	4775 Sculpture Studio	4982 Gatehouse	4768 Administration	4741 Ceramics Studio	4760 Workshop	4981 Arts &Craft Studio	4737 W. Wing, Room 1	4973 Kitchen	4977 Background Sample
Sampling Date	-	-	29/01/12	29/01/12	29/01/12	29/01/12	29/01/12	29/01/12	29/01/12	29/01/12	29/01/12	29/01/12	29/01/12	29/01/12	01/02/12	01/02/12	29/01/12
Dichloromethane	600[1]	na	13	<7	<8	<4	<8	<5	<8	<8	9	43	<4	10	<9	<5	<8
Benzene	1.7[2]	6.8	<7	<7	<7	<4	<7	<5	**9**	<7	<7	<8	<4	<8	<9	<5	<7
Toluene	5,000[3]	na	50	50	21	64	<8	34	204	<9	10	<9	222	<10	12	20	<9
Ethylbenzene	265[4]	na	<10	<9	<10	<6	<10	<7	12	<10	<10	<11	<6	<11	<12	<6	<10
Xylenes	870[5]	na	129	<27	<29	<17	<29	<21	65	<30	<30	<32	<17	<33	<35	<19	<30
4-Ethyltoluene	-	na	37	<10	<11	<6	<11	<8	<11	<12	<11	<12	<6	<13	<14	<7	<11
Acetone	30,000[6]	na	<6	<5	24	38	<5	23	98	<6	<5	<6	47	<6	<6	<4	<5
Cyclohexane	6,000[7]	na	<8	<7	<8	12	<8	6	21	<8	<8	<8	33	<9	<9	<5	<8
Ethyl acetate	-	na	<8	<8	<8	<5	<8	<5	17	<8	<8	<9	<5	<9	<10	<5	<8
Heptane	-	na	<9	<8	<9	<5	<9	<6	<9	<9	<9	<10	<5	<10	<11	<6	<9
Hexane	700[8]	na	<8	<8	37	137	<8	66	66	<8	<8	<9	380	<9	20	21	<8
Isopropyl Alcohol	7,000[9]	na	<6	7	<5	11	<5	<4	<6	7	17	<6	4	<6	<6	10	<5
2-Butanone (MEK)	5,000[10]	na	<7	<6	<7	<4	<7	<4	12	<7	<7	<7	13	<8	<8	<4	<7
Ethanol	100,000[11]	na	20	4	10	82	65	19	14	<4	10	49	35	6	18	316	<4
n-Propylbenzene	1,000[9]	na	19	<10	<11	<6	<11	<8	<11	<12	<11	<12	<6	<13	<14	<7	<11
Naphthalene	10[12]	40	<12	<11	<12	<7	<12	<8	<12	<12	<12	<13	12	<13	<14	<8	<12
Styrene	260[2]	na	<10	<9	<9	<6	<9	<6	28	<10	<10	<10	<5	<11	<11	<6	<10
Trimethylbenzene	220[13]	880	258	<20	<22	<12	<22	<16	<22	<24	<22	<24	<12	<26	<28	<14	<22

Note(s):

1. USEPA (2011), Toxicological Review of Dichloromethane in support of summary information on the Integrated Risk Information System (IRIS);
2. WHO (2000), Air Quality Guidelines for Europe, Second Edition, European series No 91;
3. USEPA (2005), Toxicological Review of Toluene in support of summary information on the Integrated Risk Information System (IRIS);
4. ATSDR (2010). Toxicological Profile for Ethylbenzene (calculated from published criteria of 0.06ppm);
5. WHO (1997). Xylenes, Environmental Health Criteria 190, International Programme on Chemical Safety (ICPS) - note that meta-, para- & ortho - xylene results have been combined under the one criteria value;
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7. USEPA (2003), Toxicological Review of Cyclohexane in support of summary information on the Integrated Risk Information System (IRIS);
8. USEPA (2005), Toxicological Review of n-Hexane in support of summary information on the Integrated Risk Information System (IRIS);
9. CalEPA (2012), Regional Screening Level for Resident Air Supporting Table, April 2012
10. USEPA (2003), Toxicological Review of Methyl Ethyl Ketone (MEK) in support of summary information on the Integrated Risk Information System (IRIS);
11. CalEPA/OEHHA (1999), Health & Environmental Assessment of the Use of Ethanol as a Fuel Oxygenate, Volume V: Potential Health Risks of Ethanol in Gasoline
12. WHO (2010), WHO Guidelines for Indoor Air Quality, Selected Pollutants;
13. MoE (2007), Development of Ontario Air Standards for Trimethylbenzenes (1,2,3-Trimethylbenzene, 1,2,4-Trimethylbenzene and 1,3,5-Trimethylbenzene) – note that 1,2,4-Trimethylbenzene & 1,3,5-Trimethylbenzene results have been combined under the one criteria value;
14. screening criteria based on 24hour exposure therefore adjusted by a factor of x4 to account for commercial exposure time of 40 hours per week;
15. – indicates that no criteria have been established; and
16. values that exceed initial screening criteria are shaded in grey; values that exceed time adjusted criteria are highlighted in bold.

13.4.1 Benzene

There is a certain amount of benzene present in urban air from vehicle emissions that may have attributed to the background apportionment in the sample collected in the sculpture studio. This is less likely given the background ambient sample did not report any detectable concentrations of benzene, nor was it detected in any other sample other than inside the sculpture studio. Outdoor sources, however, are often identified as responsible for benzene in ambient air indoors (Jia *et al*. 2010).

It is also considered unlikely that buried gasworks waste is the source of the benzene concentrations as benzene has not been detected in soils surrounding sculpture studio (or in most soil sampling locations across the site) to date (Table 7 and Figure 3). Although the soil directly beneath buildings has not been tested, previous experience on numerous other legacy gas-work sites indicates there is minimal contamination of soil beneath original gasworks buildings (as the buildings prevented the disposal of wastes beneath them).

TABLE 7 ELEVATED CONCENTRATIONS OF BENZENE IN SOIL

Sample location	Sampling Date	Sample depth (m)	Benzene concentration (mg/kg)	Distance to nearest building (m)	Benzene vapour detected in nearby buildings
BH11	**27/01/2011**	0.5 - 0.6	13.7	10m from visual arts studios	No
TP7	**18/01/2011**	1.75 - 1.8	21.6	55m from theatre	No
TP2	**18/01/2011**	0.95 - 1.0	5.2	15m to admin office	No

Benzene has been detected in groundwater, however not in groundwater monitoring wells in closest proximity to the sculpture studio (Figure 3). Groundwater is located at approximately 7-9 mbgs and is drawn radially from the site, way from the sculpture studio, due to drawdown by the encircling sewers. Therefore it is not considered likely that impacted groundwater is the source of the benzene concentrations in the sculpture studio. Refer to Figure 3 for all groundwater sample locations and benzene concentrations.

In addition benzene concentrations in groundwater are below the health screening levels (for >8m depth of clay soil; HSL A for South Port Nursing home and HSL-D for Gasworks Park) for vapour intrusion detailed in Table B2 in Appendix B of the CRC CARE Technical Report no. 10, *Part 2: Application document* (Friebel and Nadebaum, 2011). This indicates that the benzene concentrations in groundwater are too low to generate sufficient concentrations of benzene vapour to pose a risk to human health of the site users.

Benzene is a common VOC and is often found in buildings where a distinct source cannot be identified (Brown, 2002). The benzene may have originated from oxyacetylene welding, lacquers, spray-paint, varnish or a number of other chemicals that contain VOC that are used in the sculpture studio.

13.4.2 Naphthalene

A single naphthalene concentration of 12µg/m^3 exceeded the original screening criteria of 10µg/m^3 in the theatre workshop during the second round of sampling. Naphthalene was not detected in of the adjacent rooms or areas within the theatre/administration complex, including the theatre, dressing room, rehearsal room, café and administration building. The

MDL for some of these samples was raised over the initial screening criteria in the second sampling round.

Naphthalene concentrations were not reported, however, as exceeding the exposure/time adjusted criteria of 30µg/m^3 and all laboratory MDL were also below this adjusted criteria.

The closest naphthalene impacts identified in groundwater are localised down gradient in the southeast corner of the site (GW24 with a concentration of 4,530µg/L), approximately 40m from the workshop. Impacted groundwater is flowing radially away from the theatre/administration complex and not beneath the buildings, due to the drawdown from encircling sewers. Therefore it is not considered likely that impacted groundwater is the source of the naphthalene.

Elevated concentrations of naphthalene (over 100 mg/kg across the site and over 20 mg/kg for those sampling locations close to the buildings) detected in soil are presented in Table 8 and in Figure 4. Based on this information, it appears that naphthalene impacts in soil are unlikely to generate soil vapour in most of the locations, with exception of BH11. Therefore it is considered unlikely that the naphthalene detected in the theatre workshop originated from vapour intrusion from a soil source.

TABLE 8 ELEVATED CONCENTRATIONS OF NAPHTHALENE IN SOIL

Sample location	Sampling Date	Sample depth (m)	Naphthalene concentration (mg/kg)	Distance to nearest building (m)	Naphthalene vapour detected in nearby buildings
BH11	**28/01/2011**	0.5-0.6	6,600	10m from visual arts studios	No
BH13	**27/01/2011**	1.1-1.3	22.7	8m from theatre workshop	Yes
BH14	**27/01/2011**	1.3-1.4	69.3	10m from theatre	Yes
BH15	**28/01/2011**	0.8-0.9	527	Adjacent to photography darkroom	Not tested, but naphthalene not detect in admin office
TP7	**18/01/2011**	1.75-1.8	2,440	55m from theatre	No
TP14	**19/01/2011**	0.85-0.9	117	50m to sculpture studio	No

There are numerous studies documenting many other common sources of naphthalene in indoor ambient air (Batterman *et al*., 2012; Jia and Batterman, 2010; Jia *et al.* 2010; Brown 2002). It is possible that the naphthalene is a result of degassing from indoor sources of chemicals stored and used in the workshop. In particular the site inspection identified grip adhesive, containing sodium naphthalene formaldehyde, within the workshop which could act as a potential indoor naphthalene source. In addition mothballs, which are a common source of naphthalene vapour in the ambient air, is likely used to store and preserve theatre costumes and so may be responsible for the detected naphthalene concentration.

Alternatively the theatre workshop was noted as being partially open to the atmosphere, hence could be more influenced by external sources of naphthalene such as tailpipe

emissions (Jia and Batterman, 2010). This is less likely given the background sample did not report detectable concentrations of naphthalene.

Based on this information it is considered unlikely that the naphthalene detected in the theatre workshop originated from the tar waste buried in the soil or impacted groundwater but rather is at least partially a result of degassing from indoor sources. Regardless of its origin, naphthalene is not considered to pose an unacceptable health risk at the site.

13.4.3 Trimethylbenzene

A single trimethylbenzene concentration of 258µg/m^3 (which comprised of 1,2,4-tmethylbenzene and 1,3,5-trimethylbenzene) exceeded the original screening criteria of 220µg/m^3 in the Visual Arts Studio 1 during the second round of sampling. However, trimethylbenzene concentrations were not reported in excess of the exposure / time adjusted criteria of 660µg/m^3.

Trimethylbenzenes have not been assessed in previous environmental investigations at this site therefore may exist in soil and groundwater. Environmental Earth Sciences considers it more likely, however, that this concentration has originated from a background indoor source such as paint, varnish or primers. Regardless of its origin, trimethylbenzene is not considered to pose an unacceptable health risk to at the site.

14 CONCLUSIONS

Detectable concentrations of vapours measured at the site by Environmental Earth Sciences were low and appear largely due to indoor cross contaminating sources noted to be within the building such as paints, solvents, thinners, glues, resins etc. Only benzene, naphthalene and trimethylbenzene concentrations in three separate locations exceeded initial screening criteria, and only benzene exceeded the exposure adjusted criteria. Environmental Earth Sciences consider that the concentrations are attributable to indoor sources rather than from as a result of gasworks waste at the site.

The vapour intrusion exposure pathway appears to be mitigated by the following factors:

- building design, including ventilation, building height and subsurface penetrations;
- radial flow of impacted groundwater outwards away from buildings due to drawdown from sewers;
- the low likelihood of gasworks waste buried in soil beneath or in close proximity to original gasworks buildings; and
- natural site setting with depth to groundwater greater than 7m in sandy clay soils.

Based on the results of this assessment, Environmental Earth Sciences consider that any sub-surface vapour intrusion at the site appears to be negligible and unlikely to result in a chronic unacceptable health risk to building users. On this basis, remedial options and / or management systems are not considered necessary at this time to manage vapour intrusion into site buildings. This conclusion is provisional upon site land use and buildings remaining unaltered.

This assessment has been limited to addressing the impacts of ground gases to an assumed receptor population under specific exposure scenarios, based on information available at the time of the assessment. The assessment approach presented does not consider a fully

probabilistic estimate of risk, but presents conditional estimates based on a number of assumptions regarding exposure and hazard consistent with an internationally endorsed regulatory approach. Further assessments would be required to properly assess risk where site uses vary from the assumed site conditions and/or exposure settings used in this assessment.

This report must be read in its entirety, including with the attached "Environmental Earth Sciences General Limitations".

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A report is provided inclusive of all documentation sections, limitations, tables, figures and appendices and should not be provided or copied in part without all supporting documentation for any reason, because misinterpretation may occur.

Subsurface conditions change

Understanding an environmental study will reduce exposure to the risk of the presence of contaminated soil and or groundwater. However, contaminants may be present in areas that were not investigated, or may migrate to other areas. Analysis cannot cover every type of contaminant that could possibly be present. When combined with field observations, field measurements and professional judgement, this approach increases the probability of identifying contaminated soil and or groundwater. Under no circumstances can it be considered that these findings represent the actual condition of the site at all points.

Environmental studies identify actual sub-surface conditions only at those points where samples are taken, when they are taken. Actual conditions between sampling locations differ from those inferred because no professional, no matter how qualified, and no sub-surface exploration program, no matter how comprehensive, can reveal what is hidden below the ground surface. The actual interface between materials may be far more gradual or abrupt than an assessment indicates. Actual conditions in areas not sampled may differ from that predicted. Nothing can be done to prevent the unanticipated. However, steps can be taken to help minimize the impact. For this reason, site owners should retain our services.

Problems with interpretation by others

Advice and interpretation is provided on the basis that subsequent work will be undertaken by Environmental Earth Sciences VIC. This will identify variances, maintain consistency in how data is interpreted, conduct additional tests that may be necessary and recommend solutions to problems encountered on-site. Other parties may misinterpret our work and we cannot be responsible for how the information in this report is used. If further data is collected or comes to light we reserve the right to alter their conclusions.

Obtain regulatory approval

The investigation and remediation of contaminated sites is a field in which legislation and interpretation of legislation is changing rapidly. Our interpretation of the investigation findings should not be taken to be that of any other party. When approval from a statutory authority is required for a project, that approval should be directly sought by the client.

Limit of liability

This study has been carried out to a particular scope of works at a specified site and should not be used for any other purpose. This report is provided on the condition that Environmental Earth Sciences VIC disclaims all liability to any person or entity other than the client in respect of anything done or omitted to be done and of the consequence of anything done or omitted to be done by any such person in reliance, whether in whole or in part, on the contents of this report. Furthermore, Environmental Earth Sciences VIC disclaims all liability in respect of anything done or omitted to be done and of the consequence of anything done or omitted to be done by the client, or any such person in reliance, whether in whole or any part of the contents of this report of all matters not stated in the brief outlined in Environmental Earth Sciences VIC's proposal number and according to Environmental Earth Sciences general terms and conditions and special terms and conditions for contaminated sites.

To the maximum extent permitted by law, we exclude all liability of whatever nature, whether in contract, tort or otherwise, for the acts, omissions or default, whether negligent or otherwise for any loss or damage whatsoever that may arise in any way in connection with the supply of services. Under circumstances where liability cannot be excluded, such liability is limited to the value of the purchased service.

FIGURES

Source: UBD Australian City Streets (version 2.1)
(page 283, B8)
E 319317 N 5809245

0 500
Scale in Metres

ENVIRONMENTAL EARTH SCIENCES
THE KNOW AND THE HOW

Title:	**Locality Map**		
Location:	**21 Graham Street Albert Park, Vic.**		
Client:	**City of Port Phillip**	Job No:	**210074**
Project Man: **DJ**	Scale: **As shown**	**Figure 1**	
Drawn By: **LB**	Date: **October 2012**		

Legend

Site Boundary

Vapour Sample Locations

- 1. Theatre
- 2. Theatre Workshop
- 3. Rehearsal Room
- 4. Administration Offices
- 5. Cafe
- 6. Dressing Room
- 7. Gatehouse
- 8. Visual Arts Studio 2
- 9. Visual Arts Studio 1
- 10. Ceramics Studio
- 11. Arts & Craft Studio
- 12. Sculpture Studio
- 13. Kitchen/Communal Area
- 14a. West Wing Room 1
- 14b. West Wing Room 3

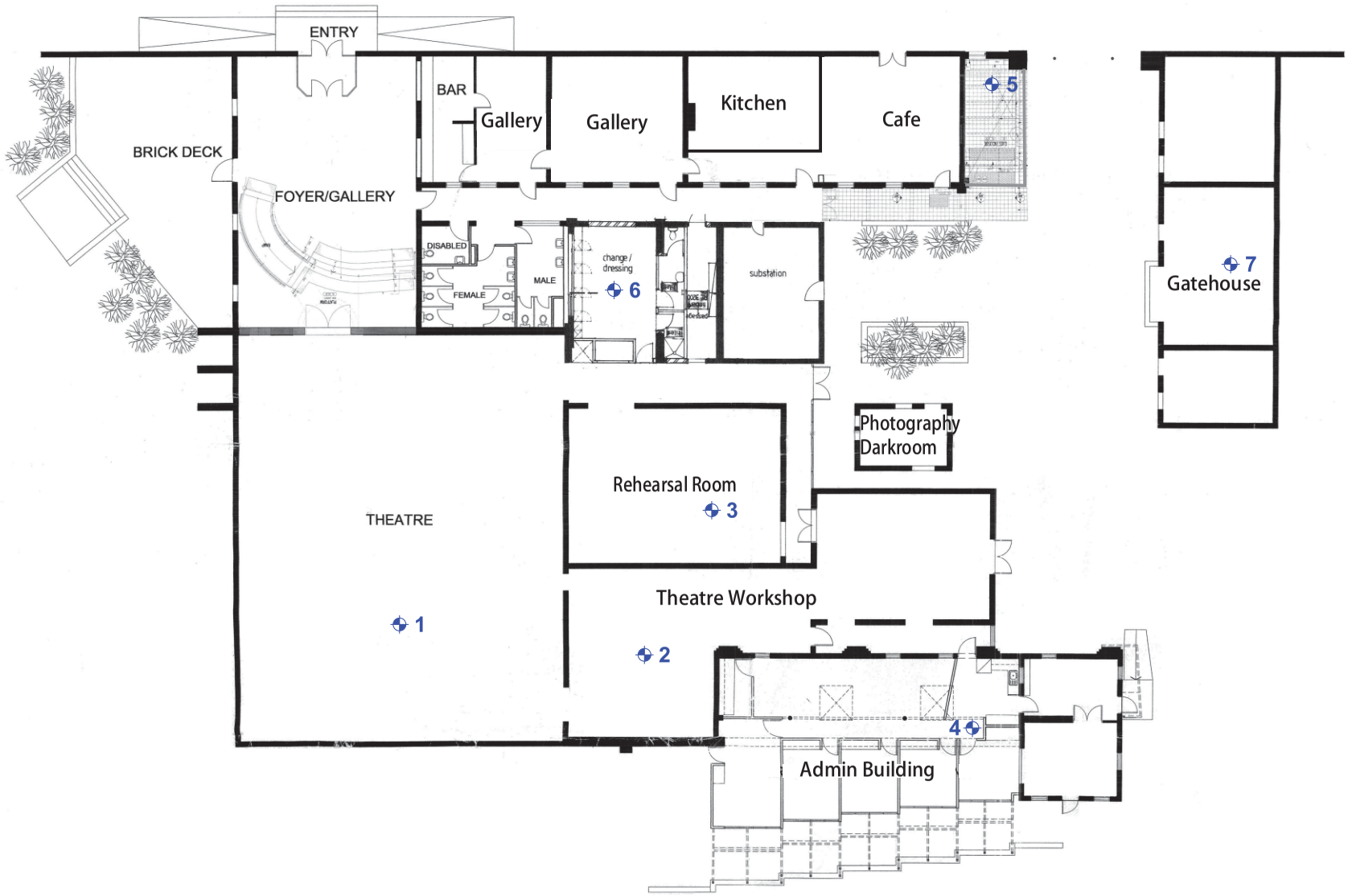
0 5 10 20 30 40 50 Metres

ENVIRONMENTAL EARTH SCIENCES

Title: Site Layout and Vapour Sample Locations	
Location: South Melbourne Gasworks	
Client: City of Port Phillip	Job number: 210074
Proj Man: AW	Source: NearMap (2011). [Image Date: 2010]
Drawn by: PF	Date: October 2012

Figure 2

GRAHAM STREET



Vapour Sampling Location

ENVIRONMENTAL EARTH SCIENCES THE KNOW AND THE HOW	Title: Theatre/Administration Complex		
	Location: South Melbourne Gasworks		
Client: City of Port Phillip		Job No: 210074	
Project Man: AW	Scale: As shown	Figure 2A	
Drawn By: PF	Date: March 2012		

Legend

- Site Boundary
- Vapour Sample Locations
- Groundwater Bore Locations
- Borehole Locations
- Test Pit Locations

0 5 10 20 30 40 50 Metres

ENVIRONMENTAL EARTH SCIENCES

Title:	Benzene Soil & Groundwater Impacts
Location:	South Melbourne Gasworks
Client: City of Port Phillip	Job number: 210074
Proj Man: AW	Source: NearMap (2011). [Image Date: 2010]
Drawn by: PF	Date: October 2012

Figure 3

Legend

- Site Boundary
- Vapour Sample Locations
- Groundwater Bore Locations
- Test Pit Locations
- Borehole Locations

0 5 10 20 30 40 50 Metres

ENVIRONMENTAL EARTH SCIENCES	Title: Naphthalene Soil and Groundwater Impacts	
	Location: South Melbourne Gasworks	
Client: City of Port Phillip		Job number: 210074
Proj Man: AW	Source: NearMap (2011). [Image Date: 2010]	
Drawn by: PF	Date: October 2012	**Figure 4**

APPENDIX A SITE INSPECTION CHECKLISTS

Visual arts 1&2 (separated by partion wall that doesn't extend to ceiling)

Complete this form for each building involved in indoor air testing

Preparer's Name: Anne Whitney Date/Time Prepared: 26/05/2011
Preparer's Affiliation: ECS Work Phone: (02) 96871666
Purpose of Investigation: Identify suitable sampling location + potential indoor source

1. OCCUPANT:

Interviewed: Y/N

Last Name:_____ First Name:_____

Address:_____

County:_____

Home Phone:_____ Alternate Phone:_____

Number of Occupants/persons at this location:_____

Age of Occupants:_____

2. OWNER OR LANDLORD: (Check if same as occupant____)

Interviewed: Y/N

Last Name:_____ First Name:_____

Address:_____

County:_____

Home Phone:_____ Alternate Phone:_____

Guidance for Assessing and Remediating Vapor Intrusion in Buildings

3. BUILDING CHARACTERISTICS:

Type of Building: (Circle appropriate response)

Residential	School	Commercial/Multi-use
Industrial	Church	Other: Artist Paint Studios

If the property is residential, type? (Circle appropriate response)

Ranch	2-Family	3-Family
Raised Ranch	Split-Level	Colonial
Cape Cod	Contemporary	Mobile Home
Duplex	Apartment House	Townhouse/Condos
Modular	Log Home	Other:_____

If multiple units, how many?_____

If the property is commercial, type?
Business Type(s) Artist Studio

Does it include residences (i.e., multi-use)? Y/(N) If yes, how many?_____

Other characteristics:
Number of floors 1 Building age original gasworks bldg.

Is the building insulated Y/(N)? How air tight? Tight / Average / (Not Tight)

4. AIRFLOW
Use air current tubes or tracer smoke to evaluate airflow patterns & qualitatively describe:

Airflow between floors

_____

_____

_____

* NB Garden Studio - same construction but completely separate * has carpet - bare room → SARKING BUT NOT INSULATED. no artists/contaminating sources → used for children activities CEILING FAN

Airflow near source

Outdoor air infiltration

& GAPS IN DOOR..

Infiltration into air ducts

air ducts in wall near ceiling (to outside)

5. BASEMENT & CONSTRUCTION CHARACTERISTICS (Circle all that apply)

a. Above grade construction: wood frame concrete stone (brick)

b. Basement type: full crawlspace slab other N/A

c. Basement floor: concrete dirt stone other N/A

d. Basement floor: unsealed sealed
covered with N/A

e. (Concrete floor): unsealed sealed
sealed with SLAB on GRADE.

f. Foundation walls: poured block stone

other

g. Foundation walls: unsealed (sealed) Brick.
sealed with

h. The basement is: wet damp dry moldy

i. The basement is: finished unfinished partially finished

j. Sump present? Y /(N)

k. Water in sump? Y /(N) (not applicable)

Basement/Lowest level depth below grade: (feet) N/A

Identify potential soil vapor entry points & approximate size (e.g., cracks, utility ports, drains)

cracks in concrete floor (minimal only one minor one noted) / doors.

6. HEATING, VENTING & AIR CONDITIONING (Circle all that apply)

Type of heating system(s) used in this building: (circle all that apply – note primary)

Hot air circulation	Heat pump	Hot water baseboard
Space heaters	Steam radiation	Radiant floor
Electric baseboard	Wood stove	Outdoor wood boiler

Other PORTABLE ELECTRIC. (not installed in building)

The primary type of fuel used is:

Natural gas	Fuel oil	Kerosene
(Electric)	Propane	Solar
Wood	Coal	

Domestic hot water tank fueled by: ?

Boiler/furnace located in: Basement Outdoors Main Floor
Other N/A

Air conditioning: Central air (Window units) (Open windows?)
(shut for sampling)

Heat Pump None

Are there air distribution ducts present? Y / N

Describe the supply & cold air return ductwork & its condition where visible, including whether there is a cold air return & tightness of duct joints. Indicate the locations on the floor plan diagram.

7. OCCUPANCY

Is basement/lowest lever occupied? Full-time Occasionally
Seldom Almost never

Level General use of each floor (e.g., familyroom, bedroom, laundry, workshop, storage)

Basement: —

1st Floor Artist Paint Studio

2nd Floor —

3rd Floor —

4th Floor —

8. FACTORS THAT MAY INFLUENCE INDOOR AIR QUALITY

a. Is there an attached garage? Y / (N)
b. Does the garage have a separate heating unit? Y / N (NA)
c. Are petroleum-powered machines or vehicles stored in the garage (e.g., lawnmower, ATV, car) Y/N Please specify N/A
d. Has the building ever had a fire? Y / (N) When
e. Is a kerosene or unvented gas space heater present? Y / (N)
Where & Type?
f. Is there a workshop or hobby/craft area? (Y) / N
Where & Type? PAINT STUDIO
g. Is there smoking in the building? Y / N Frequency? unknown.
h. Have cleaning products been used recently? Y / N When & Type? unknown
i. Have cosmetic products been used recently? Y / N When & Type? unlikely.
j. Has painting/staining been done in the last 6 months? (Y) / N
Where & When? Continuous.
k. Is there new carpet, drapes or other textiles? Y / (N) Where & When?
l. Have air fresheners been used recently? Y / (N) When & Type?
m. Is there a kitchen exhaust fan? Y / N
If yes, where vented? N/A
n. Is there a bathroom exhaust fan? Y / N
If yes, where vented? N/A
o. Is there a clothes dryer? Y / (N) If yes, ~~is it vented outside? Y / N~~
p. Has there been a pesticide application? Y / (N) When & Type?
Are there odors in the building Y / N
If yes please describe: Strong paint smell.

Do any of the building occupants use solvents or volatile chemicals at work? (Y) / N
(e.g., chemical manufacturing or laboratory, auto mechanic or auto body shop, painting, fuel oil delivery, boiler mechanic, pesticide applicator, cosmetologist, carpet installer)
If yes, what type of solvents are used? Acetone/Turpentine/methanol ethanol
If yes, are their clothes washed at work? Y / (N)

Do any of the building occupants regularly use or work at a dry-cleaning service?
(circle appropriate response)
Yes, use dry-cleaning regularly (weekly) NO.

Yes, use dry-cleaning infrequently (monthly or less)
Yes, work at a dry-cleaning service
No
Unknown

Is there a radon mitigation system for the building/structure? Y / N

Date of Installation:_____

Is the system active or passive? Active/Passive N/A

9. WATER & SEWAGE

Water Supply: Public water Drilled well Driven well Dug well
Other:_____

Sewage Disposal: Public sewer Septic tank Leach field Dry well
Other:_____

10. RELOCATION INFORMATION (for oil spill residential emergency)

a. Provide reasons why relocation is recommended:_____

b. Residents choose to: remain in home relocate to friends/family relocate to hotel/motel

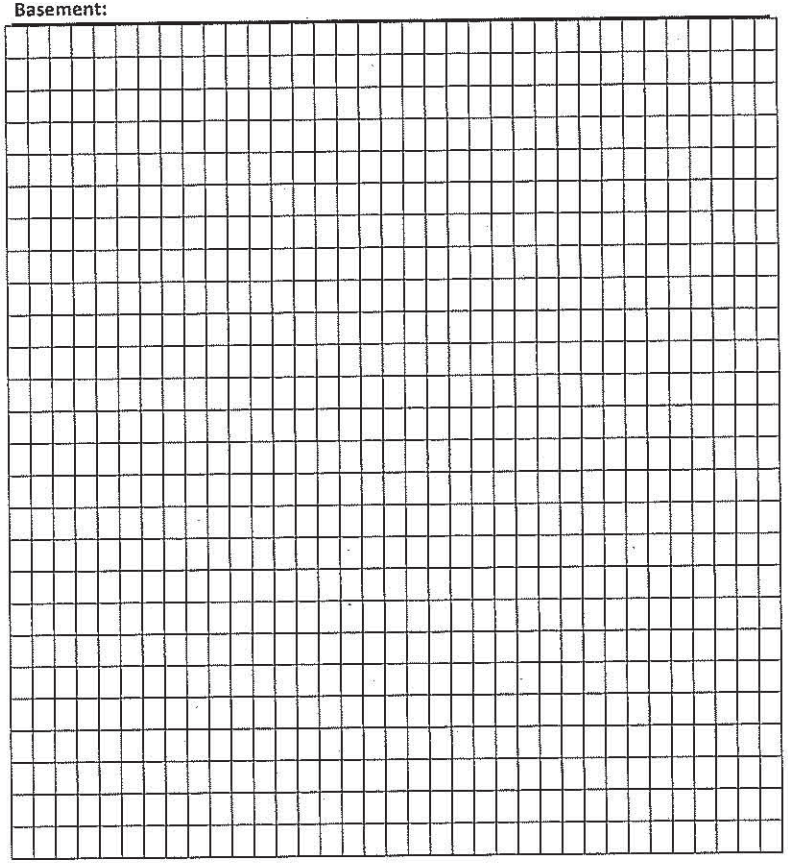
c. Responsibility for costs associated with reimbursement explained? Y / N

d. Relocation package provided & explained to residents? Y / N

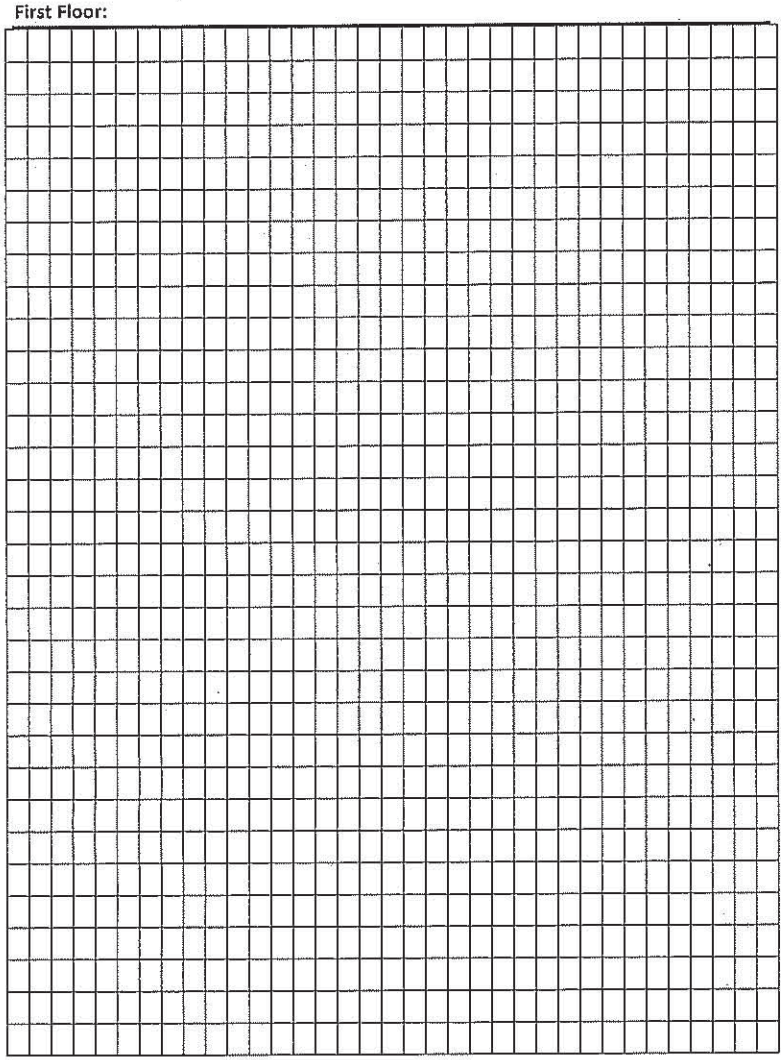
11. FLOOR PLANS

Draw a plan view sketch of the basement & first floor of the building. Indicate air sampling locations, possible indoor air pollution sources and PID meter readings. If the building does not have a basement, please note.

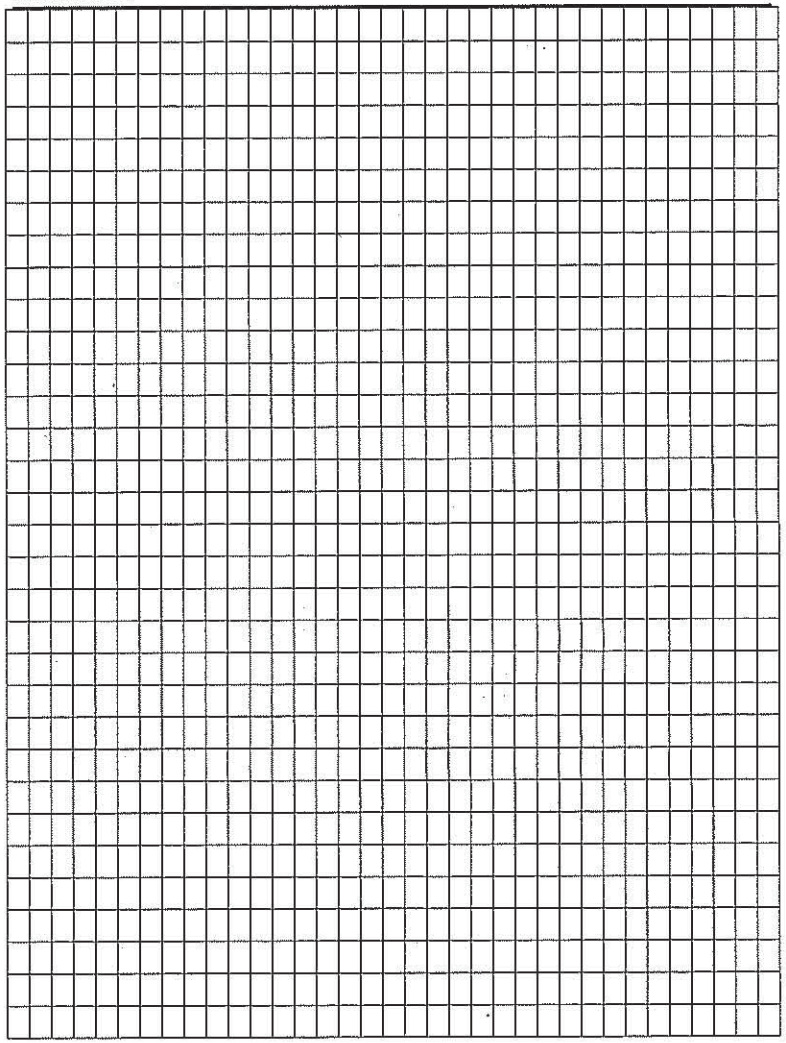
Basement:



First Floor:



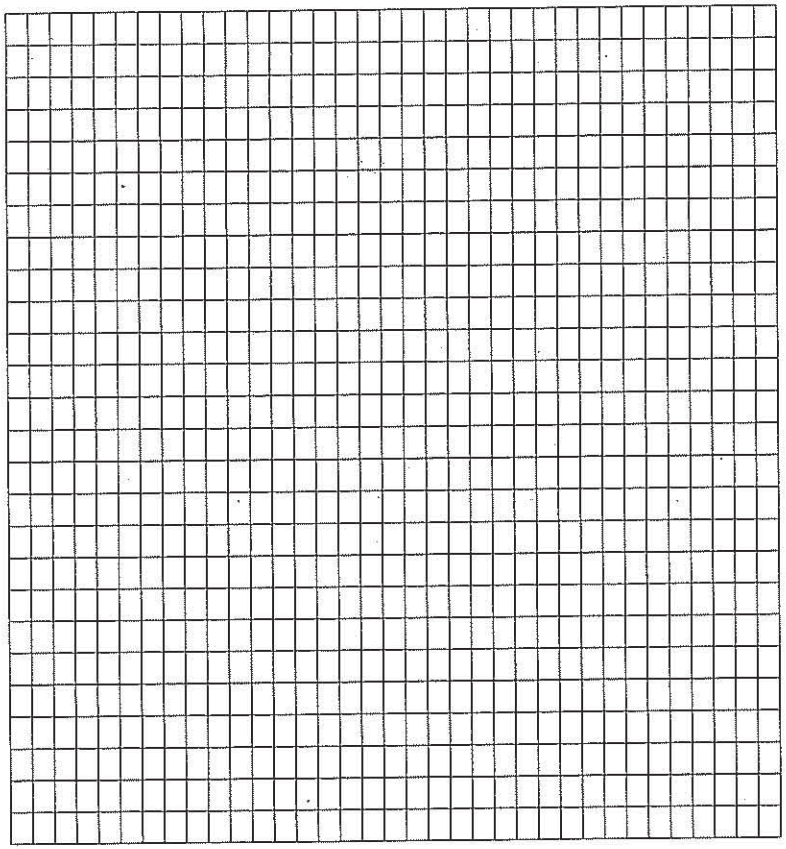
Second Floor:



12. OUTDOOR PLOT

Draw a sketch of the area surrounding the building being sampled. If applicable, provide information on spill locations, potential air contamination sources (industries, gas stations, repair shops, landfills, etc), outdoor air sampling location(s) & PID meter readings.

Also indicate compass direction, wind direction & speed during sampling, the locations of the well & septic system, if applicable, & a qualifying statement to help locate the site on a topographic map.



13. PRODUCT INVENTORY FORM

Make & Model of field instrument used: _____

List specific products found in the residence that have the potential to affect indoor air quality.

Location	Product Description	Size (units)	Condition*	Chemical Ingredients	Field Instrument Reading (units)	Photo** Y/N
	Acrylic / water-based oil paints.					
	Paint Thinners or Solvents			- methanol		
				- ethanol		
				- Turps		
				- acetone.		
	Enamel					

*Describe the condition of the product containers as Unopened (UO), Used (U), or Deteriorated (D)
** Photographs of the front & back of the product containers can replace the hand written list of chemical ingredients. However, the photographs must be of good quality & ingredient labels must be legible.

SCULPTURE STUDIO

Complete this form for each building involved in indoor air testing

Preparer's Name: Anne Whincup Date/Time Prepared: 26/05/2011
Preparer's Affiliation: EES Work Phone: (03) 96871666.
Purpose of Investigation: Identify suitable sampling locations & potential indoor sources

1. OCCUPANT:

Interviewed: Y/N

Last Name:_____ First Name:_____

Address:_____

County:_____

Home Phone:_____ Alternate Phone:_____

Number of Occupants/persons at this location:_____

Age of Occupants:_____

2. OWNER OR LANDLORD: (Check if same as occupant_____)

Interviewed: Y/N

Last Name:_____ First Name:_____

Address:_____

County:_____

Home Phone:_____ Alternate Phone:_____

3. BUILDING CHARACTERISTICS:

Type of Building: (Circle appropriate response)

Residential	School	Commercial/Multi-use
Industrial	Church	Other:_____

If the property is residential, type? (Circle appropriate response)

Ranch	2-Family	3-Family
Raised Ranch	Split Level	Colonial
Cape Cod	Contemporary	Mobile Home
Duplex	Apartment House	Townhouse/Condos
Modular	Log Home	Other:_____

If multiple units, how many?_____

If the property is commercial, type?

Business Type(s) SCULPTURE STUDIO

Does it include residences (i.e., multi-use)? Y/N If yes, how many?_____

Other characteristics:

Number of floors 1 Building age ORIGINAL GASWORKS BUILDING

Is the building insulated Y/N? How air tight? Tight / Average / Not Tight

HIGH CEILINGS.

4. AIRFLOW

Use air current tubes or tracer smoke to evaluate airflow patterns & qualitatively describe:

Airflow between floors N/A.

Airflow near source N/A

Outdoor air infiltration
-DOOR (GAPS)
- VENTILATION FAN IN WALL.

Infiltration into air ducts
AIR DUCTS NOTED IN WALL.

5. BASEMENT & CONSTRUCTION CHARACTERISTICS (Circle all that apply)

a. Above grade construction: wood frame concrete stone brick WALLS
FLOOR.

b. Basement type: full crawlspace slab other N/A

c. Basement floor: concrete dirt stone other N/A

d. Basement floor: unsealed sealed
covered with N/A.

e. Concrete floor: unsealed sealed
sealed with

f. Foundation walls: poured block stone brick.

other

g. Foundation walls: unsealed sealed
sealed with

h. The basement is: wet damp dry moldy N/A

i. The basement is: finished unfinished partially finished N/A

j. Sump present? Y / N

k. Water in sump? Y / N not applicable

Basement/Lowest level depth below grade: SLAB ON GRADE CONSRUCTION (feet)

Identify potential soil vapor entry points & approximate size (e.g., cracks, utility ports, drains)

6. HEATING, VENTING & AIR CONDITIONING (Circle all that apply)

Type of heating system(s) used in this building: (circle all that apply – note primary)

Hot air circulation	Heat pump	Hot water baseboard
Space heaters	Steam radiation	Radiant floor
Electric baseboard	Wood stove	Outdoor wood boiler

Other WALL MOUNTED

The primary type of fuel used is:

Natural gas	Fuel oil	Kerosene
Electric	Propane	Solar
Wood	Coal	

Domestic hot water tank fueled by: N/A

Boiler/furnace located in: Basement Outdoors Main Floor N/A
Other

Air conditioning: Central air Window units Open windows / DOORS

Heat Pump None

Are there air distribution ducts present? Y / (N)

Describe the supply & cold air return ductwork & its condition where visible, including whether there is a cold-air return & tightness of duct joints. Indicate the locations on the floor plan diagram.

7. OCCUPANCY

Is basement/lowest lever occupied? Full-time (assume 8 hours) Occasionally

Seldom Almost never

Level General use of each floor (e.g., familyroom, bedroom, laundry, workshop, storage)

Basement: N/A

1st Floor SCULPTURE STUDIO — WOOD & METAL WORKING.

2nd Floor N/A

3rd Floor N/A

4th Floor N/A

8. FACTORS THAT MAY INFLUENCE INDOOR AIR QUALITY

a. Is there an attached garage? Y (N)

b. Does the garage have a separate heating unit? Y / N (NA)

c. Are petroleum-powered machines or vehicles stored in the garage (e.g., lawnmower, ATV, car) Y (N) Please specify

d. Has the building ever had a fire? Y (N) When

e. Is a kerosene or unvented gas space heater present? Y (N)

Where & Type?

f. Is there a workshop or hobby/craft area? (Y) N

Where & Type? SCULPTURE STUDIO

g. Is there smoking in the building? Y / (N) Frequency?

h. Have cleaning products been used recently? Y (N) When & Type?

i. Have cosmetic products been used recently? (Y) N When & Type?

j. Has painting/staining been done in the last 6 months? (Y) N

Where & When? WOOD PAINTING & STAINING

k. Is there new carpet, drapes or other textiles? Y (N) Where & When?

l. Have air fresheners been used recently? Y (N) When & Type?

m. Is there a kitchen exhaust fan? Y / N

If yes, where vented? N/A.

n. Is there a bathroom exhaust fan? Y / N

If yes, where vented? N/A

o. Is there a clothes dryer? Y (N) If yes, is it vented outside? ~~Y / N~~

p. Has there been a pesticide application? Y (N) When & Type?

Are there odors in the building (Y) N

If yes please describe: VOLATILE ORGANIC NOT AS STRONG AS ARTS & CRAFT OR VISUAL ARTS

Do any of the building occupants use solvents or volatile chemicals at work? (Y) N

(e.g., chemical manufacturing or laboratory, auto mechanic or auto body shop, painting, fuel oil delivery, boiler mechanic, pesticide applicator, cosmetologist, carpet installer)

If yes, what type of solvents are used? Refer to list at back.

If yes, are their clothes washed at work? Y (N)

Do any of the building occupants regularly use or work at a dry-cleaning service? (circle appropriate response)

Yes, use dry-cleaning regularly (weekly)

Yes, use dry-cleaning infrequently (monthly or less)
Yes, work at a dry-cleaning service
No
Unknown

Is there a radon mitigation system for the building/structure? Y / N
Date of Installation:_____

Is the system active or passive? Active/Passive

9. WATER & SEWAGE

Water Supply: Public water Drilled well Driven well Dug well
Other:_____

Sewage Disposal: Public sewer Septic tank Leach field Dry well
Other:_____ N/A

10. RELOCATION INFORMATION (for oil spill residential emergency)

a. Provide reasons why relocation is recommended:_____

b. Residents choose to: remain in home relocate to friends/family
relocate to hotel/motel

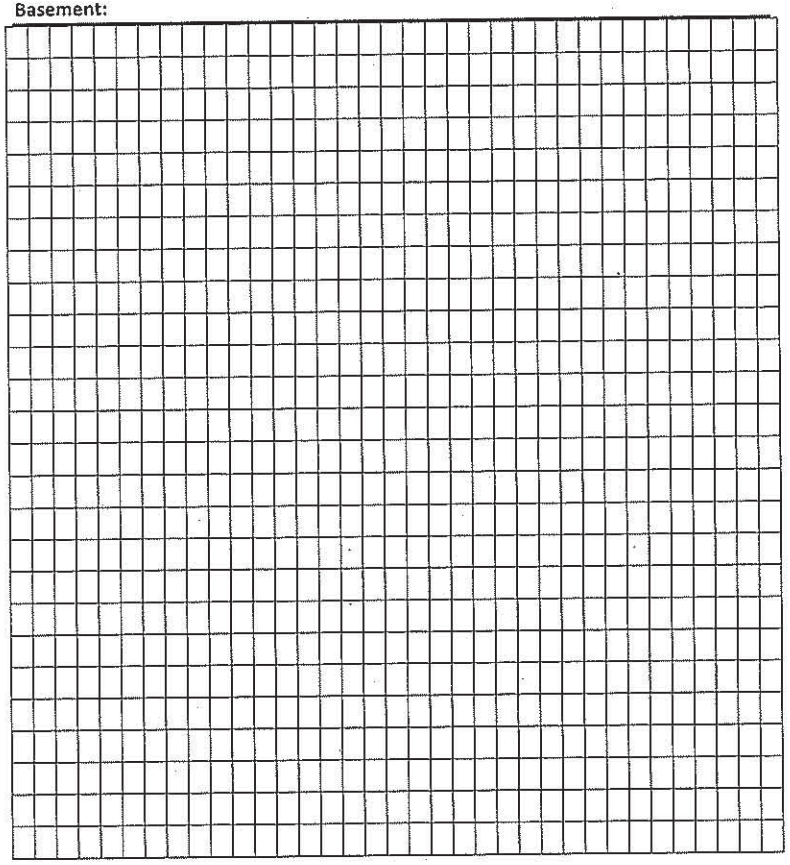
c. Responsibility for costs associated with reimbursement explained? Y / N

d. Relocation package provided & explained to residents? Y / N

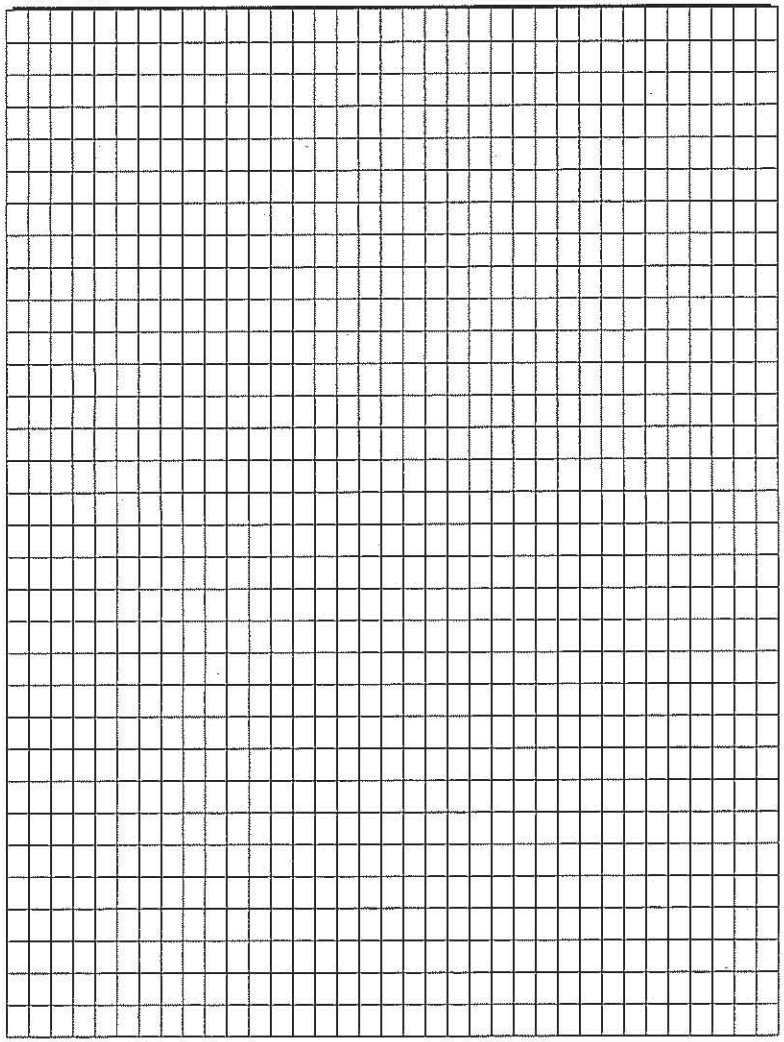
11. FLOOR PLANS

Draw a plan view sketch of the basement & first floor of the building. Indicate air sampling locations, possible indoor air pollution sources and PID meter readings. If the building does not have a basement, please note.

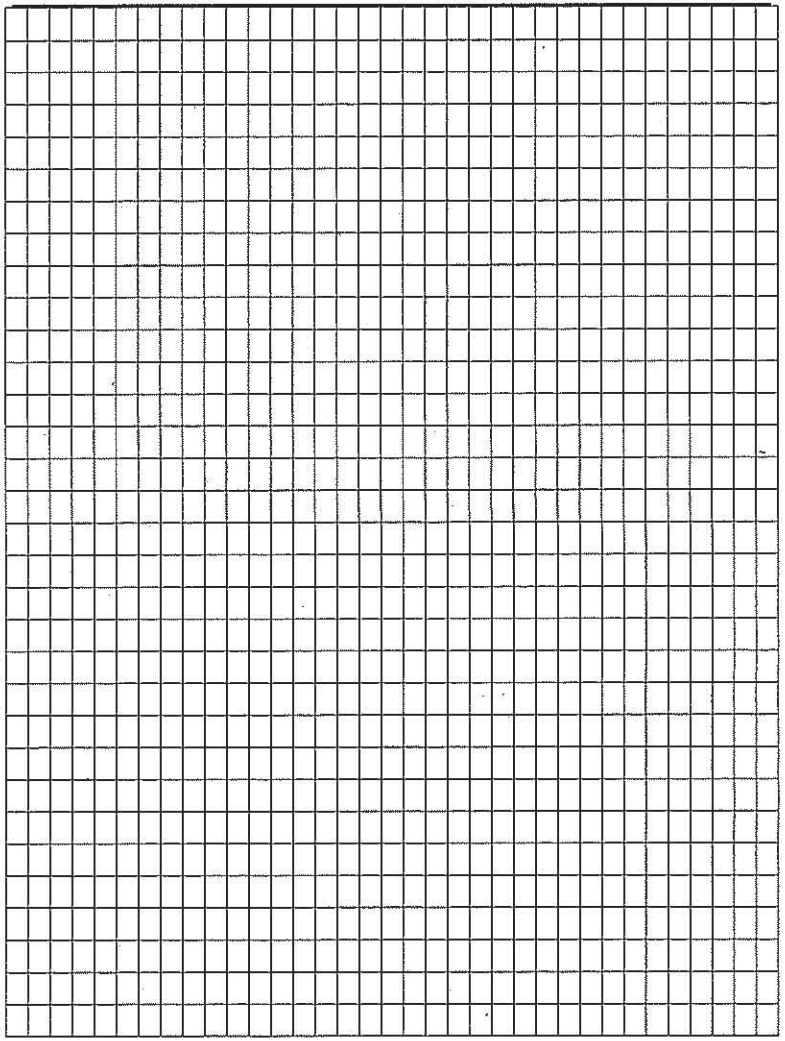
Basement:



First Floor:



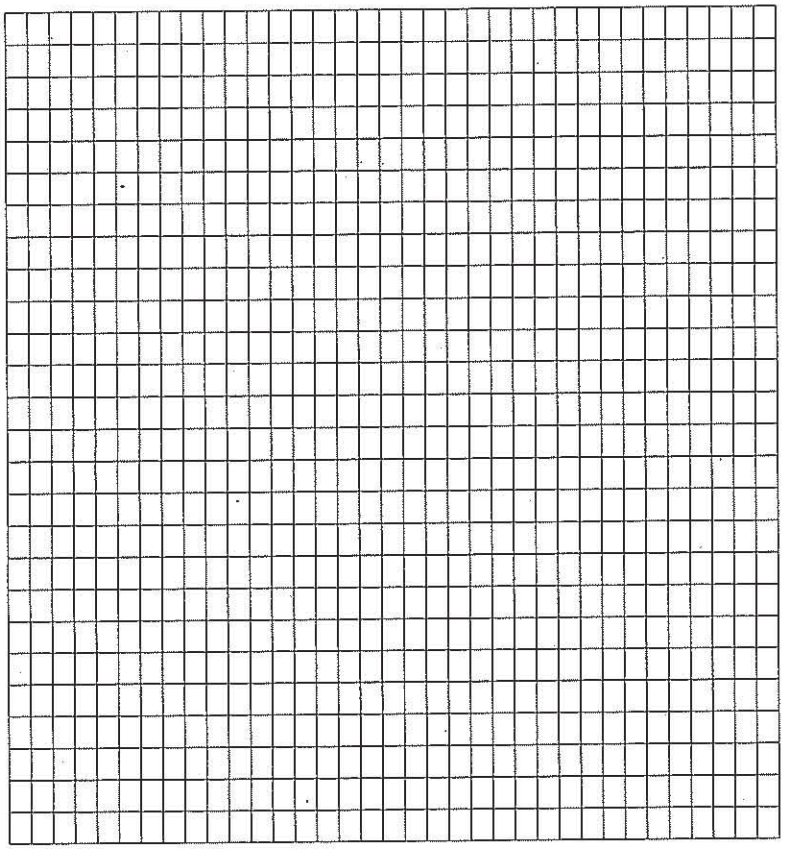
Second Floor:



12. OUTDOOR PLOT

Draw a sketch of the area surrounding the building being sampled. If applicable, provide information on spill locations, potential air contamination sources (industries, gas stations, repair shops, landfills, etc), outdoor air sampling location(s) & PID meter readings.

Also indicate compass direction, wind direction & speed during sampling, the locations of the well & septic system, if applicable, & a qualifying statement to help locate the site on a topographic map.



13. PRODUCT INVENTORY FORM

Make & Model of field instrument used:_____

List specific products found in the residence that have the potential to affect indoor air quality.

Location	Product Description	Size (units)	Condition*	Chemical Ingredients	Field Instrument Reading (units)	Photo** Y/N
	SPRAY PAINT / BUILDING PAINTS					
	ENAMEL / RESINS					
	VARNISH (WOOD)					
	WOOD STAIN.					
	ACETYLENE GAS (WELDING)		BOTTLE			
	GLUES - GRIP		ADHESIVE			
		-	ADHESIVE SPRAY.			
		-	PVA			
	METAL PRIMERS					
	SOLVENTS - ACETONE					
			- METHYLATED SPIRITS			
			- TURPS			
	PAINT STRIPPER - DICHLOROMETHANE.					

*Describe the condition of the product containers as Unopened (UO), Used (U), or Deteriorated (D)
** Photographs of the front & back of the product containers can replace the hand written list of chemical ingredients. However, the photographs must be of good quality & ingredient labels must be legible.

CERAMIC STUDIO

Complete this form for each building involved in indoor air testing

Preparer's Name: Ame Whinaps Date/Time Prepared: 26/05/2011
Preparer's Affiliation: EES Work Phone: (03) 9687 1666
Purpose of Investigation: Identify suitable sampling locations & potential indoor sources

1. OCCUPANT:

Interviewed: Y/N

Last Name:_____ First Name:_____

Address:_____

County:_____

Home Phone:_____ Alternate Phone:_____

Number of Occupants/persons at this location:_____

Age of Occupants:_____

2. OWNER OR LANDLORD: (Check if same as occupant____)

Interviewed: Y/N

Last Name:_____ First Name:_____

Address:_____

County:_____

Home Phone:_____ Alternate Phone:_____

*NB Small Electric kiln used in area open to outside air

3. BUILDING CHARACTERISTICS:

Type of Building: (Circle appropriate response)

Residential	School	Commercial/Multi-use
Industrial	Church	Other: CERAMIC STUDIO

If the property is residential, type? (Circle appropriate response)

Ranch	2-Family	3-Family
Raised Ranch	Split Level	Colonial
Cape Cod	Contemporary	Mobile Home
Duplex	Apartment House	Townhouse/Condos
Modular	Log Home	Other:_____

If multiple units, how many?_____

If the property is commercial, type?

Business Type(s)_____

Does it include residences (i.e., multi-use)? Y/(N) If yes, how many?_____

Other characteristics:

Number of floors 1 Building age ORIGINAL GASWORKS BUILDING.

Is the building insulated Y/(N)? How air tight? Tight / Average / (Not Tight) exposed to outside air (refer to Q4)

4. AIRFLOW

Use air current tubes or tracer smoke to evaluate airflow patterns & qualitatively describe:

Airflow between floors

N/A

Airflow near source

N/A.

Outdoor air infiltration

PART OF STUDIO IS OPEN TO AIR. WITH WIRE MESH SECURING THE SPACE

Infiltration into air ducts

AIR DUCTS NOTED IN WALLS NEAR CEILING.

5. BASEMENT & CONSTRUCTION CHARACTERISTICS (Circle all that apply)

a. Above grade construction: wood frame (concrete) stone (brick) walls. floor.

b. Basement type: full crawlspace slab other_____ N/A

c. Basement floor: concrete dirt stone other_____ N/A

d. Basement floor: unsealed sealed N/A
covered with _____

e. Concrete floor: (unsealed) sealed
sealed with _____ GOOD CONDITION.

f. Foundation walls: poured block (stone)

other_____ PAINTED BRICK

g. Foundation walls: (unsealed) sealed
sealed with _____

h. The basement is: wet damp dry moldy N/A

i. The basement is: finished unfinished partially finished N/A

j. Sump present? Y (N)

k. Water in sump? Y / N (not applicable)

Basement/Lowest level depth below grade: SLAB ON GRADE CONSTRUCTION. (feet)

Identify potential soil vapor entry points & approximate size (e.g., cracks, utility ports, drains)

CONCRETE FLOOR IN GOOD CONDITION WITH MINIMAL SURFACE SERVICES.

6. HEATING, VENTING & AIR CONDITIONING (Circle all that apply)

Type of heating system(s) used in this building: (circle all that apply – note primary)

Hot air circulation	Heat pump	Hot water baseboard
(Space heaters)	Steam radiation	Radiant floor
Electric baseboard	Wood stove	Outdoor wood boiler
Other_____		

The primary type of fuel used is:

Natural gas	Fuel oil	Kerosene
(Electric)	Propane	Solar
Wood	Coal	

Domestic hot water tank fueled by: N/A

Boiler/furnace located in: Basement Outdoors Main Floor N/A
Other_____

Air conditioning: Central air Window units (Open windows / door. + portable fans.

Heat Pump None

Are there air distribution ducts present? Y / (N)

Describe the supply & cold air return ductwork & its condition where visible, including whether there is a cold air return & tightness of duct joints. Indicate the locations on the floor plan diagram.

N/A.

7. OCCUPANCY

Is basement/lowest lever occupied? (Full-time) Occasionally 8 hr day assumed.

Seldom Almost never

Level General use of each floor (e.g., familyroom, bedroom, laundry, workshop, storage)

Basement: N/A

1st Floor CERAMICS STUDIO

2nd Floor N/A

3rd Floor N/A

4th Floor N/A

8. FACTORS THAT MAY INFLUENCE INDOOR AIR QUALITY

a. Is there an attached garage? Y (N)

b. Does the garage have a separate heating unit? Y (N) (NA)

c. Are petroleum-powered machines or vehicles stored in the garage (e.g., lawnmower, ATV, car) Y/(N) Please specify

d. Has the building ever had a fire? Y (N) When

e. Is a kerosene or unvented gas space heater present? Y (N)

Where & Type?

f. Is there a workshop or hobby/craft area? (Y) N

Where & Type? CERAMIC STUDIO

g. Is there smoking in the building? Y (N) Frequency?

h. Have cleaning products been used recently? Y (N) When & Type?

i. Have cosmetic products been used recently? Y (N) When & Type?

j. Has painting/staining been done in the last 6 months? Y (N)

Where & When?

k. Is there new carpet, drapes or other textiles? Y (N) Where & When?

l. Have air fresheners been used recently? Y (N) When & Type?

m. Is there a kitchen exhaust fan? Y (N)

If yes, where vented?

n. Is there a bathroom exhaust fan? Y (N)

If yes, where vented?

o. Is there a clothes dryer? Y (N) If yes, is it vented outside? Y / N

p. Has there been a pesticide application? Y (N) When & Type?

Are there odors in the building Y (N)

If yes please describe:

Do any of the building occupants use solvents or volatile chemicals at work? Y (N)

(e.g., chemical manufacturing or laboratory, auto mechanic or auto body shop, painting, fuel oil delivery, boiler mechanic, pesticide applicator, cosmetologist, carpet installer)

If yes, what type of solvents are used?

If yes, are their clothes washed at work? Y / N

Do any of the building occupants regularly use or work at a dry-cleaning service? (circle appropriate response)

Yes, use dry-cleaning regularly (weekly)

Yes, use dry-cleaning infrequently (monthly or less)
Yes, work at a dry-cleaning service
No
Unknown

Is there a radon mitigation system for the building/structure? Y / N
Date of Installation:_____

Is the system active or passive? Active/Passive

9. WATER & SEWAGE

Water Supply: Public water Drilled well Driven well Dug well
Other:_____

Sewage Disposal: Public sewer Septic tank Leach field Dry well
Other:_____ N/A

10. RELOCATION INFORMATION (for oil spill residential emergency)

a. **Provide reasons why relocation is recommended:**_____

b. **Residents choose to:** remain in home relocate to friends/family
relocate to hotel/motel

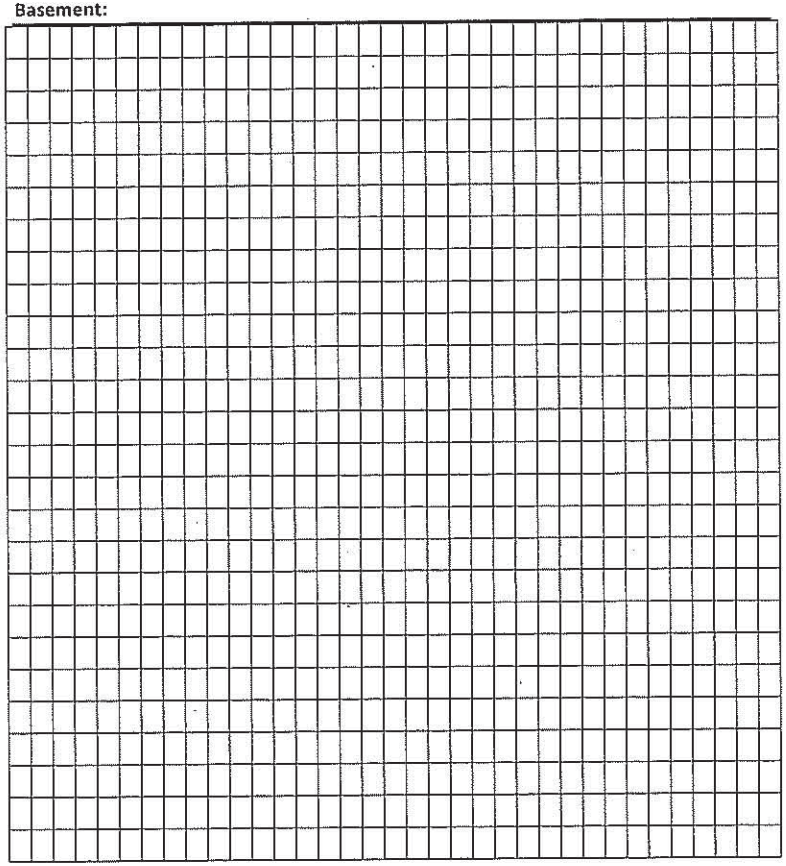
c. **Responsibility for costs associated with reimbursement explained?** Y / N

d. **Relocation package provided & explained to residents?** Y / N

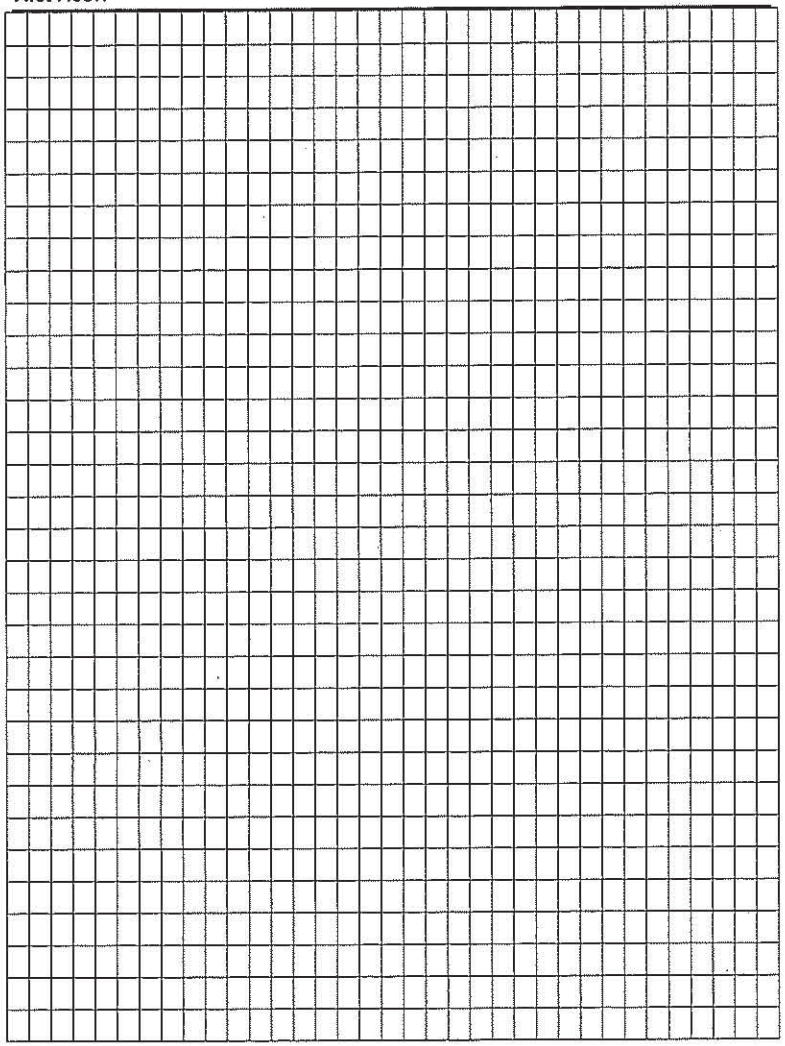
11. FLOOR PLANS

Draw a plan view sketch of the basement & first floor of the building. Indicate air sampling locations, possible indoor air pollution sources and PID meter readings. If the building does not have a basement, please note.

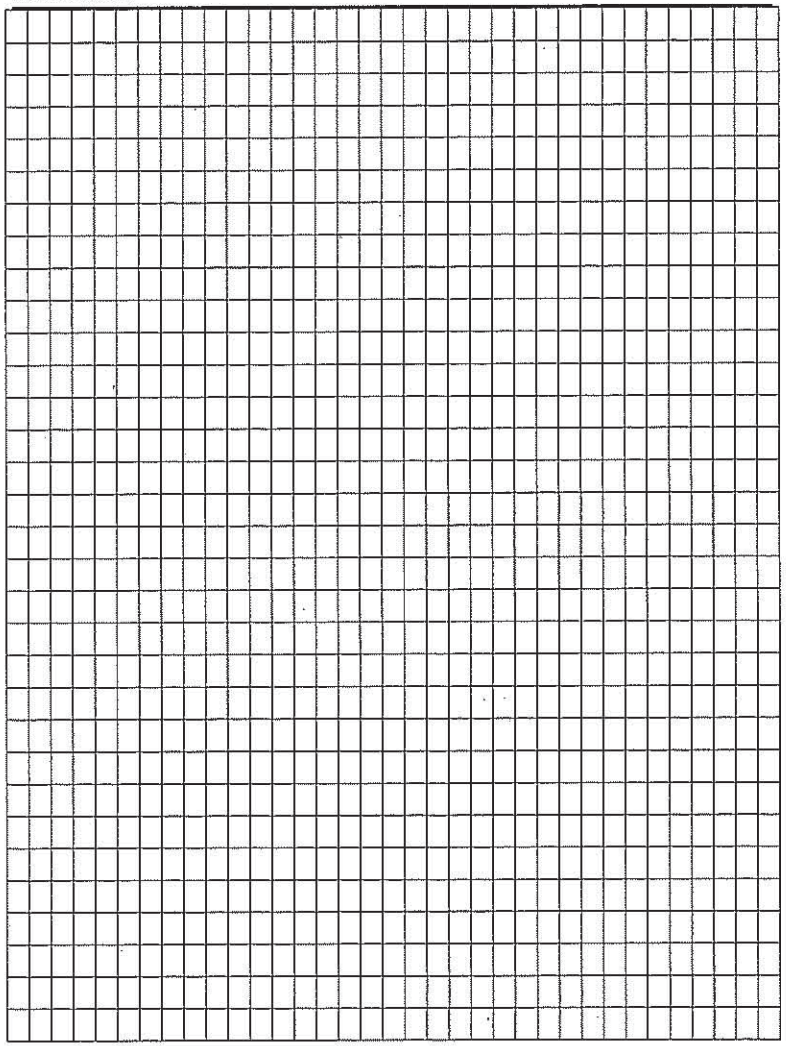
Basement:



First Floor:



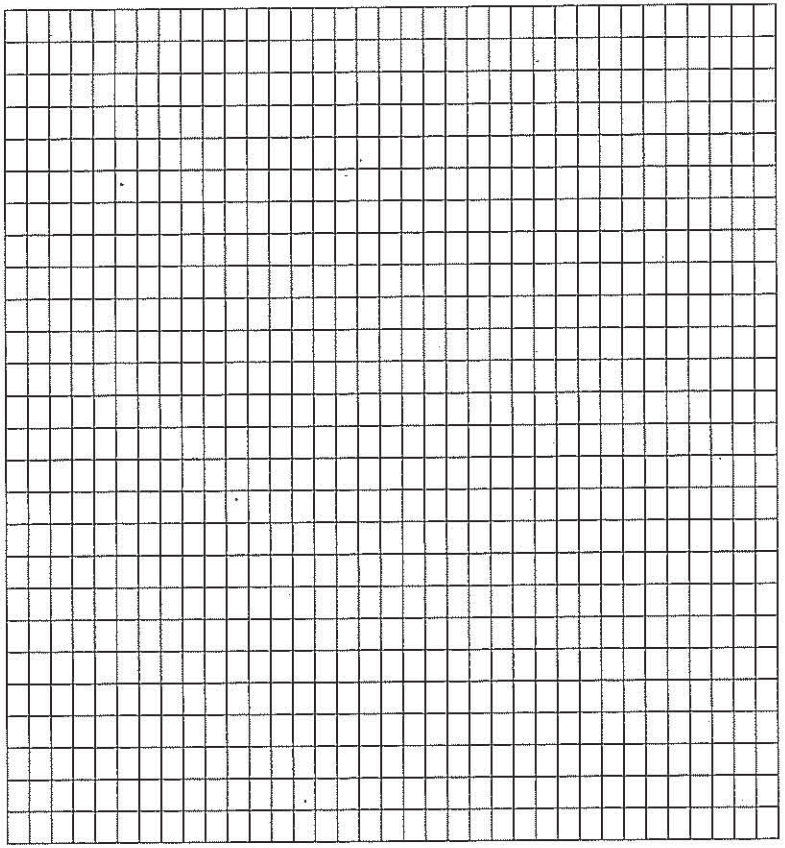
Second Floor:



12. OUTDOOR PLOT

Draw a sketch of the area surrounding the building being sampled. If applicable, provide information on spill locations, potential air contamination sources (industries, gas stations, repair shops, landfills, etc), outdoor air sampling location(s) & PID meter readings.

Also indicate compass direction, wind direction & speed during sampling, the locations of the well & septic system, if applicable, & a qualifying statement to help locate the site on a topographic map.



13. PRODUCT INVENTORY FORM

Make & Model of field instrument used:_____

List specific products found in the residence that have the potential to affect indoor air quality.

Location	Product Description	Size (units)	Condition*	Chemical Ingredients	Field Instrument Reading (units)	Photo** Y / N
- ENAMEL / GLAZES (NOT VOLATILE)						
- PIGMENT POWDERS (NOT VOLATILE)						

*Describe the condition of the product containers as Unopened (UO), Used (U), or Deteriorated (D)
** Photographs of the front & back of the product containers can replace the hand written list of chemical ingredients. However, the photographs must be of good quality & ingredient labels must be legible.

ARTS & CRAFT STUDIO.

Complete this form for each building involved in indoor air testing

Preparer's Name: Anne Whincup Date/Time Prepared: 26/05/2011
Preparer's Affiliation: EES Work Phone: (03) 9087 1666.
Purpose of Investigation: Identify suitable sampling locations & potential indoor sources.

1. OCCUPANT:

Interviewed: Y/N

Last Name:_____ First Name:_____

Address:_____

County:_____

Home Phone:_____ Alternate Phone:_____

Number of Occupants/persons at this location:_____

Age of Occupants:_____

2. OWNER OR LANDLORD: (Check if same as occupant_____)

Interviewed: Y/N

Last Name:_____ First Name:_____

Address:_____

County:_____

Home Phone:_____ Alternate Phone:_____

3. BUILDING CHARACTERISTICS:

Type of Building: (Circle appropriate response)

Residential	School	Commercial/Multi-use
Industrial	Church	Other:_____

If the property is residential, type? (Circle appropriate response)

Ranch	2-Family	3-Family
Raised Ranch	Split Level	Colonial
Cape Cod	Contemporary	Mobile Home
Duplex	Apartment House	Townhouse/Condos
Modular	Log Home	Other:_____

If multiple units, how many?_____

If the property is commercial, type?
Business Type(s) — ARTS & CRAFT STUDIO (GROUP CLASSES/ ACTIVITIES)

Does it include residences (i.e., multi-use)? Y/N If yes, how many?_____

Other characteristics:
Number of floors 1 Building age ORIGINAL GASWORKS BUILDING.

Is the building insulated Y/N? How air tight? Tight / Average / Not Tight

TIN ROOF.

4. AIRFLOW

Use air current tubes or tracer smoke to evaluate airflow patterns & qualitatively describe:

Airflow between floors N/A

Airflow near source N/A.

Outdoor air infiltration
DOOR - HAS LARGE GAP UNDERNEATH
WINDOWS.

Infiltration into air ducts
AIR DUCTS NOTED NEAR CEILING.
(TO OUTSIDE)

5. BASEMENT & CONSTRUCTION CHARACTERISTICS (Circle all that apply)

a. Above grade construction: wood frame (concrete) stone (brick) - WALLS
FLOOR.

b. Basement type: full crawlspace slab other N/A

c. Basement floor: concrete dirt stone other N/A

d. Basement floor: unsealed sealed
covered with N/A.

e. Concrete floor: (unsealed) sealed
sealed with

f. Foundation walls: poured block stone
other

g. Foundation walls: unsealed sealed PARTIALLY SEALED.
sealed with W. PLASTER.

h. The basement is: wet damp dry moldy N/A

i. The basement is: finished unfinished partially finished N/A

j. Sump present? Y (N)

k. Water in sump? Y / N (not applicable)

Basement/Lowest level depth below grade: SLAB ON GRADE CONSTRUCTION (feet)

Identify potential soil vapor entry points & approximate size (e.g., cracks, utility ports, drains)
SMALL KITCHEN & TOILET HAVE SUBSLAB SERVICES.
NO CRACKS NOTED IN CONCRETE FLOOR.

6. HEATING, VENTING & AIR CONDITIONING (Circle all that apply)

Type of heating system(s) used in this building: (circle all that apply – note primary)

Hot air circulation	Heat pump	Hot water baseboard
(Space heaters)	Steam radiation	Radiant floor
Electric baseboard	Wood stove	Outdoor wood boiler
Other		

MOUNTED ON WALL & SMALL PORTABLE ONES

The primary type of fuel used is:

Natural gas	Fuel oil	Kerosene
(Electric)	Propane	Solar
Wood	Coal	

Domestic hot water tank fueled by: UNKNOWN

Boiler/furnace located in: Basement Outdoors Main Floor N/A.
Other

Air conditioning: Central air Window units (Open windows)
& small wall unit
& portable fans.

Heat Pump None

Are there air distribution ducts present? Y (N)

Describe the supply & cold air return ductwork & its condition where visible, including whether there is a cold air return & tightness of duct joints. Indicate the locations on the floor plan diagram.

7. OCCUPANCY

Is basement/lowest lever occupied? Full-time Occasionally Seldom Almost never

Level General use of each floor (e.g., familyroom, bedroom, laundry, workshop, storage)

Basement: N/A

1st Floor ARTS & CRAFTS GROUP ACTIVITIES.

2nd Floor N/A

3rd Floor N/A

4th Floor N/A.

8. FACTORS THAT MAY INFLUENCE INDOOR AIR QUALITY

a. Is there an attached garage? Y (N)

b. Does the garage have a separate heating unit? Y / N (NA)

c. Are petroleum-powered machines or vehicles stored in the garage (e.g., lawnmower, ATV, car) Y (N) Please specify

d. Has the building ever had a fire? Y (N) When

e. Is a kerosene or unvented gas space heater present? Y (N)

Where & Type?

f. Is there a workshop or hobby/craft area? (Y) / N

Where & Type? ARTS & CRAFT

g. Is there smoking in the building? Y / (N) Frequency? UNKNOWN

h. Have cleaning products been used recently? Y / N When & Type? PRODUCTS IN TOILET & KITCHEN

i. Have cosmetic products been used recently? Y (N) When & Type?

j. Has painting/staining been done in the last 6 months? (Y) N

Where & When? ARTISTIC PAINTING

k. Is there new carpet, drapes or other textiles? Y (N) Where & When?

l. Have air fresheners been used recently? Y (N) When & Type?

m. Is there a kitchen exhaust fan? Y (N)

If yes, where vented?

n. Is there a bathroom exhaust fan? (Y) / N

If yes, where vented?

o. Is there a clothes dryer? Y (N) If yes, is it vented outside? ~~Y / N~~

p. Has there been a pesticide application? Y (N) When & Type?

Are there odors in the building (Y) / N

If yes please describe: STRONG PAINT/GLUE/VOLATILE ORGANIC ODOUR,

Do any of the building occupants use solvents or volatile chemicals at work? (Y) / N

(e.g., chemical manufacturing or laboratory, auto mechanic or auto body shop, painting, fuel oil delivery, boiler mechanic, pesticide applicator, cosmetologist, carpet installer)

If yes, what type of solvents are used? see list at back.

If yes, are their clothes washed at work? Y (N)

Do any of the building occupants regularly use or work at a dry-cleaning service? (circle appropriate response)

Yes, use dry-cleaning regularly (weekly)

Yes, use dry-cleaning infrequently (monthly or less)
Yes, work at a dry-cleaning service
No
Unknown

Is there a radon mitigation system for the building/structure? Y / N
Date of Installation:_____

Is the system active or passive? Active/Passive

9. WATER & SEWAGE

Water Supply: Public water Drilled well Driven well Dug well
Other:_____

Sewage Disposal: Public sewer Septic tank Leach field Dry well
Other:_____

10. RELOCATION INFORMATION (for oil spill residential emergency)

a. Provide reasons why relocation is recommended:_____

b. Residents choose to: remain in home relocate to friends/family
relocate to hotel/motel

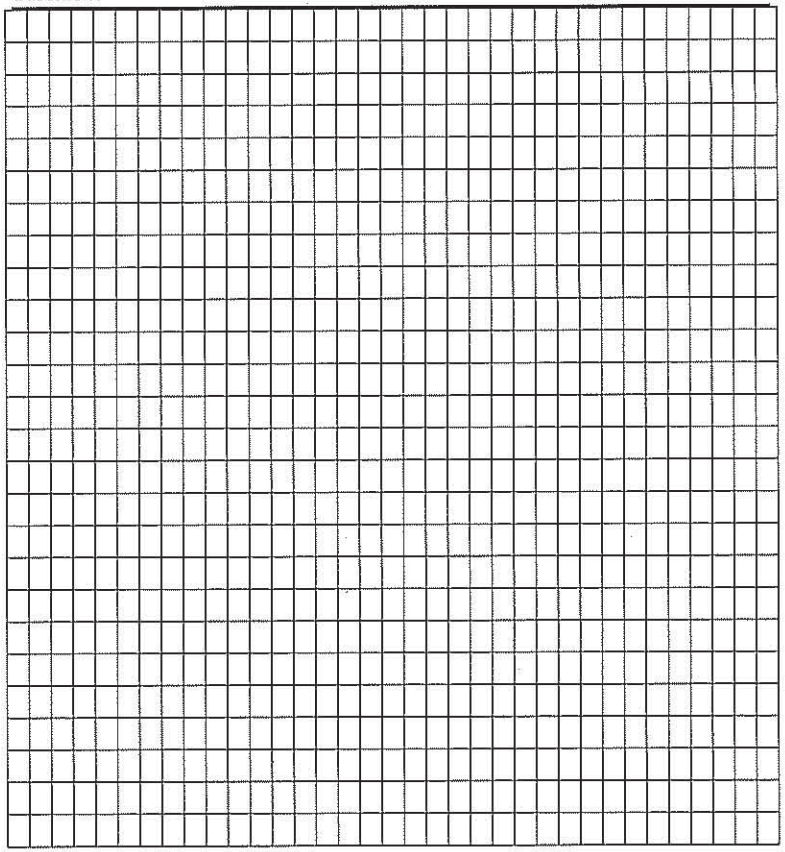
c. Responsibility for costs associated with reimbursement explained? Y / N

d. Relocation package provided & explained to residents? Y / N

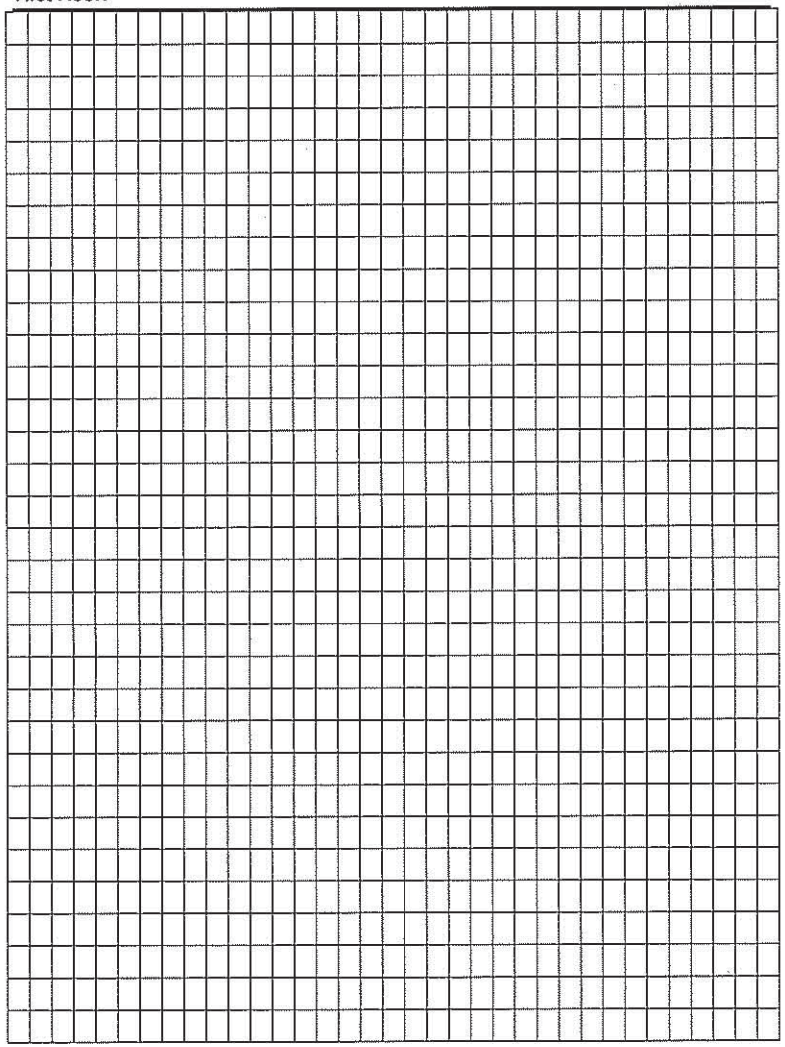
11. FLOOR PLANS

Draw a plan view sketch of the basement & first floor of the building. Indicate air sampling locations, possible indoor air pollution sources and PID meter readings. If the building does not have a basement, please note.

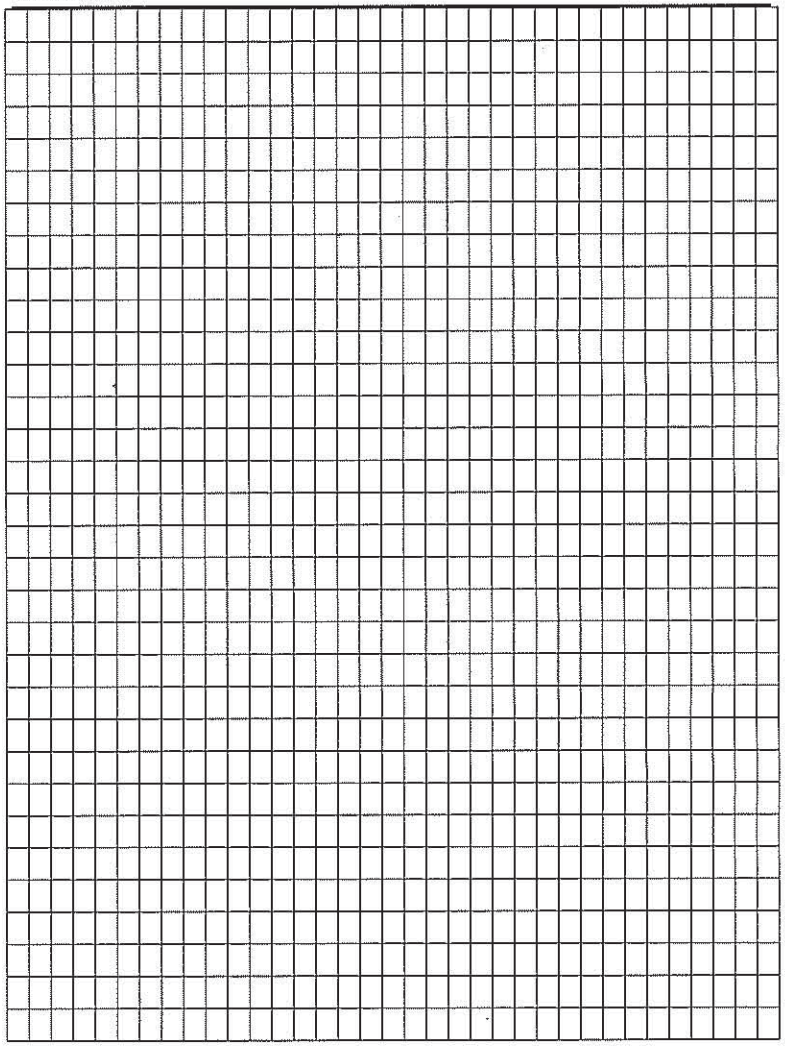
Basement:



First Floor:



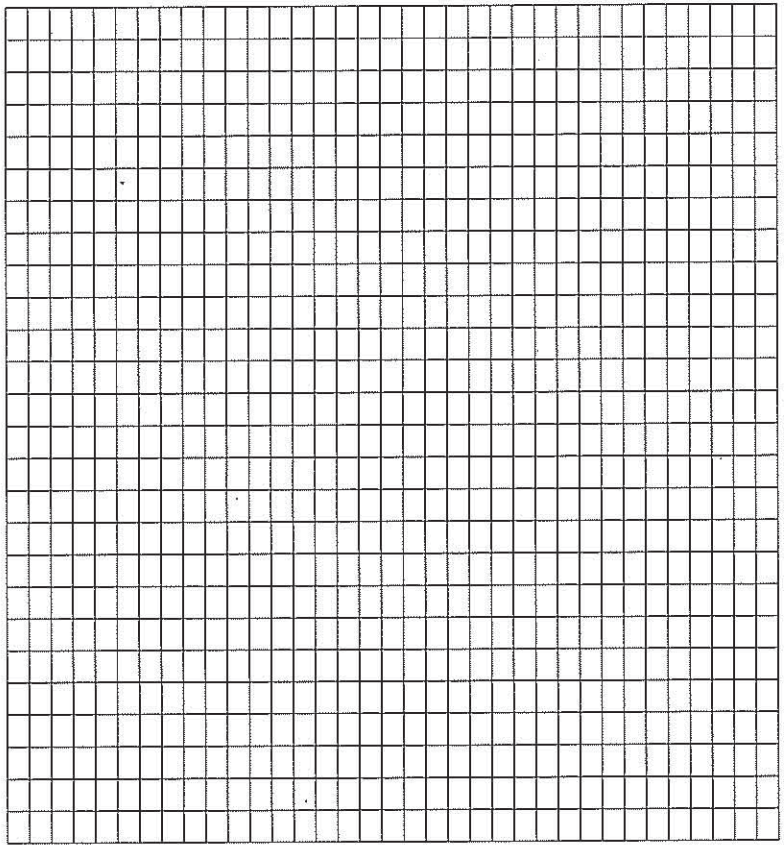
Second Floor:



12. OUTDOOR PLOT

Draw a sketch of the area surrounding the building being sampled. If applicable, provide information on spill locations, potential air contamination sources (industries, gas stations, repair shops, landfills, etc), outdoor air sampling location(s) & PID meter readings.

Also indicate compass direction, wind direction & speed during sampling, the locations of the well & septic system, if applicable, & a qualifying statement to help locate the site on a topographic map.



13. PRODUCT INVENTORY FORM

Make & Model of field instrument used:_____

List specific products found in the residence that have the potential to affect indoor air quality.

Location	Product Description	Size (units)	Condition*	Chemical Ingredients	Field Instrument Reading (units)	Photo** Y / N
	ARTISTIC PAINTS - OIL, ACRYLIC, WATER BASED SPRAY PAINT.					
	SOLVENTS & THINNERS - METHO					
				- ETHANOL.		
				- TURPS		
				- ACETONE		
	GLUES - PVA					
	INSECT REPELLANT AEROSOL.					
	CLEANING PRODUCTS IN BATHROOM.					

*Describe the condition of the product containers as Unopened (UO), Used (U), or Deteriorated (D)
** Photographs of the front & back of the product containers can replace the hand written list of chemical ingredients. However, the photographs must be of good quality & ingredient labels must be legible.

Gasworks admin Building. Building 9

Complete this form for each building involved in indoor air testing

Preparer's Name: Dave James Date/Time Prepared: 18/05/2011
Preparer's Affiliation: EES Work Phone: 96871666
Purpose of Investigation: Identify suitable sampling locations. * potential indoor sources.

1. OCCUPANT:

Interviewed: Y/N

Last Name:_____ First Name:_____

Address:_____

County:_____

Home Phone:_____ Alternate Phone:_____

Number of Occupants/persons at this location:_____

Age of Occupants:_____

2. OWNER OR LANDLORD: (Check if same as occupant_____)

Interviewed: Y/N

Last Name:_____ First Name:_____

Address:_____

County:_____

Home Phone:_____ Alternate Phone:_____

3. BUILDING CHARACTERISTICS:

Type of Building: (Circle appropriate response)

Residential	School	Commercial/Multi-use
Industrial	Church	Other: Admin building

If the property is residential, type? (Circle appropriate response)

Ranch	2-Family	3-Family
Raised Ranch	Split Level	Colonial
Cape Cod	Contemporary	Mobile Home
Duplex	Apartment House	Townhouse/Condos
Modular	Log Home	Other: office building

If multiple units, how many? 1

If the property is commercial, type?

Business Type(s)_____

Does it include residences (i.e., multi-use)? Y/N If yes, how many?_____

Other characteristics:

Number of floors 1 Building age_____

Is the building insulated Y/N? How air tight? Tight / Average / Not Tight

4. AIRFLOW

Use air current tubes or tracer smoke to evaluate airflow patterns & qualitatively describe:

Airflow between floors

Airflow near source

Outdoor air infiltration

Infiltration into air ducts

5. BASEMENT & CONSTRUCTION CHARACTERISTICS (Circle all that apply)

a. Above grade construction: wood frame concrete stone brick

b. Basement type: full crawlspace slab other_____

c. Basement floor: concrete dirt stone other_____

d. Basement floor: unsealed (sealed) s/ab on grade
covered with _____ carpet allows.

e. Concrete floor: unsealed sealed
sealed with _____

f. Foundation walls: poured block stone
other brick

g. Foundation walls: unsealed (sealed)
sealed with _____

h. The basement is: wet damp dry moldy

i. The basement is: finished unfinished partially finished

j. Sump present? Y / N

k. Water in sump? Y / N not applicable

Basement/Lowest level depth below grade: No basement (feet)

Identify potential soil vapor entry points & approximate size (e.g., cracks, utility ports, drains)

6. HEATING, VENTING & AIR CONDITIONING (Circle all that apply)

Type of heating system(s) used in this building: (circle all that apply – note primary)

Hot air circulation	Heat pump	Hot water baseboard
Space heaters	Steam radiation	Radiant floor
Electric baseboard	Wood stove	Outdoor wood boiler

Other_____

The primary type of fuel used is:

Natural gas	Fuel oil	Kerosene
(Electric)	Propane	Solar
Wood	Coal	

Domestic hot water tank fueled by: elect.

Boiler/furnace located in: Basement Outdoors Main Floor
Other NO

Air conditioning: Central air Window units (Open windows)

Heat Pump (None)

Are there air distribution ducts present? (Y) / N

Describe the supply & cold air return ductwork & its condition where visible, including whether there is a cold air return & tightness of duct joints. Indicate the locations on the floor plan diagram.

air vents at top of building.

7. OCCUPANCY

Is basement/lowest lever occupied? Full-time Occasionally
Seldom Almost never

Level **General use of each floor (e.g., familyroom, bedroom, laundry, workshop, storage)**

Basement:_____

1st Floor office building. — copier room / printer

2nd Floor_____

3rd Floor_____

4th Floor_____

8. FACTORS THAT MAY INFLUENCE INDOOR AIR QUALITY

a. Is there an attached garage? Y / N
b. Does the garage have a separate heating unit? Y / N NA
c. Are petroleum-powered machines or vehicles stored in the garage (e.g., lawnmower, ATV, car) Y/N Please specify_____
d. Has the building ever had a fire? Y (N) When_____
e. Is a kerosene or unvented gas space heater present? Y / (N)
Where & Type?_____
f. Is there a workshop or hobby/craft area? Y (N)
Where & Type?_____
g. Is there smoking in the building? Y / (N) Frequency?_____
h. Have cleaning products been used recently? Y / N When & Type?_____
i. Have cosmetic products been used recently? Y / (N) When & Type?_____
j. Has painting/staining been done in the last 6 months? Y / (N)
Where & When?_____
k. Is there new carpet, drapes or other textiles? (Y) N Where & When?____
l. Have air fresheners been used recently? Y / (N) When & Type?_____
m. Is there a kitchen exhaust fan? Y / N
If yes, where vented?_____
n. Is there a bathroom exhaust fan? Y / N
If yes, where vented?_____
o. Is there a clothes dryer? Y / N If yes, is it vented outside? Y / N
p. Has there been a pesticide application? Y / N When & Type?_____
Are there odors in the building Y / N
If yes please describe:_____

Do any of the building occupants use solvents or volatile chemicals at work? (Y) / N
(e.g., chemical manufacturing or laboratory, auto mechanic or auto body shop, painting, fuel oil delivery, boiler mechanic, pesticide applicator, cosmetologist, carpet installer)
If yes, what type of solvents are used? printer cartridges.
If yes, are their clothes washed at work? Y (N)

Do any of the building occupants regularly use or work at a dry-cleaning service? (circle appropriate response)
Yes, use dry-cleaning regularly (weekly)

Yes, use dry-cleaning infrequently (monthly or less)
Yes, work at a dry-cleaning service
No
Unknown

Is there a radon mitigation system for the building/structure? Y / N ?

Date of Installation: o

Is the system active or passive? Active/Passive

9. WATER & SEWAGE

Water Supply: (Public water) Drilled well Driven well Dug well
Other:

Sewage Disposal: (Public sewer) Septic tank Leach field Dry well
Other:

10. RELOCATION INFORMATION (for oil spill residential emergency)

a. Provide reasons why relocation is recommended:

b. Residents choose to: remain in home relocate to friends/family relocate to hotel/motel

c. Responsibility for costs associated with reimbursement explained? Y / N

d. Relocation package provided & explained to residents? Y / N

No kitchen fan. / minor clean products.
- wall heater / air conditioner.

11. FLOOR PLANS

Draw a plan view sketch of the basement & first floor of the building. Indicate air sampling locations, possible indoor air pollution sources and PID meter readings. If the building does not have a basement, please note.

Basement: