Air Quality and Mould Inspection Report: Nauru Regional Processing Centre

Property Address:	Regional Processing Centre, Republic of Nauru
Date of Assessment:	09/10/14 – 14/10/14
This report has been requested for client:	Transfield Services
This report has been prepared by:	s. 47F(1) Biological Health Services on Tuesday 23rd December 2014

Executive Summary

Transfield Services provides integrated property and asset management services in Nauru and other countries. s. 33(a)(iii) . Asylum seekers or Transferees are housed in marquee-style accommodation tents on a wooden floor. Some tents are air-conditioned or have ceiling fans while others do not. The relative humidity and temperature is often >80% and 30°C respectively. Rainfall and high levels of humidity are common. These conditions are defined as unavoidable limitations deriving from the circumstances of Nauru. It has been observed that mould has grown on many of the tent surfaces, inside and outside. Although mould is found almost everywhere, it needs moisture and nutrients to grow. Significant indoor mould is almost always synonymous with the presence of moisture and accumulation within the indoor building envelope. Mould exposure can induce disease in several ways. Inhalation of live (viable) and dead (non-viable) fungi, fungal fragments or cell components, and of their microbial agents (odours caused from microbial volatile organic compounds) and are thought to be the most important mechanism. The majority of fungal spores are small enough to have aerodynamic diameters of 2-10µm, which is the size-range that can get into the upper and lower respiratory tract and cause rhinitis, asthma and alveolitis. Inhalation and aeroslization can happen in many ways and is influenced by building design and use patterns as well as mechanical ventilation sources. Persons are also exposed to mould through direct skin contact with spores or mycelium or cell-fragments. Factors that influence disease include the concentration and types of fungi, the presence of hidden moisture, and the dose-response relationship. Exposure to mould can sensitize persons and they can become immunosuppressed, experience allergy or become hypersensitive due to ingestion of toxins (mycotoxins). Transfield Services reported that to date, cleaning of the accommodation tents with bleach has partially worked, however, the mould tends to come back after several weeks. The purpose of this report is to quantify the existing levels of mould on surfaces and in the airspace of tents and other buildings at Nauru. This information is presented in terms of

thirteen different buildings or room volumes that are used for core activities on the Island by the service provider, allied contractors and other service providers and the asylum seekers themselves. The asylum seekers are housed on RPC2 and RPC3 depending on gender and family associations. RPC1 is the main base used for service provider accommodation and management functions. The tent material coupled with the elevated humidity and temperature has resulted in widespread and severe visible mould on inside and outside material surfaces. s. 33(a)(iii), s. 47C(1) [redacted] Therefore, all the accommodation tents require disposal and replacement with new or decontamination. A range of decontamination methods are therefore reviewed and suggested. The aim will be to remove the bulk visible mould through cleaning, followed by disinfection, followed by encapsulation of the tent surfaces with an s. 47(1)(b) [redacted] coating. Contamination was also assessed on RPC1 across a range of different modular buildings of various form and construction. Mould was again observed and quantified in multiple locations and was similarly graded into different risk categories. Again, a range of decontamination and maintenance cleaning methods are suggested for implementation. This report impacts on the maintenance management and cleaning services plans currently in use since mould is foreseeably likely to impact on the safety, well being and hygiene of the Transferees and other persons at this site. The problems can however be addressed in a systematic and scientific way through informed decision making to maintain and improve standards of cleaning and hygiene with regard to unavoidable limitations of Nauru. While no single approach can eliminate all risk from mould, the environmental remediation recommendations are both broad and specific and should enable Transfield Services to balance competing priorities and needs while exercising flexible yet effective judgment.

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Background Information

Operation Sovereign Borders (OSB) is a military-led, border security operation supported and assisted by a wide range of federal government agencies. The Offshore Detention and Returns Task Group—led by the Department of Immigration and Border Protection (DIBP) is responsible for the Nauru site. Construction company Transfield Services is paid by the Australian government to run the offshore detention centres at Nauru and at Manus Island.

In June 2014, Transfield Services began dialogue with me with the view to performing an on-site aerobiology inspection of the mould problem due to potential health concerns (work health and safety). It was reported to me that there was visible mould on some accommodation tents and that the problem kept coming back after thorough cleaning. Discussions ensued prior to attending at Nauru that covered moisture and condensation effects, relative humidity and ambient indoor and outdoor temperature of the region, seasonal rainfall and the temporary, impermanent accommodation issue inherent to the tent-city accommodation. To date, cleaning of the tents has included the use of sodium hypochlorite (bleach) wash downs, that according to visual perception by staff, has worked for some period (several weeks to few months), but that then the mould eventually reappears. It is notable that this procedure has been recommended as a suitable mould prevention strategy[1] in the literature, although its use is somewhat controversial.

Many airborne and surface-bound fungal and bacterial cells and spores are capable of causing disease in persons by direct infection, toxicosis or by allergy. A voluminous literature exists regarding the impact of water damage on and in the built environment and the potential for niche exploitation by moulds, yeasts and bacteria that in turn can cause a range of adverse health impacts in persons[2]. A complete literature review regarding the association between mould, yeast, bacteria, hyphal fragments, spores, endotoxins, mycotoxins, microbial volatile organic compounds, volatile organic compounds and other bioaerosols is beyond the scope of this report, and the interested reader is encouraged to consult the references at the end of this document.

1 Centers for Disease Control and Prevention. [*Mold Prevention Strategies and Possible Health Effects in the Aftermath of Hurricanes and Major Floods*. MMWR] 2006;55(No. RR-8).

2 *World Health Guidelines For Indoor Air Quality – Dampness and Mould*. 2009.

The purpose of this study is to evaluate the extent of the mould problem and particulate matter (air quality) at the Regional Processing Centre (RPC) at Nauru. The secondary aim of this study is to collect viable fungi, yeasts and bacteria that are typical of the contaminants inside the built environment and compare this to the outside, normal, ambient air which is the control. The third aim is to identify dominant fungi with the view towards developing and implementing a disinfection protocol for affected surfaces or room volumes. The fourth aim is to suggest avenues for future work that may become apparent during analysis of the data and development of recommendations.

The RPC is composed of three main areas, designated as RPC1, 2 and 3. RPC1 is the Main Staff Admin/Housing area for personnel from Transfield Services and other agencies. RPC2 is the Men's camp, while RPC3 is the Women and Families camp.

Introduction

In October 2014 I attended on-site to carry out the inspection and assessment reported on here, which is defined as the Baseline Survey Process, BSP. The aim of the BSP is to survey the three sites for readily observable moulds and physical deficiencies that may be conducive to mould formation. The BSP is not designed to serve as a comprehensive survey for the presence of observable mould and physical deficiencies, nor is it intended to reduce the risk of the presence of observable mold and physical deficiencies conducive to mould, nor is it to eliminate the risk that observable mold and physical deficiencies conducive to mold may pose to the building or its occupants.

The initial inspection and testing proposal was put together following several email and phone discussions with Transfield where it was decided to test/sample a few accommodation tents that showed no mould, some with mould and some having severe mould.

The initial sampling plan proposal aim was to test a minimum of: FOUR types of environments to include: x2 bad, x1 intermediate, x1 considered good.

This sampling plan had been worked out prior to arrival at Nauru and included the intention to take live cultures of fungi for analysis onto Petri-plate culture. To this end a Permit to Import Quarantine Material (Permit No: IP14016198) was obtained from the Department of Agriculture, Fisheries and Forestry to allow for differential and general agar culture media Petri plates to be brought from Australia to Nauru and then transported from Nauru back to Australia for the purpose of air and surface sampling of the environment and in buildings.

It is noted that the aim of this BSP is to provide guidance with regard to practical cleaning or other decontamination efforts that could be used to minimize mould growth, although it should be recognized that:

As noted by EPA 402-K-01-001, sampling cannot be used to assess whether a commercial

> building complies with federal standards, since no EPA or other federal standards or Threshold Limit Values (TLVs) have been established for mold spores. And, sampling would only produce results reflecting a specific moment in time in the best case and could produce inaccurate or misleading results in the worst case.
>
> **Active Standard ASTM E2418**

Importantly, the data defined by this BSP will be assessed against the Australian Mould Guideline (2010), which provides a clear set of reference threshold values that have been followed in the absence of a Standard.

On arrival to Nauru and after a tour of the Island the initial sampling proposal was significantly revised and expanded in consult with Transfield personnel. Transfield staff decided on which buildings or areas should be sampled/investigated. Both visual and multi-sensory observations (bulk visible mould and damp smells) showed that the scale of the mould contamination problem at Nauru is considered to be an enormous challenge. Mould was observed to be affecting almost all external and internal walls, ceilings and roofs of every tent used for accommodation at RPC2 and 3. Visible mould and mould odours were also present in many of the portable buildings on RPC1.

Therefore, the scope of this inspection was extended beyond the initial proposal to sample as many representative structures and areas spanning across all three RPC's and was designed to maximize the limited microbiological sampling resources that had been taken from Australia to carry out testing. This report therefore defines the elements investigated as part of this baseline survey.

Sampling Schedule

1.	Fly-in from Brisbane, tour of island by car	09/10/14
2.	RPC 2 – Main Admin Area	10/10/14
3.	RPC 2 – Tent #18	11/10/14
4.	RPC 3 – Tent #37	12/10/14
5.	RPC 3 – Tents #36, #38, #39, #40	12/10/14
6.	RPC 1 – PsyCare offices (x2)	13/10/14
7.	RPC 1 – IHMS Hospital	13/10/14
8.	RPC 1 – Mess Hall and Cold Storage Areas	13/10/14
9.	RPC 1 – A Building (Room 103)	13/10/14
10.	RPC 1 – H 219 (Room 219)	13/10/14
11.	RPC1 – School	13/10/14
12.	Fly out to Brisbane with samples in Esky	14/10/14
13.	Fly into Melbourne with samples and incubate after arrival	15/10/14

General Observations

Asylum seekers are housed in marque-style tents. Each tent is entered via flaps at either end. Some tents are air-conditioned; some have circulating ceiling-mounted fans while others have no method to provide cooling. Flooring is of unfinished marine plywood. Gravel distributed around tents is used to presumably improve drainage. Initially, asylum seekers were housed in portable/modular housing that makes up the bulk of the built-structure on RPC1. Recently though, an influx of additional asylum seekers led to the use of tents for housing. The ambient temperature is regularly in the high 30°C. Relative humidity is commonly above 85%. There is a strong smell of mould in many of the buildings/units used for accommodation on RPC1. There are many examples of in-room visible mould patches on walls and ceilings in different buildings on RPC1. The tents in either RPC2 or RPC3 have very extensive (almost universal) visible mould inside and outside on tent surfaces affecting walls, ceilings and roofs. Bathroom, shower, recreation/gym, tents used for worship and mess hall areas are all affected. Staff are in the main fly-in, fly-out so exposure risks are intermittent, while for asylum seekers, exposure risks are persistent. There is a rigorous policy concerning the taking of digital photographs and video that impacted on this report, since a 'video-tour' would have defined the scale and extent of the problem more completely. Due to privacy and procedural concerns, and without perspective-scale imagery, the scale of this mould problem is difficult to convey in text. However, a large number of targeted photographs have been taken that were approved for use in this report, and these highlight many different localized mould affected surfaces or areas without showing persons or buildings in-use. Table A below shows several

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[redacted]

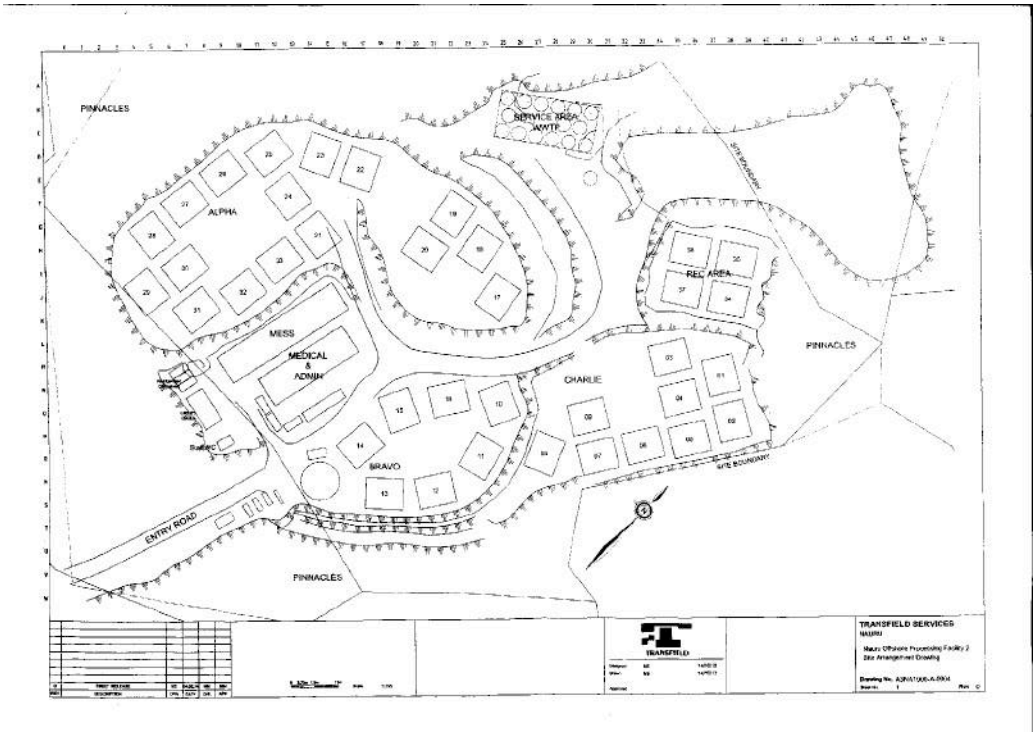

Figure A2. Map of RPC2 showing tent arrangement for the male/single person camp.

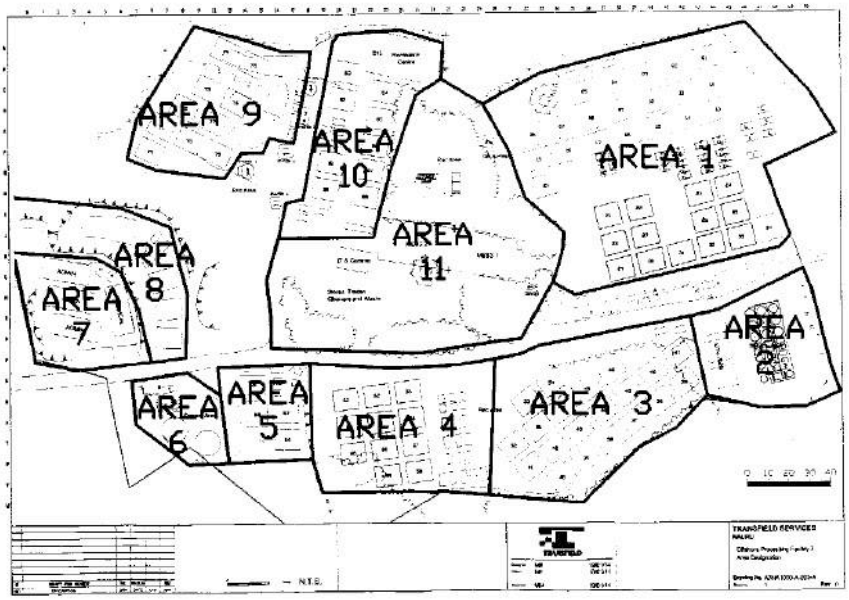

Figure A3. Map of RPC3 for the women's/family camp.

Sampling Approach

This assessment is to compare the suspect area from non-suspect areas and outdoors. This includes but is not limited to total airborne and dominant spore types, total viable airborne fungi seen at culture, hyphal fragments, and background debris (and their concentrations). The objective is to know whether there are amplification sources in the complaint area(s).

Sampling was broken down into different data sets for each area examined as follows:

1. Direct Readings: Direct reading sampling includes temperature, humidity and moisture levels and infra red thermography.
2. Datalogging: Sampling focused on particle counts inside versus outside.
3. Biological Sampling – Non-Culture Based Analysis: Sampling included the use of bio-tape to remove surface matter and air sampling for spores into an air-cassette.
4. Biological Sampling – Culture-Based Analysis: Sampling included the use of swabs and an air impactor.
5. Biological Sampling – Chemical-Based Analysis: Sampling included the use of Adenosine Triphosphate (ATP) activity.

Results will be provided in tabular and/or graphical format of all sampling results including direct reading, data-logging, and laboratory sampling (culturable and non-culturable).

Methods

Pre-prepared sterile culture media (Department of Microbiology & Immunology, The University of Melbourne) was packed into an Esky and transported from Melbourne to Brisbane and onto Nauru where the plates were stored in a fridge until use in the field. After sampling, plates were placed into zip-locked bags and stored at room temperature until all samples were packed back into the Esky and taken by air from Nauru to Brisbane and onto Melbourne according to the Permit to Import Quarantine Material (IP14016198). Each plate was periodically photographed to generate a time-series growth profile. Ambient air temperature was measured using an Environmental Instrument Temperature/Humidity/Dew Point Meter as required. Localised wall, floor and ceiling surface moisture levels were recorded using an Environmental Instrument Moisture Tester if required. Alternatively, selected localised wall, floor and ceiling temperature profiles were recorded using a FLIR i5 Infrared Thermographic Camera if required. Indoor air quality to evaluate fine and coarse particulate matter ($PM_{2.5}$ and PM_{10}) was measured using an AeroTrak Particle Counter, Model 9306-4. Adenosine Triphosphate, an indicator of microbial and vegetative matter bio-burden was evaluated with a Ruhof ATP Complete swab system, where swabs of flat surfaces used a standard 10 x 10cm area of interest. Similarly, swabs of uniform 10 x 10cm area of selected surfaces were streak-sampled if required for viable cell counting to Petri-plates using sterile cotton tipped applicators (Dynarex). Interpretation of colony forming unit counts (CFU) was compared to reference standards published in the *Australian Mould Guideline* (Kemp & Neumeister-Kemp, 2010). Microbiological testing was performed by taking air and/or surface samples onto sterile Potato Dextrose Agar (PDA) Petri-plates for fungi and for bacteria onto NC AGAR – Horse Blood Agar and Nalidixic Acid and Colistin (Oxoid Formulation Base) supplemented with colistin and nalidixic acid. The antibiotics suppress growth of *Enterobacteriaceae* and *Pseudomonas* species while allowing yeasts, *Staphylococci*, *Streptococci* and *Enterococci* to grow. Certain gram-negative organisms, such as *Gardnerella* vaginalis and some *Bacteroides* species can grow very well. Colistin disrupts the cell membrane of gram-negative organisms, it is particularly effective against *Pseudomonas* species. Nalidixic acid blocks DNA replication in susceptible bacteria and acts against many gram-negative bacteria. Candidiasis causing organisms were isolated using CHROM AGAR – Chromogenic Candida Agar (Dutec Formulation - CHROMagar Candida Agar CA222). This is a differential medium for the isolation and differentiation of *Candida sp* using a colour reaction. Typical results show: *Candida albicans* – green colonies, *Candida tropicalis* – blue colonies or *Candida glabrata* – mauve colonies. Air sampling was performed by exposing plates agar surface upwards for two (2) minutes using a QuickTake Anderson type impact sampler set at 28.3L per/minute flow rate as required. We follow the standard detailed in Bioaerosols: Assessment and Control (Macher, 1999) where the detection limit is one colony forming unit per plate = 18 colony forming units per cubic metre (CFU/m^3). Surface samples were taken if required by taking sterile swabs of regions of interest and transferring via streak inoculation onto PDA plates. These were incubated at 30°C for up to 7 days under controlled conditions as well as ambient conditions during travel from Nauru to Melbourne, before presumptive Genus identification and microbial counts were taken and documented on different days before confluent growth conditions. Colonies were identified

to Genus and or Species for each plate at Day 5 for fungi that grew on PDA media. Colonies that grew on the other differential media were already selective for specific types of microorganisms and were scored as appropriate for that medium. Identification of *Genus* and *Species* for fungi was made with reference to Larone (2011), St-Germain & Summerbell (2011) and Winn Jr et al. (1997) as well as other reference/taxonomic texts or keys. Colony counts using the standard colony forming unit index, CFU was performed in this report on Days 3, 4 and 5 and were facilitated using an electronic colony counter to assist with manual indexing of discrete colonies on the Petri-plate. Image analysis of petri plates used ImageJ *ver* 1.48, National Institute of Health. Optical density and mode image analysis operations used standard algorithms and a circular region of interest was used to digitally isolate only the contents of each Petri-plate. Optical density assessed the dominant grey-scale from light transmittance, while the mode is the most frequent observation of spectral density. Thee routines provided a decision framework for comparing biofilm characteristics. Statistical analysis was performed using Sigma Plot *ver* 13.0 or Microsoft Excel *ver* 14.1.4 or RStudio *ver* 0.98.1091. Key industry references, standards, and guidance documents included but were not limited to:

1. Standard Guide for Assessment Of Fungal Growth in Buildings. ASTM International. Designation: ASTM D7338 - 14.
2. Standard Guide for Readily Observable Mold and Conditions Conducive to Mold in Commercial Buildings: Baseline Survey Process. ASTM International. Designation: ASTM E2418 – 06
3. Standard Test Method for Categorization and Quantification of Airborne Fungal Structures in an Inertial Impaction Sample by Optical Microscopy. ASTM International. Designation: ASTM D7391 - 09
4. Standard Test Method for Categorization and Quantification of Airborne Fungal Structures in an Inertial Impaction Sample by Optical Microscopy. ASTM International. Designation: D7391 – 09.
5. Standard Practice for Collection of Fungal Material From Surfaces by Tape Lift. ASTM International. Designation: D7910 – 14.
6. Standard Practice for Collection of Fungal Material from Surfaces by Swab. ASTM International. Designation: ASTM D7789-12
7. Standard Test Method for Evaluating Degree of Surface Disfigurement of Paint Films by Fungal or Algal Growth, or Soil and Dirt Accumulation. ASTM International. Designation: D3274 – 09 (Reapproved 2013).
8. Standard Guide for Developing Methodology for Evaluating the Ability of Indoor Materials to Support Microbial Growth Using Static Environmental Chambers. ASTM International. Designation: ASTM D6329 - 98(2008)
9. Work Item: ASTM WK28565 - New Practice for the Collection of Culturable Airborne Fungi on Agar Plates by Inertial Impaction Systems. ASTM International. Designation: ASTM WK28565
10. Work Item: New Practice for Collection of Total Airborne Fungal Spores via Inertial Impaction Methodology. ASTM International. Designation: ASTM WK22872
11. Work Item: New Practice for Developing and Performing a Sampling Strategy to Collect Meaningful Data during the Assessment of Fungal Growth in Buildings. ASTM International. Designation: ASTM WK32489
12. Standard 55-2013 -- Thermal Environmental Conditions for Human Occupancy (ANSI Approved)
13. EPA 402-K-01-001. Mold Remediation in Schools and Commercial Buildings. United States Environmental Protection Agency. September 2008.
14. BSR/IESO/ASHRAE Standard 3210-20XX First Public Review Draft. Standard Guide for the Assessment of Education Facilities for Moisture Affected Areas and Fungal Contamination. Stake, J., Harr, B., Havics, A., Lapotaire, J., Rosenberg, S., Sweet, E. & Harman, P. (2014). BSR/IESO/ASHRAE 3210 S [45-Day Public Review Period from November 21, 2014 to January 5, 2015]
15. Kemp. P. & Neumeister-Kemp, H. (2010). Australian Mould Guideline. The Enviro Trust.

16. Kemp, P. & Neumeister-Kemp, H. (2010). The Mould Worker's Handbook – A Practical Guide for Remediation. The Enviro Trust.
17. BSR-IICRC S520-2008 Mold Remediation Standard and Reference Guide for Professional Mold Remediation
18. PAS 64:2013 Mitigation and recovery of water damaged buildings. Code of practice, British Standards Institution
19. Environmental Abatement Council of Ontario's (EACO) Mould Abatement Guidelines. Edition 2 (2010)
20. WHO Guidelines for Indoor Air Quality: Dampness and Mould. World Health Organisation. ISBN 978 92 890 4168

Results

1. RPC 2 – Main Admin Area Tent

Data was collected for analysis that included:

1. General observations and photographic summary
2. Basic descriptive dimensions of the tent
3. Relative humidity and ambient temperature – inside and outside
4. Moisture content of selected areas
5. Spot temperatures of the tent
6. Air quality parameters ($PM_{2.5}$ and PM_{10}) of the internal tent volume regions/areas versus outdoors
7. ATP surface hygiene of the internal and external surfaces of the tent at different locations

General Observations of RPC2 – Main Admin Area Tent

This tent is air-conditioned and is used for administration. There are several partitions that form individual offices of differing sizes. Power is available and this tent is air-conditioned. The air conditioning plant and equipment is immediately to the side of the main entrance and is visually contaminated on the external surfaces with what appears to be mould and algae. There is a high level of condensation on the outside of ductwork. This tent is a high-activity building and it appears that many persons use this throughout the day and night. The tent measured 10m wide x 30m length. The low point, floor to ceiling height was approx. 2.28m, while the high point, was approx. 3.86m. The tent has a pitched roof sloping towards the side walls (low point).

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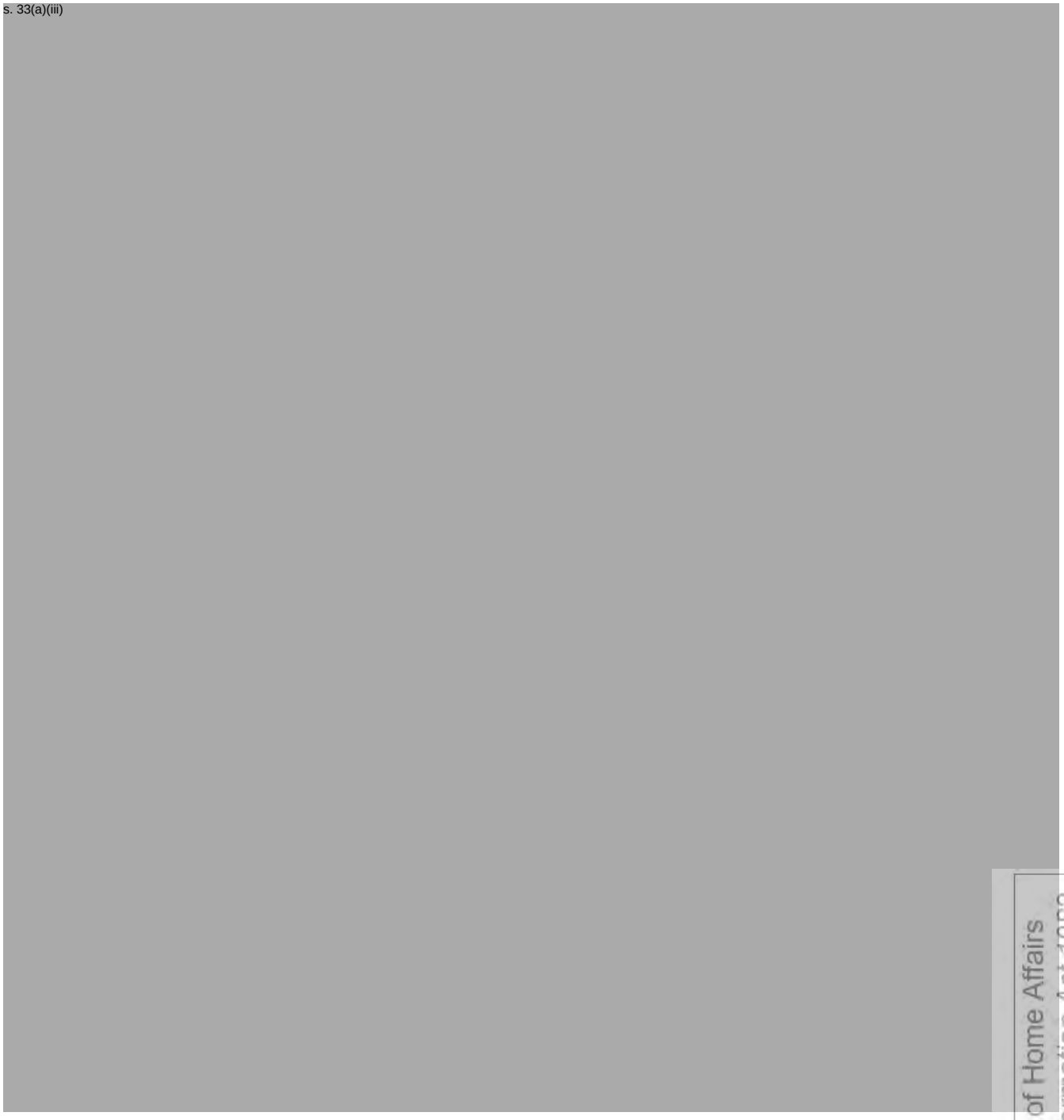


Environmental Parameters of RPC2 – Main Admin Area Tent

The following areas were sampled:

1. Outdoor Control
2. Entrance (2.5 m inside from front flap)
3. Office (RHS)
4. Site Manager's Office

5. Welfare Case Management Office
6. Education Office

Location	Relative Humidity	Temperature
Outdoor Control	59.15 ± 0.51	32.25 ± 0.73
Entrance	38.93 ± 0.49	29.77 ± 0.06
Office (RHS)	40.60 ± 0.10	29.50 ± 0.00
Site Manager's Office	39.47 ± 0.40	29.10 ± 0.00
Welfare Case Management Office	37.83 ± 0.15	28.90 ± 0.00
Education Office	42.87 ± 0.50	28.27 ± 0.06
Mean Indoor Levels	39.94 ± 1.92	29.11 ± 0.58

Table 1.2. Comparison of the outdoor relative humidity and temperature for several locations inside the Main Admin Tent on RPC2 relative to the outdoor ambient air and humidity. This tent is fully air conditioned and the data shows that AC provides a significant benefit in terms of reducing the indoor relative humidity. This is likely to retard the growth of mould indoors. It was noted that none of the internal walls appeared to show mould growth. Mould growth appeared to be restricted to outside, on external wall surfaces. The airconditioning significantly helps control the indoor relative humidity to levels that are not conducive to mould growth.

Moisture tests were conducted on the wooden flooring inside the tent as well as some of the internal plywood walls. These showed respectively: 12.32% ± 0.80 and 10.70% ± 0.23. These moisture levels are considered in the normal range.

Spot temperature readings from within the tent directed towards the roof line since significant visible mould was seen on the roof, revealed that the temperature variation was of course dependent on the direction of the sun with roof line mean readings on the sunny side showing 30.68°C ± 1.86 while it was 25.63°C ± 0.40 on the shaded side.

Air Quality Testing of RPC2 – Main Admin Area Tent

Indoor air quality has also been assessed using a laser particle counter. Readings were taken from outside which served as the control and from inside the tent (indoor environment). If the indoor environment is compromised, then the indoor counts are likely to show higher levels compared with the control. The 6-channels cover bin sizes of size classes spanning: 0.3, 0.5, 1.0, 3.0, 5.0 and 10µm size fractions. The size distributions follow a logarithmic decay from smallest to largest; therefore we can compare and contrast between different rooms or spaces using the smallest size class as the diagnostic. This is because there is good research evidence (Brasel et al., 2004) that mould and allergens inside homes are presented to sensitive individuals on the smallest size particles, of less than 1µm.

Other research shows that there is a strong relationship between indoor air quality and allergic and respiratory health of school age children and for adults who are sensitized to fungal bioaerosols. Concentrations of fine particles with aerodynamic diameter ≤2.5µm, referred to as the $PM_{2.5}$ fraction are those size classes spanning the average over bins of size: 0.3, 0.5, 1.0

and 3.0µm. Coarse particles are those generally greater than 10µm and includes the 5 and 10µm classes. The fine particles are easily inhaled and clinical manifestations of asthma and rhinitis are strongly correlated with indoor environments that present high $PM_{2.5}$ particulates (Anessi-Maesano et al., 2012). Allied research by McCormack et al. (2011) showed that indoor particulate matter, especially the $PM_{2.5}$ and PM_{10} size class was positively correlated with asthma and allergic sensitization in children and sensitized adults. It is known that fungal hyphae are generally larger and are commonly indexed using the PM_{10} size class, although fragments of mould have been shown to be well indexed by the $PM_{2.5}$ size class, so both classes of particulates are important to quantify. Recent research by Mobasher et al. (2013) has shown that the $PM_{2.5}$ fraction exposure during the first trimester of pregnancy were significantly associated with hypertensive disorders of pregnancy. Allied research by Agay-Shay et al. (2013) has shown that for the coarse particles, the PM_{10} class, maternal exposure to increased concentrations of PM_{10} was associated with congenital heart defects.

Particulate matter counts are a highly sensitive method to evaluate indoor air quality and is considered to quantify both viable and non-viable particulates. I cite the following papers as evidence:

(i) Cao, Chen., Jiang, W., Wang, B., Fang, J., Lang, J., Tian, G., Jiang, J. & Zhu, T. (2014). Inhalable microorganisms in Beijing's $PM_{2.5}$ and PM_{10} pollutants during a severe smog event. *Environ Sci Technol*. **48**(3): 1499-1507.

Their results showed:
The fungal versus bacterial fraction for $PM_{2.5}$ was = 13% : 86.1%
The fungal versus bacterial fraction for PM_{10} was = 18.3% : 81%
Therefore, the PM_{10} size classification captures higher numbers of fungal bioaerosols, 18.3% versus 13% for the $PM_{2.5}$.

(ii) Degobbi, C., Lopes, Fernanda D.T.Q.S., Carvalho-Oliveira, R., Munoz, J.E. & Saldiva, P.H.N. (2011). Correlation of fungi and endotoxin with $PM_{2.5}$ and meteorological parameters in atmosphere of Sao Paulo, Brazil. *Atmospheric Environment*. **45**(13): 2277-2283.

"The results have shown that fungi and endotoxins represent significant portion of $PM_{2.5}$, reaching average concentrations of 772.23 spores µg-1 of $PM_{2.5}$ and 5.52EU mg-1 of $PM_{2.5}$ respectively. Hyaline basidiospores, *Cladosporium* and total spore counts were correlated to $PM_{2.5}$. Genera *Penicillium/Aspergillus* were correlated to the total mass of $PM_{2.5}$. Therefore, the relative contribution of bioaerosol in $PM_{2.5}$ should be considered in future studies aimed at evaluating the clinical impact of exposure to air pollution."

(iii) Alghamdi, M.A., Shamy, M., Redal, M.A., Khoder, M., Awad, A.H and Elserougy, S. (2014). Microorganisms associated particulate matter: a preliminary study. *Sci Total Environ*. 479-480(1 May): 109-116.

This paper worked out the microbiological contribution of particulate matter (PM) and discovered that: "The sum of microbial loads was higher in PM_{10} than $PM_{2.5}$, however a significant correlation ($r = 0.57$, $P \leq 0.05$) was found between the sum of microbial loads

associated PM_{10} and $PM_{2.5}$. *Aspergillus fumigatus* and *Aspergillus niger* were the common fungal types associated PM. Wind speed positively correlated with airborne microorganisms associated PM. The regression model showed that the inverse $PM_{2.5}$ concentration ($1/PM_{2.5}$) was a significant determinant of fungal count associated PM."

Therefore, at Nauru we will examine how PM varies in different areas of the island. The following areas of the Main Admin Tent were sampled:

1. Outdoor Control #1
2. Outdoor Control #2
3. Outdoor Control #3
4. Entrance
5. Office (RHS)
6. Site Manager's Office
7. Welfare Case Management Office
8. Education Office

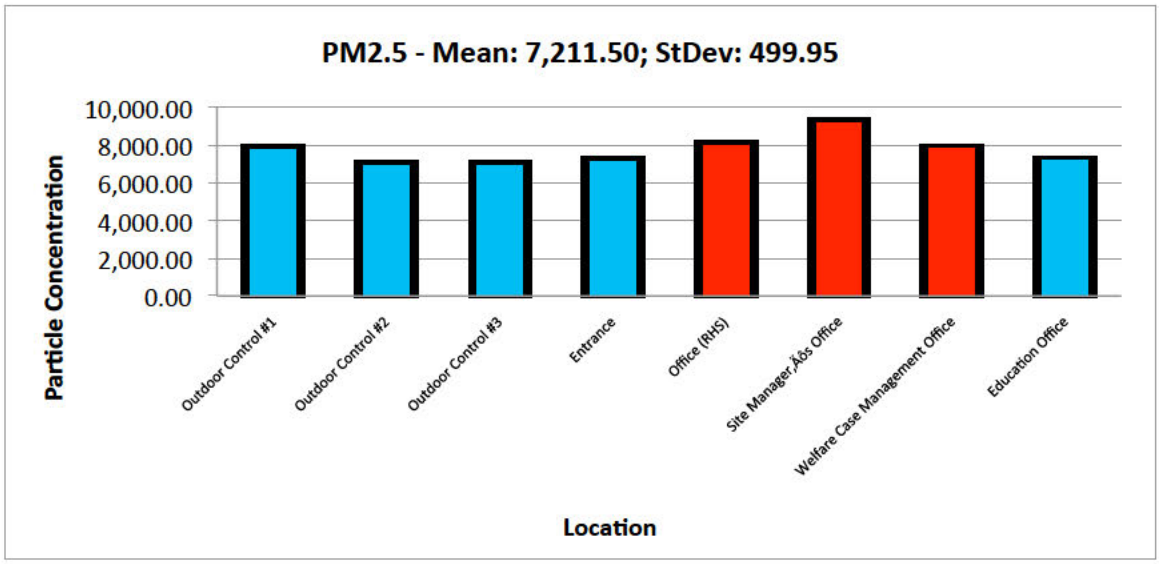


Figure 1.1. The bioaerosol distribution for the $PM_{2.5}$ class of fine particles for each area tested versus the three outdoor controls. The mean and standard deviation for the three controls is provided for reference. Based on this evidence, THREE of the FIVE areas or 60% of the tested areas in the tent are contaminated with fine particles that exceed normal concentration levels relative to the three outdoor controls. s. 33(a)(iii), s. 47C(1)

[redacted]

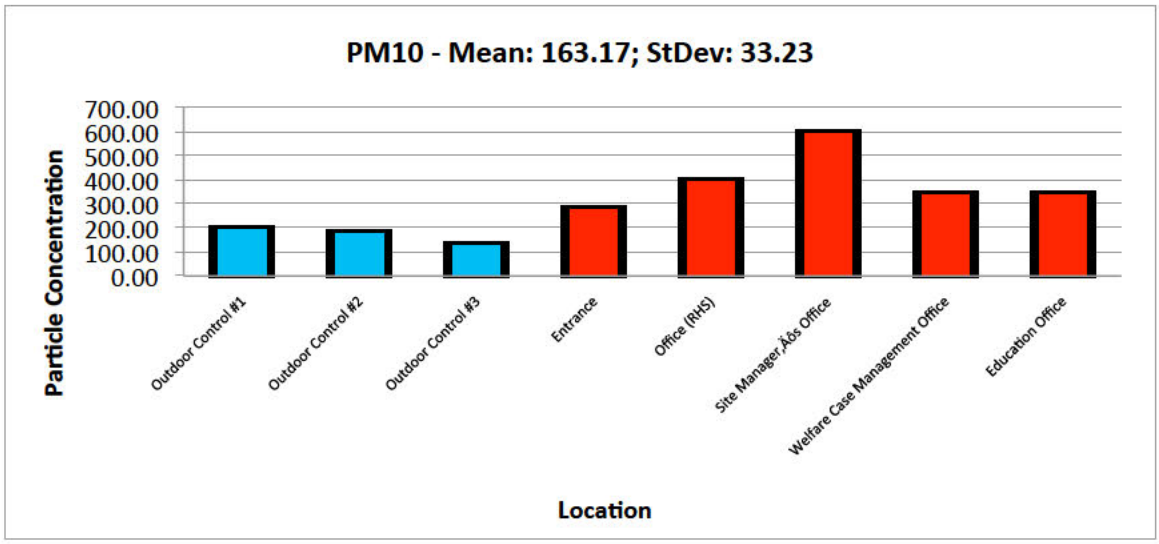


Figure 1.2. The bioaerosol distribution for the PM_{10} class of fine particles for each area tested versus the outside controls. The mean and standard deviation for the three controls is provided for reference. The PM_{10} size class is the coarser fraction that generally shows mould spores and hyphal fragments.

s. 33(a)(iii), s. 47C(1)

[redacted]

ATP Results of RPC2 – Main Admin Area Tent

Adenosine Triphosphate, an indicator of microbial and vegetative matter bio-burden was evaluated with a Ruhof ATP Complete swab system. The ATP Complete system is aimed at hospitals and healthcare facilities to provide a rapid and reliable way to test for cleanliness of surfaces and hard to reach areas – which in turn, would help reduce hospital acquired infections in the workplace and improve staff safety. The method works by detecting an enzyme called ATP (adenosine triphosphate). This is a universal energy molecule found in all animal, plant, bacterial, yeast and fungal cells. The benefits of rapid swab technology are that it provides on-the-spot information allowing for immediate corrective action and is faster than traditional microbiology and better than visual inspection. As well, it provides the opportunity for trend analysis and cleaning validation.

The use of ATP for rapid hygiene testing after water damage claims is well supported by the fact that the British Standard PAS 64:2013 for Mitigation and Recovery of Water Damaged Buildings: Code of Practice states that a "hygiene testing record - using ATP or swabs" is used when planning and provisioning for a company to clean, decontaminate and dry a flooded building. In addition, other research by Shaughnessy et al (2013) and Smith (2009 etc.) has published threshold specifications for ATP in use in Schools and when assessing water damage and possible microbial contamination after flooding/water ingress. As well, the use of ATP has been further validated by the US Department of Homeland Security Science and Technology Directorate with regard to biological assay of microbial agent (2014).

One relative light unit is considered to be equivalent to 1ftmol of ATP. Recommended Pass/Fail criteria have been developed and we review these below in Table 1.3.

Application	Recommended Pass/Fail Criteria	
	Pass (RLU) ✓	Fail (RLU) ✗
Surgical Instruments and Scopes	0-45	46 and over
Sterile Processing, table tops, counter tops	0-45	46 and over
Hand hygiene	0-200	201 and over
Benchmark risk for hospital surface cleanliness	0-100	101 and over

Table 1.3. Pass/Fail Interpretation Guidelines for the Ruhoff ATP Complete system.

It should be noted also that according to several publications by S.K. Smith (2009 and others) threshold values using the Ruhoff system have been developed and matched against the IICRC S520 Condition thresholds as follows, where surface samples were relatively dry or had been impacted with water and were near dry when sampled for ATP.

Samples Surface Condition	Moisture Content (%)	ATP Testing Results (RLU)		IICRC S520 Condition
		Pass (RLU) ✓	Fail (RLU) ✗	
No visible microbial growth	<15%	1-150	>151	1
No visible microbial growth – within areas with visible microbial growth	<15%	50-150	>151	2
Visible microbial growth	<15%	NA	>150	3
Visible microbial growth	≥15%	NA	>500	3

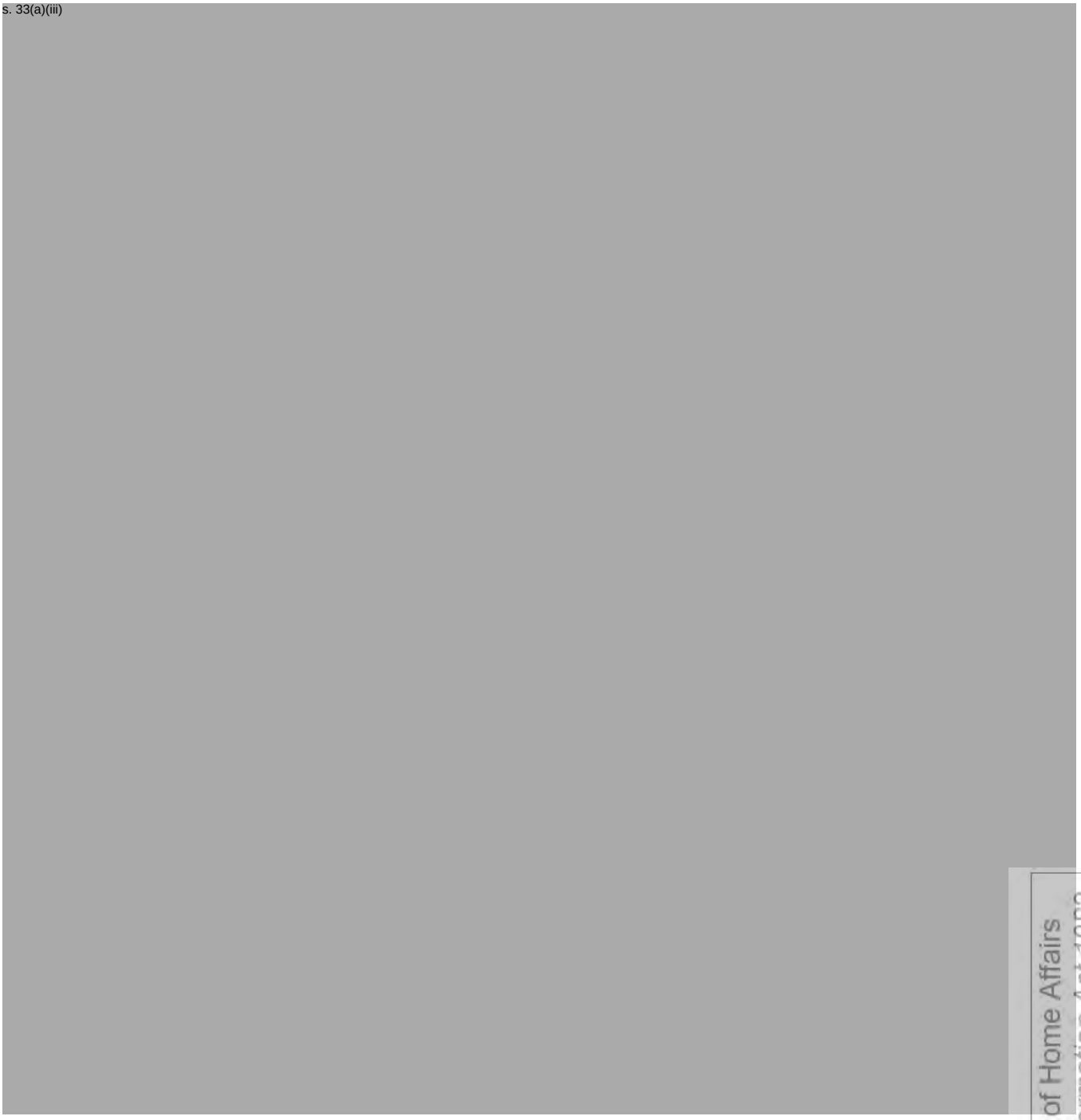
Table 1.4. Pass/Fail Interpretation Guidelines for the Ruhoff ATP Complete system according to S.K. Smith.

Therefore, in this report, I have set the ATP threshold at 150RLU.

Adenosine triphosphate (ATP) bioluminescence is a method to rapidly swab any area to look for vegetative material. It is an excellent method to measure microscopic and invisible areas to detect the presence of vegetative material, normally found in bacterial and fungal cells. In this way, ATP measures the level of surface contamination and is widely used by environmental health officers to assist with assessing cleanliness. The expected levels of ATP are in the range 45-150 fmol measured as relative light units (rlu) of ATP for a clean area. Mould affected areas almost always show levels significantly higher and over 150 rlu. In this study, we have used the more liberal RLU threshold of 150 to interpret results into pass and fail categories after Table 1.4. The following areas were sampled:

1. Wooden Floor
2. External Surface of Air Conditioning Ductwork
3. External Surface of Main Admin Tent at Entrance

s. 33(a)(iii)



s. 33(a)(iii), s. 47C(1)

2. RPC 2 – Sample Tent #18

Data was collected for analysis that included:

1. General observations and photographic summary
2. Basic descriptive dimensions of the tent
3. Relative humidity and ambient temperature – inside and outside
4. Moisture content of selected areas
5. Spot temperatures of the tent inside and outside
6. Air quality parameters ($PM_{2.5}$ and PM_{10}) of the internal tent volume at different locations within the tent
7. Sampling grid methodology
8. ATP surface hygiene of the internal and external surfaces of the tent at different locations
9. Viable mould sampling to PDA of (i) air (ii) surface swabs - inside tent surfaces (walls and ceiling) and (iii) surface swabs - external tent surfaces (walls and roof)
10. Viable bacterial sampling to CHROM- AGAR and NC-AGAR of (i) air (ii) surface swabs - inside tent surfaces (walls and ceiling) and (iii) surface swabs - external tent surfaces (walls and roof)
11. Air sampling inside and outside the tent to Air-O-Cell cassettes
12. Surface sampling (inside and outside) to Bio Tape-Lifts for microscopic examination
13. Infra Red thermal imaging of the tent – inside and outside

General Observations of RPC2 – Tent #18

In comparison with the RPC2 – Main Admin Area tent, this accommodation tent #18 is not air conditioned. There were three ceiling mounted circulating fans in use. The tent measured 10m wide x 12m length. The low point floor to ceiling height was approx. 2.36m, while the high point was approx. 4m. The tent had a pitched roof sloping towards the side walls (low point). This tent is used to house male asylum seekers. At the time of testing the tent was considered to have very good cross flow ventilation, since each end of the tent was open and the side walls could be kept adjar.

s. 33(a)(iii)

s. 33(a)(iii)

Environmental Parameters of RPC2 – Tent #18

The following areas were sampled:

1. Outdoor Control
2. Inside Tent #18

Location	Relative Humidity	Temperature
Outdoor Control	72.77 ± 1.00	29.43 ± 0.31
Mean Indoor Levels	70.13 ± 0.76	31.00 ± 0.26

Table 2.2. Comparison of the outdoor relative humidity and temperature for several locations inside the RPC2 Tent #18 relative to the outdoor ambient air and humidity. This tent is not airconditioned but uses three ceiling mounted fans to provide some control of the air temperature and to provide air circulation. The relative humidity is considered very high.

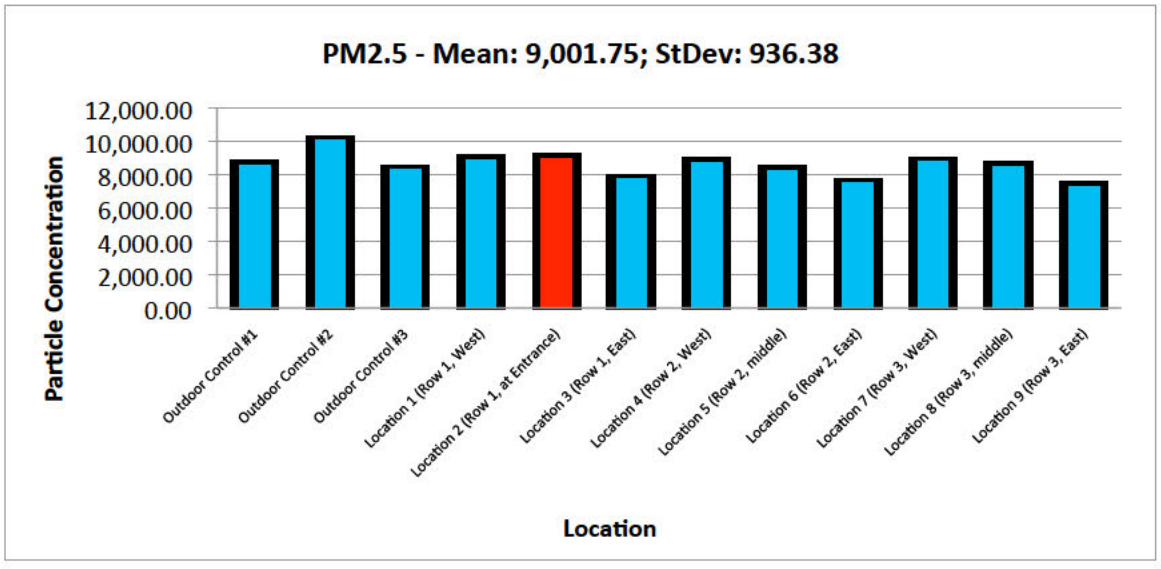
Moisture tests were conducted on the wooden flooring inside the tent. These showed: 20.53% ± 0.87. The wooden flooring is considered to show trapped moisture that would be conducive to mould growth especially considering the abundant ligninocellulose content of this flooring.

Spot temperature readings from within the tent taken from multiple locations across the underside of the internal ceiling sampling at multiple areas showing visible mould, revealed that the temperature variation was 43.00°C ± 1.47. The ceiling temperature is considered very high and would put selective pressure on thermotolerant mould and bacterial strains that can withstand high local temperatures.

Air Quality Testing of RPC2 – Tent #18

The following areas were sampled:

1. Outdoor Control #1
2. Outdoor Control #2
3. Outdoor Control #3
4. Location 1 (Row 1, West)
5. Location 2 (Row 1, at Entrance)
6. Location 3 (Row 1, East)
7. Location 4 (Row 2, West)
8. Location 5 (Row 2, Middle)
9. Location 6 (Row 2, East)
10. Location 7 (Row 3, West)
11. Location 8 (Row 3, Middle)
12. Location 9 (Row 3, East)



s. 33(a)(iii), s. 47C(1)

NO FORSEEABLE cause for concern by the occupants or staff attending to the occupants. It is my view that the excellent natural ventilation is assisting with dilution of the fine-sized $PM_{2.5}$ particle loading that is reasonably likely to be present due to the visual bulk of mould observed inside this tent.

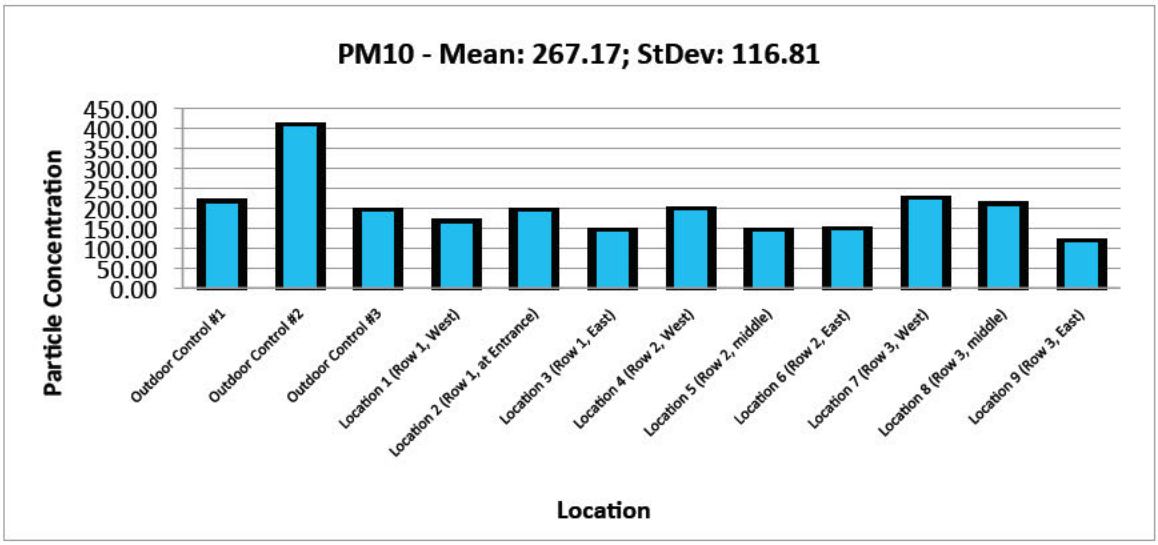
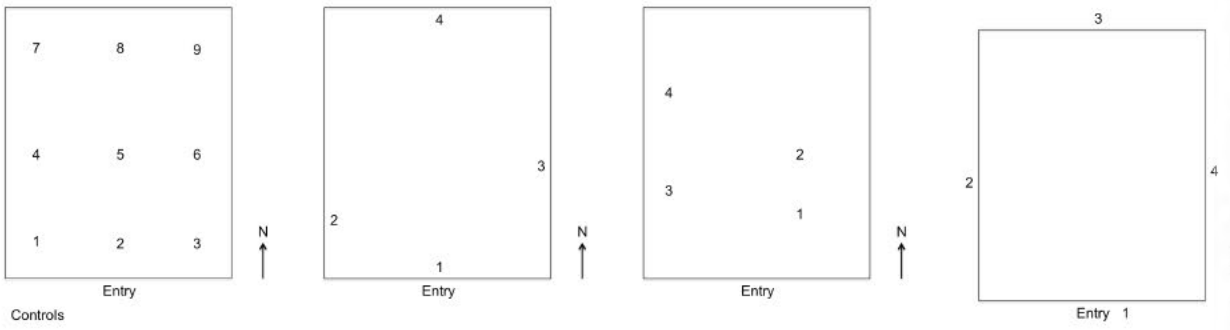


Figure 2.2. The bioaerosol distribution for the PM_{10} class of fine particles for each area tested versus the outside controls. The mean and standard deviation for the three controls is provided for reference. The PM_{10} size class is the coarser fraction that generally shows mould spores and hyphal fragments. Based on this evidence, NONE of the NINE areas inside the tent are contaminated with coarse particles that exceed normal concentration levels relative to the three outdoor controls and are considered statistically valid. It is concluded that there is NO evidence of an indoor air quality problem presented by coarse particles belonging to this size class grouping inside the tent and IS NOT considered serious and is of NO FORSEEABLE cause for concern by the occupants or staff attending to the occupants. It is my view that the excellent natural ventilation is assisting with dilution of the coarse-sized PM_{10} particle loading that is reasonably likely to be present due to the visual bulk of mould observed inside this tent.

Sampling Grid

A consistent sampling method was followed. This is to ensure that comparisons between a typical tent on RPC2 and RPC3 can be made. Figure 2.3 shows the general sampling grid locations for the different tests. In principle all internal walls, floors and ceilings were sampled and compared to all external walls and roofs.



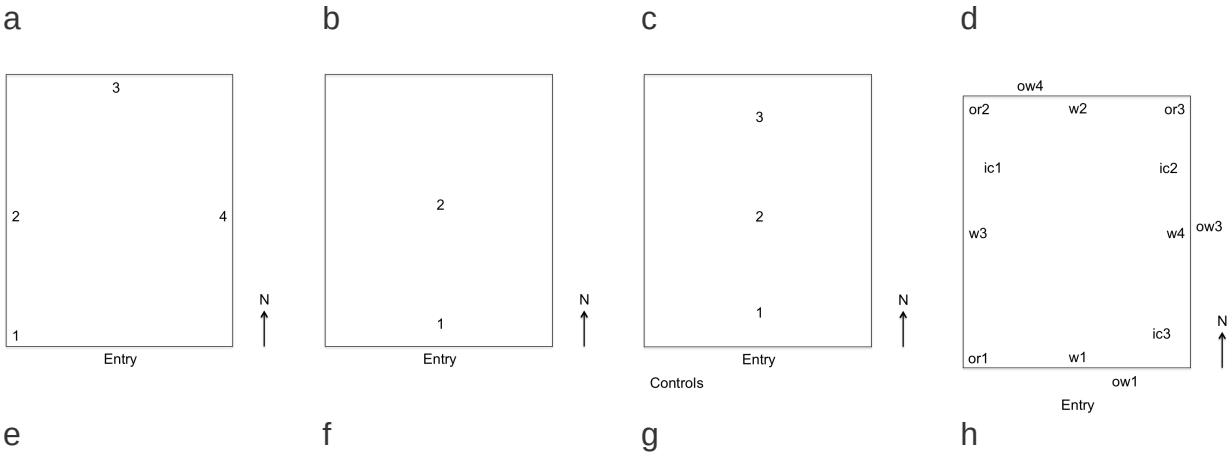


Figure 2.3. Samples of air and or surface swabs or ATP swabs were made from the locations given in the following schematic diagrams. This sampling grid was followed in general for samples taken from RPC2 – Tent #18 and RPC3 – Tent #37 to ensure identical sampling and comparison between data sets. (a). Particulate matter, $PM_{2.5}$ and PM_{10} (b) ATP, Internal Walls, (c) ATP, Internal Roofs, (d) ATP, External Walls, (e) ATP, External Roofs, (f) ATP, Internal Floors, (g) Indoor Air, (h) Swabs: Internal walls, w; Internal ceilings, ic; Outside walls, ow; Outside Roofs, or.

ATP Results of RPC2 – Tent #18

The following areas were sampled:

1. Internal Wall – South
2. Internal Wall – West
3. Internal Wall – East
4. Internal Wall – North
5. Internal Ceiling – SE Side
6. Internal Ceiling – Middle
7. Internal Ceiling – West
8. Internal Ceiling – NW
9. External Wall – South
10. External Wall – West
11. External Wall – North
12. External Wall – East
13. External Roof – South
14. External Roof – West
15. External Roof – North
16. External Roof – East
17. Internal Floor – South
18. Internal Floor - Middle

Location – RPC2 Tent #18	ATP Result	Interpretation
Internal Wall – South	15 rlu	Low

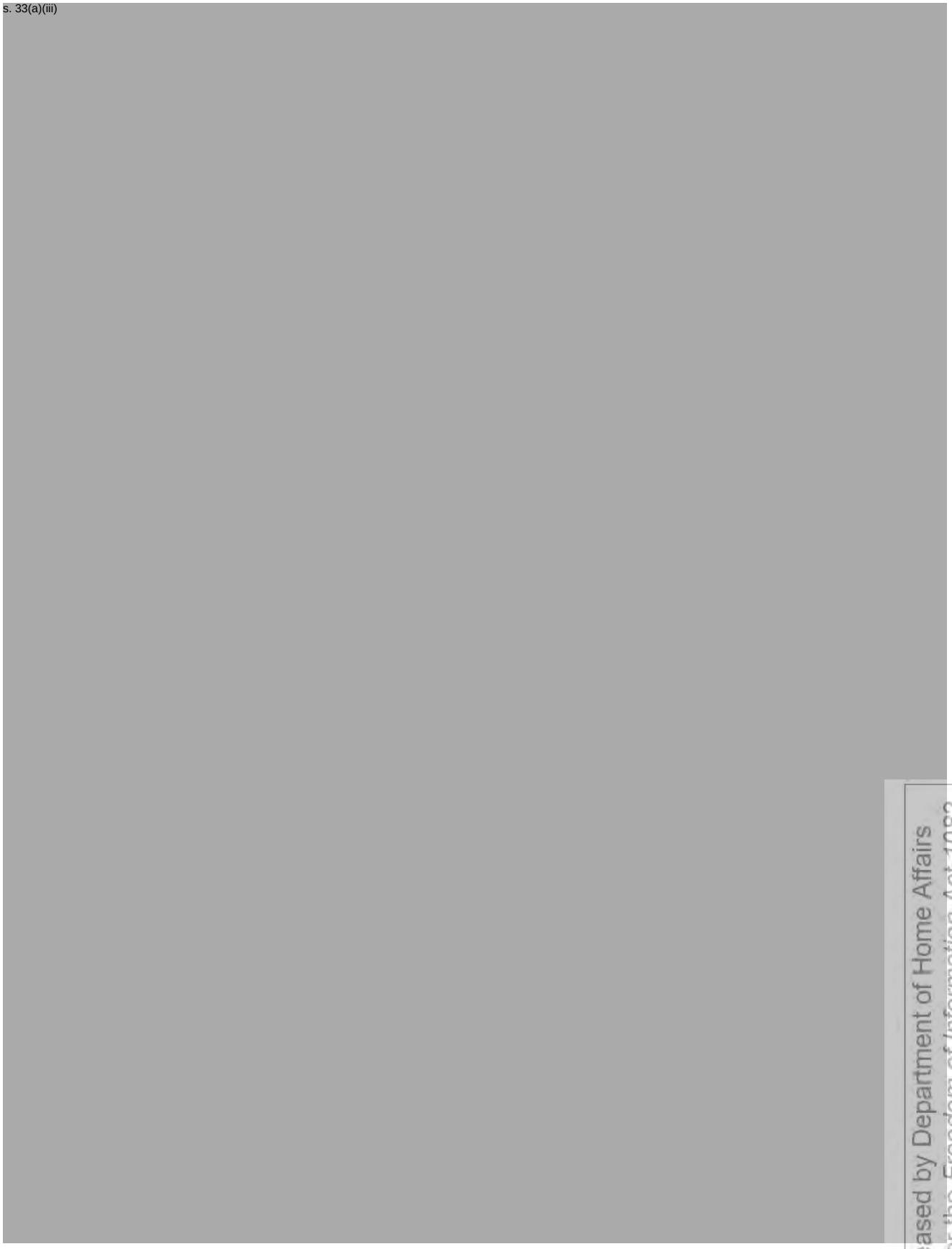
s. 33(a)(iii)

[redacted]

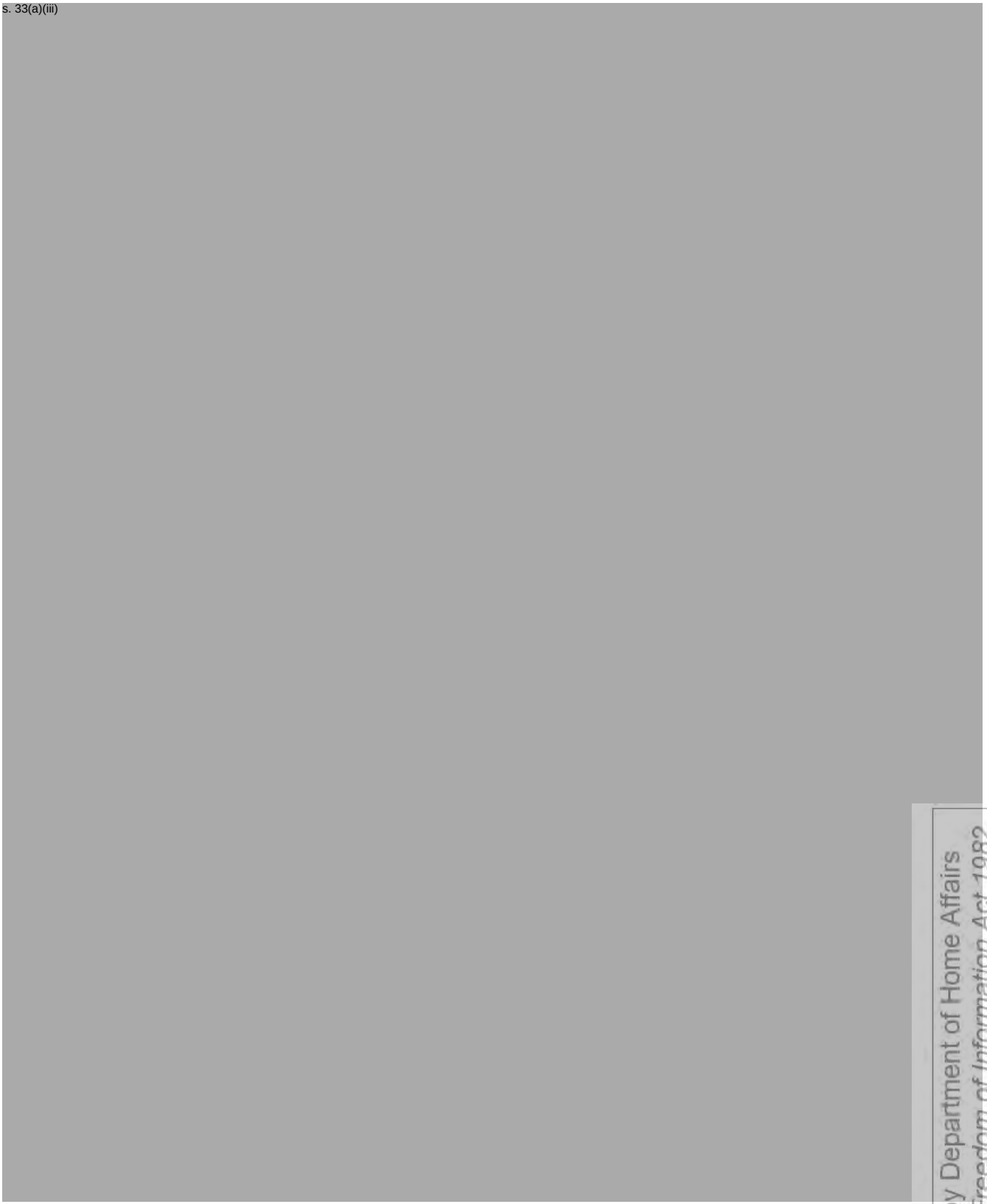
s. 33(a)(iii)

[redacted]

s. 33(a)(iii)



s. 33(a)(iii)



This data can be further summarized to determine the cumulative impact of the different readings by plotting the mean values for the different regions.

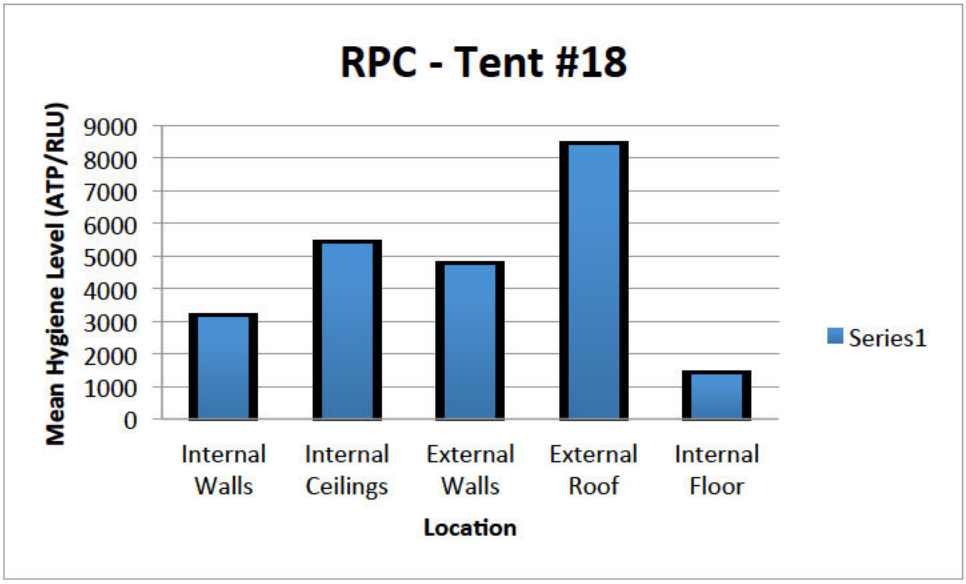


Figure 2.4. The mean ATP values were plotted for each area and we can see that in order from worst to least: (i) External roof, (ii) Internal ceilings, (iii) External walls, (iv) Internal walls, followed by the (v) Internal floor.

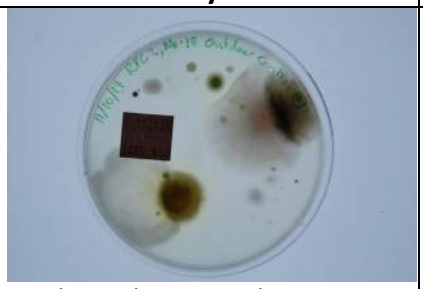
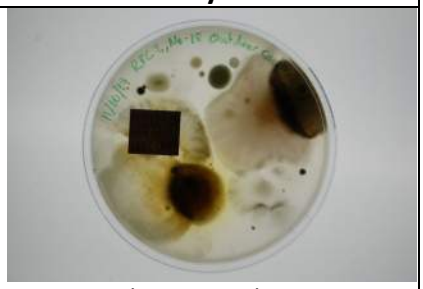
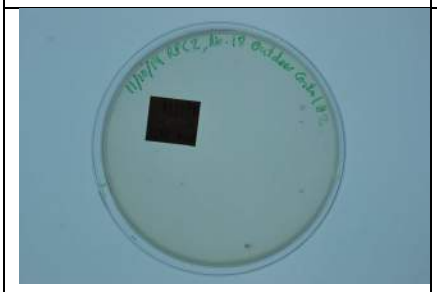
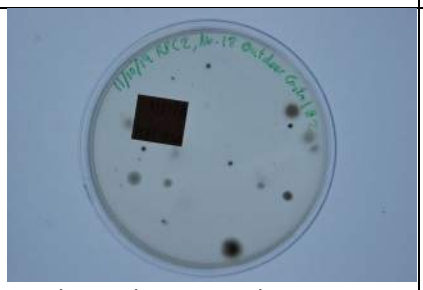
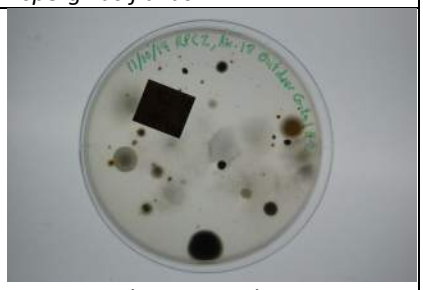
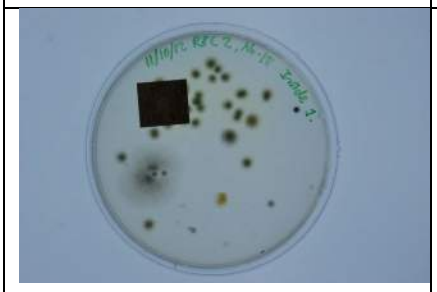
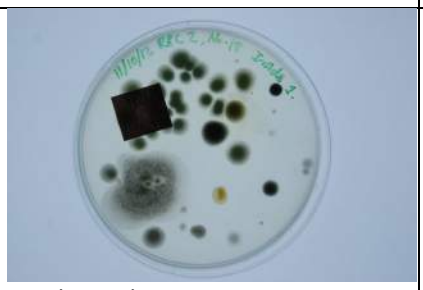
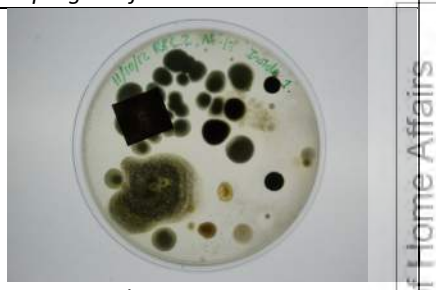
The ATP results show that the external roof is the most significantly affected surface with ATP-containing microorganisms. The internal tent ceilings are the next most affected surface; followed by the external walls; then the internal walls; and lastly the internal floors. The main difference between this tent (#18) and the Main Admin Tent is that Tent #18 is not air conditioned and is used for accommodation. All surfaces pose a high dermal contact risk to persons.

Biological Sampling – Culture-Based Analysis of RPC2 – Tent #18

Fungi:

The following PDA petri plates were used to measure the air quality inside and outside RPC2 Tent #18 by measuring the level of viable fungi that were present as bioaerosols in the air.

1. Outdoor Control #1
2. Outdoor Control #2
3. Inside Tent, Location #1
4. Inside Tent, Location #2
5. Inside Tent, Location #3

PDA AGAR – Location: RPC2 - Tent #18		
Day 3	**Day 4**	**Day 5**
 Fig 1a. Outdoor Control #1 Air Sample CFU = 13	 Fig 1b. Outdoor Control #1 Air Sample CFU = 25	 Fig 1c. Outdoor Control #1 Air Sample CFU = 28 *Cladosporium, Scedosporium, Penicillium, Microsporum, Aspergillus flavus*
 Fig 2a. Outdoor Control #2 Air Sample CFU = 11	 Fig 2b. Outdoor Control #2 Air Sample CFU = 32	 Fig 2c. Outdoor Control #2 Air Sample CFU = 70 *Cladosporium, Scedosporium, Penicillium, Microsporum, Aspergillus flavus*
 Fig 3a. Inside Tent, Location #1 Air Sample CFU = 39	 Fig 3b. Inside Tent, Location #1 Air Sample CFU = 40	 Fig 3c. Inside Tent, Location #1 Air Sample CFU = >100 *Alternaria, Aspergillus flavus, Penicillium, Rhizopus, Candida sp., Aspergillus niger, Aspergillus fumigatus*

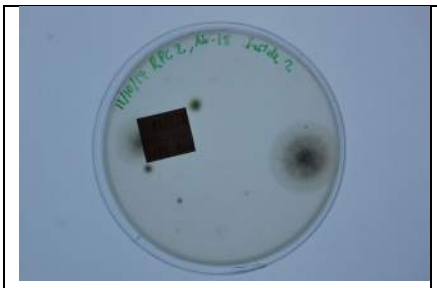
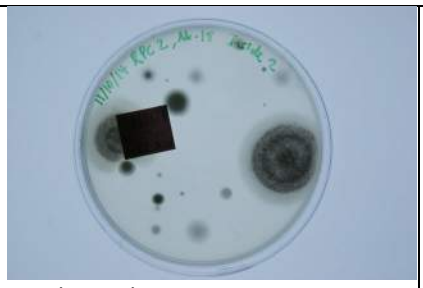
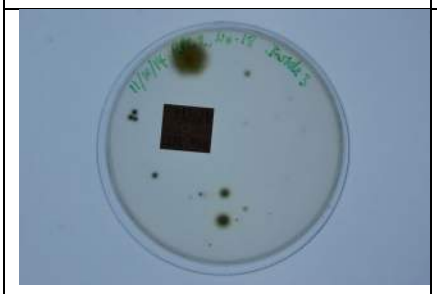
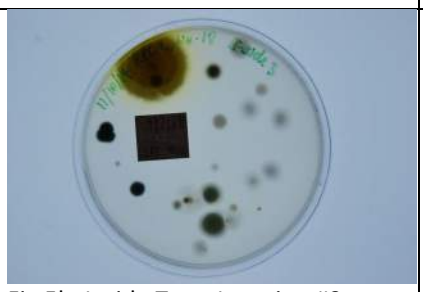
 Fig 4a. Inside Tent, Location #2 Air Sample CFU = 11	 Fig 4b. Inside Tent, Location #2 Air Sample CFU = 20	 Fig 4c. Inside Tent, Location #2 Air Sample CFU = >150 *Aspergillus flavus, Penicillium, Rhizopus, Candida sp., Aspergillus fumigatus, Aspergillus niger*
 Fig 5a. Inside Tent, Location #3 Air Sample CFU = 19	 Fig 5b. Inside Tent, Location #3 Air Sample CFU = 26	 Fig 5c. Inside Tent, Location #3 Air Sample CFU = 28 *Epicoccum, Aspergillus versicolor, Aspergillus flavus, Chaetomium, Chrysosporium, Microsporum, Cladosporium, Aspergillus tereus, Candida sp.*

Table 2.4. Air samples were taken at the different locations and incubated for 3-5 days and inspected daily. The total number of different fungi were measured each day to plot the colony forming units, CFU on each day. Once growth has reached Day 5 it is evident that the levels of mould inside the tent is higher than the levels outside the tent. This means that all persons who enter this tent are being exposed to viable moulds at levels well beyond the background levels present in the atmosphere. Fungi were identified to Genus and or Species on each plate on Day 5.

Details for the pathogenicity of the different fungi is given in Appendix 1.

This data can be summarized in a graph shown below in Figure 2.5.

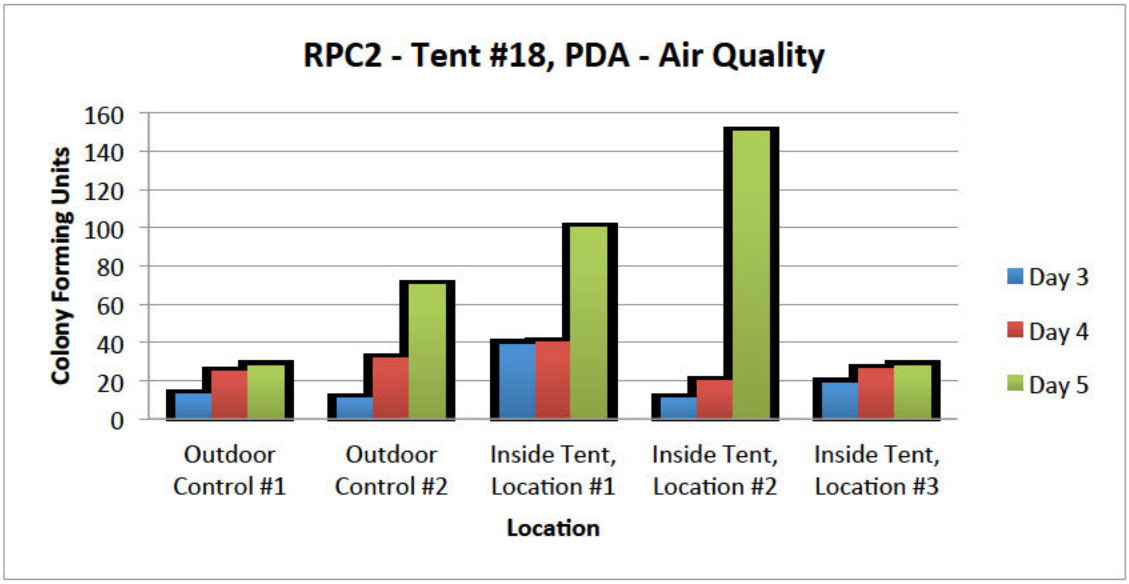


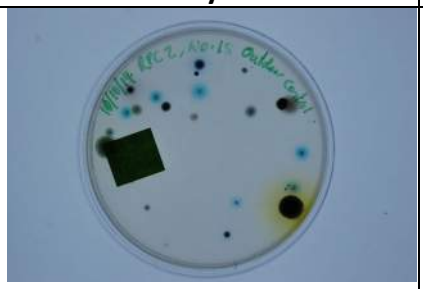
Figure 2.5. The colony forming unit counts were plotted on each day as bar graphs. Inside the tent at locations #1 and #2 confirms that the airspace concentration of viable fungi is significantly higher than outdoors. Inside the tent at Location #3 was taken towards the rear of this tent where the opening was almost completely open, so the potential for good mixing of indoor and outdoor air is also reflected in the CFU readings that are closer to the outdoor control that locations in other internal areas of this accommodation tent.

Two out of three locations sampled inside the tent showed levels of more than twice the mean of the two outdoor controls. This means that the air quality inside this tent is unacceptable and it is foreseeably likely that all persons who enter this tent are breathing in and are exposed to dermal contact with viable mould and spores at levels that are in excess to the outdoor normal concentration.

Bacteria (air samples):

The following two air samples were also taken from within Tent #18 onto CHROM AGAR and NC AGAR respectively to measure the air quality inside and outside the tent by measuring the level of viable bioaerosols including bacteria and yeasts that are not always detected using PDA agar and were compared against the outdoor control air. Table 2.5 details the plate reactions for Candida yeast species and mixed fungal populations. The green colonies are considered to be *Candia albicans*. The other dominant fungi seen were *Aspergillus fumigatus* and *Geotrichum* species.

1. Outdoor Control
2. Inside Tent, Location #1
3. Inside Tent, Location #2

CHROM AGAR – Location: RPC2 - Tent #18		
Day 3	**Day 4**	**Day 5**
		
Fig 1a. Outdoor Control #1 Air Sample CFU = 19	Fig 1b. Outdoor Control #1 Air Sample CFU = 26	Fig 1c. Outdoor Control #1 Air Sample CFU = 31

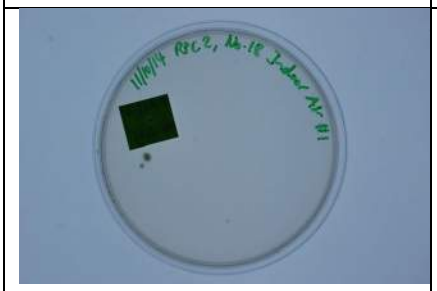
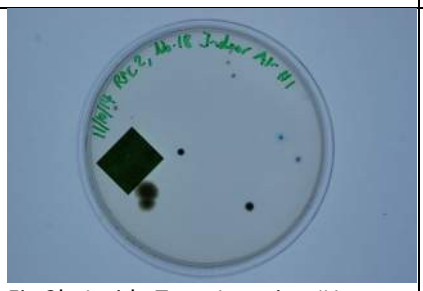
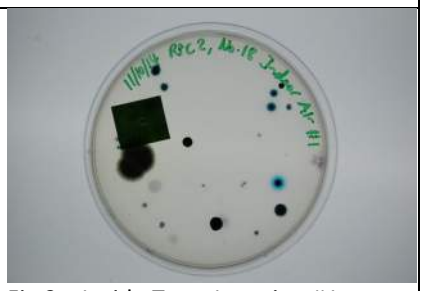

		

Fig 2a. Inside Tent, Location #1 Air Sample CFU = 4	Fig 2b. Inside Tent, Location #1 Air Sample CFU = 11	Fig 2c. Inside Tent, Location #1 Air Sample CFU = 27

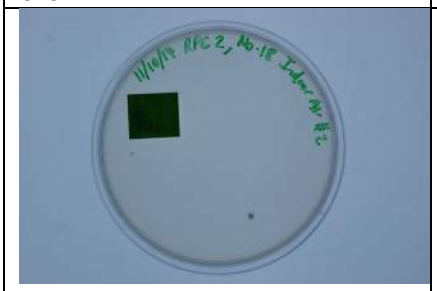
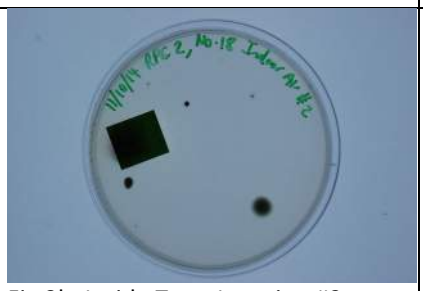

	

Fig 3a. Inside Tent, Location #2 Air Sample CFU = 4	Fig 3b. Inside Tent, Location #2 Air Sample CFU = 6	Fig 3c. Inside Tent, Location #2 Air Sample CFU = 16

Table 2.5. Air samples were sampled onto CHROMagar candida medium for the presumptive identification of Candia yeast species and detection of mixed fungal populations from air on RPC2 – Tent #18. The aim is to determine if the indoor tent environment presents with a threat from Candidiasis-causing microorganisms. These results suggest that the air space inside the tent has lower levels of Candida sp. that outdoors.

This data can be summarized in a graph shown below.

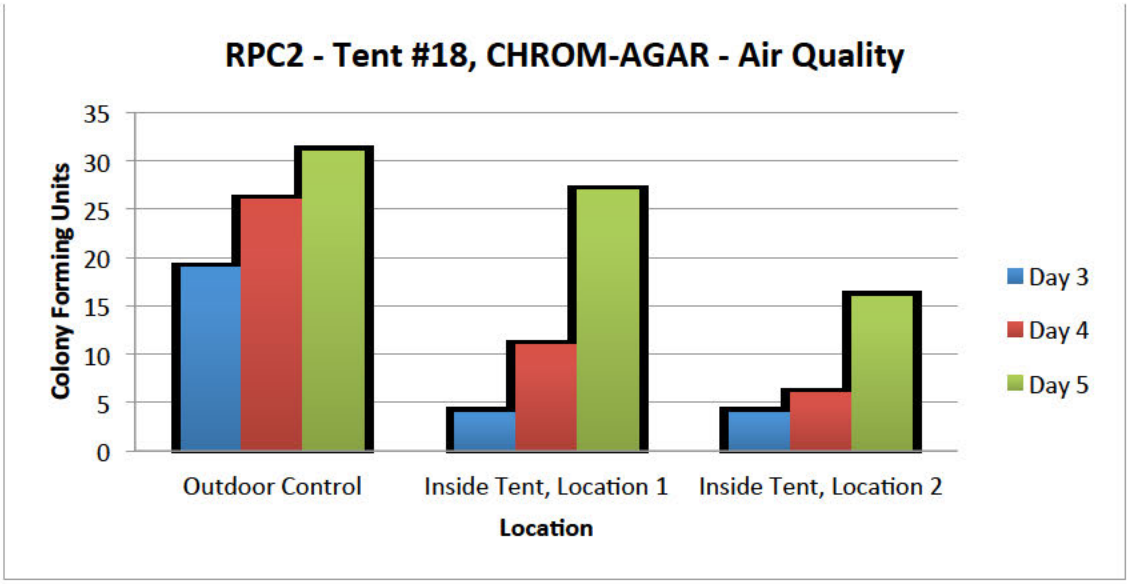


Figure 2.6 The colony forming unit counts were plotted on each day as bar graphs. Inside the tent at locations #1 and #2 confirms that the airspace concentration of viable fungi is higher than outdoors.

Tables 2.5 and 2.6 reveal that the levels of airborne viable yeasts is less than the outdoor levels and that the risk of exposure inside the tent from Candidiasis-causing microorganisms is less than outdoors.

The next type of differential medium is a type of blood agar used for the isolation and cultivation of fastidious bacteria especially between *Streptococcus*, *Enterococcus* and *Aerococcus*. Different types of Gram-positive cocci produce exotoxins called hemolysins that are able to destroy red blood cells and hemoglobin. Three different types of reactions are possible on NC Agar. These are: Beta hemolysis (β), Alpha hemolysis (α) or Gamma hemolysis (γ). NC agar is a type of blood agar and is a general purpose enrichment media used to grow fastidious microorganisms and to differentiate bacteria based on their hemolytic properties. For example, we can differentiate between bacteria such as *Streptococcus pyogenes* (β-hemolysis), *Streptococcus pneumonia* (α-hemolysis) or *Staphylococcus epidermidis* (ϒ-hemolysis). Table 2.7-2.8 shows what types of haemolysis reactions were detected on the NC Agar Plates from air samples within the Tent and from outside. It is straightforward to read the hemolytic reaction and each plate has been photographed with transmitted light (from behind) at Days 3, 4 and 5. Final interpretation was made at Day 5.

- Beta hemolysis (β) is defined as complete lysis of red blood cells showing a clear zone. This is because many bacteria produce toxic enzymes that can destroy red blood cells. Typical bacteria showing Beta hemolysis include *Streptococcus pyogenes*.
- Alpha hemolysis (α) is defined as the reduction of the hemoglobin in red blood cells to methemoglobin which diffuses into the agar surrounding the colony. This is seen as a green or brown discoloration of the medium – where the cells are in fact bruised. Typical bacteria showing

Alpha hemolysis include *Streptococcus* "viridans group" like *S. mutans*, *S. mitis*, *S. salivarius* or *S. pneumoniae*.

- Gamma hemolysis (γ) reflects the fact that there is no hemolytic reaction and the medium remains the same colour. Typical bacteria showing Gamma hemolysis include *Enterococcus faecalis* and *Staphylococcus epidermidis*.

NC AGAR – Hemolysis Reactions Evaluated at Day 5, Location: RPC2 Tent #18				
AIR SAMPLING				
Location	**Sample/Figure Number**	**β**	**α**	**ϒ**
Outdoor Control	Figure 1c	+		+
Inside Tent, Location #1	Figure 2c	+	+	++
Inside Tent, Location #2	Figure 3c	++	++	++

Table 2.7. Hemolysis reactions scored on NC Agar after growth for 5 days at 30°C. If any of the three different types of hemolytic reactions are present, then they are scored with a "+". If no hemolytic reaction reaction of that type is observed, then that field remains empty, while no viable growth after 5 days is scored as "NIL Growth" A semi-quantitative scale from low (+), medium (++), or high (+++) is also defined. The results clearly show that the indoor air contains bacteria that show all three types of hemolysis reactions and that the colony forming units counts are indeed higher inside the tent that outdoors.

NC AGAR – Location: RPC2 Tent #18		
Day 3	**Day 4**	**Day 5**

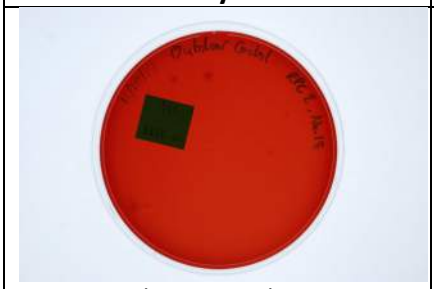
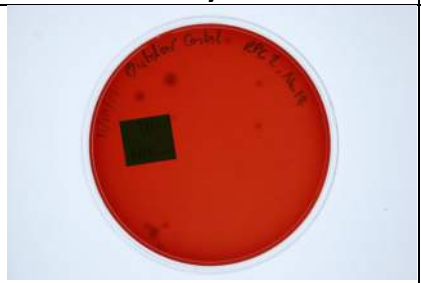
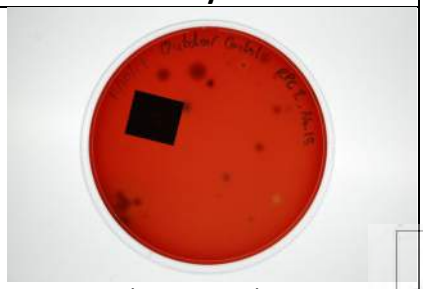

		

Fig 1a. Outdoor Control #1 Air Sample CFU = 5	Fig 1b. Outdoor Control #1 Air Sample CFU = 15	Fig 1c. Outdoor Control #1 Air Sample CFU = 23

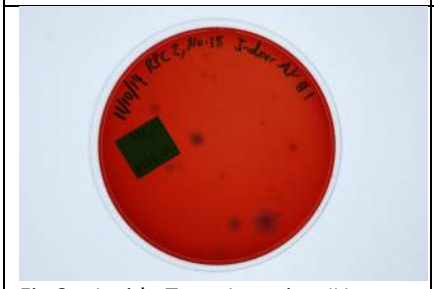
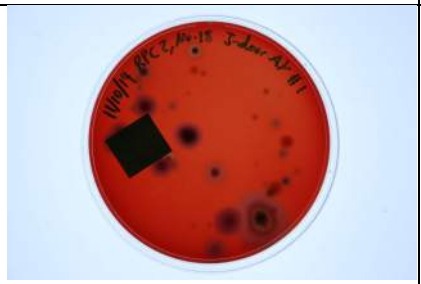
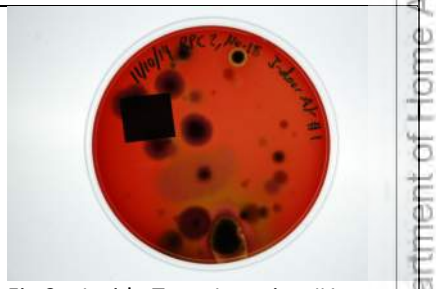

		

Fig 2a. Inside Tent, Location #1 Air Sample CFU = 20	Fig 2b. Inside Tent, Location #1 Air Sample CFU = 44	Fig 2c. Inside Tent, Location #1 Air Sample CFU = 48

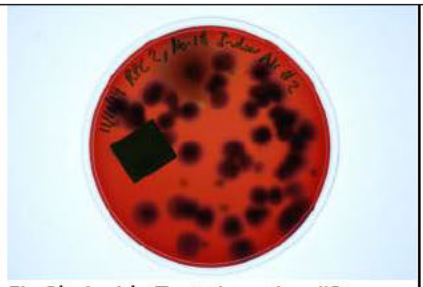
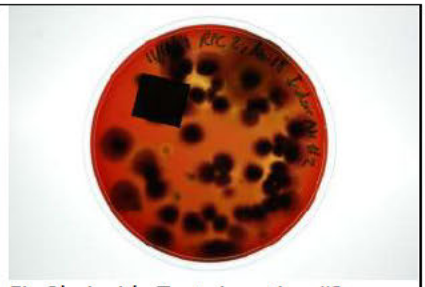
		
Fig 3a. Inside Tent, Location #2 Air Sample CFU = 84	Fig 3b. Inside Tent, Location #2 Air Sample CFU = 74	Fig 3b. Inside Tent, Location #2 Air Sample CFU = 78 Unidentified black yeast

Table 2.8. The colony forming unit counts, CFU were performed on NC Agar on days: 3, 4 and 5 for air samples taken from each of the different locations. Anaerobic streak-stabbing was not performed to look for Streptolysins that are best observed under anaerobic conditions. The results demonstrate that the airspace inside the tent is considered heavily contaminated with exotoxin producing bacteria with selection towards γ-hemolytic strains which have the appearance of Streptococcus pneumonia along with other mixed fungal populations.

This data can be summarized in a graph Figure 2.7 shown below.

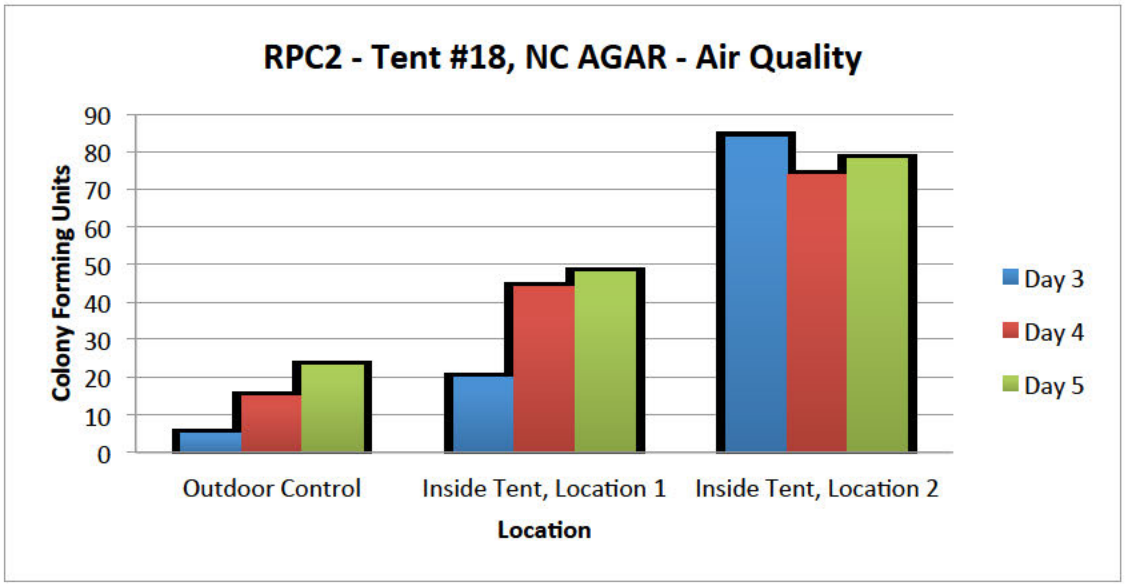


Figure 2.7. The colony forming unit counts for bacteria and fungi that grew on the selective NC Agar media were plotted. We can see that in order from worst to least versus the outdoor control: (i) Inside Location #2, (ii) Inside Location #1, meaning that the air quality indoors is significantly worse than outdoors in terms of viable haemolytic bacteria and fungi.

The data is Tables 2.7-2.8 confirms that the indoor tent air is significantly contaminated with viable pathogenic bacteria (and fungi) that are in excess to the normal outdoor control air. This means that the air quality inside this tent is unacceptable and it is foreseeably likely that all persons who enter this tent are breathing in and are exposed to dermal contact with viable bacteria (haemolytic pathogens and other microflora that can be selected for using this

differential medium) at levels that are in excess to the normal outdoor concentration (Figure 2.7).

Fungi (surface samples) of RPC2 – Tent #18:

The following areas were surface swabbed and inoculated onto PDA petri plates used to measure the local surface-bound fungal levels.

1. Inside Tent Wall Location #1
2. Inside Tent Wall Location #2
3. Inside Tent Wall Location #3
4. Inside Tent Wall Location #4
5. Outside Tent Wall Location #1
6. Outside Tent Wall Location #2
7. Outside Tent Wall Location #3
8. Outside Tent Wall Location #4
9. Outside Roof Location #1
10. Outside Roof Location #2
11. Outside Roof Location #3
12. Inside Ceiling Location #1
13. Inside Ceiling Location #2
14. Inside Ceiling Location #3

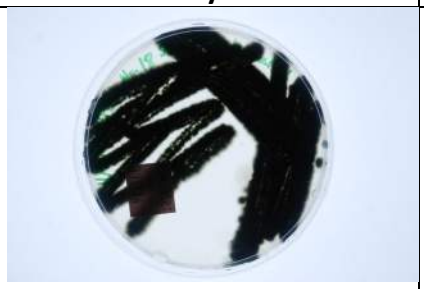
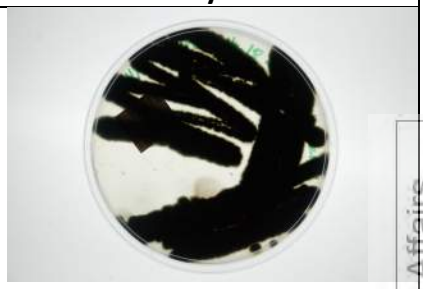
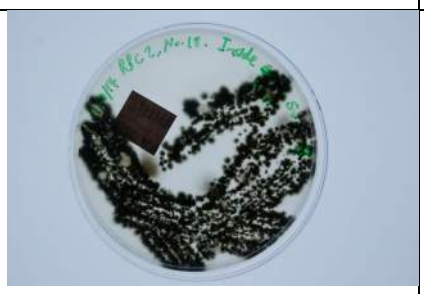
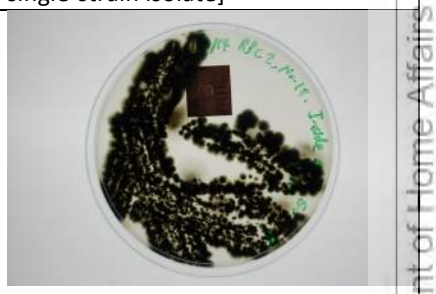
PDA Swabs – Location: RPC2 - Tent #18		
Day 3	**Day 4**	**Day 5**
		
Figure 1a. Inside Tent Wall Location #1 Swab sample CFU = >300 OD: 97.429 ± 78.819	Figure 1b. Inside Tent Wall Location #1 Swab sample CFU = >300	Figure 1c. Inside Tent Wall Location #1 Swab sample CFU = >300 OD = 67.53 Mode = 4 *Alternaria, Aspergillus flavus, Chaetomium*

 Figure 2a. Inside Tent Wall Location #2 Swab sample CFU = >300	 Figure 2b. Inside Tent Wall Location #2 Swab sample CFU = >300	 Figure 2c. Inside Tent Wall Location #2 Swab sample CFU = >300 OD = 73.72 Mode = 5 *Aspergillus niger, Aspergillus flavus, Chaetomium, Alternaria*
 Figure 3a. Inside Tent Wall Location #3 Swab sample CFU = >300	 Figure 3b. Inside Tent Wall Location #3 Swab sample CFU = >300	 Figure 3c. Inside Tent Wall Location #3 Swab sample CFU = >300 OD = 79.62 Mode = 5 *Aspergillus flavus* [pure, single-strain isolate]
 Figure 4a. Inside Tent Wall Location #4 Swab sample CFU = >300	 Figure 4b. Inside Tent Wall Location #4 Swab sample CFU = >300	 Figure 4c. Inside Tent Wall Location #4 Swab sample CFU = >300 OD = 88.36 Mode = 6 *Aspergillus flavus, Aspergillus fumigatus, Chaetomium*

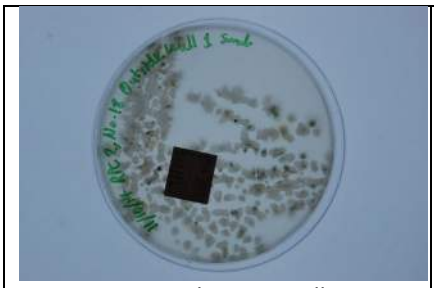
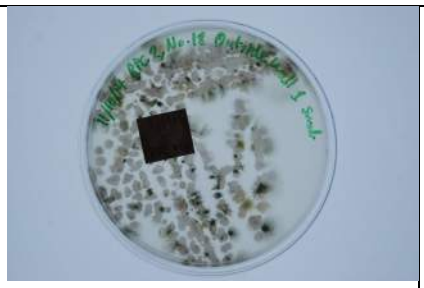
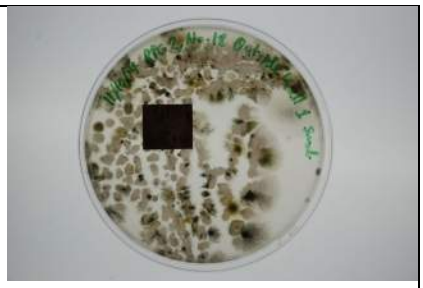
		

Figure 5a. Outside Tent Wall Location #1 Swab sample CFU = ~135	Figure 5b. Outside Tent Wall Location #1 Swab sample CFU = >150	Figure 5c. Outside Tent Wall Location #1 Swab sample CFU = >150 OD = 121.24 Mode = 177 *Candida sp., Penicillium, Cladosporium*, unidentified *Zygomycete*

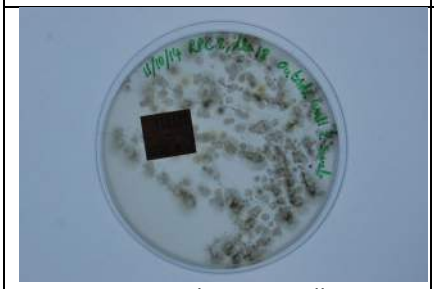
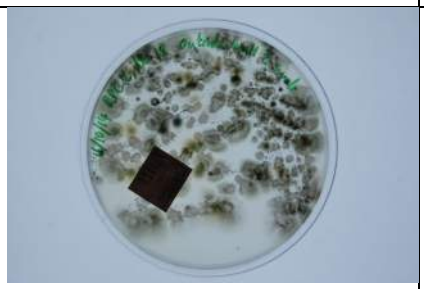
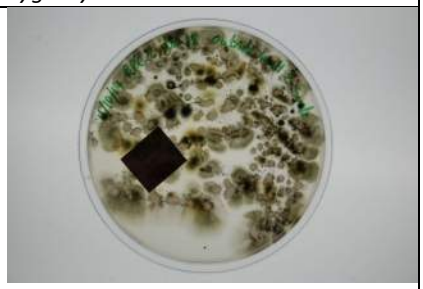

		

Figure 6a. Outside Tent Wall Location #2 Swab sample CFU = >150	Figure 6b. Outside Tent Wall Location #2 Swab sample CFU = >150	Figure 6c. Outside Tent Wall Location #2 Swab sample CFU = >150 OD = 108.35 Mode = 171 *Candida sp., Penicillium, Cladosporium*, Aspergillus niger, unidentified *Zygomycete*

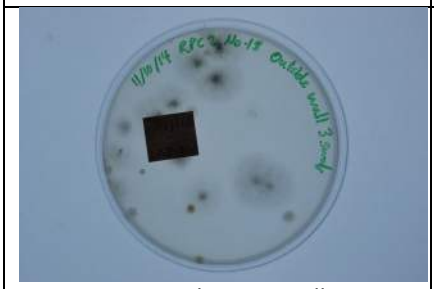
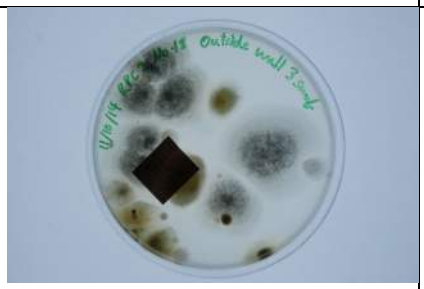
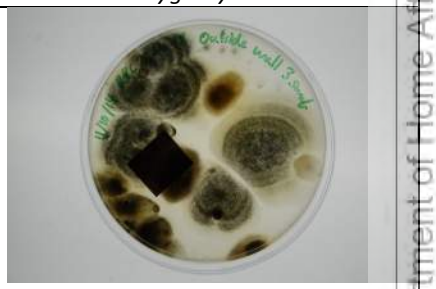
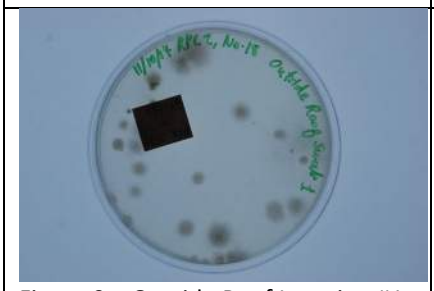
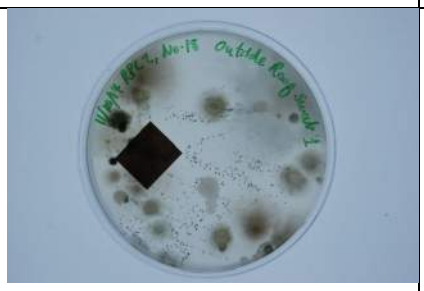
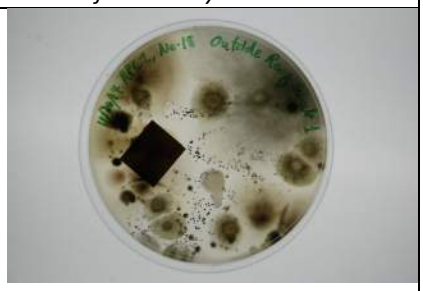
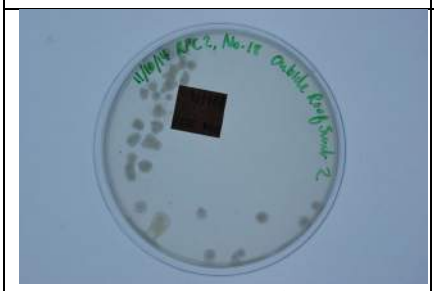
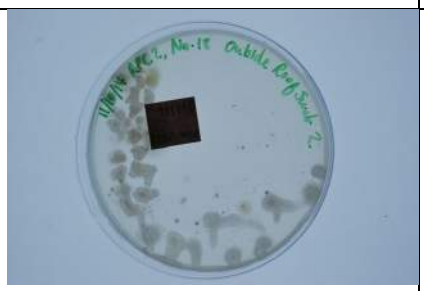
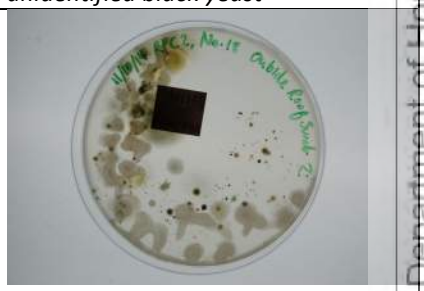
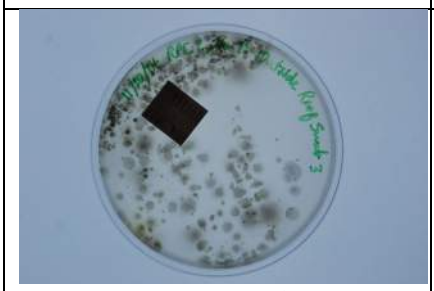
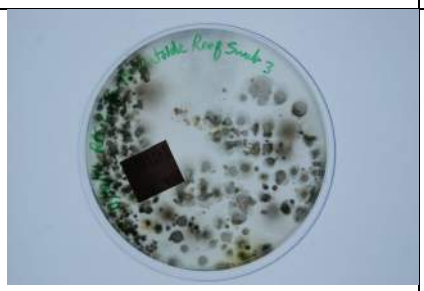
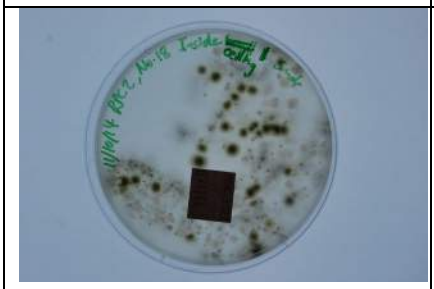
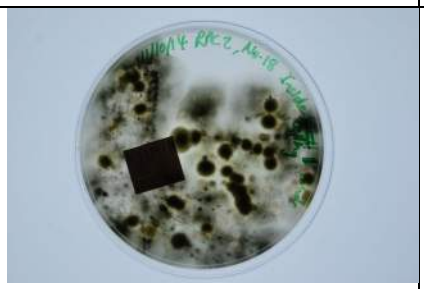
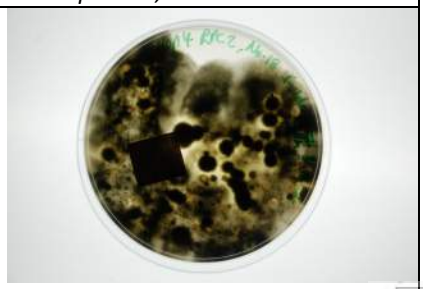

		

Figure 7a. Outside Tent Wall Location #3 Swab sample CFU = 26 OD: 132.098 ± 30.237	Figure 7b. Outside Tent Wall Location #3 Swab sample CFU = 29	Figure 7c. Outside Tent Wall Location #3 Swab sample CFU = 40 OD = 99.03 Mode = 168

		Aspergillus flavus, Aspergillus niger, Cladosporium, Phoma, Candida sp.
 Figure 8a. Outside Tent Wall Location #4 Swab sample CFU = >250 OD: 111.439 ± 46.090	 Figure 8b. Outside Tent Wall Location #4 Swab sample CFU = >300	 Figure 8c. Outside Tent Wall Location #4 Swab sample CFU = >300 OD = 79.22 Mode = 6 *Cladosporium, Aspergillus flavus, Aspergillus fumigatus, Chryspsporium, Chaetomium, Penicillium, Candida sp., unidentified black yeast*
 Figure 9a. Outside Roof Location #1 Swab sample CFU = 28	 Figure 9b. Outside Roof Location #1 Swab sample CFU = ~130	 Figure 9c. Outside Roof Location #1 Swab sample CFU = >130 OD = 109.60 Mode = 157 *Aspergillus flavus, Aspergillus niger, Cladosporium, Phoma, Candida sp., unidentified black yeast*
 Figure 10a. Outside Roof Location #2 Swab sample CFU = 33	 Figure 10b. Outside Roof Location #2 Swab sample CFU = ~150	 Figure 10c. Outside Roof Location #2 Swab sample CFU = >150

		OD = 140.26 Mode = 171 *Candida sp., unidentified black yeast, Rhodotorula, Cladosporium, Penicillium, Scedosporium*
 Figure 11a. Outside Roof Location #3 Swab sample CFU = ~120	 Figure 11b. Outside Roof Location #3 Swab sample CFU = ~120	 Figure 11c. Outside Roof Location #3 Swab sample CFU = >120 OD = 94.78 Mode = 6 *Aspergillus nidulans, Candida sp., Aspergillus flavus, Rhodotorula, Cladosporium, Aureobasidium*
 Figure 12a. Inside Ceiling Location #1 Swab sample CFU = >100	 Figure 12b. Inside Ceiling Location #1 Swab sample CFU = >100	 Figure 12c. Inside Ceiling Location #1 Swab sample CFU = >100 OD = 66.88 Mode = 7 *Chrysosporium, Drechslera, Aspergillus flavus, Aspergillus fumigatus, Cladosporium, Candida sp.,* unidentified black yeast, *Rhizopus*

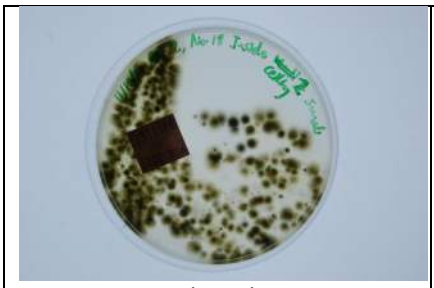
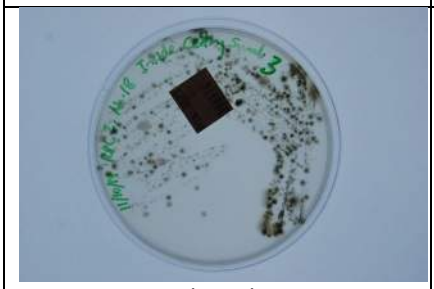
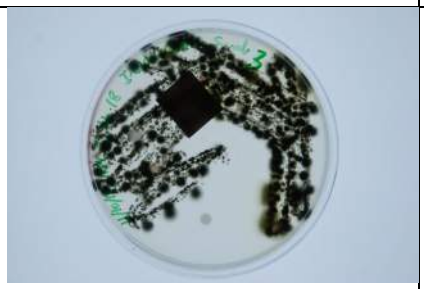
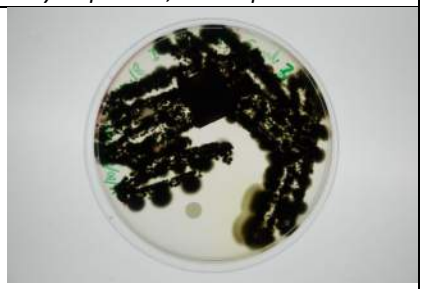
 Figure 13a. Inside Ceiling Location #2 Swab sample CFU = >100 OD: 125.607 ± 56.889	 Figure 13b. Inside Ceiling Location #2 Swab sample CFU = >100	 Figure 13c. Inside Ceiling Location #2 Swab sample CFU = >100 OD = 70.72 Mode = 4 *Penicillium, Candida sp., Aspergillus flavus, Aspergillus fumigatus, Chrysosporium, Cladosporium*
 Figure 14a. Inside Ceiling Location #3 Swab sample CFU = >300	 Figure 14b. Inside Ceiling Location #3 Swab sample CFU = >300	 Figure 14c. Inside Ceiling Location #3 Swab sample CFU = >300 OD =82.56 Mode = 4 *Candida tropicalis, Candida sp.,* Unidentified black yeast, *Cladosporium*, *Aspergillus flavus, Aspergillus fumigatus*

Table 2.9. Swabs of 100cm^2 were taken using a sterile swab rotated across the surface in a zig-zag pattern up and down and across and down. Swabs were streak transferred immediately onto sterile petri-plates. The results after 5-days growth yielded dominant cultures from each location. The total number of colony forming units are only semi-useful due to the fact that overgrowth occurred from the fast-growing fungi. Each 5-day old plate was analysed using image analysis to determine the mean optical density (OD) and Mode to estimate the biofilm thickness that is likely to occur on the different tent surfaces. This was found to be a sensitive method to classify fungal populations from different areas as being either similar or different.

The morphology of some of the Candida or yeast-like organisms in culture suggests that there are some very obvious examples of black yeast-like fungi. These are known to be thermotolerant and it is very likely that the outside extreme temperatures and high localized temperatures on for example tent surfaces, tent rigid beams etc. provide a unique niche that

has been exploited by the black yeasts. I mention this here, since black yeasts are implicated in very serious human infections (Vicente et al., 2008, Sudhadham et al., 2008, Suzuki et al., 2012,).

This data above has been analyzed and summarized below in Figures 2.8 and 2.9.

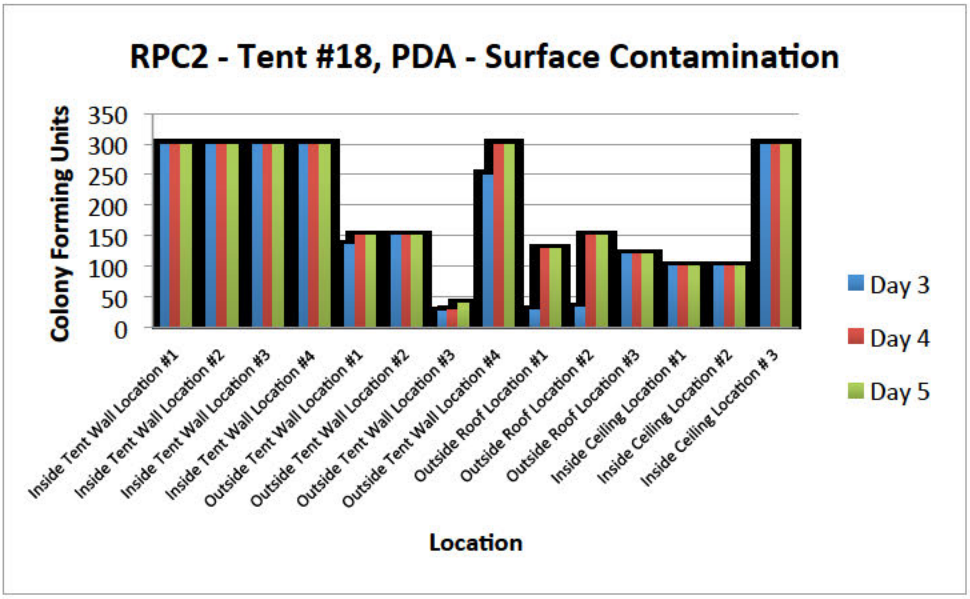
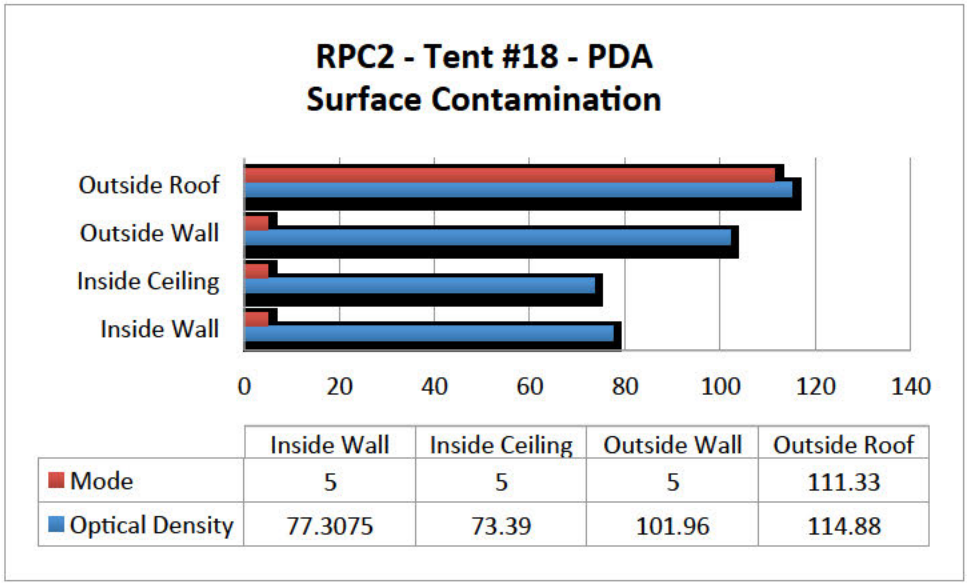


Figure 2.8. Surface fungal contamination on each of the different locations plotted against days of growth. The inside tent walls appear to show the worst levels of CFU. The swabs transfers quickly showed the high-viability of the fungi, and although each swab was a mixed microflora the isolates can be considered typical of the biofilms that grow on the tent material.



	Inside Wall	Inside Ceiling	Outside Wall	Outside Roof
Mode	5	5	5	111.33
Optical Density	77.3075	73.39	101.96	114.88

Figure 2.9. Each Petri plate at Day 5 was analysed using image analysis to calculate the Moe and optical density of

the transmitted light through the plates. Low OD values are dark, while High OD are light. The mode allows the populations of cells to be classified as similar or different. In these samples, the biofilm growth morphology for the outside roof is different to that observed for the inside walls, inside ceilings which are identical. The outside wall growth is different again to the growth on the roof.

The following swabs were taken onto both CHROM AGAR and NC AGAR.

1. Inside Ceiling
2. Inside Wall
3. Inside Floor
4. Outside Wall
5. Outside Roof

CHROM AGAR – Location: RPC2 Tent #18		
Day 3	**Day 4**	**Day 5**

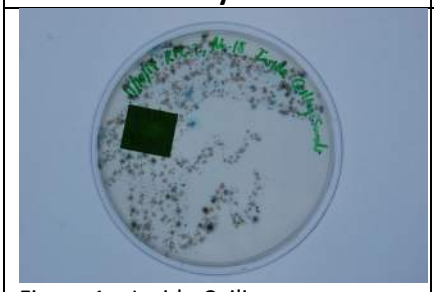
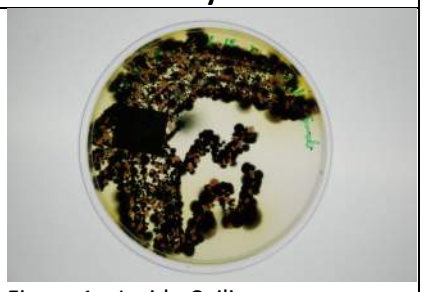

		

Figure 1a. Inside Ceiling Swab sample CFU = >300	Figure 1b. Inside Ceiling Swab sample CFU = >300	Figure 1c. Inside Ceiling Swab sample CFU = >300

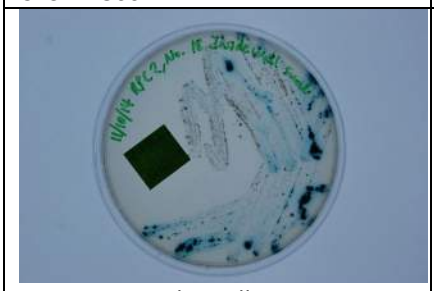



Figure 2a. Inside Wall Swab sample CFU = >150	Figure 2b. Inside Wall Swab sample CFU = >300	Figure 2c. Inside Wall Swab sample CFU = >300

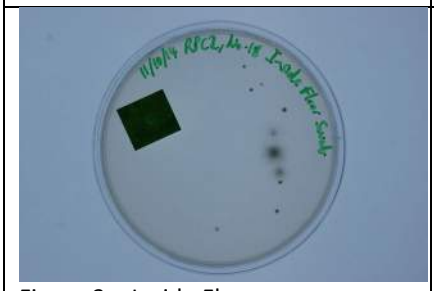
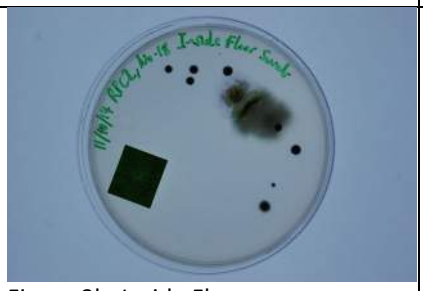

	

Figure 3a. Inside Floor Swab sample CFU = 11	Figure 3b. Inside Floor Swab sample CFU = 16	Figure 3c. Inside Floor Swab sample CFU = 11

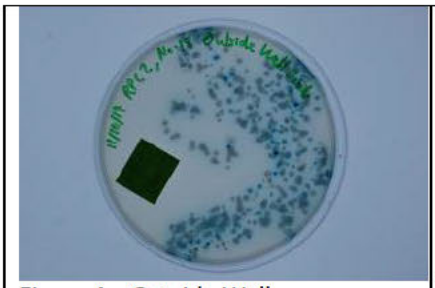


Figure 4a. Outside Wall
Swab sample
CFU = ~220

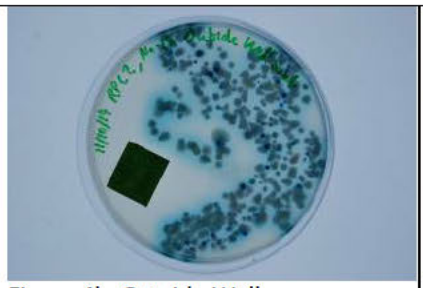


Figure 4b. Outside Wall
Swab sample
CFU = >200

Figure 4c. Outside Wall
Swab sample
CFU = >200

Figure 5a. Outside Roof
Swab sample
CFU = 15

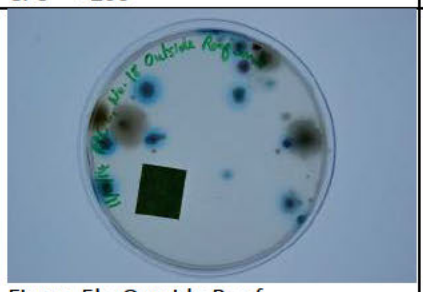


Figure 5b. Outside Roof
Swab sample
CFU = >90

Figure 5c. Outside Roof
Swab sample
CFU = >150

Table 2.10. Swab testing for the inside walls and ceilings reveals alarming results showing that these surfaces are heavily contaminated with human pathogenic fungi and yeasts. The least contaminated surface was observed for the inside floor. The Day 3 and 4 results reveal high levels of Candida albicans bacteria (green colonies) on the outside wall. Overgrowth with other fungi by Day 4 for the inside wall makes it difficult to comment on the levels of Candida. The inside ceiling also shows characteristic salmon-pink colonies of Candida krusei.

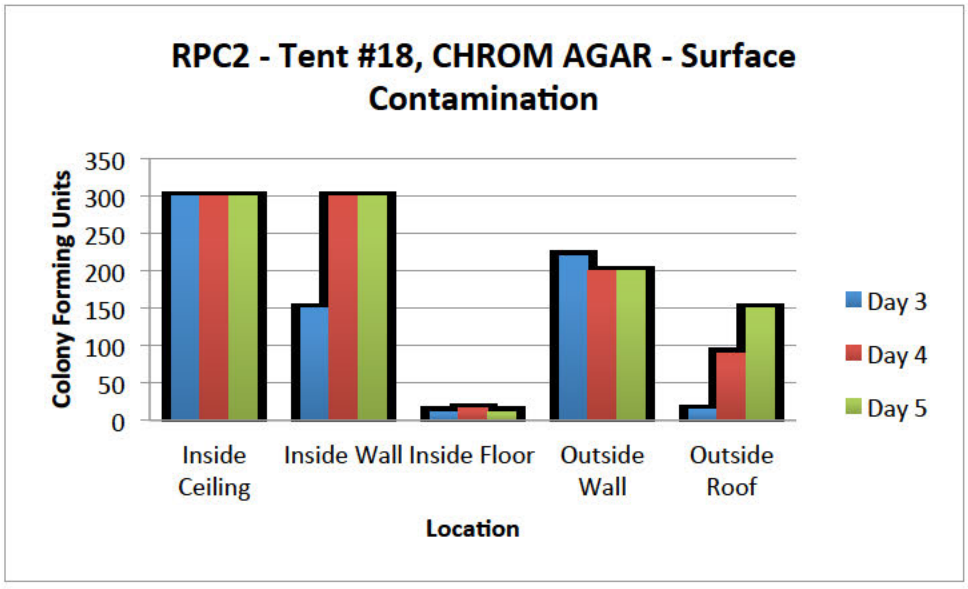


Figure 2.10. Plots of the colony forming unit counts for the petri plates shown in Table 2.10 show the relative levels of contamination in graphical format.

Table 2.10 shows what types of haemolysis reactions were detected on the NC Agar Plates. Three different types of reactions are possible on NC Agar. These are: Beta hemolysis (β), Alpha hemolysis (α) or Gamma hemolysis (γ). NC agar is a type of blood agar and is a general purpose enrichment mediu used to grow fastidious microorganisms and to differentiate bacteria based on their hemolytic properties. It is straightforward to read the hemolytic reaction and each plate has been photographed with transmitted light (from behind) at Days 3, 4 and and 5. Interpretation was made at Day 5.

- Beta hemolysis (β) is defined as complete lysis of red blood cells showing a clear zone. This is because many bacteria produce toxic enzymes that can destroy red blood cells. Typical bacteria showing Beta hemolysis include *Streptococcus pyogenes*.
- Alpha hemolysis (α) is defined as the reduction of the hemoglobin in red blood cells to methemoglobin which diffuses into the agar surrounding the colony. This is seen as a green or brown discoloration of the medium – where the cells are in fact bruised. Typical bacteria showing Alpha hemolysis include *Streptococcus* "viridans group" like *S. mutans*, *S. mitis*, *S. salivarius* or *S. pneumoniae*.
- Gamma hemolysis (γ) reflects the fact that there is no hemolytic reaction and the medium remains the same colour. Typical bacteria showing Gamma hemolysis include Enterococcus faecalis.

Growth Medium: NC AGAR – Hemolysis Reactions Evaluated at Day 5 **Location: RPC2 Tent #18**				
SWAB SAMPLING				
Location	**Sample/Figure Number**	**β**	**α**	**ϒ**
Inside Ceiling	Figure 1c	+++	-	+
Inside Wall of Tent	Figure 2c	+++	+	+
Inside Floor of Tent	Figure 3c	++	++	++
Outside Wall of Tent	Figure 4c	++	++	++
Outside Roof of Tent	Figure 5c	++	++	++

Table 2.10. Hemolysis reactions scored on NC Agar after growth for 5 days at 30°C. If any of the three different types of hemolytic reactions are present, then they are scored with a "+". If no hemolytic reaction reaction of that type is observed, then that field is scored with a "-", while no viable growth after 5 days is scored as "NIL Growth" A semi-quantitative scale from low (+), medium (++), or high (+++) is also defined.

NC AGAR – Location: RPC2 Tent #18		
Day 3	**Day 4**	**Day 5**

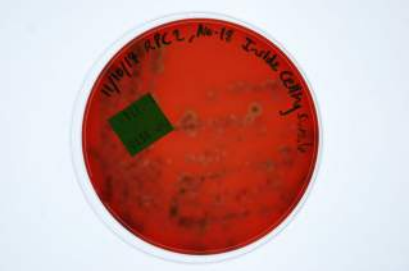



Figure 1a. Inside Ceiling Swab sample CFU = >150	Figure 1b. Inside Ceiling Swab sample CFU = >300	Figure 1c. Inside Ceiling Swab sample CFU = >300 Unidentified black yeast
		
Figure 2a. Inside Wall Swab sample CFU = >300	Figure 2b. Inside Wall Swab sample CFU = >300	Figure 2c. Inside Wall Swab sample CFU = >300 Unidentified black yeast

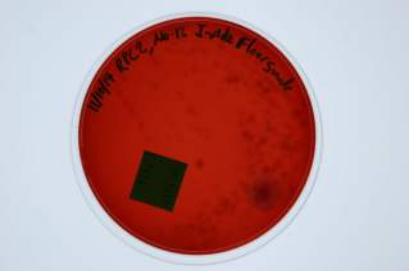
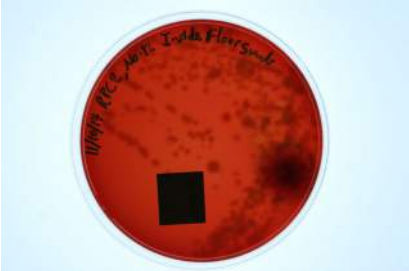
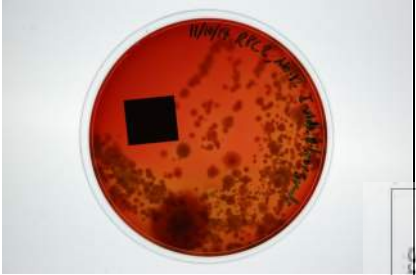

		

Figure 3a. Inside Floor Swab sample CFU = ~100	Figure 3b. Inside Floor Swab sample CFU = >200	Figure 3c. Inside Floor Swab sample CFU = >200

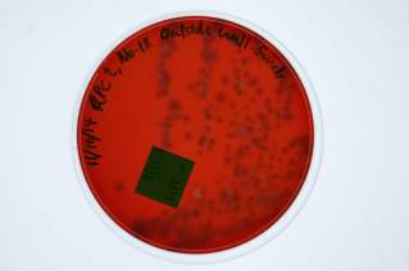
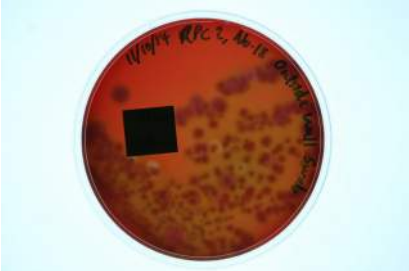
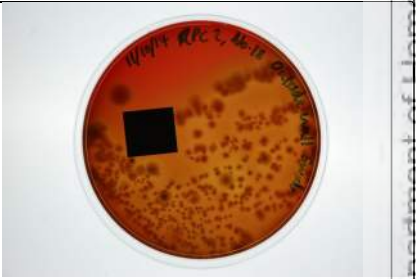

		

Figure 4a. Outside Wall Swab sample CFU = ~150	Figure 4b. Outside Wall Swab sample CFU = >150	Figure 4c. Outside Wall Swab sample CFU = >150

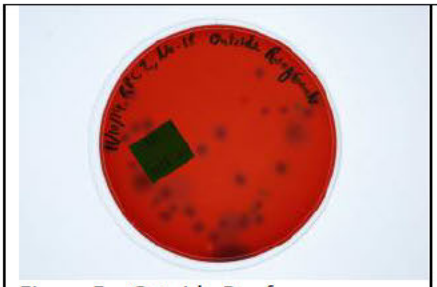


Figure 5a. Outside Roof
Swab sample
CFU = 38

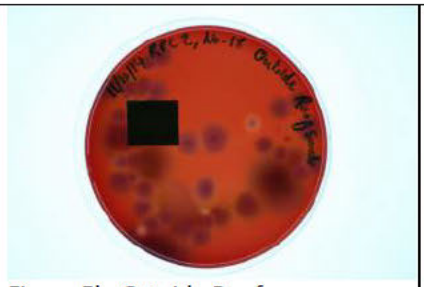


Figure 5b. Outside Roof
Swab sample
CFU = >150

Figure 5c. Outside Roof
Swab sample
CFU = >150

Table 2.11. Hemolysis reactions scored to show the colony forming unit counts, CFU on NC Agar on days: 3, 4 and 5 for swab samples taken from each of the different locations. Since these are all swab samples, there is no control and we need to evaluate contamination based on the levels of CFU and the dominance of haemolytic reaction. It is known that Candida albicans and Staphylococcus aureus can produce hemolytic factor and could account for the dominant β-hemolysis reaction seen on all of the plates by Day 5.

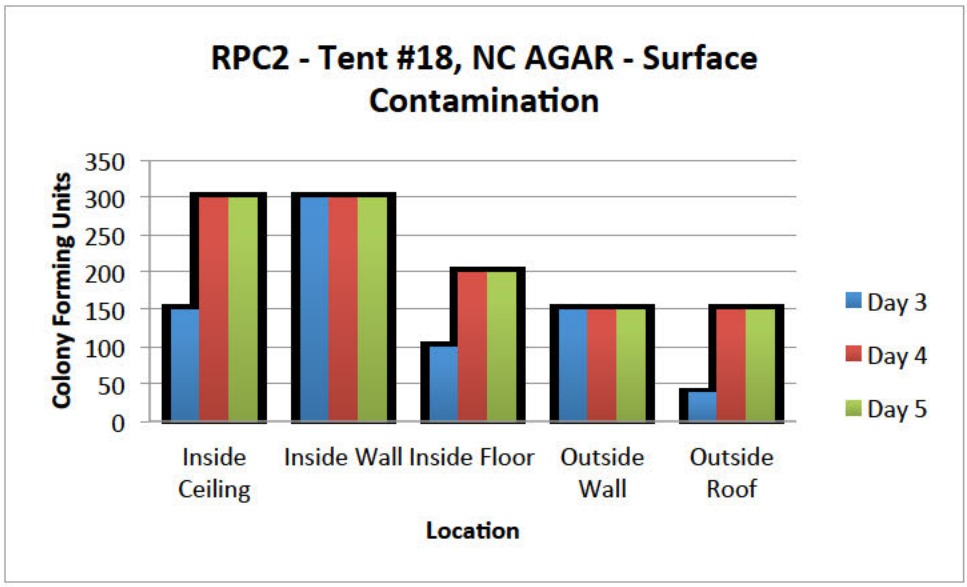
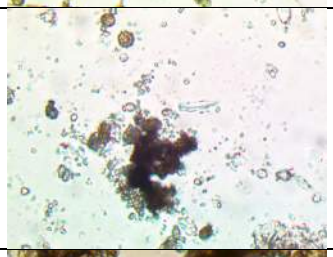
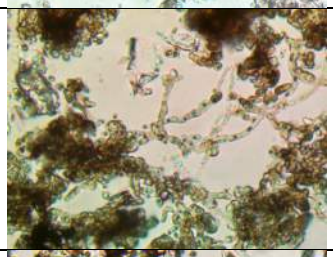


Figure 2.11. The colony forming unit counts, CFU were plotted for each area. The worst affected locations are the (i) inside ceiling, the (ii) inside wall, followed by the (iii) inside floor. The two outside walls and roof regions showed lower numbers of CFU than all the inside tent areas.

Tape Lifts of RPC2 – Tent #18

The following areas were sampled using Tape Lifts for microscopic examination.

1. Outside Wall
2. Outside Roof
3. Inside Wall
4. Inside Ceiling

Tape Lift Classification – RPC2, Tent #18				
Location	**Typical ROI Example Micrograph**	**Fungal/Mould Spore Loading**	**Fungal/Mould Mycelium Loading**	**Fungal/Mould ID**
Outside Wall		High	High	Unidentified basidiospores *Aspergillus/Penicillium* *Ulocladium*
Outside Roof		Very High	Low	*Epicoccum* Smut spores *Myxomycete* (slime mould) Unidentified yeasts
Inside Wall		Very High	Very High	*Aspergillus sp.* *Cladosporium* *Trichoderma* *Ulocladium* Unidentified yeasts
Inside Ceiling		Very High	Very High	*Aspergillus sp.* *Chaetomium* *Nigrospora* Rust spores Unidentified basidiospores *Stachybotrys* Unidentified yeasts

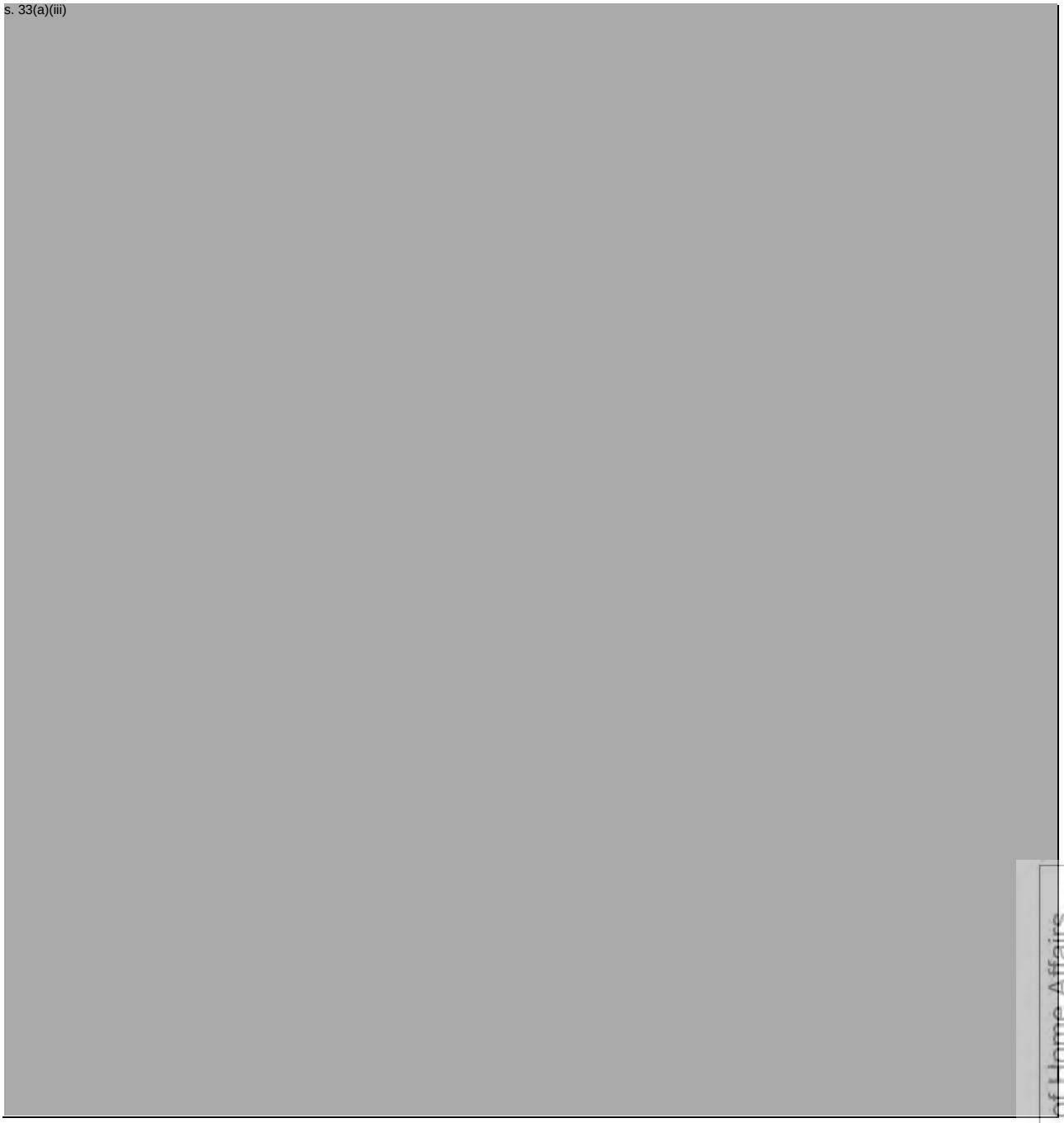
Loading Concentration Key
Low = 1-25%
Medium = 26-50%
High = 51-75%
Very High = 76-100%
Assessments were made using bright field microscopy at x600 and x1000 magnification. At least 50 fields of view (ROI) were examined per slide.

Table 2.13. Table showing the tape lift results for Tent #18 using the "Assessment & Sampling Approaches for Indoor Microbial Assessments," Geoffrey A. Clarke, Synergist (AIHA) November 2001 that reports on field of view loading criteria. Spore morphology was evaluated at x600 magnification using established reference texts.

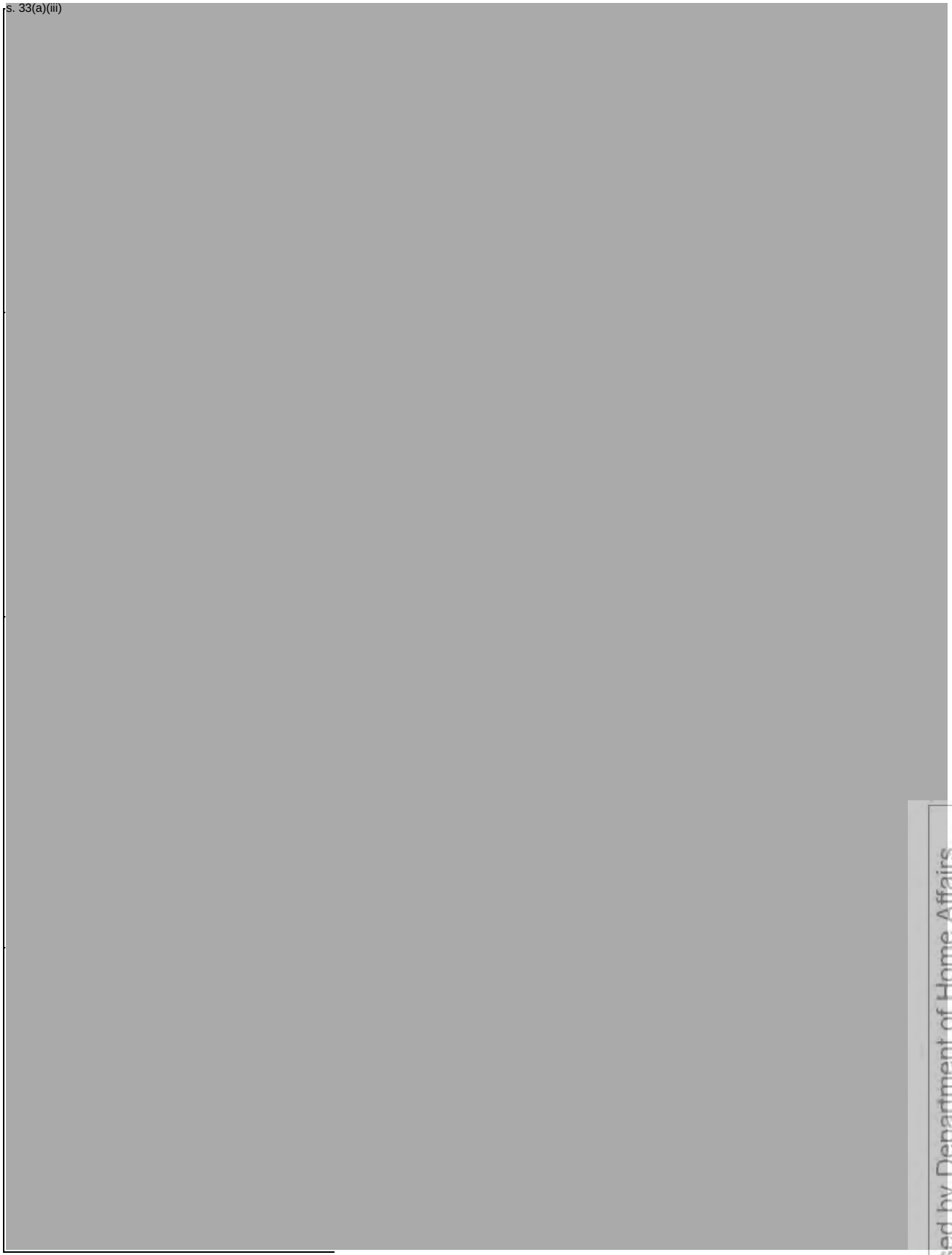
Infra Red Thermography of RPC2 – Tent #18

Infra red thermal imaging was used to evaluate the thermal profile of the tent area under study.

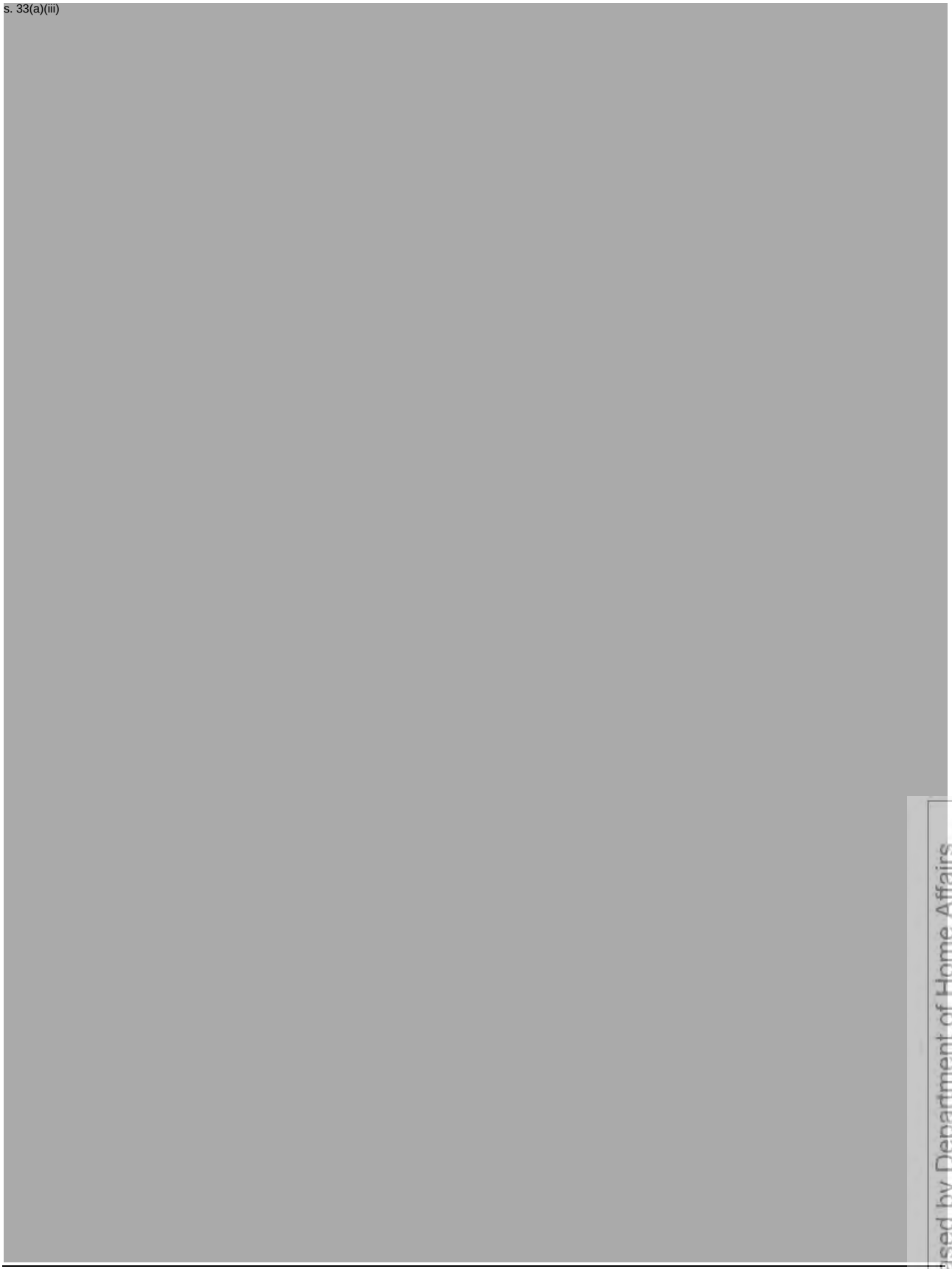
s. 33(a)(iii)



s. 33(a)(iii)



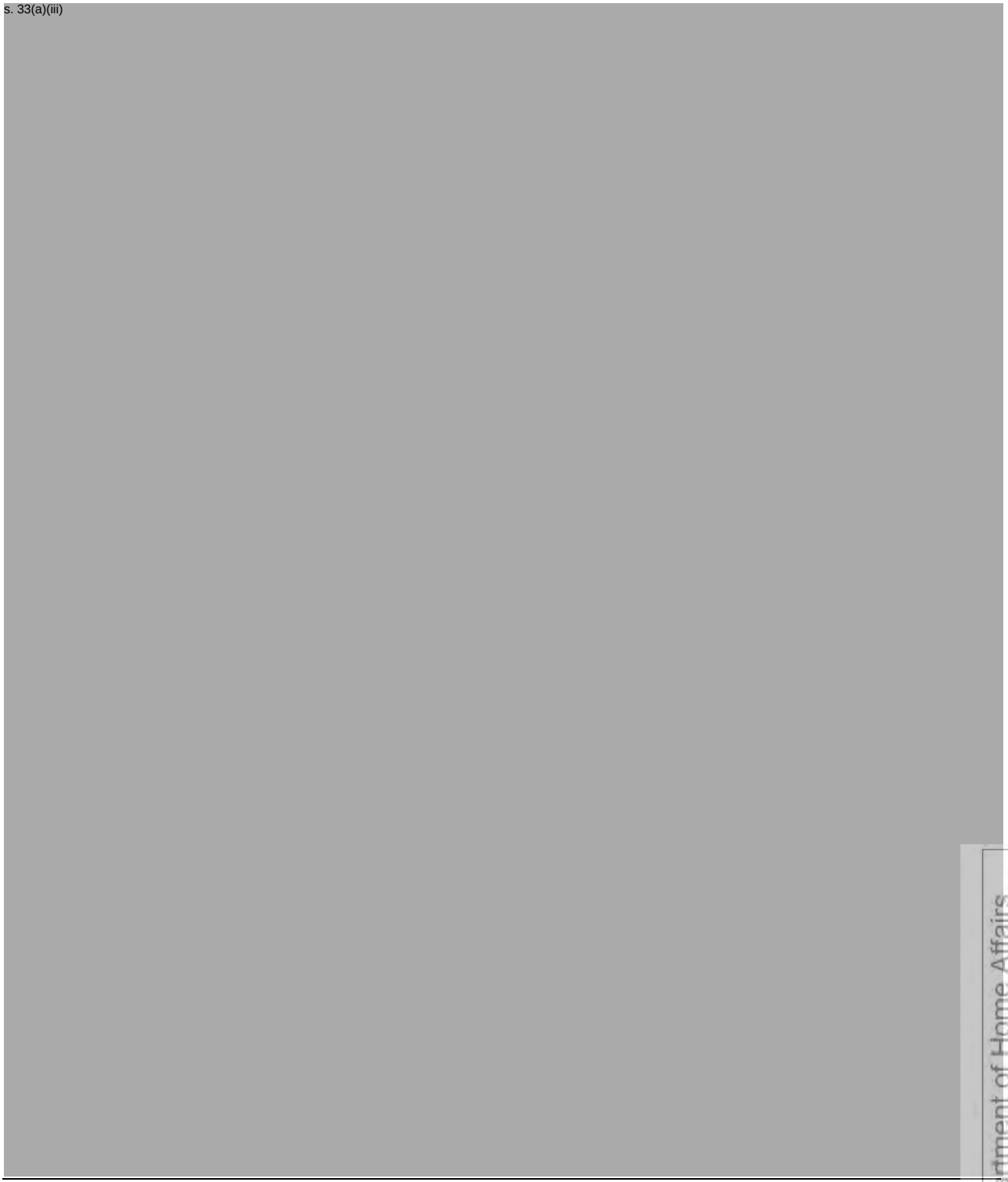
s. 33(a)(iii)



s. 33(a)(iii)

[redacted]

s. 33(a)(iii)



s. 33(a)(iii)

3. RPC 3 – Sample Tent #37

Data was collected for analysis that included:

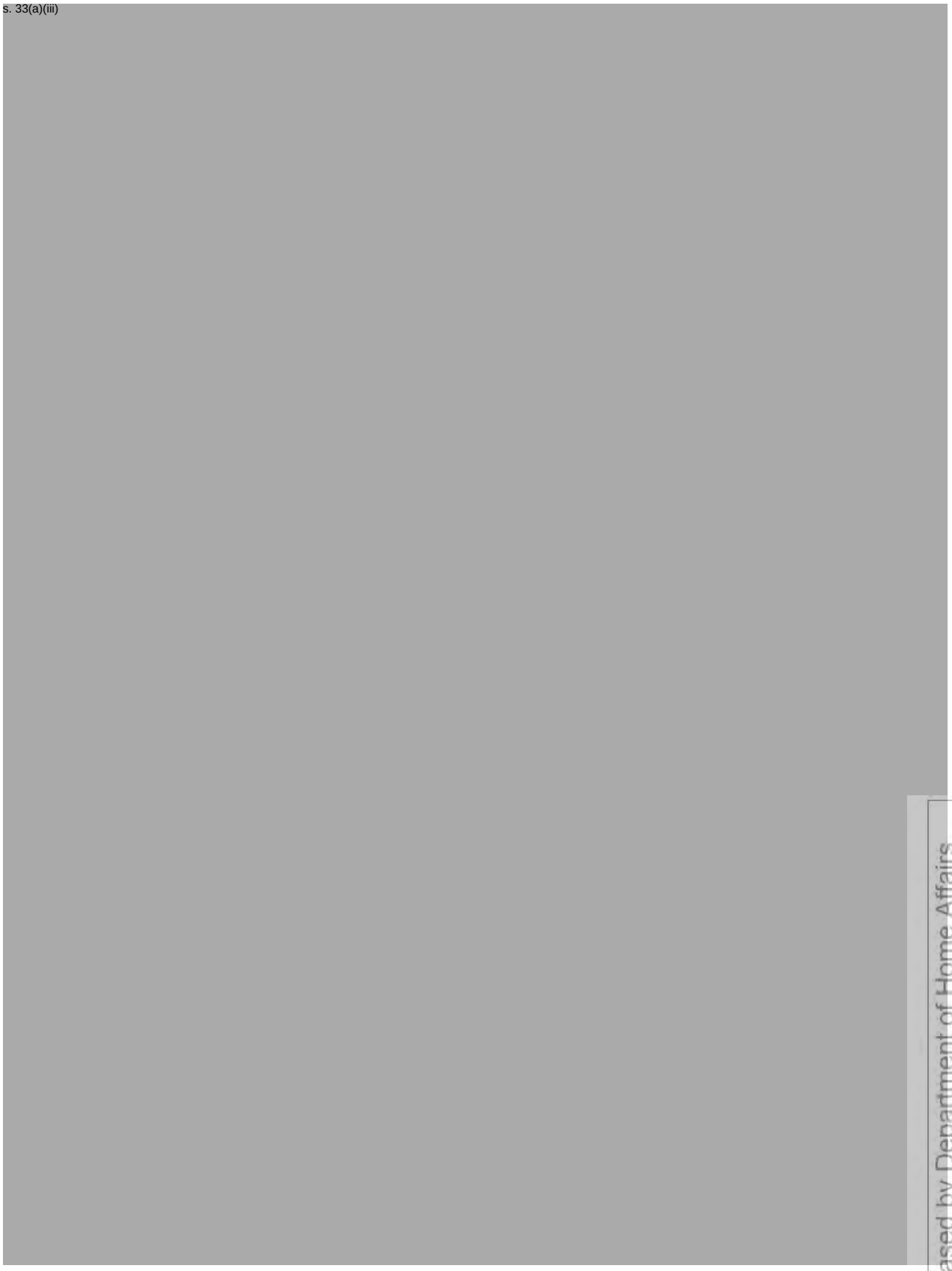
1. General observations and photographic summary
2. Basic descriptive dimensions of the tent
3. Relative humidity and ambient temperature – inside and outside
4. Moisture content of selected areas
5. Spot temperatures of the tent inside and outside
6. Air quality parameters ($PM_{2.5}$ and PM_{10}) of the internal tent volume at different locations within the tent
7. Sampling grid methodology
8. ATP surface hygiene of the internal and external surfaces of the tent at different locations
9. Viable mould sampling to PDA of (i) air (ii) surface swabs - inside tent surfaces (walls and ceiling) and (iii) surface swabs - external tent surfaces (walls and roof)
10. Viable bacterial sampling to CHROM- AGAR and NC-AGAR of (i) air (ii) surface swabs - inside tent surfaces (walls and ceiling) and (iii) surface swabs - external tent surfaces (walls and roof)
11. Air sampling inside and outside the tent to Air-O-Cell cassettes
12. Surface sampling (inside and outside) to Bio Tape-Lifts for microscopic examination
13. Infra Red thermal imaging of the tent – inside and outside

General Observations of RPC3 – Tent #37

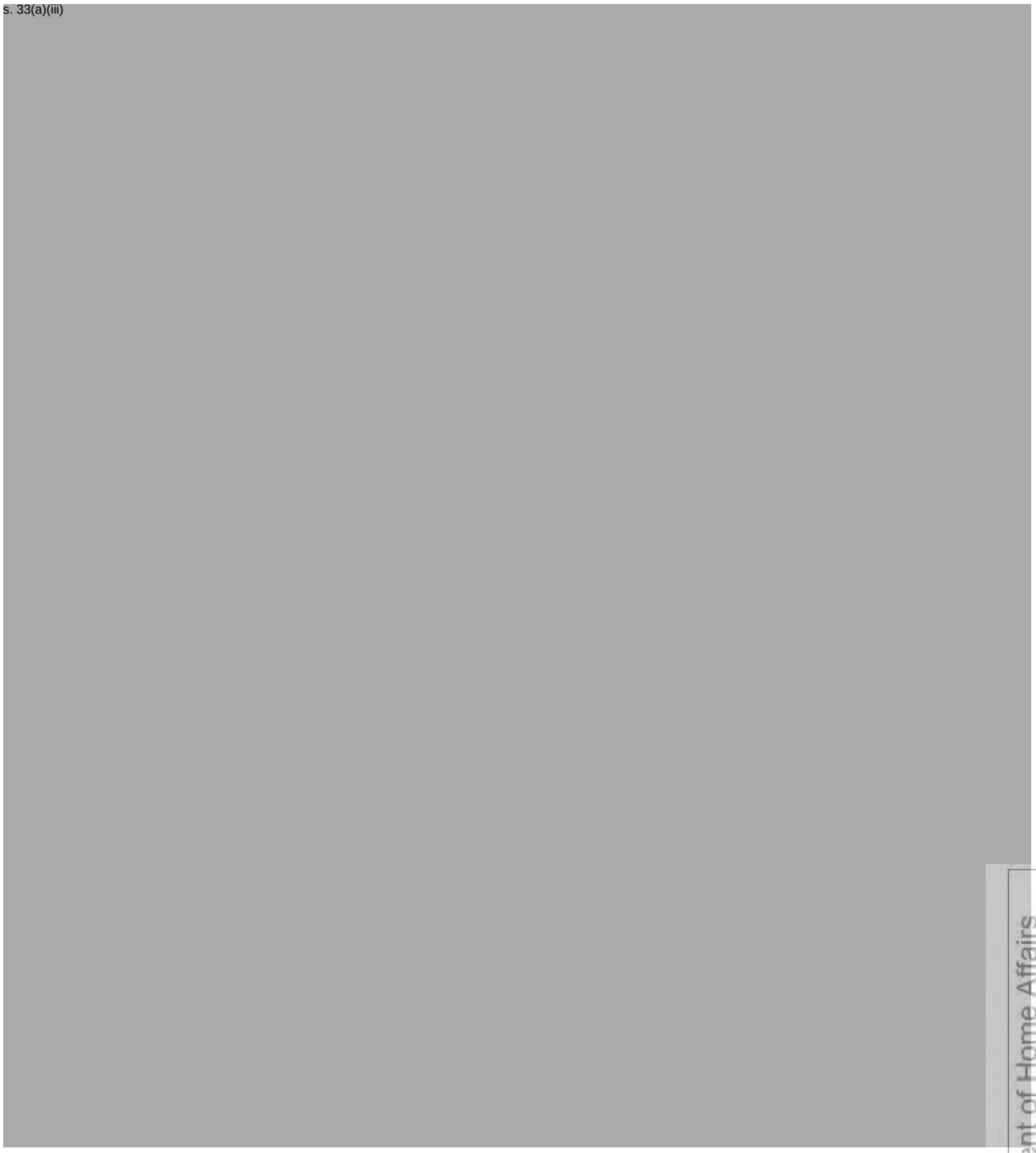
In comparison with the Admin Building on RPC2 – Tent #18, this accommodation tent #37 is neither airconditioned, nor does it have ceiling fans. However, several portable type oscillating fans were noted in some of the Family cubicles. This tent measured 10m wide x 12.7m length. The low point floor to ceiling height was approx. 2.33m, while the high point was approx. 4m. The tent had a pitched roof sloping towards the side walls (low point).

s. 33(a)(iii)

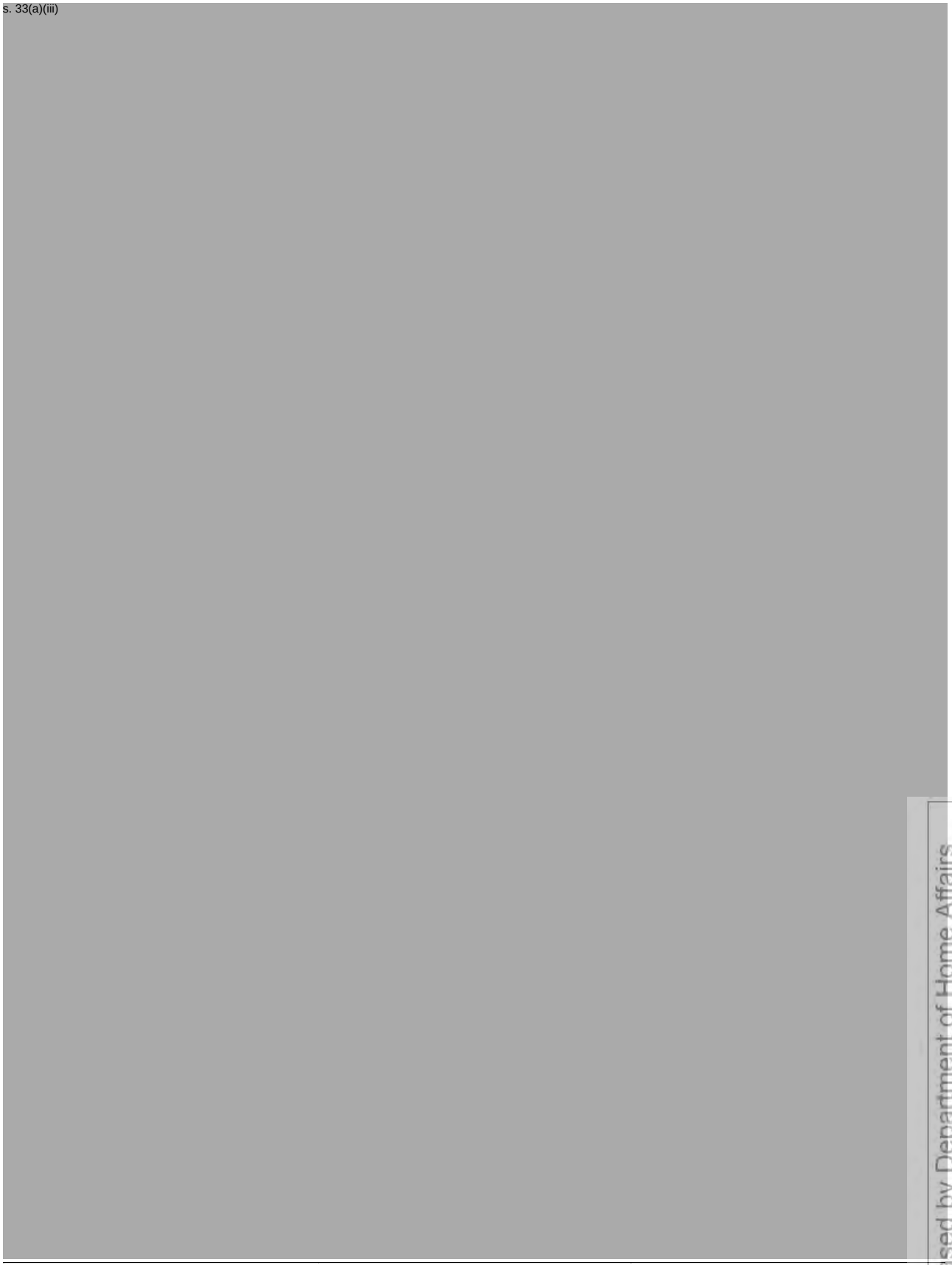
s. 33(a)(iii)



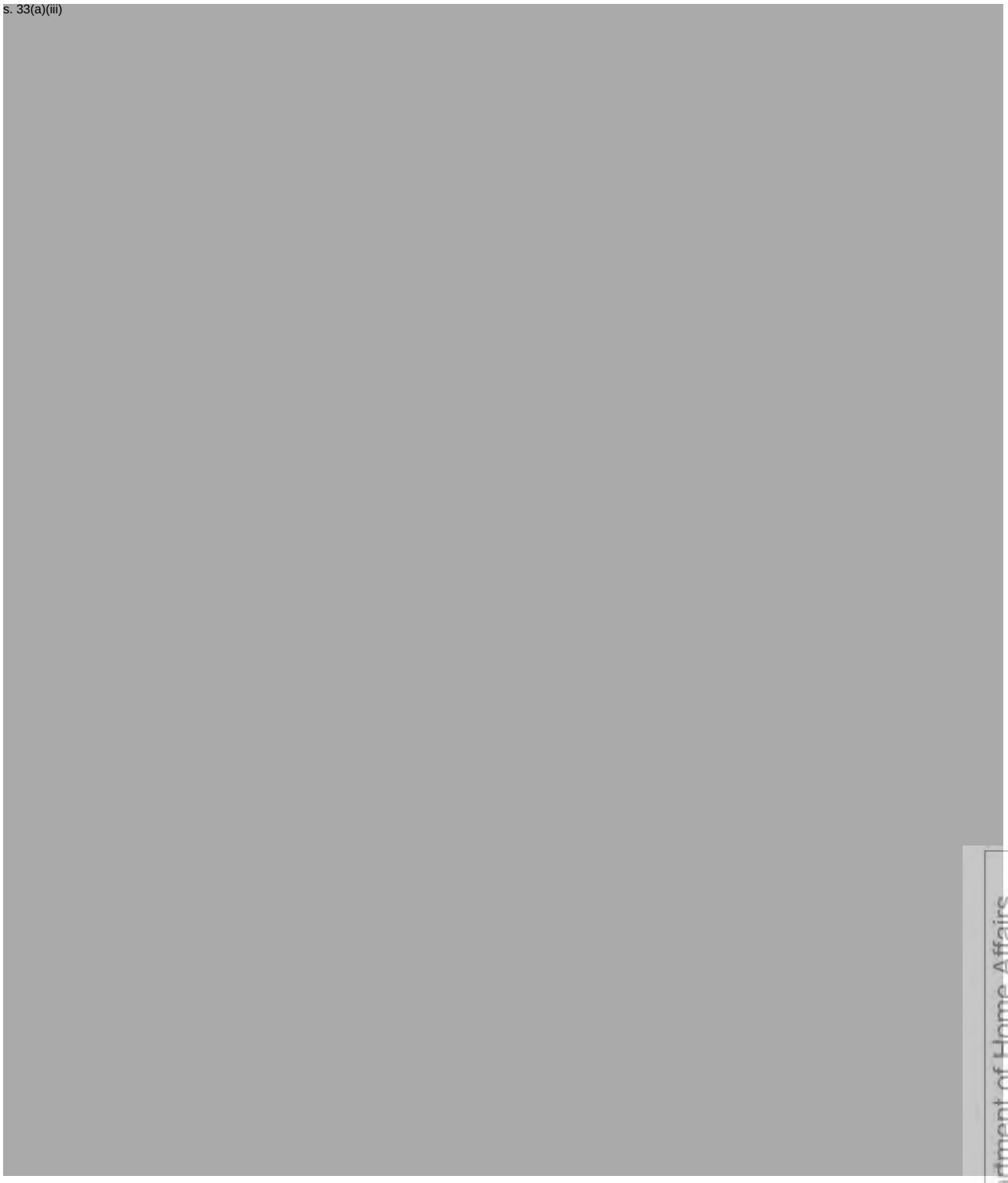
s. 33(a)(iii)



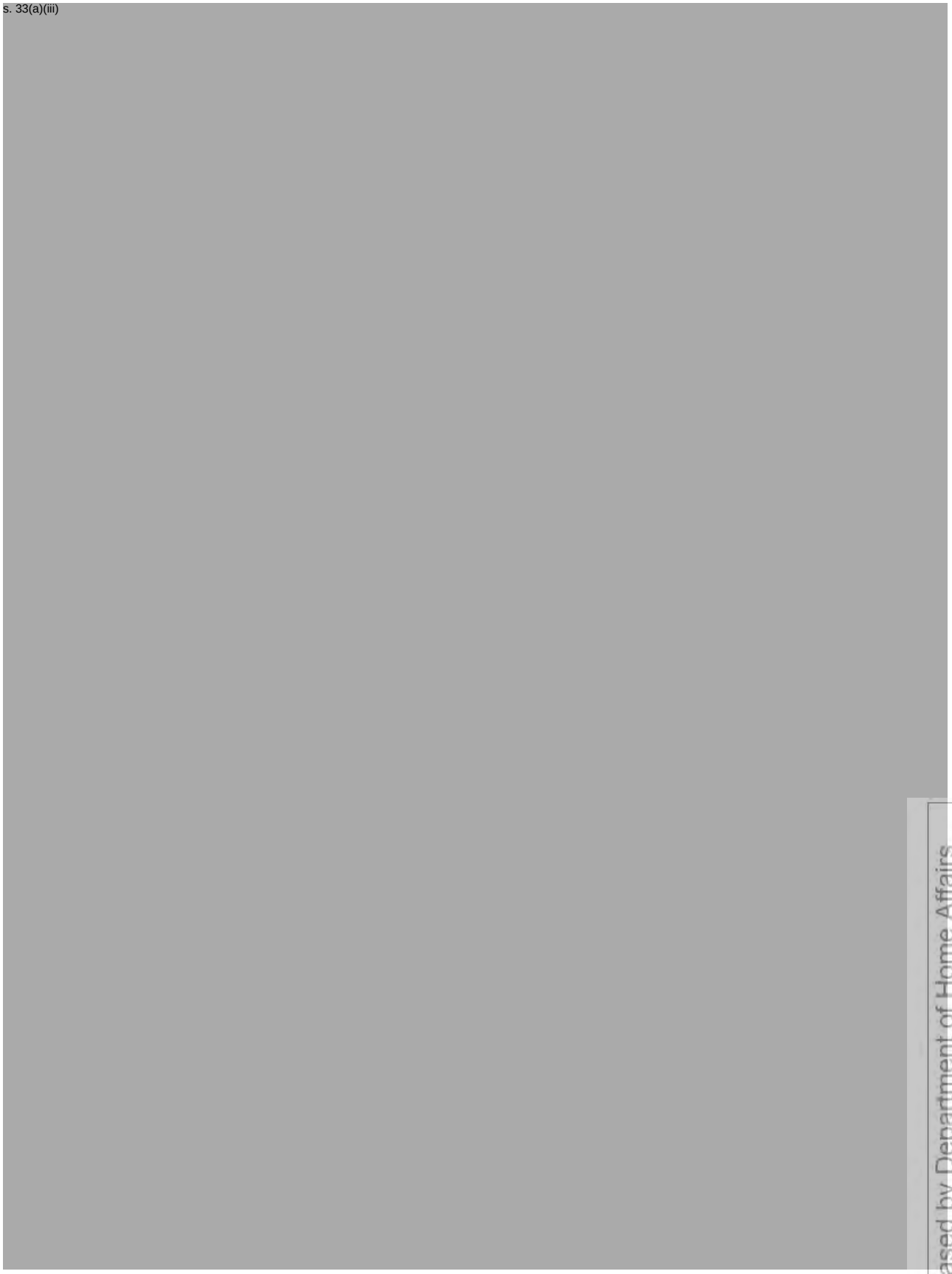
s. 33(a)(iii)



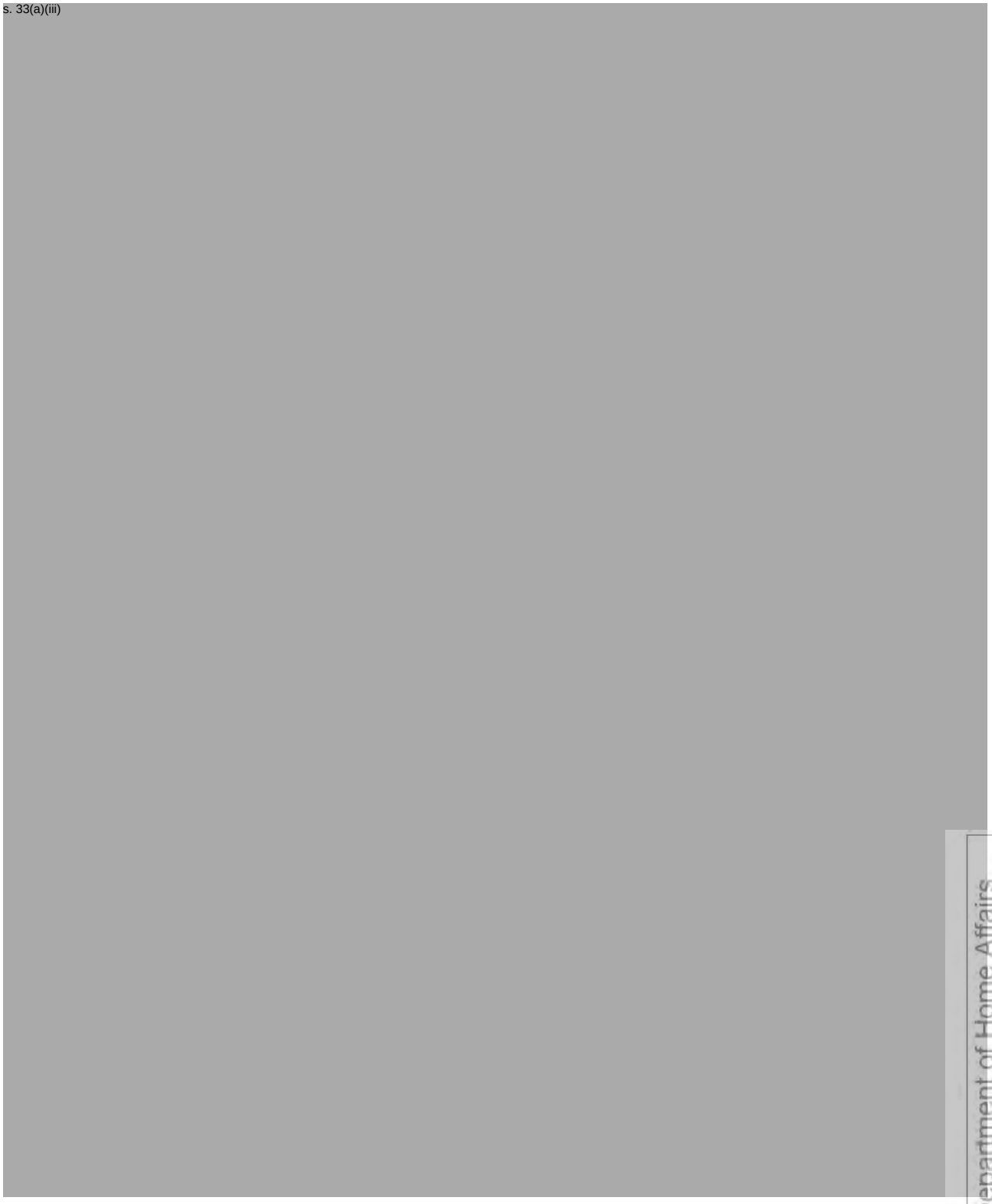
s. 33(a)(iii)



s. 33(a)(iii)



s. 33(a)(iii)



s. 33(a)(iii)

Environmental Parameters of RPC3 – Tent #37

The following areas were sampled:

1. Outdoor Control
2. Inside Tent #37

Location	Relative Humidity	Temperature
Outdoor Control	75.15 ± 0.87	30.23 ± 0.39
Mean Indoor Levels	75.60 ± 0.56	29.15 ± 0.29

Table 3.2. Comparison of the outdoor relative humidity and temperature for several locations inside the RPC3 Tent #37 relative to the outdoor ambient air and humidity. This tent is not air-conditioned. Each tent is partitioned on each side providing a central hallway with individual Family cubicles on each side. Some cubicles have portable electrical fans. It is notable that the relative humidity on RPC2 Tent #18 was also over 70% indoors and out.

Moisture tests were conducted on the wooden flooring inside the tent. These showed: 22.38% ± 5.20. This reading is also high enough for it to be concluded that the floor is retaining moisture – and this level of moisture would be sufficient to support microbial growth. It is further noted that in comparison with RPC2 (Tent #18) that the moisture content for #37 is very similar. Therefore the flooring moisture content between camps and tents is shown to be equivalent in water content level; and in both cases is much higher than expected.

Spot temperature readings from within the tent taken from multiple locations across the underside of the internal ceiling sampling at multiple areas showing visible mould, revealed that the temperature variation was 38.07°C ± 0.93.

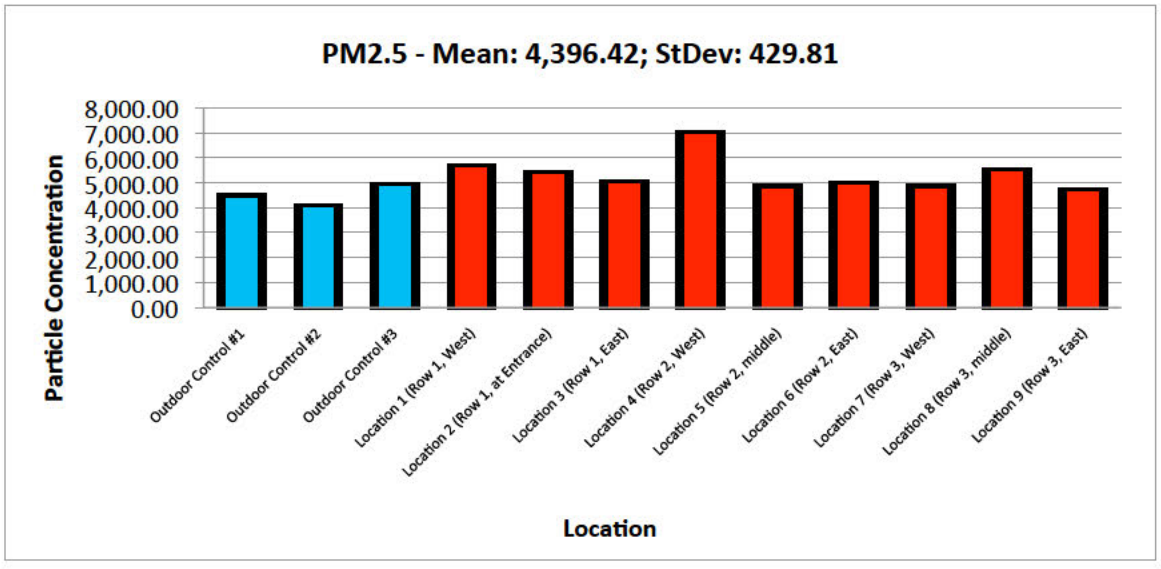
Sampling Grid

A consistent sampling method was followed between tents on RPC2 and RPC3. This is to ensure that comparisons between a typical tent on either area could be made. Figure 2.3 shows the sampling grid locations for the different tests that were also identically performed here for Tent #37. In principle all internal walls, floors and ceilings were sampled and compared to all external walls and roofs.

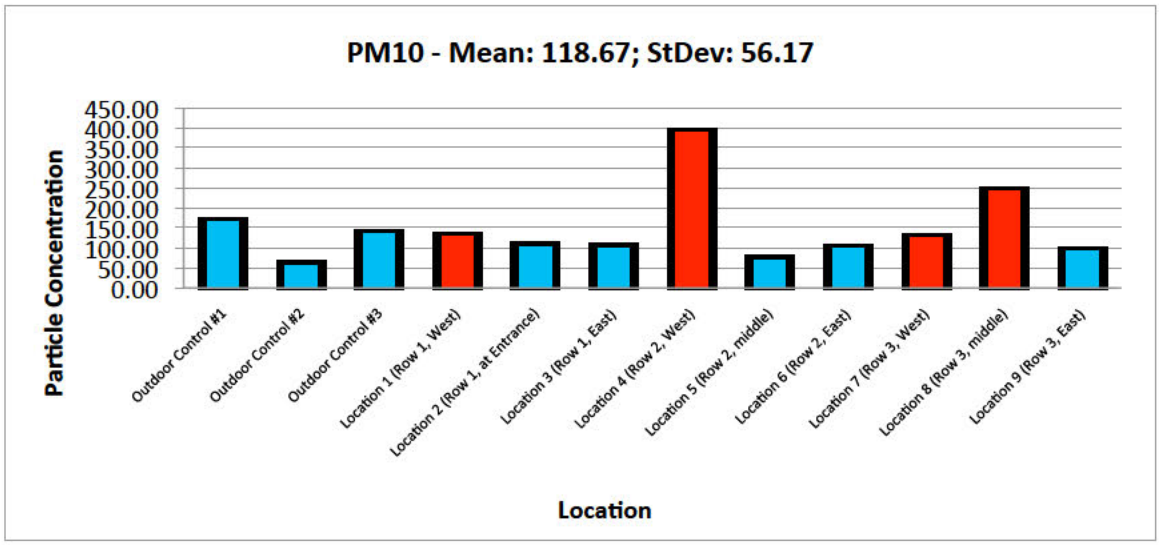
Air Quality Testing of RPC3 – Tent #37

The following areas were sampled:

1. Outdoor Control #1
2. Outdoor Control #2
3. Outdoor Control #3
4. Location 1 (Row 1, West)
5. Location 2 (Row 1, at Entrance)
6. Location 3 (Row 1, East)
7. Location 4 (Row 2, West)
8. Location 5 (Row 2, Middle)
9. Location 6 (Row 2, East)
10. Location 7 (Row 3, West)
11. Location 8 (Row 3, Middle)
12. Location 9 (Row 3, East)



s. 33(a)(iii), s. 47C(1)



s. 33(a)(iii), s. 47C(1)

Collectively, this data confirms that for the fine particles, the $PM_{2.5}$ counts show that approx. 100% of the tested areas show EVIDENCE of airborne contamination with small-sized, respirable particulate material (Particulate Matter – inorganic and/or bioaerosols). Comparatively, for the coarse particles belonging to the PM_{10} size class, 44% of the areas show HIGHER THAN NORMAL levels of airborne particulates s. 33(a)(iii), s. 47C(1)

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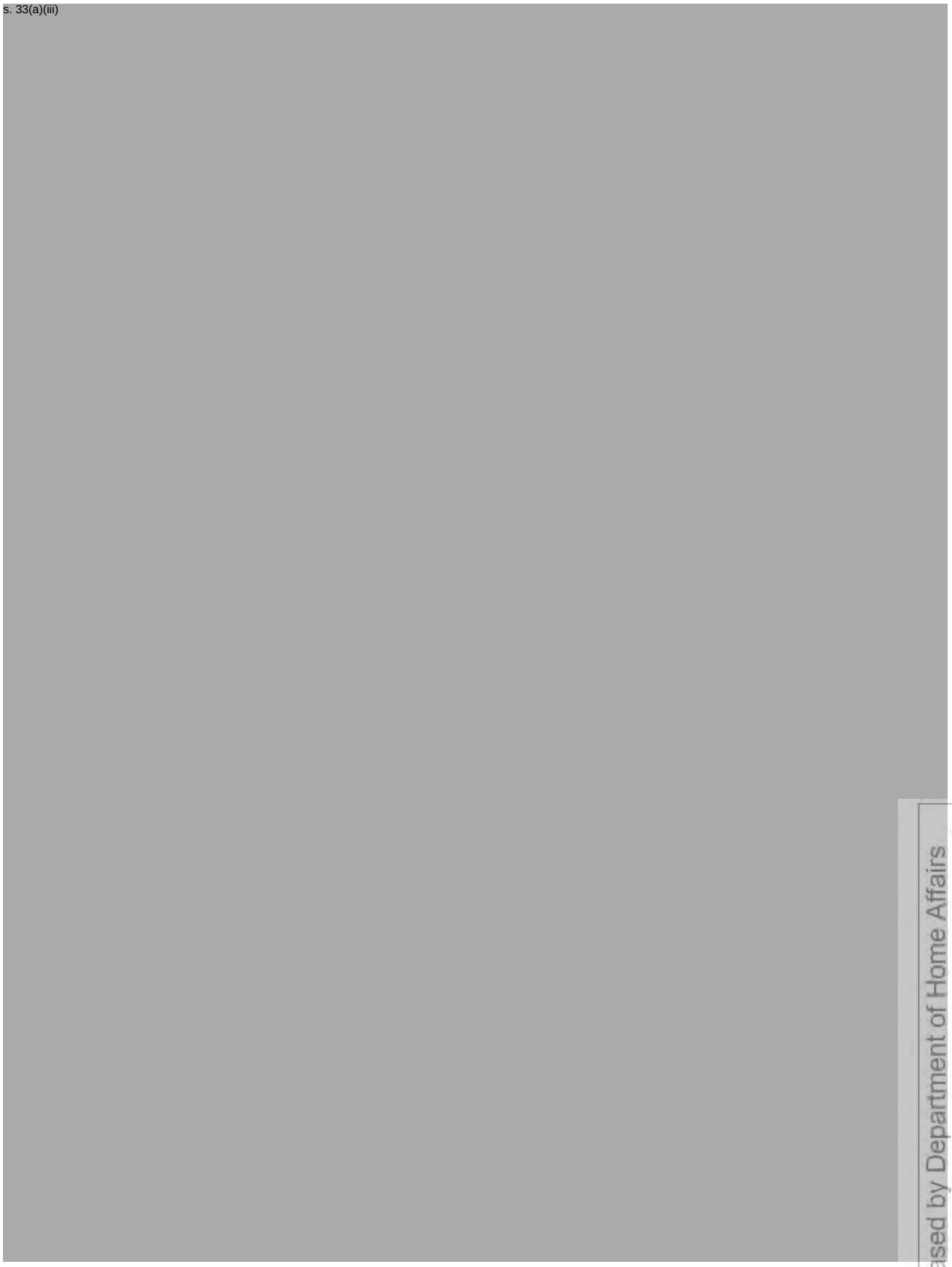
ATP Results of RPC2 – Tent #37

The following areas were sampled:

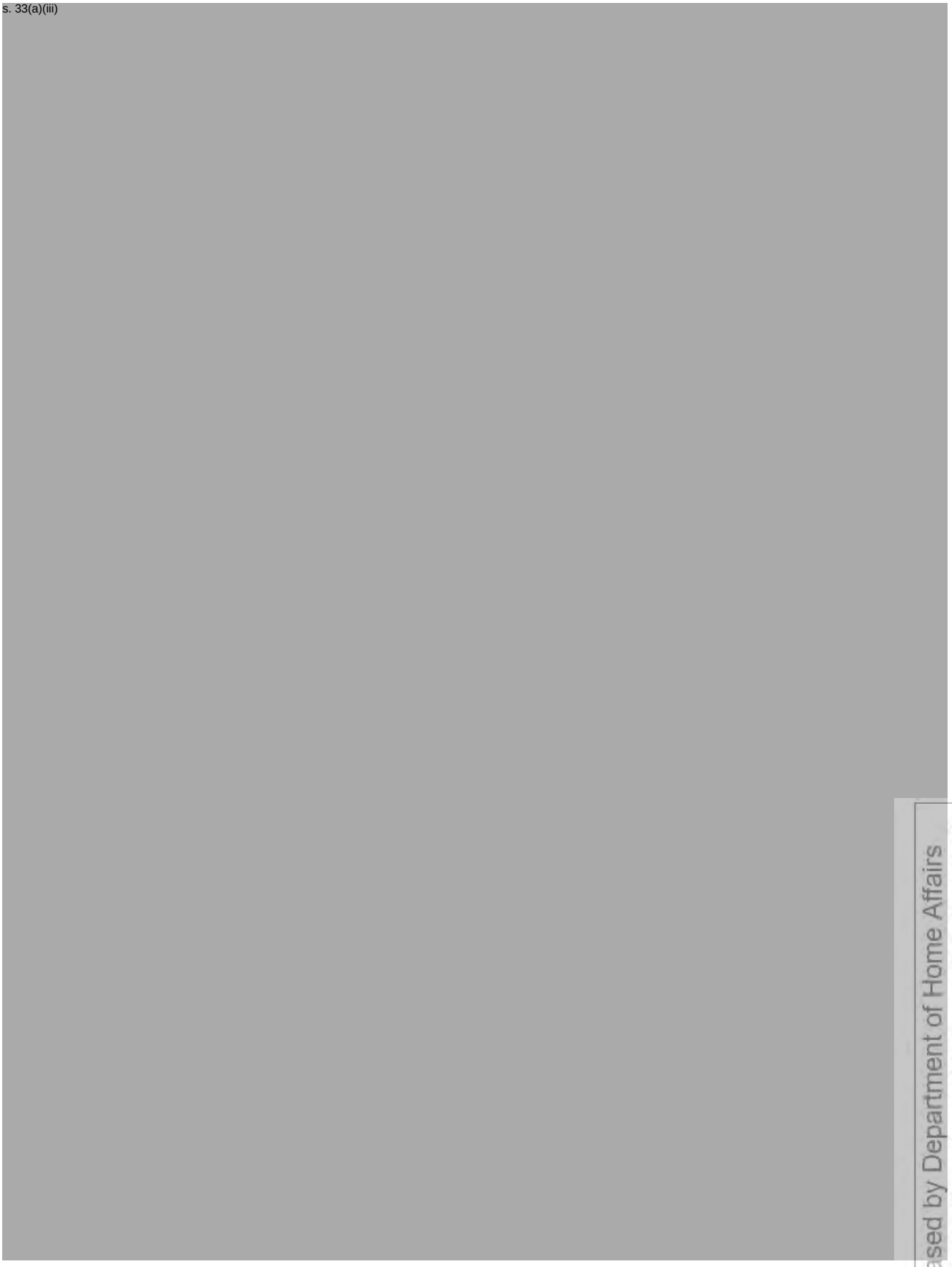
1. Internal Wall – South
2. Internal Wall – West
3. Internal Wall – East
4. Internal Wall – North
5. Internal Ceiling – SW Side
6. Internal Ceiling – SE Side
7. Internal Ceiling – NW Side
8. Internal Ceiling – NE Side
9. External Wall – South
10. External Wall – West
11. External Wall – North
12. External Wall – East
13. External Roof – SW Side
14. External Roof – NW Side
15. External Roof – NE Side
16. External Roof – SE Side
17. Internal Floor – South
18. Internal Floor – Middle

s. 33(a)(iii)

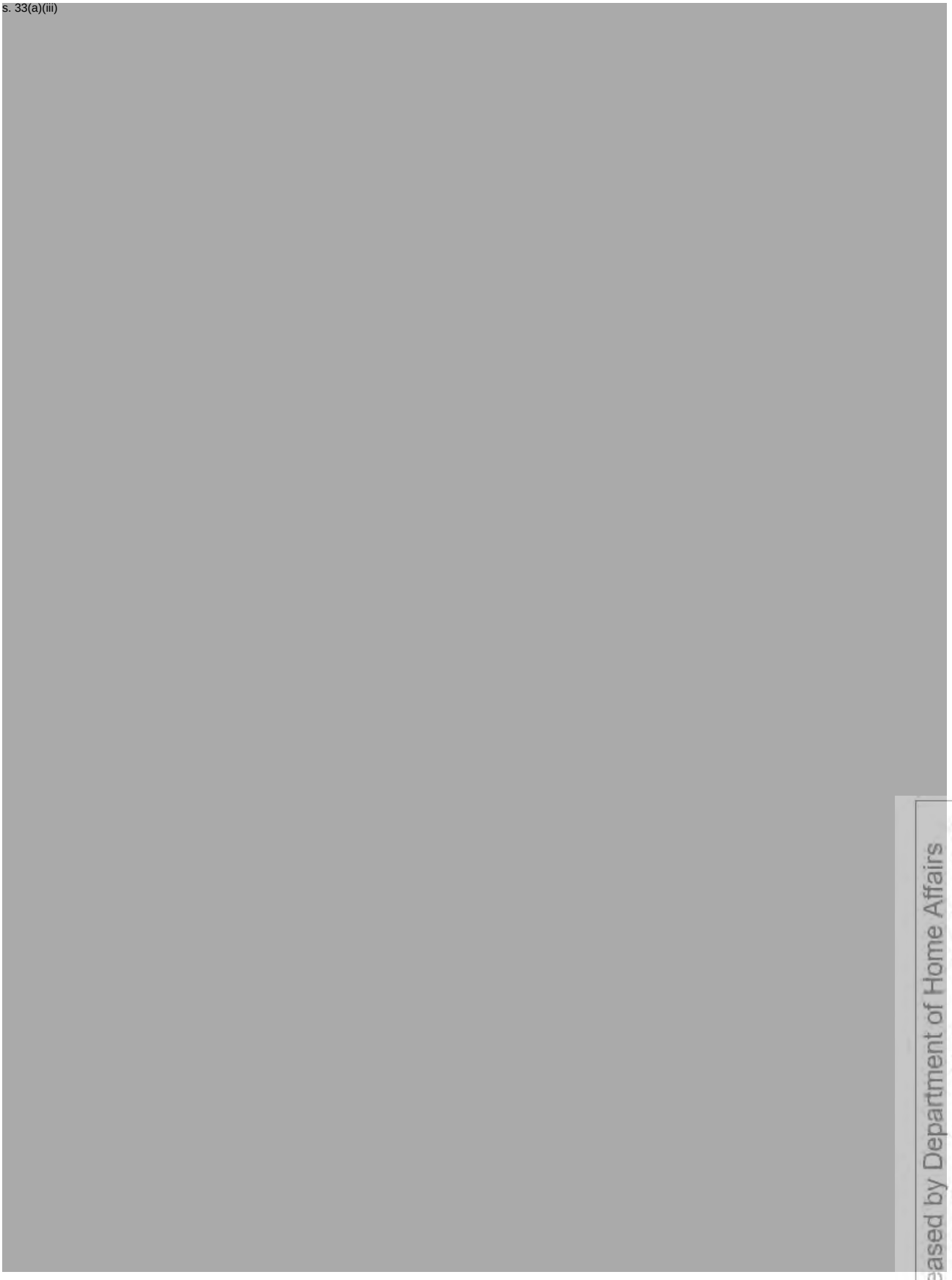
s. 33(a)(iii)



s. 33(a)(iii)



s. 33(a)(iii)



s. 33(a)(iii)

The ATP results confirm that the majority of the tested surfaces (indoors and outdoors) have levels of cellular matter that is unacceptable and well beyond what would be considered clean and hygienic.

This data can be further summarized to determine the combined impact of the different readings by plotting the mean values for the different regions.

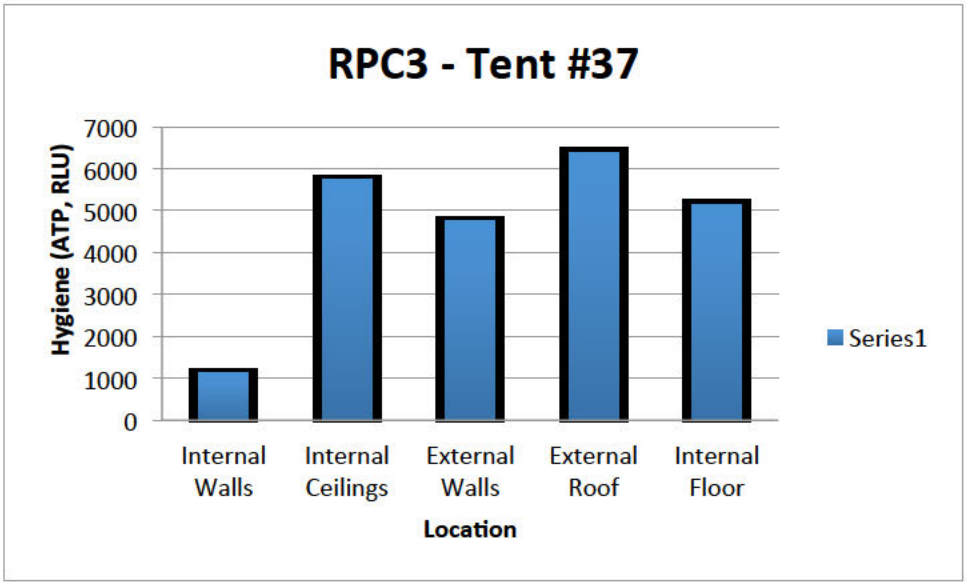


Figure 3.3. The mean ATP values were plotted for each area and we can see that in order from worst to least: (i) External roof, (ii) Internal ceilings, (iii) Internal Floor, (iv) External walls, followed by the (v) Internal walls. These ATP readings should be compared with Figure 2.4 that reflects the conditions on RPC2 Tent #18.

The ATP results show that the external roof is the most significantly affected surface with ATP-containing bio-loading. The internal tent ceilings are the next most affected surface; followed by the internal floor; then followed by the external walls. The internal walls are the least affected of the 5 sampled areas within this tent.

We can also compare this data with the same data for RPC2 – Tent #18. Both sets of ATP results confirm that the two dominant affected areas are both seen for the (i) External Roof and the (ii) Internal ceilings. This suggests that a combination of condensation and precipitation coupled with high day-time heating is allowing the tent roof/ceiling to act as a hot-box and behave as an incubator, whilst trapping moisture.

Biological Sampling – Culture-Based Analysis of RPC2 – Tent #37

Fungi:

The following PDA petri plates were used to measure the air quality inside and outside the RPC3 tent by measuring the level of viable bioaerosols.

1. Outdoor Control #1
2. Outdoor Control #2
3. Inside Tent, Location #1 (Middle)
4. Inside Tent, Location #2 (East side, front)
5. Inside Tent, Location #3 (West side, end)

PDA AGAR – Location: RPC3 Tent #37		
Day 3	**Day 4**	**Day 5**

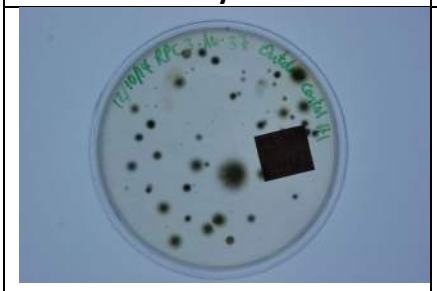
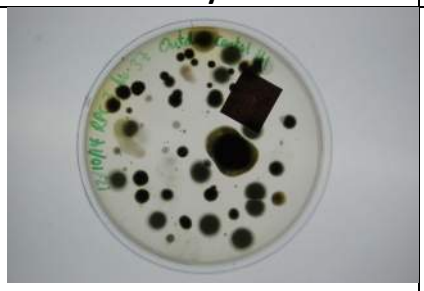
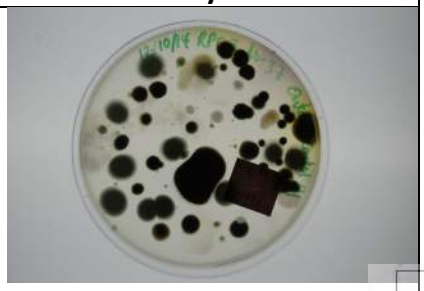

		

Fig 1a. Outdoor Control #1 Air Sample CFU = 62	Fig 1b. Outdoor Control #1 Air Sample CFU = 74	Fig 1c. Outdoor Control #1 Air Sample CFU = 76 *Aspergillus flavus, Penicillium, Cladosporium, Chaetomium, Candida sp., Trichophyton*

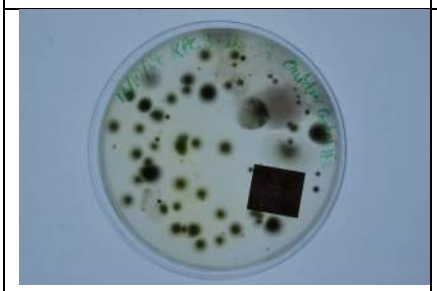
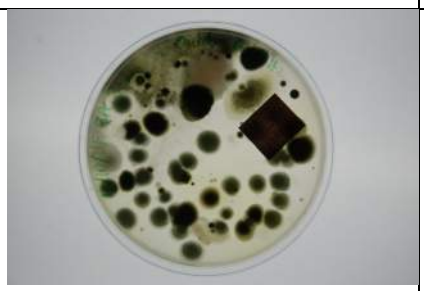

	

Fig 2a. Outdoor Control #2 Air Sample CFU = 85	Fig 2b. Outdoor Control #2 Air Sample CFU = 72	Fig 2c. Outdoor Control #2 Air Sample CFU = ~80

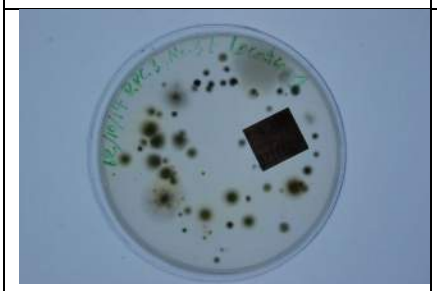
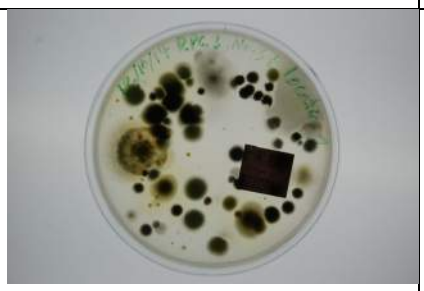
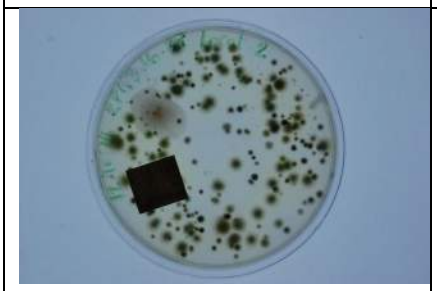
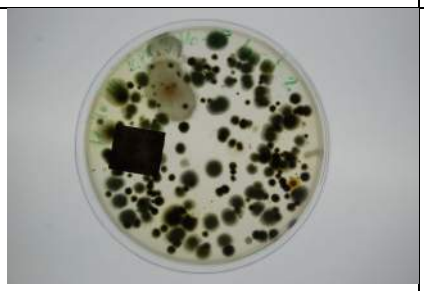
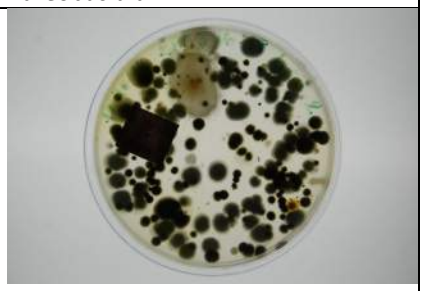
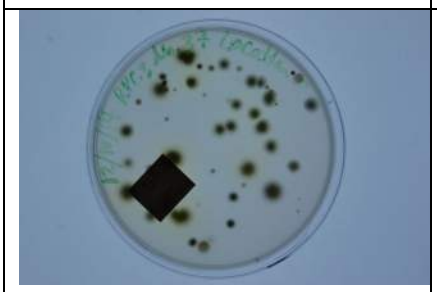
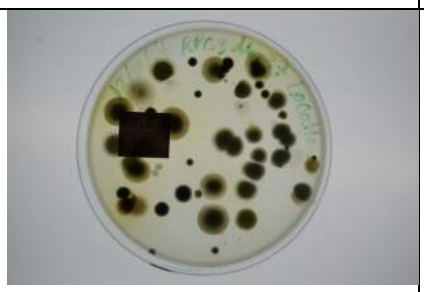
		Aspergillus niger, Aspergillus flavus, Cladosporium, Scedosporium
 Fig 3a. Inside Tent, Location #1 Air Sample CFU = 87	 Fig 3b. Inside Tent, Location #1 Air Sample CFU = ~100	 Fig 3c. Inside Tent, Location #1 Air Sample CFU = >110 *Cladosporium, Aspergillus flavus, Penicillium, Fusarium, Candida sp., Aureobasidium*
 Fig 4a. Inside Tent, Location #2 Air Sample CFU = ~250	 Fig 4b. Inside Tent, Location #2 Air Sample CFU = 225	 Fig 4c. Inside Tent, Location #2 Air Sample CFU = ~200 *Cladosporium, Aspergillus flavus, Penicillium, Fusarium, Candida sp.,* Unidentified black yeast, *Aureobasidium, Ulocladium*
 Fig 5a. Inside Tent, Location #3 Air Sample CFU = 51	 Fig 5b. Inside Tent, Location #3 Air Sample CFU = 66	 Fig 5c. Inside Tent, Location #3 Air Sample CFU = 65 *Cladosporium, Aspergillus flavus, Fusarium, Aureobasidium, Ulocladium, Aspergillus tereus, Chaetomium, Penicillium*

Table 3.3. Air samples were taken at the different locations and incubated for 3-5 days and inspected daily. The total number of different fungi were measured each day to plot the colony forming units, CFU on each day. For this tent, two of the air samples showed higher CFU than outdoors, while one sample showed levels that were similar to the outdoors. It is notable that in the middle of the tent (Location #2) the reading was much higher than at either ends of the tent where the flaps are always open. Colonies were identified to Genus and or Species for each plate at Day 5 for fungi that grew on PDA media. Colonies that grew on the other differential media were already selective for specific types of microorganisms and were scored as appropriate for that medium.

This data can be summarized in a graph below in Figure 3.4.

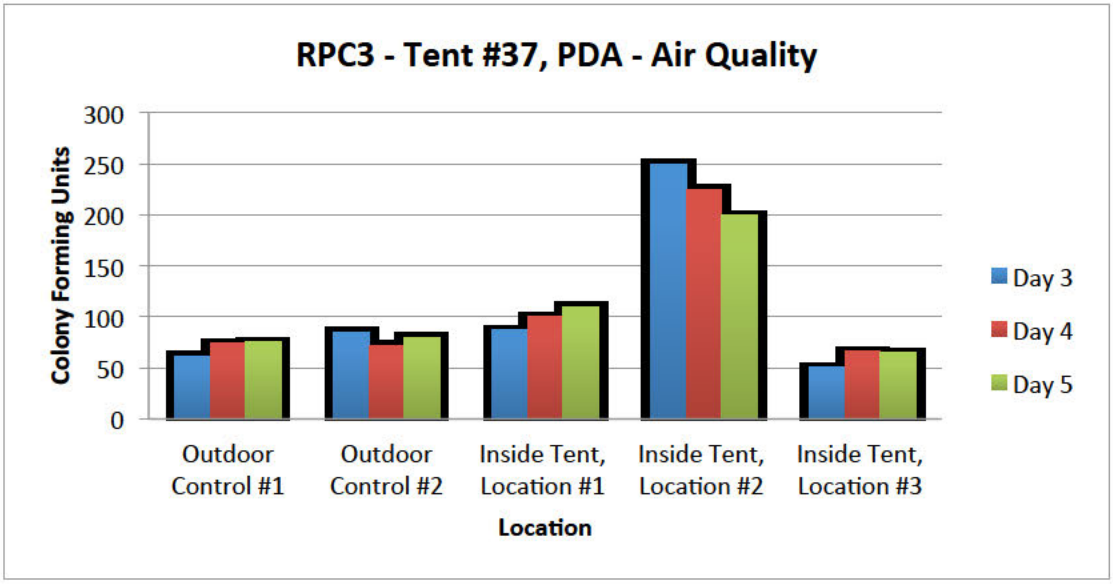


Figure 3.4. The colony forming unit counts were plotted on each day as bar graphs. Inside the tent at locations #1 and #2 confirms that the airspace concentration of viable fungi is significantly higher than outdoors. Inside the tent at Location #3 was taken towards the rear of this tent where the opening was almost completely open, so the potential for good mixing of indoor and outdoor air is also reflected in the CFU readings that are closer to the outdoor control that locations in other internal areas of this accommodation tent.

One of the three locations sampled inside the tent showed levels more than twice the mean of the two outdoor controls. However, the other two inside tent samples showed levels of ambient air fungal bioaerosols that were either slightly higher or lower than the outdoor controls. This means that some cubicles are contaminated and some aren't. Unfortunately, there are no visual cues that can be used to assist with determination of acceptable or unacceptable indoor/in-tent fungal loading levels. It is likely that in practice each cubicle would be assessed depending on occupant history and symptomology and visual bulk or other quantitative parameters.

Bacteria (air samples):

The following two air samples were also taken from within Tent #18 onto CHROM AGAR and NC AGAR respectively to measure the air quality inside and outside the tent by measuring the level of viable bioaerosols including bacteria and yeasts that are not always detected using PDA agar

and were compared against the outdoor control air. Table 3.4 details the plate reactions for Candida yeast species and mixed fungal populations. As before on RPC2 – Tent #18, we again see a dominace of *Aspergillus fumigatus* and *Geotrichum* species as well as some *Epicoccum* sp.

1. Outdoor Control
2. Inside Tent, Location #1
3. Inside Tent, Location #2

CHROM AGAR – Location: RPC3 Tent #37		
Day 3	**Day 4**	**Day 5**

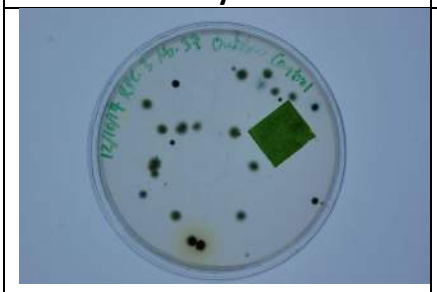
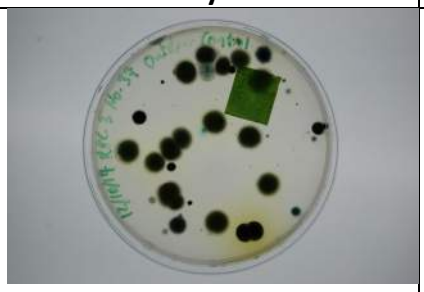
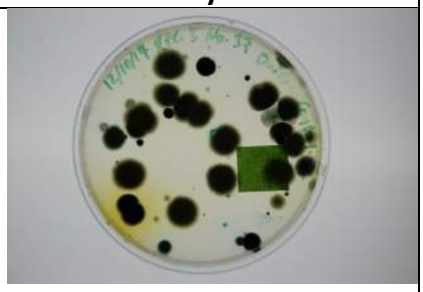

		

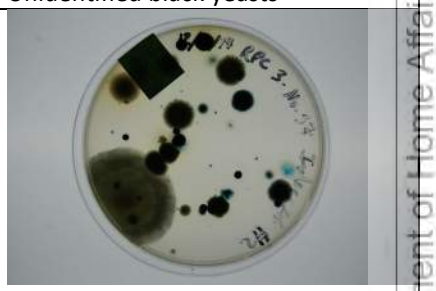
Fig 1a. Outdoor Control #1 Air Sample CFU = 32	Fig 1b. Outdoor Control #1 Air Sample CFU = 50	Fig 1c. Outdoor Control #1 Air Sample CFU = 55
		
Fig 2a. Inside Tent, Location #1 Air Sample CFU = 40	Fig 2b. Inside Tent, Location #1 Air Sample CFU = 48	Fig 2c. Inside Tent, Location #1 Air Sample CFU = 95 Unidentified black yeasts
		
Fig 3a. Inside Tent, Location #2 Air Sample CFU = 31	Fig 3b. Inside Tent, Location #2 Air Sample CFU = 62	Fig 3c. Inside Tent, Location #2 Air Sample CFU = 60 Unidentified black yeasts

Table 3.4. Air samples were sampled onto CHROMagar candida medium for the presumptive identification of Candia yeast species and detection of mixed fungal populations from air on RPC3 – Tent #37. The aim is to determine if the indoor tent environment presents with a threat from Candidiasis-causing microorganisms. These

results suggest that by Day 5 the air space inside the tent (Location #1) is definitely higher in Candida-type aerosols. Location #2 closer to the middle of the tent however showed overall levels of cultivatable bioaerosols similar to the outdoor levels.

This data can be summarized in a graph shown below.

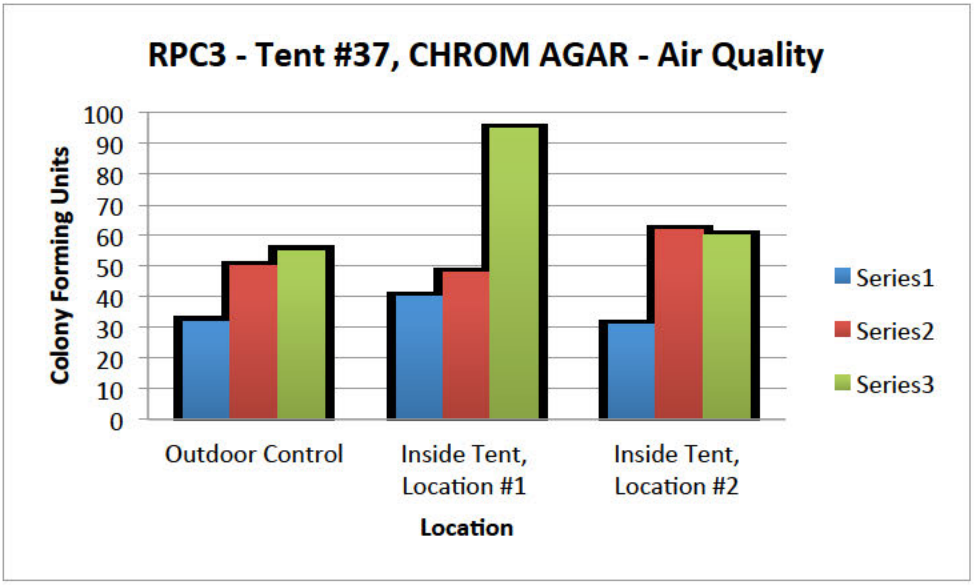


Figure 3.4. The colony forming unit counts were plotted on each day as bar graphs. Inside the tent at locations #1 and #2 confirms that the airspace concentration of viable fungi is higher than outdoors.

Table 3.5 and 3.6 reveal that the levels of airborne viable yeasts is less than the outdoor levels and that the risk of exposure inside the tent from Candidiasis-causing microorganisms is less than outdoors.

As before for the analysis of the air and surfaces on RPC2 – Tent #18, for this Tent we again use blood agar for the isolation and cultivation of fastidious bacteria like *Streptococcus*, *Enterococcus* and *Aerococcus*. Table 3.5 and 3.6 shows what types of haemolysis reactions were detected on the NC Agar Plates from air samples within the Tent and from outside. It is straightforward to read the hemolytic reaction and each plate has been photographed with transmitted light (from behind) at Days 3, 4 and 5. Final interpretation was made at Day 5.

Growth Medium: NC AGAR – Hemolysis Reactions Evaluated at Day 5, Location: RPC3 Tent #37				
AIR SAMPLING				
Location	**Sample/Figure Number**	**β**	**α**	**Y**
Outdoor Control	Figure 1c	+		+
Inside Tent, Location #1	Figure 2c	+	+	+
Inside Tent, Location #2	Figure 3c	++	+	+

Table 3.5. Hemolysis reactions scored on NC Agar after growth for 5 days at 30°C. If any of the three different types of hemolytic reactions are present, then they are scored with a "+". If no hemolytic reaction of that type is observed, then that field remains empty, while no viable growth after 5 days is scored as "NIL Growth" A semi-quantitative scale from low (+), medium (++), or high (+++) is also defined. The results clearly show that the indoor air contains bacteria that show all three types of hemolysis reactions and that the colony forming units counts are indeed higher inside the tent that outdoors.

NC AGAR – Location: RPC3 Tent #37		
Day 3	**Day 4**	**Day 5**

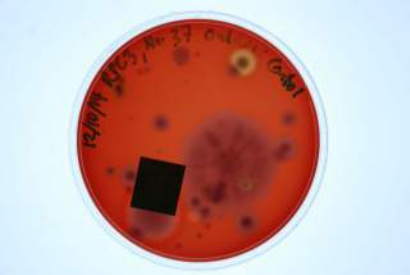
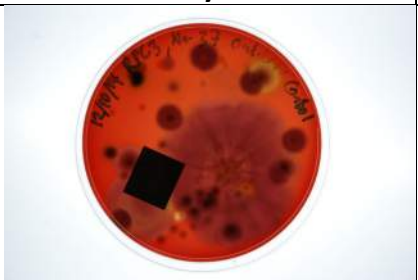
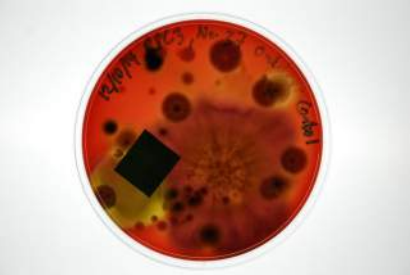

		

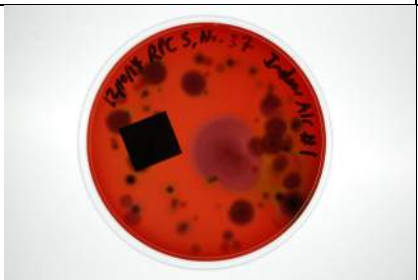
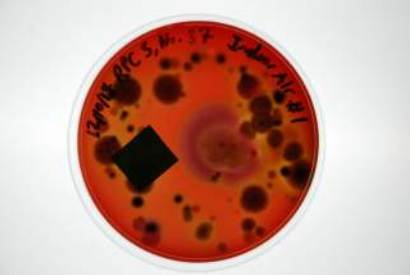
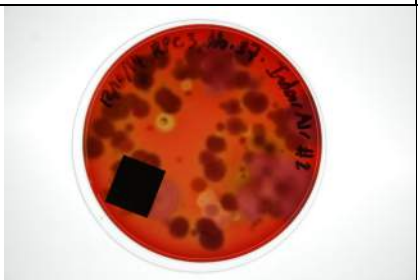
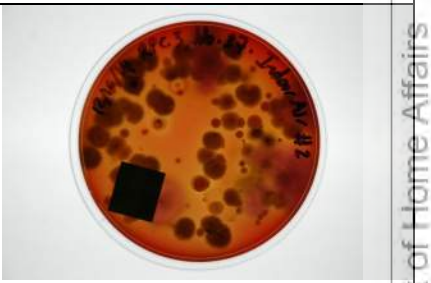
Fig 1a. Outdoor Control #1 Air Sample CFU = 34	Fig 1b. Outdoor Control #1 Air Sample CFU = 46	Fig 1c. Outdoor Control #1 Air Sample CFU = 50
		
Fig 2a. Inside Tent, Location #1 Air Sample CFU = 70	Fig 2b. Inside Tent, Location #1 Air Sample CFU = 96	Fig 2c. Inside Tent, Location #1 Air Sample CFU = ~100
		
Fig 3a. Inside Tent, Location #2 Air Sample CFU = 90	Fig 3b. Inside Tent, Location #2 Air Sample CFU = >100	Fig 3b. Inside Tent, Location #2 Air Sample CFU = ~100

Table 3.6. The colony forming unit counts, CFU were performed on NC Agar on days: 3, 4 and 5 for air samples taken from each of the different locations. Anaerobic streak-stabbing was not performed to look for Streptolysins that are best observed under anaerobic conditions. The results demonstrate that the airspace inside the tent is considered heavily contaminated with exotoxin producing bacteria with selection towards γ-hemolytic strains which have the appearance of Streptococcus pneumonia along with other mixed fungal populations. The results between tent #18 and Tent #37 on the two different camps arte considered to show similar results for the hemolytic

reactions displayed.

This data can be summarized in a graph Figure 3.5 shown below.

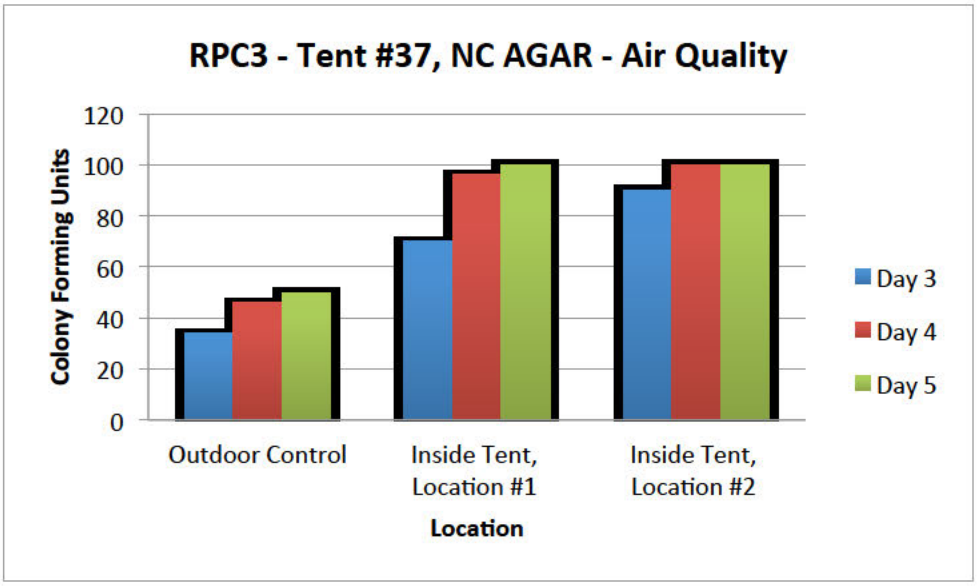


Figure 3.5. The colony forming unit counts for bacteria and fungi that grew on the selective NC Agar media were plotted. We can see that in order from worst to least versus the outdoor control: (i) Inside Location #2, (ii) Inside Location #1, meaning that the air quality indoors is significantly worse than outdoors in terms of viable haemolytic bacteria and fungi.

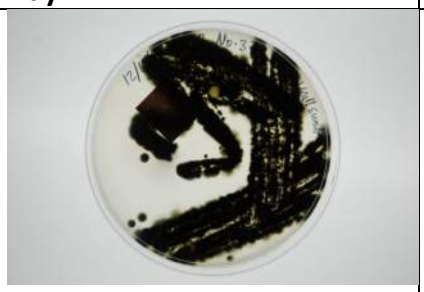
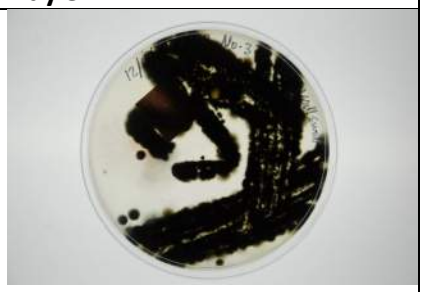
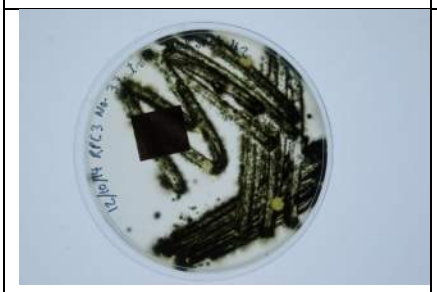
The data is Tables 3.4 and 3.6 confirms that the indoor tent air is significantly contaminated with viable pathogenic bacteria (and fungi) that are in excess to the normal outdoor control air. This means that the air quality inside this tent is unacceptable and it is foreseeably likely that all persons who enter this tent are breathing in and are exposed to dermal contact with viable bacteria (haemolytic pathogens and other microflora that can be selected for using this differential medium) at levels that are in excess to the normal outdoor concentration.

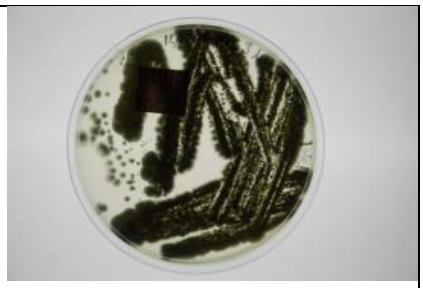
Fungi (surface samples) of RPC3 – Tent #37:

The following areas were surface swabbed and inoculated onto PDA petri plates used to measure the local surface-bound fungal levels.

1. Inside Tent Wall Location #1
2. Inside Tent Wall Location #2
3. Inside Tent Wall Location #3
4. Inside Tent Wall Location #4
5. Outside Tent Wall Location #1
6. Outside Tent Wall Location #2
7. Outside Tent Wall Location #3
8. Outside Tent Wall Location #4

9. Outside Roof Location #1
10. Outside Roof Location #2
11. Outside Roof Location #3
12. Inside Ceiling Location #1
13. Inside Ceiling Location #2
14. Inside Ceiling Location #3
15. Inside Floor Location #1
16. Inside Floor Location #2

PDA Swabs – Location: RPC3 Tent #37		
Day 3	**Day 4**	**Day 5**
 Figure 1a. Inside Tent Wall Location #1 Swab sample CFU = >300	 Figure 1b. Inside Tent Wall Location #1 Swab sample CFU = >300	 Figure 1c. Inside Tent Wall Location #1 Swab sample CFU = >300 OD = 78.74 Mode = 4 *Fusarium, Aspergillus flavus, Rhizopus, Trichophyton, Microsporum*
 Figure 2a. Inside Tent Wall Location #2 Swab sample CFU = >300	 Figure 2b. Inside Tent Wall Location #2 Swab sample CFU = >300	 Figure 2c. Inside Tent Wall Location #2 Swab sample CFU = >300 OD = 65.94 Mode = 4 *Aspergillus niger, Aspergillus flavus, Cladosporium, Drechslera, Trichophyton*

		
Figure 3a. Inside Tent Wall Location #3 Swab sample CFU = >300	Figure 3b. Inside Tent Wall Location #3 Swab sample CFU = >300	Figure 3c. Inside Tent Wall Location #3 Swab sample CFU = >300 OD = 82.57 Mode = 19 *Aspergillus flavus* [pure, single-strain isolate]

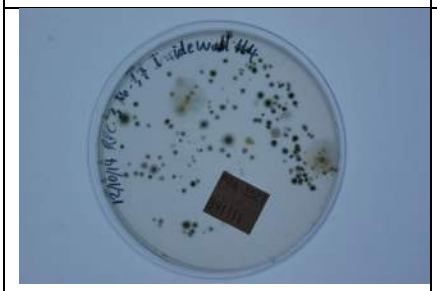
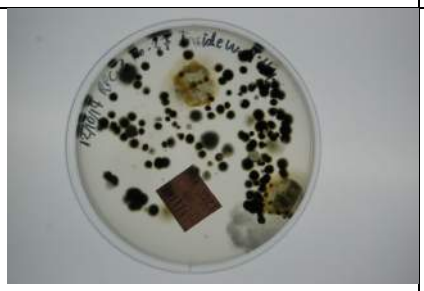
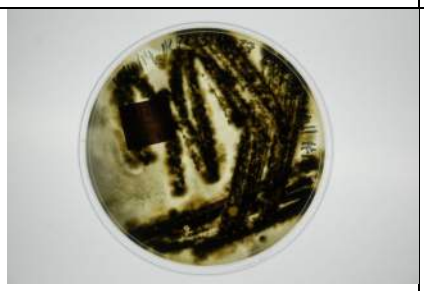
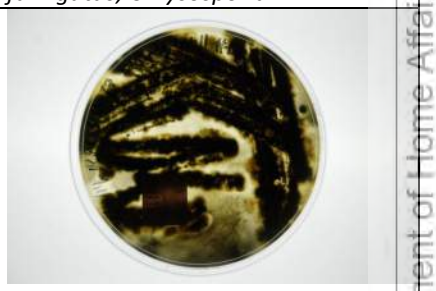
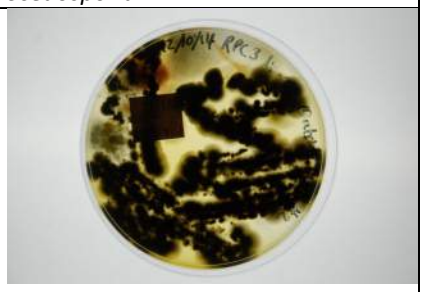
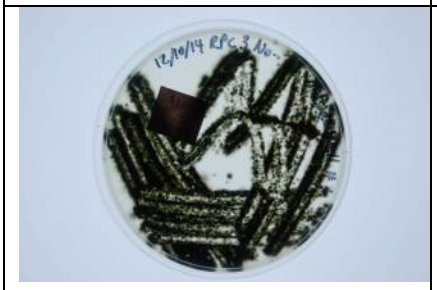
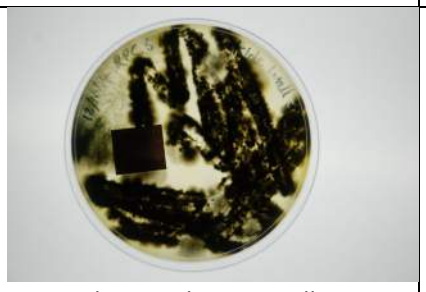
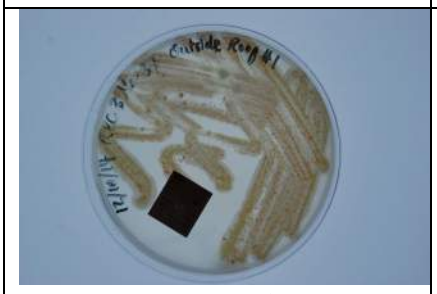
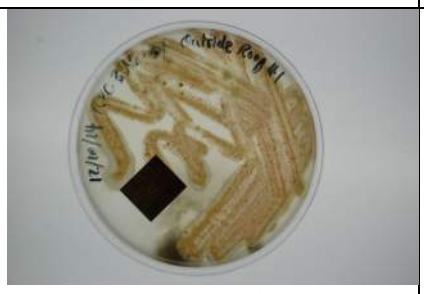
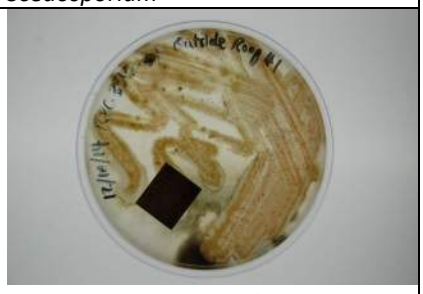
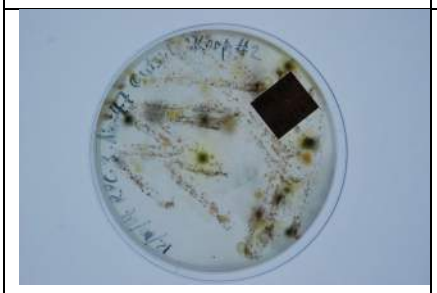
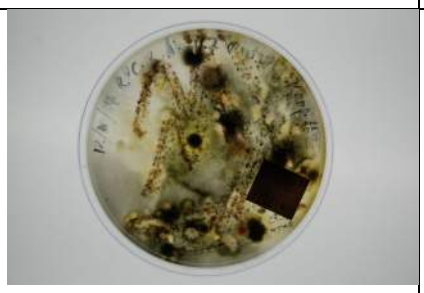
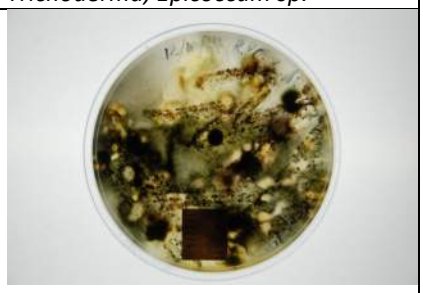
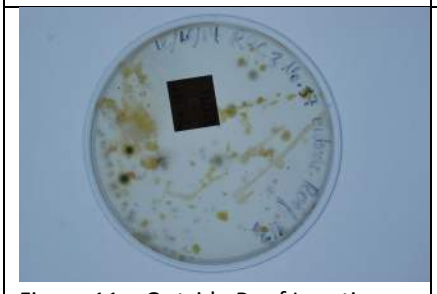
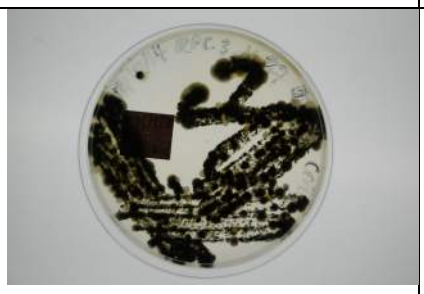
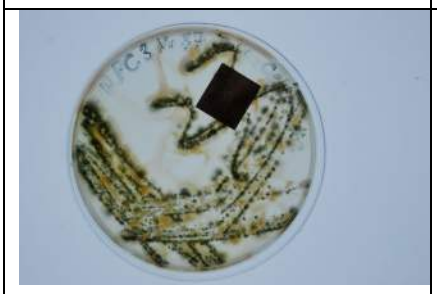

	

Figure 4a. Inside Tent Wall Location #4 Swab sample CFU = 165	Figure 4b. Inside Tent Wall Location #4 Swab sample CFU = ~140	Figure 4c. Inside Tent Wall Location #4 Swab sample CFU = ~140 OD = 107.1 Mode = 168 *Penicillium, Cladosporium, Aspergillus flavus, Aspergillus fumigatus, Chrysosporium*
		
Figure 5a. Outside Tent Wall Location #1 Swab sample CFU = >300	Figure 5b. Outside Tent Wall Location #1 Swab sample CFU = >300	Figure 5c. Outside Tent Wall Location #1 Swab sample CFU = >300 OD = 52.06 Mode = 5 *Aspergillus niger, Penicillium,*

		Ulocladium, Aspergillus flavus, Scedosporium
 Figure 6a. Outside Tent Wall Location #2 Swab sample CFU =>200	 Figure 6b. Outside Tent Wall Location #2 Swab sample CFU = >300	 Figure 6c. Outside Tent Wall Location #2 Swab sample CFU = >300 OD = 65.93 Mode = 5 *Aspergillus niger, Scedosporium, Chaetomium, Aspergillus flavus, Aspergillus fumigatus*
 Figure 7a. Outside Tent Wall Location #3 Swab sample CFU = >300	 Figure 7b. Outside Tent Wall Location #3 Swab sample CFU = >300	 Figure 7c. Outside Tent Wall Location #3 Swab sample CFU = >300 OD = 51.0 Mode = 6 *Aspergillus niger, Ulocladium, Penicillium, Aspergillus flavus, Scedosporium*
 Figure 8a. Outside Tent Wall Location #4 Swab sample CFU = >300	 Figure 8b. Outside Tent Wall Location #4 Swab sample CFU = >300	 Figure 8c. Outside Tent Wall Location #4 Swab sample CFU = >300 OD = 55.24

		Mode = 5 *Aspergillus niger, Penicillium, Ulocladium, Aspergillus flavus, Scedosporium*
 Figure 9a. Outside Roof Location #1 Swab sample CFU = >300	 Figure 9b. Outside Roof Location #1 Swab sample CFU = >300	 Figure 9c. Outside Roof Location #1 Swab sample CFU = >300 OD = 112.6 Mode = 109 *Candida sp., Aspergillus flavus, Trichoderma, Epicoccum sp.*
 Figure 10a. Outside Roof Location #2 Swab sample CFU = >300	 Figure 10b. Outside Roof Location #2 Swab sample CFU = >300	 Figure 10c. Outside Roof Location #2 Swab sample CFU = >300 OD = 87.81 Mode = 9 *Chrysosporium, Candida sp., Rhizomucor*
 Figure 11a. Outside Roof Location #3 Swab sample CFU =~150	 Figure 11b. Outside Roof Location #3 Swab sample CFU =~150	 Figure 11c. Outside Roof Location #3 Swab sample CFU =>150 OD = 116.95

		Mode = 168 *Alternaria, Unidentified black yeasts, Candida sp., Chrysosporium, Chaetomium*
 Figure 12a. Inside Ceiling Location #1 Swab sample CFU =>300	 Figure 12b. Inside Ceiling Location #1 Swab sample CFU =>300	 Figure 12c. Inside Ceiling Location #1 Swab sample CFU = >300 OD = 80.59 Mode = 4 *Candida sp., Cladosporium, unidentified black yeasts, Aspergillus flavus, Chaetomium*
 Figure 13a. Inside Ceiling Location #2 Swab sample CFU =>300	 Figure 13b. Inside Ceiling Location #2 Swab sample CFU =>300	 Figure 13c. Inside Ceiling Location #2 Swab sample CFU = >300 OD = 75.31 Mode = 2 *Candida sp., Cladosporium, unidentified black yeasts, Aspergillus flavus, Chaetomium, Penicillium*
 Figure 14a. Inside Ceiling Location #3	 Figure 14b. Inside Ceiling Location #3	 Figure 14c. Inside Ceiling Location #3

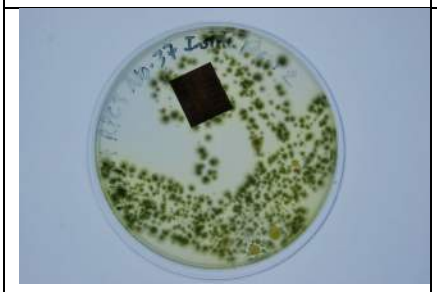
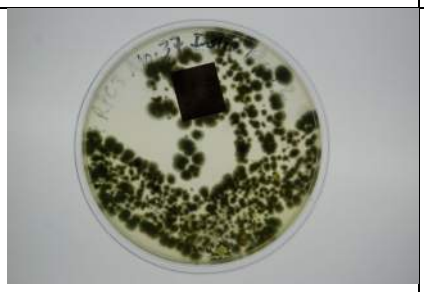
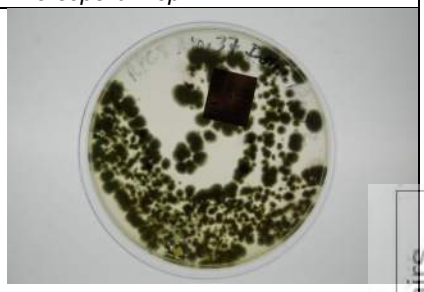
Swab sample CFU =>300	Swab sample CFU =>300	Swab sample CFU = >300 OD = 85.11 Mode = 6 *Aspergillus flavus, Candida krusei, Sporobolomyces, Cladosporium,* unidentified black yeasts
 Figure 15a. Inside Floor Location #1 Swab sample CFU =>300	 Figure 15b. Inside Floor Location #1 Swab sample CFU =>300	 Figure 15c. Inside Floor Location #1 Swab sample CFU = >300 OD = 82.9 Mode = 7 *Aspergillus flavus, Aspergillus fumigatus, Chrysosporium, Cladosporium, Candida sp.,* unidentified black yeasts, *Microsporum sp.*
 Figure 16a. Inside Floor Location #2 Swab sample CFU =>300	 Figure 16b. Inside Floor Location #2 Swab sample CFU =>300	 Figure 16c. Inside Floor Location #2 Swab sample CFU = >300 OD = 97.45 Mode = 190 *Aspergillus flavus, Aspergillus fumigatus, Cladosporium, Chrysosporium*

Table 3.7. Swabs of 100cm^2 were taken using a sterile swab rotated across the surface in a zig-zag patern up and down and across and down. Swabs were streak transferred immediately onto sterile petri-plates. The results after 5-days growth yielded dominant cultures from each location. The total number of colony forming units are only semi-useful due to the fact that overgrowth occurred from the fast-growing fungi. Each 5-day old plate was analysed using image analysis to determine the mean optical density (OD) and Mode to estimate the biofilm thickness that is likely to occur on the different tent surfaces. This was found to be a sensitive method to classify

fungal populations from different areas as being either similar or different.

This data above has been analyzed and summarized below in Figures 3.6 and 3.7.

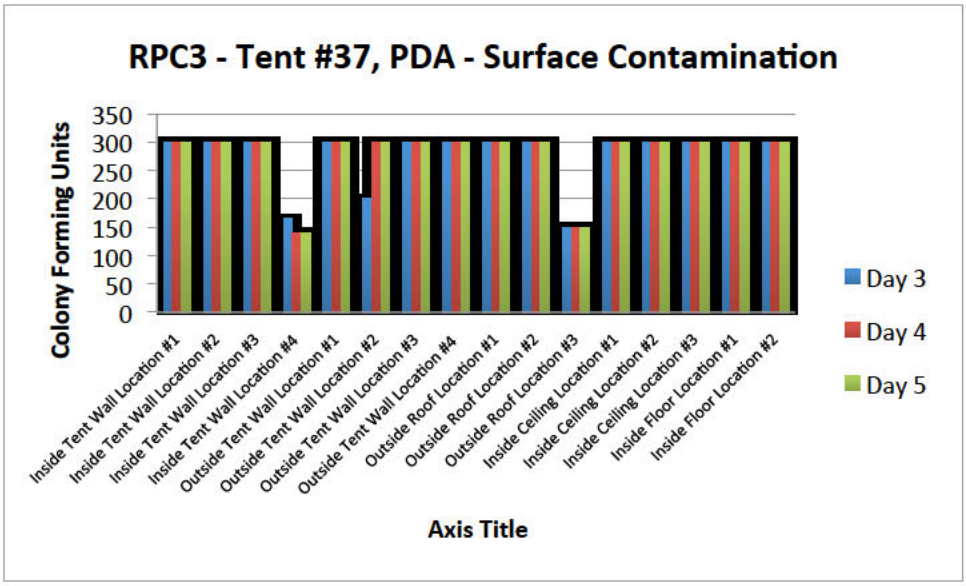
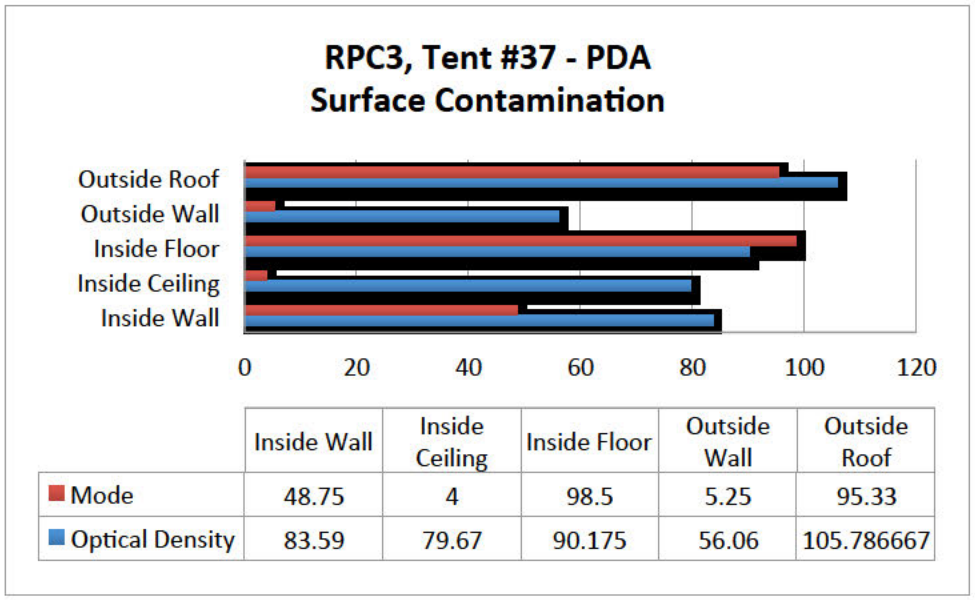


Figure 3.6. Surface fungal contamination on each of the different locations plotted against days of growth. The inside tent walls appear to show the worst levels of CFU. The swabs transfers quickly showed the high-viability of the fungi, and although each swab was a mixed microflora the isolates can be considered typical of the biofilms that grow on the tent material.



	Inside Wall	Inside Ceiling	Inside Floor	Outside Wall	Outside Roof
Mode	48.75	4	98.5	5.25	95.33
Optical Density	83.59	79.67	90.175	56.06	105.786667

Figure 3.7. Each Petri plate at Day 5 was analysed using image analysis to calculate the Mode, M and optical density, OD of the transmitted light through the plates. Low OD values are dark, while High OD are light. The Mode is the most frequent observation, and is equivalent to the dominant light frequency. The mode allows the

populations of cells to be classified as similar or different. In these samples, the biofilm growth morphology for the outside roof is different to that observed for the inside walls and inside ceilings which are identical. The outside wall growth is different again to the growth on the roof.

The following swabs were taken onto both CHROM AGAR and NC AGAR.

1. Inside Wall
2. Outside Wall
3. Inside Ceiling
4. Outside Roof
5. Inside Floor

CHROM AGAR – Location: RPC3 Tent #37		
Day 3	**Day 4**	**Day 5**
		
Figure 1a. Inside Ceiling Swab sample CFU = >60	Figure 1b. Inside Ceiling Swab sample CFU = >250	Figure 1c. Inside Ceiling Swab sample CFU= >300
		
Figure 2a. Inside Wall Swab sample CFU = >300	Figure 2b. Inside Wall Swab sample CFU = >300	Figure 2c. Inside Wall Swab sample CFU = >300
		
Figure 3a. Inside Floor Swab sample CFU = >300	Figure 3b. Inside Floor Swab sample CFU = >300	Figure 3c. Inside Floor Swab sample CFU = >300

Figure 4a. Outside Wall Swab sample CFU = >200

Figure 4b. Outside Wall Swab sample CFU = >200

Figure 4c. Outside Wall Swab sample CFU = >200

Figure 5a. Outside Roof Swab sample CFU = >100

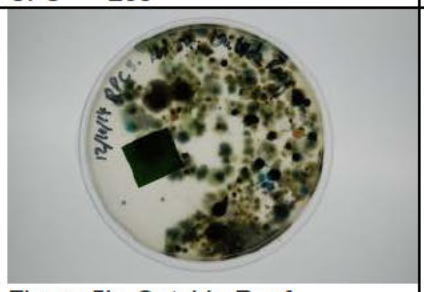


Figure 5b. Outside Roof Swab sample CFU = ~150

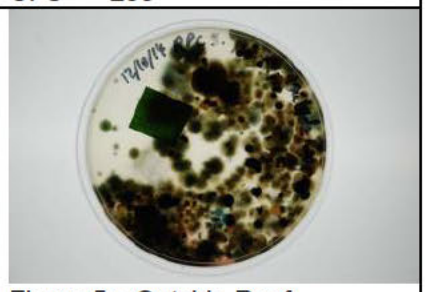


Figure 5c. Outside Roof Swab sample CFU = >150

Table 3.8. Swab testing for the inside walls and ceilings reveals alarming results showing that these surfaces are heavily contaminated with human pathogenic fungi and yeasts. The least contaminated surface was observed for the inside floor. The Day 3 and 4 results reveal high levels of Candida albicans bacteria (green colonies) on the outside wall. Overgrowth with other fungi by Day 4 for the inside wall makes it difficult to comment on the levels of Candida. The inside ceiling also shows characteristic salmon-pink colonies of Candida krusei.

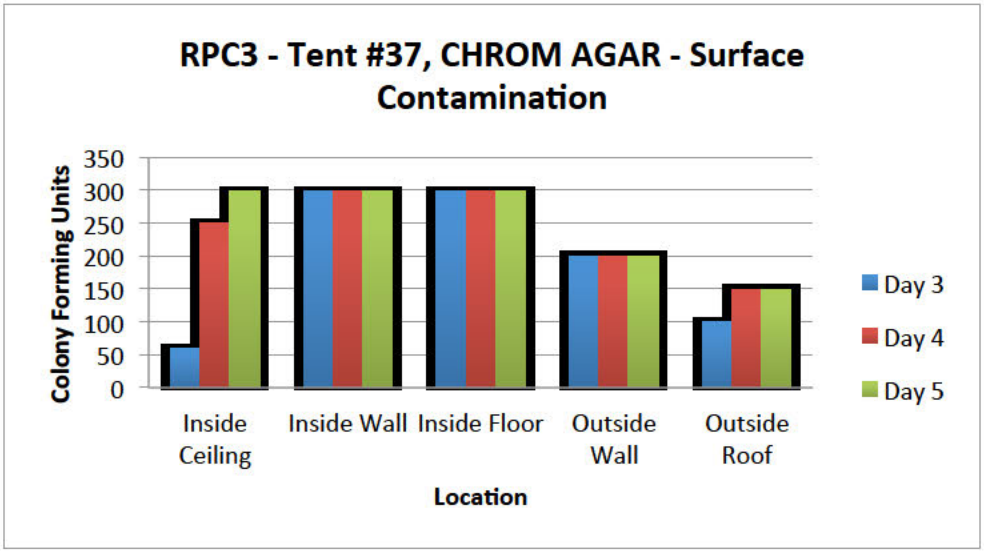


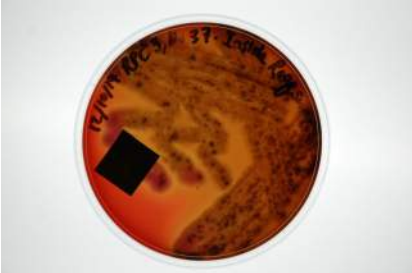
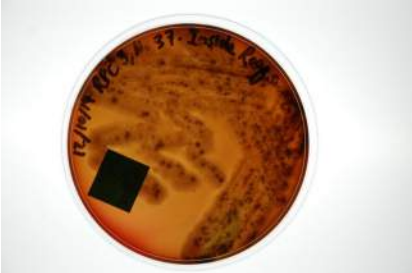
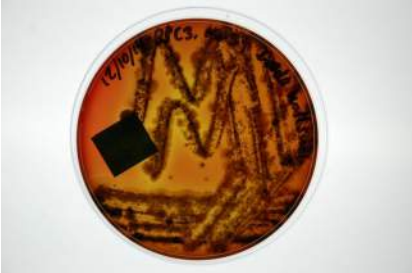
Figure 3.8. Plots of the colony forming unit counts for the petri plates shown in Table 3.8 showing the relative levels of Candida contamination in graphical format.

Table 3.9 shows what types of haemolysis reactions were detected on the NC Agar Plates. It is straightforward to read the hemolytic reaction and each plate has been photographed with transmitted light (from behind) at Days 3, 4 and and 5. Interpretation was made at Day 5 from the information in Table 3.10.

- Beta hemolysis (β) is defined as complete lysis of red blood cells showing a clear zone. This is because many bacteria produce toxic enzymes that can destroy red blood cells. Typical bacteria showing Beta hemolysis include *Streptococcus pyogenes*.
- Alpha hemolysis (α) is defined as the reduction of the hemoglobin in red blood cells to methemoglobin which diffuses into the agar surrounding the colony. This is seen as a green or brown discoloration of the medium – where the cells are in fact bruised. Typical bacteria showing Alpha hemolysis include *Streptococcus* "viridans group" like *S. mutans*, *S. mitis*, *S. salivarius* or *S. pneumoniae*.
- Gamma hemolysis (γ) reflects the fact that there is no hemolytic reaction and the medium remains the same colour. Typical bacteria showing Gamma hemolysis include *Enterococcus faecalis*.

Growth Medium: NC AGAR – Hemolysis Reactions Evaluated at Day 5 **Location: RPC3 Tent #37**				
SWAB SAMPLING				
Location	**Sample/Figure Number**	**β**	**α**	**ϒ**
Inside Ceiling	Figure 1c	+++	-	+
Inside Wall of Tent	Figure 2c	+++	++	+
Inside Floor of Tent	Figure 3c	+++	+	+
Outside Wall of Tent	Figure 4c	++	++	+
Outside Roof of Tent	Figure 5c	+++	-	+

Table 3.9. Hemolysis reactions scored on NC Agar after growth for 5 days at 30°C. If any of the three different types of hemolytic reactions are present, then they are scored with a "+". If no hemolytic reaction of that type is observed, then that field is scored with a "-", while no viable growth after 5 days is scored as "NIL Growth" A semi-quantitative scale from low (+), medium (++), or high (+++) is also defined.

NC AGAR – Location: RPC3 Tent #37		
Day 3	**Day 4**	**Day 5**
		
Figure 1a. Inside Ceiling Swab sample CFU = >300	Figure 1b. Inside Ceiling Swab sample CFU = >300	Figure 1c. Inside Ceiling Swab sample CFU = >300
		
Figure 2a. Inside Wall Swab sample CFU = >300	Figure 2b. Inside Wall Swab sample CFU = >300	Figure 2c. Inside Wall Swab sample CFU = >300 Unidentified black yeasts

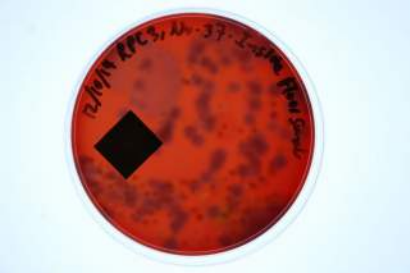
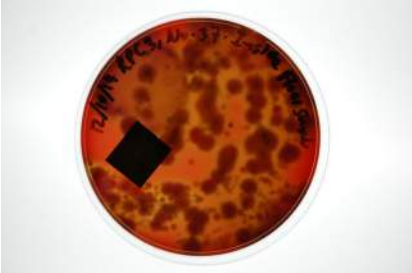
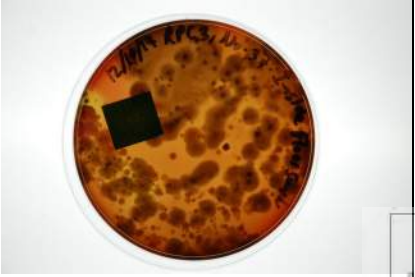

		

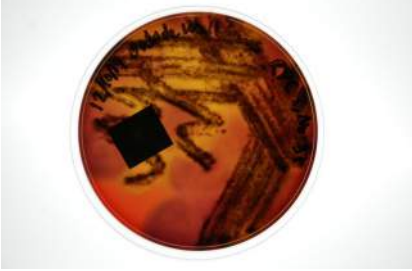
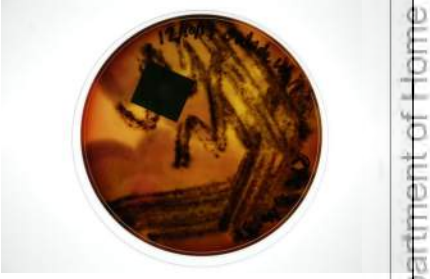
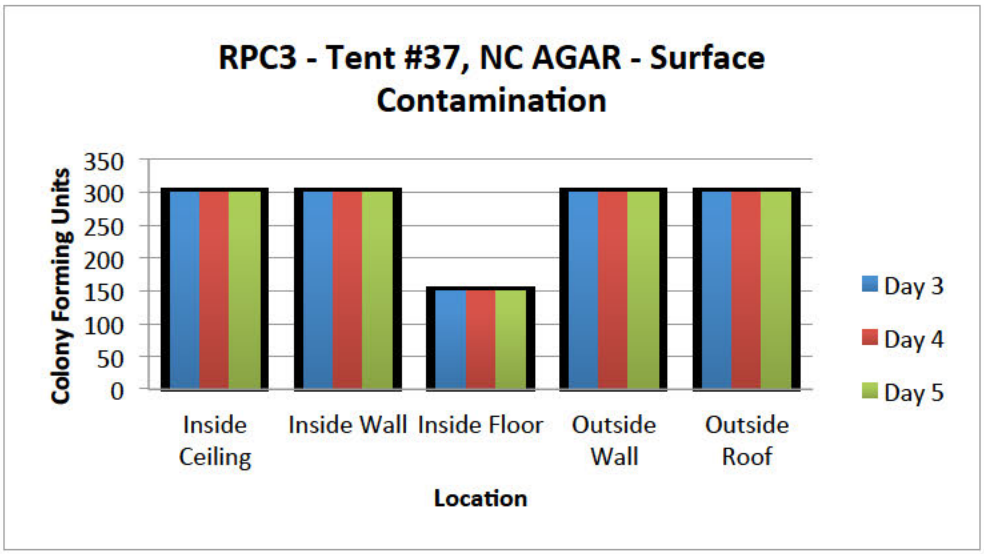
Figure 3a. Inside Floor Swab sample CFU = ~150	Figure 3b. Inside Floor Swab sample CFU = >150	Figure 3c. Inside Floor Swab sample CFU = >150
		
Figure 4a. Outside Wall Swab sample CFU = >300	Figure 4b. Outside Wall Swab sample CFU = >300	Figure 4c. Outside Wall Swab sample CFU = >300 Unidentified black yeasts

Figure 5a. Outside Roof
Swab sample
CFU = >300

Figure 5b. Outside Roof
Swab sample
CFU = >300

Figure 5c. Outside Roof
Swab sample
CFU = >300

Table 3.10. Hemolysis reactions scored to show the colony forming unit counts, CFU on NC Agar on days: 3, 4 and 5 for swab samples taken from each of the different locations. Since these are all swab samples, there is no control and we need to evaluate contamination based on the levels of CFU and the dominance of haemolytic reaction. It is known that Candida albicans and Staphylococcus aureus can produce hemolytic factor and could account for the dominant β-hemolysis reaction seen on all of the plates by Day 5.



s. 33(a)(iii), s. 47C(1)

Tape Lifts of RPC3 – Tent #37

The following areas were sampled using Tape Lifts for microscopic examination.

5. Outside Wall
6. Outside Roof
7. Inside Wall
8. Inside Ceiling

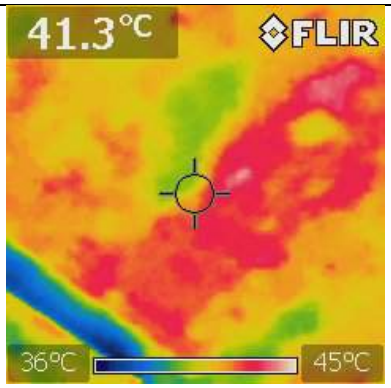
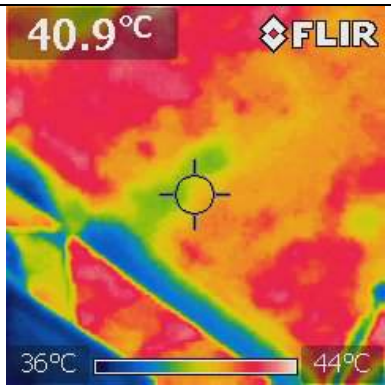
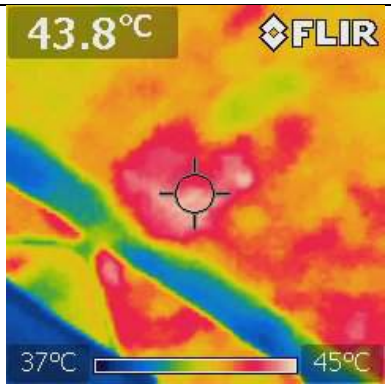
Tape Lift Classification – RPC3, Tent #37				
Location	**Typical ROI Example Micrograph**	**Fungal/Mould Spore Loading**	**Fungal/Mould Mycelium Loading**	**Fungal/Mould ID**
Outside Wall		Low	Very High	*Ulocladium* *Trichoderma koningii*
Outside Roof		Very High	Low	*Ulocladium* Unidentified ascospores *Chaetomium* *Spegazzinia*
Inside Wall		Low	Very High	*Aspergillus/Penicillium* Unidentified smuts Unidentified yeasts
Inside Ceiling		High	Very High	*Alternaria* *Cladosporium* *Stachybotrys* Unidentified yeasts *Aspergillus sp.*

Loading Concentration Key
Low = 1-25%
Medium = 26-50%
High = 51-75%
Very High = 76-100%
Assessments were made using bright field microscopy at x600 and x1000 magnification. At least 50 fields of view (ROI) were examined per slide.

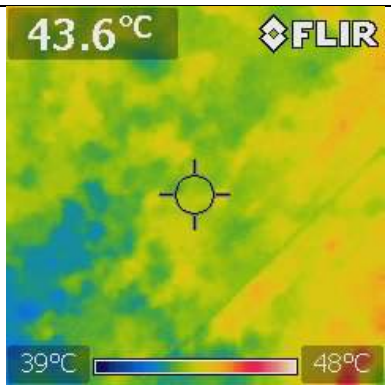
Table 3.12. Table showing the tape lift results for Tent #37 using the "Assessment & Sampling Approaches for Indoor Microbial Assessments," Geoffrey A. Clarke, Synergist (AIHA) November 2001 that reports on field of view loading criteria. Note that only a single frame from the microscopy is shown.

Infra Red Thermography of RPC3 – Tent #37

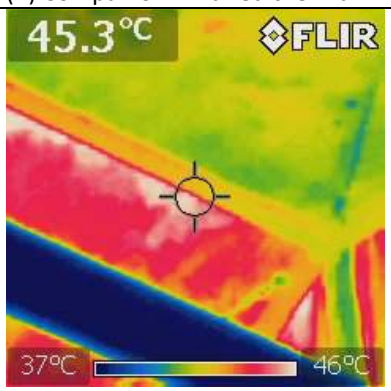
Infra red thermal imaging was used to evaluate the thermal profile of the tent area under study (Table 3.13).

Location: RPC3 Tent #37	
s. 33(a)(iii)	**Infra Red Scan**
	 (b) Companion infra red thermal image to that shown in (a).
	 (d) Companion infra red thermal image to that shown in (c).
	 (f) Companion infra red thermal image to that shown in (e).

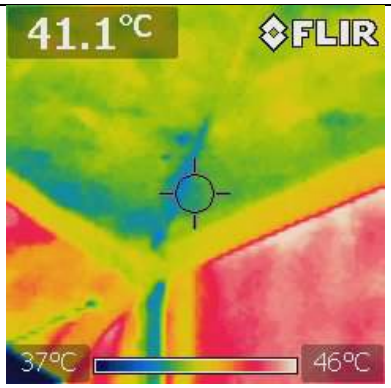
s. 33(a)(iii)



(h) Companion infra red thermal image to that shown in (g).

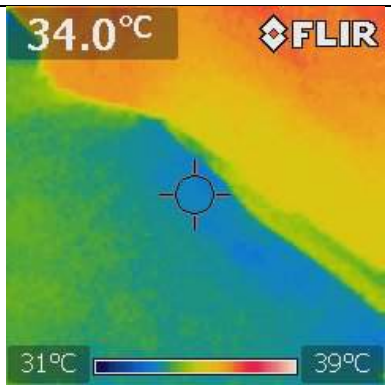


(j) Companion infra red thermal image to that shown in (i).

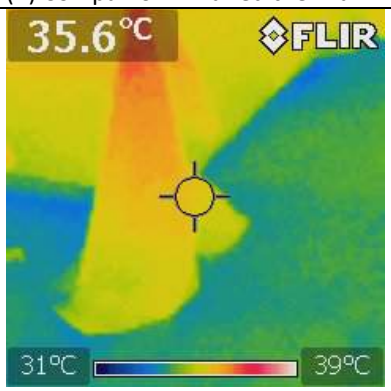


(l) Companion infra red thermal image to that shown in (k).

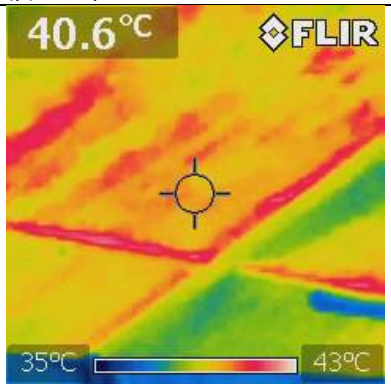
s. 33(a)(iii)



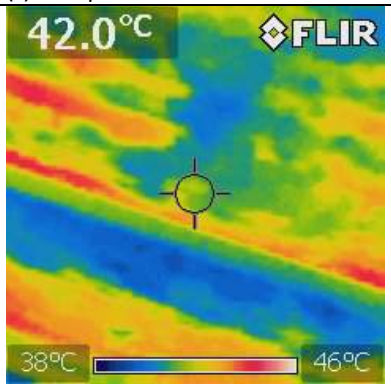
(n) Companion infra red thermal image to that shown in (m).



(p) Companion infra red thermal image to that shown in (o).

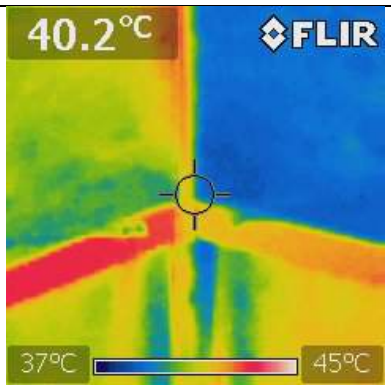


(r) Companion infra red thermal image to that shown in (q).

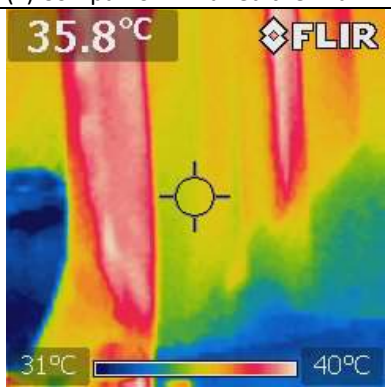


(t) Companion infra red thermal image to that shown in (s).

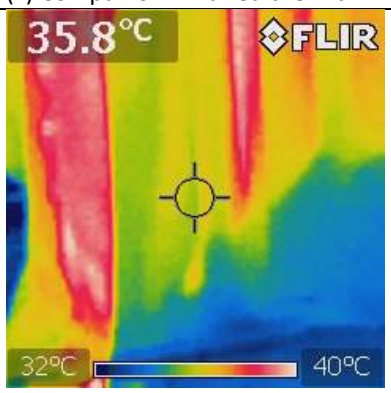
s. 33(a)(iii)



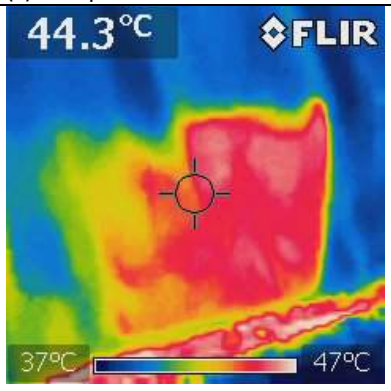
(v) Companion infra red thermal image to that shown in (u).



(x) Companion infra red thermal image to that shown in (w).

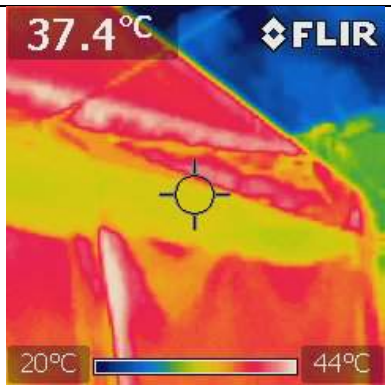


(z) Companion infra red thermal image to that shown in (y).

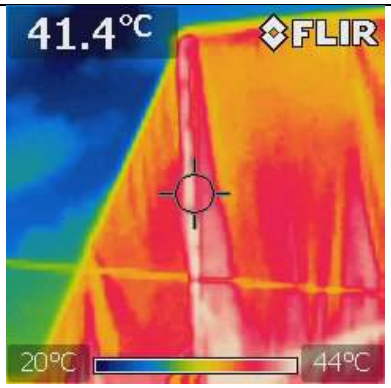


(b1) Companion infra red thermal image to that shown in (a1).

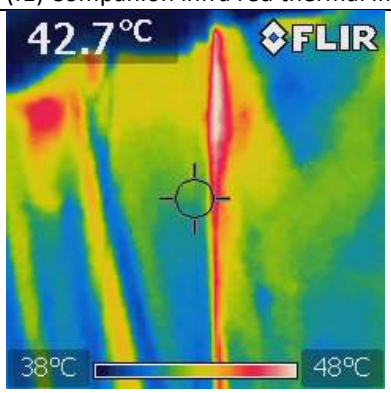
s. 33(a)(iii)



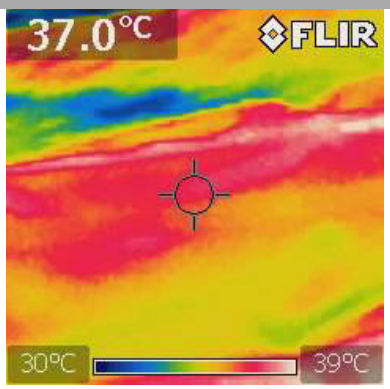
(d1) Companion infra red thermal image to that shown in (c1).



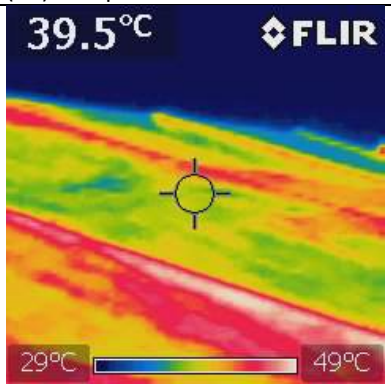
(f1) Companion infra red thermal image to that shown in (e1).



(h1) Companion infra red thermal image to that shown in (g1).



(h1) The roofline shows how hostile from a thermal imaging perspective



(i1) Another example of the exterior roof showing the patchy temperature profile across the tent roof surface where the fungi have

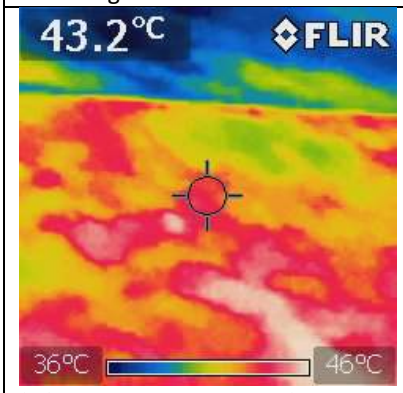
the tent material is. Therefore, all the fungal biofilms are well adapted to attaching to this material	established persistent biofilms
 (j1) Another example of the exterior roof showing the patchy temperature profile across the tent roof surface where the fungi have established persistent biofilms	INTENTIONALLY BLANK

Table 3.13. Infra red thermal inspection results for RPC3 - Tent 37.

4. RPC 3 – Tent #39

Several adjacent tents to #37 were also inspected using spot testing to get a feel for how mould contamination has developed in these areas. The reason for these next inspections is that two sets of tents, RPC2 – Tent #18 and RPC3 – Tent #37 have been analysed completely in a like-for-like manner. Spot data for analysis included:

1. Viable mould sampling to PDA of (i) air (ii) surface swabs - inside tent surfaces (walls and ceiling) and (iii) surface swabs - external tent surfaces (walls and roof)

Biological Sampling – Culture-Based Analysis of RPC3 – Tent #39

Fungi:

1. Outdoor Control, Air Sample
2. Inside Tent, Air Sample, Location #1
3. Inside Tent, Air Sample, Location #2
4. Inside Ceiling, Swab Sample
5. Inside Wall, Swab Sample
6. Inside Floor, Swab Sample
7. Outside Roof, Swab Sample

PDA AGAR – Location: RPC3 Tent #39		
Day 3	**Day 4**	**Day 5**

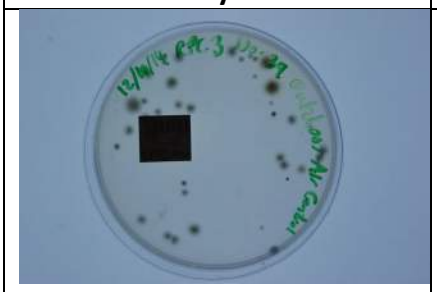
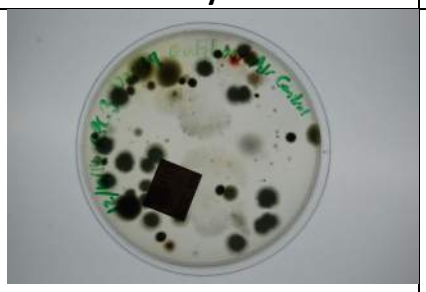
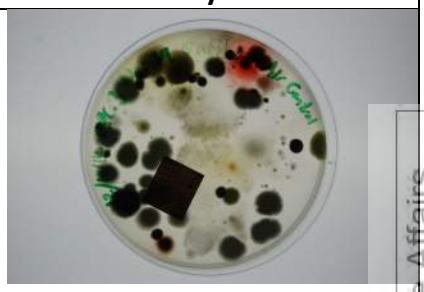

		

Fig 1a. Outdoor Control #1 Air Sample CFU = 35	Fig 1b. Outdoor Control #1 Air Sample CFU = 70	Fig 1c. Outdoor Control #1 Air Sample CFU = 80 *Chaetomium, Aspergillus nidulans, Aspergillus fumigatus, Aspergillus versicolor, Aspergillus flavus*

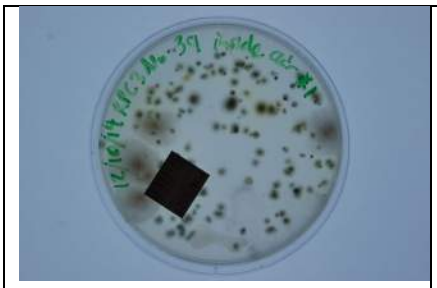
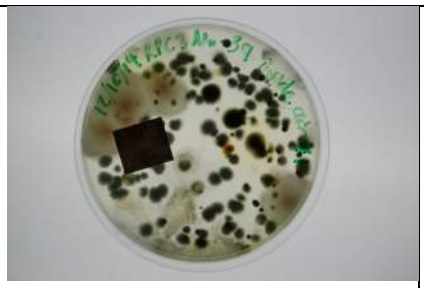
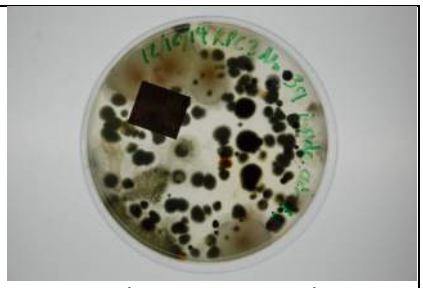
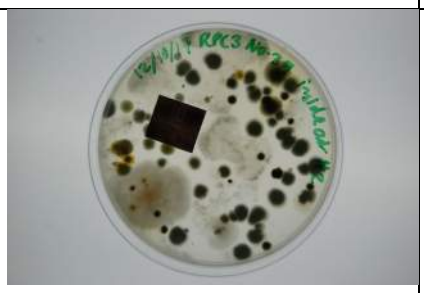
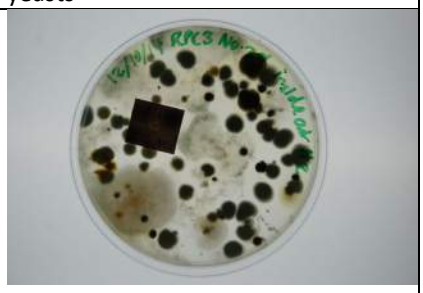
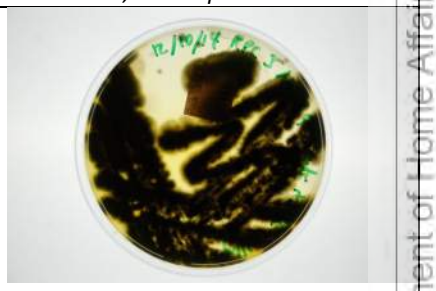
		

Fig 2a. Inside Tent, Air Sample, Location #1 Air Sample CFU = 70	Fig 2b. Inside Tent, Air Sample, Location #1 Air Sample CFU = 180	Fig 2c. Inside Tent, Air Sample, Location #1 Air Sample CFU = >180 *Aspergillus niger, Aspergillus flavus, Aspergillus fumigatus, Fusarium, Candida sp.,* unidentified black yeasts
		
Fig 3a. Inside Tent, Air Sample, Location #2 Air Sample CFU = 39	Fig 3b. Inside Tent, Air Sample, Location #2 Air Sample CFU = 110	Fig 3c. Inside Tent, Air Sample, Location #2 Air Sample CFU = 140 *Chaetomium, Chrysosporium, Aspergillus flavus, Aspergillus fumigatus, Aspergillus tereus, Aspergillus versicolor, Rhodotorula, Penicillium, Cladosporium*
		
Fig 4a. Inside Ceiling Swab Sample CFU = >300	Fig 4b. Inside Ceiling Swab Sample CFU = >300	Fig 4b. Inside Ceiling Swab Sample CFU = >300 OD = 61.11 Mode = 6 *Chaetomium, Aspergillus flavus, Aspergillus fumigatus*

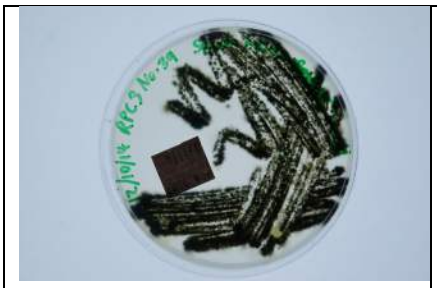
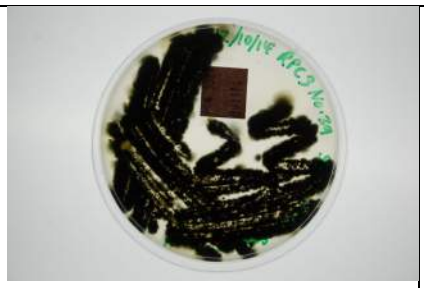
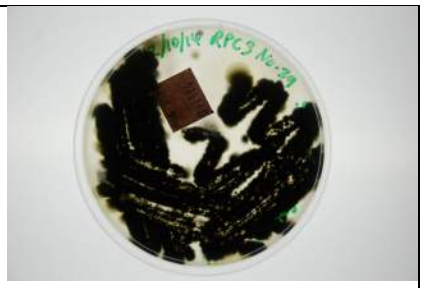
		

Fig 5a. Inside Wall Swab Sample CFU = >300	Fig 5b. Inside Wall Swab Sample CFU = >300	Fig 5c. Inside Wall Swab Sample CFU = >300 OD = 66.74 Mode = 4 *Aspergillus niger, Alternaria, Aspergillus flavus, Exserohilum*

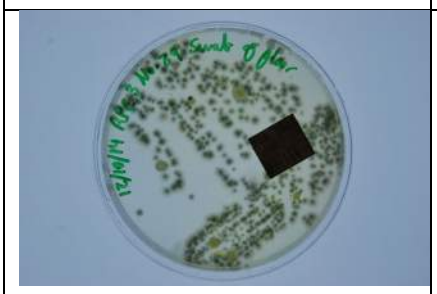



Fig 6a. Inside Floor Swab Sample CFU = >200	Fig 6b. Inside Floor Swab Sample CFU = >200	Fig 6c. Inside Floor Swab Sample CFU = >200 OD = 92.67 Mode = 188 *Aspergillus flavus, Aspergillus fumigatus, Aspergillus niger, Candida sp.*
		
Fig 7a. Outside Roof Swab Sample CFU = >150	Fig 7b. Outside Roof Swab Sample CFU = >200	Fig 7c. Outside Roof Swab Sample CFU = >200 OD = 105.81 Mode = 151 *Aspergillus niger, Candida sp., Cladosporium, Aspergillus nidulans, Chaetomium, Chrysosporium, unidentified black yeasts*

Table 4.1. Air and swab samples were plated out onto PDA to measure the colony forming units and speciate what grew. Counts are given for days 3, 4 and 5. The swabs are interpreted in terms of optical density and the mode using image analysis. Colonies were identified to Genus and or Species for each plate at Day 5 for fungi that grew on PDA media. Colonies that grew on the other differential media were already selective for specific types of microorganisms and were scored as appropriate for that medium.

For Tent #39 the optical density values as well as the mode index for this tent revealed a statistically similar colonization pattern to that seen on RPC2 – Tent #18 for the inside ceiling and inside wall.

For Tent #39 the optical density values as well as the mode index for this tent revealed a statistically similar colonization pattern to that seen on RPC3 – Tent #37 for the inside ceiling and inside wall as well and outside roof and inside floor. This confirms that for this adjacent tents, the distribution of fungi inside and outside is very similar to that shown on other tents and from other camps.

s. 33(a)(iii), s. 47C(1)

5. RPC 3 – Tent #40

Another neighbouring tent was spot tested to compare results against tents sampled earlier to look for consistencies and any differences in biofilm formation inside and outside the tents.

Data was collected for analysis that included:

1. Viable mould sampling to PDA of (i) air (ii) surface swabs - inside tent surfaces (walls and ceiling) and (iii) surface swabs - external tent surfaces (walls and roof)

Biological Sampling – Culture-Based Analysis of RPC3 – Tent #40

Fungi:

1. Outdoor Control, Air Sample
2. Inside Tent, Air Sample, Location #1
3. Inside Tent, Air Sample, Location #2
4. Inside Wall, Swab Sample
5. Outside Wall, Swab Sample

PDA AGAR – Location: RPC3 Tent #40		
Day 3	**Day 4**	**Day 5**

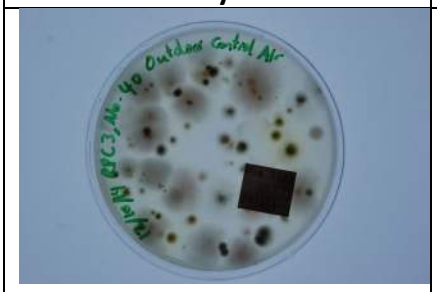
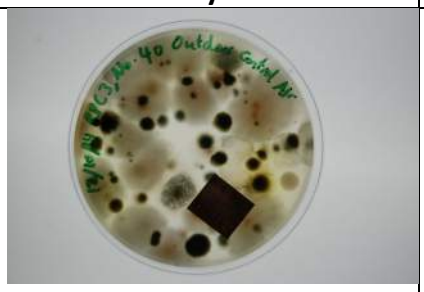
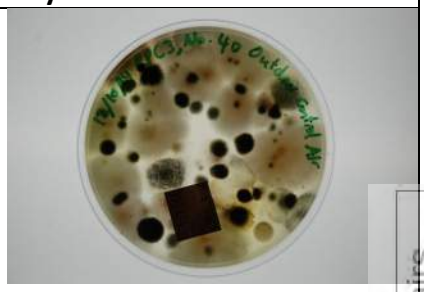

		

Fig 1a. Outdoor Control #1 Air Sample CFU = 64	Fig 1b. Outdoor Control #1 Air Sample CFU = 56	Fig 1c. Outdoor Control #1 Air Sample CFU = 60 *Chaetomium, Chrysosporium, Aspergillus niger*

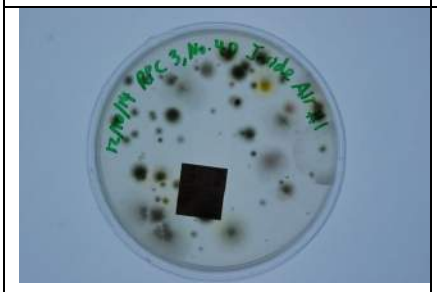
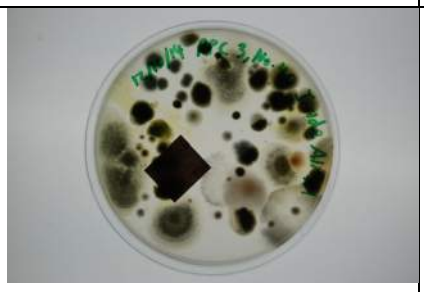
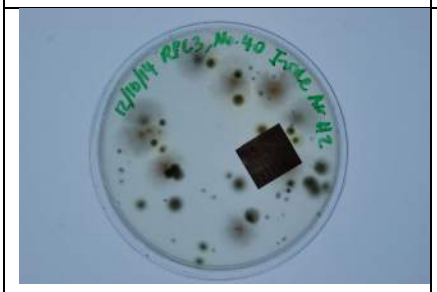
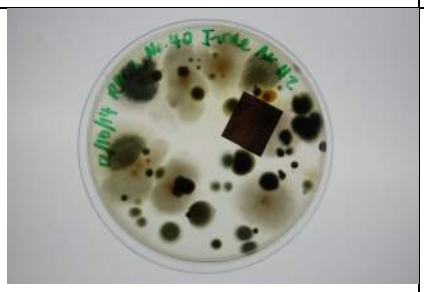
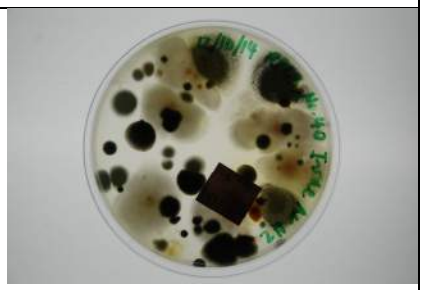
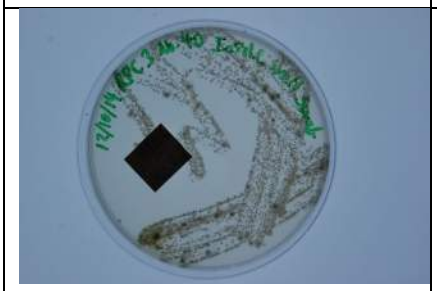

	

Fig 2a. Inside Tent, Air Sample, Location #1	Fig 2b. Inside Tent, Air Sample, Location #1	Fig 2c. Inside Tent, Air Sample, Location #1

Air Sample CFU = 80	Air Sample CFU = 75	Air Sample CFU = ~80 *Aspergillus niger, Cladosporium, Aspergillus versicolor, Aspergillus flavus, Aspergillusm fumigatus, Penicillium, Chaetomium, Chrysosporium, Candida sp.*
 Fig 3a. Inside Tent, Air Sample, Location #2 Air Sample CFU = 72	 Fig 3b. Inside Tent, Air Sample, Location #2 Air Sample CFU = 78	 Fig 3c. Inside Tent, Air Sample, Location #2 Air Sample CFU = 80 *Aspergillus niger, Aspergillus flavus, Chaetomium, Chrysosporium, Aspergillus fumigatus, Cladosporium*
 Fig 4a. Inside Wall Swab Sample CFU = >300	 Fig 4b. Inside Wall Swab Sample CFU = >300	 Fig 4c. Inside Wall Swab Sample CFU = >300 OD = 100.88 Mode = 179 *Rhodotorula, Chrysosporium, Penicillium, Phoma, Candida sp., Aspergillus flavus, Aspergillus fumigatus*, unidentified black yeasts

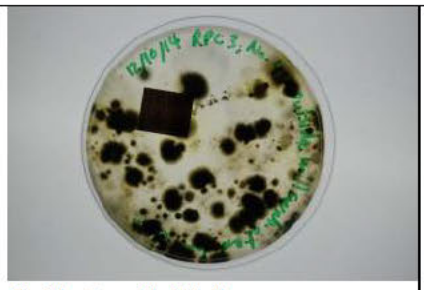
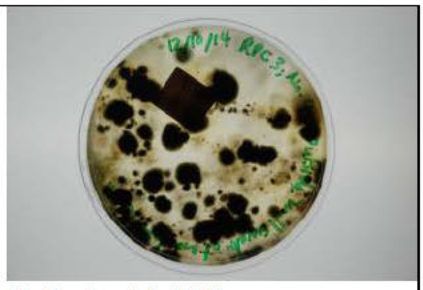
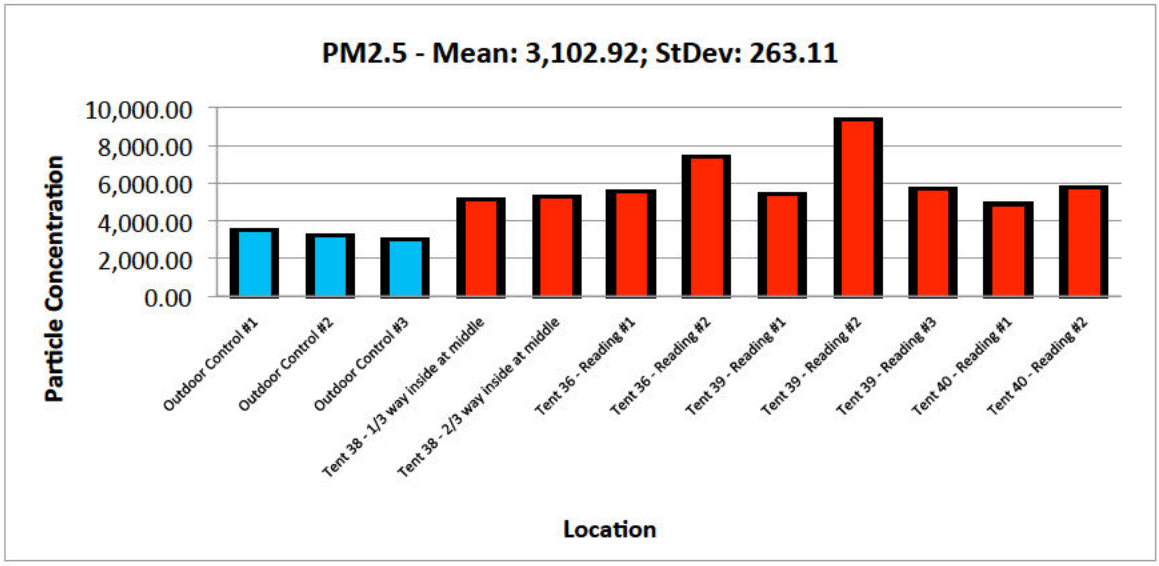
		
Fig 5a. Outside Wall Swab Sample CFU = ~200	Fig 5b. Outside Wall Swab Sample CFU = >200	Fig 5c. Outside Wall Swab Sample CFU = >200 OD = 95.04 Mode = 6 *Cladosporium, Aspergillus nidulans, Epicoccum, Aspergillus flavus, Chaetomium, Chrysosporium*

Table 5.1. Air and swab samples were plated out onto PDA to measure the colony forming units and speciate what grew. Counts are given for days 3, 4 and 5. The swabs are interpreted in terms of optical density and the mode using image analysis. Colonies were identified to Genus and or Species for each plate at Day 5 for fungi that grew on PDA media. Colonies that grew on the other differential media were already selective for specific types of microorganisms and were scored as appropriate for that medium.

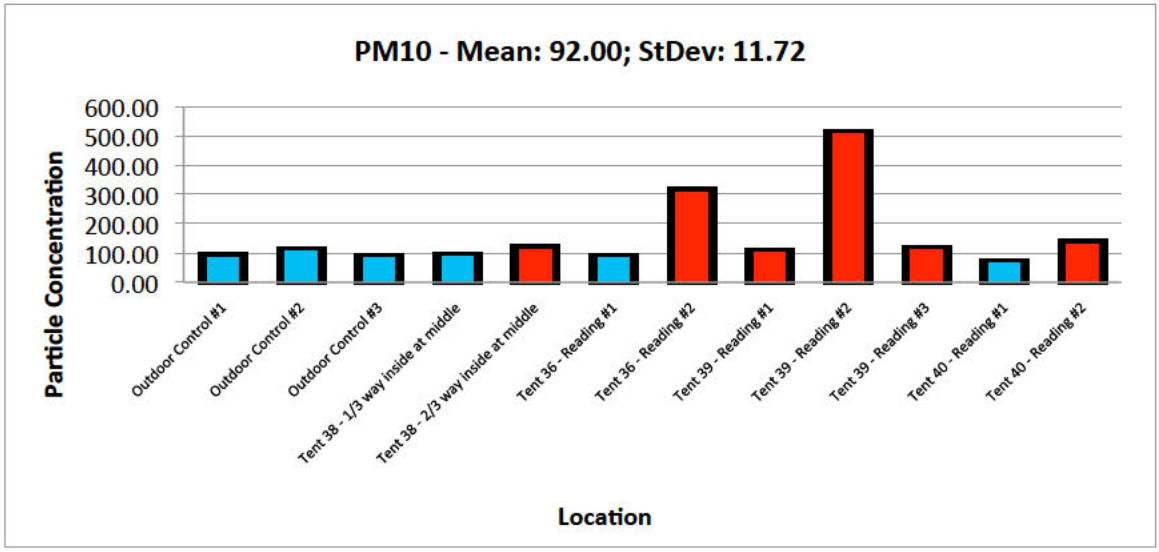
The mode, optical density values were consistent for this tent in a similar way to those seen for the other tents. Interestingly, the air samples also show elevated levels of viable moulds inside the tent compared with levels outdoors. This also supports the fact that the air quality inside the tent is severely impacted by the mould.

Air Quality Testing of RPC2 – Tents: #36, #38, #39, #40

The air quality in several other tents nearby was examined.



s. 33(a)(iii), s. 47C(1)



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6. RPC 1 – PsyCare Office #1

Data was collected for analysis that included:

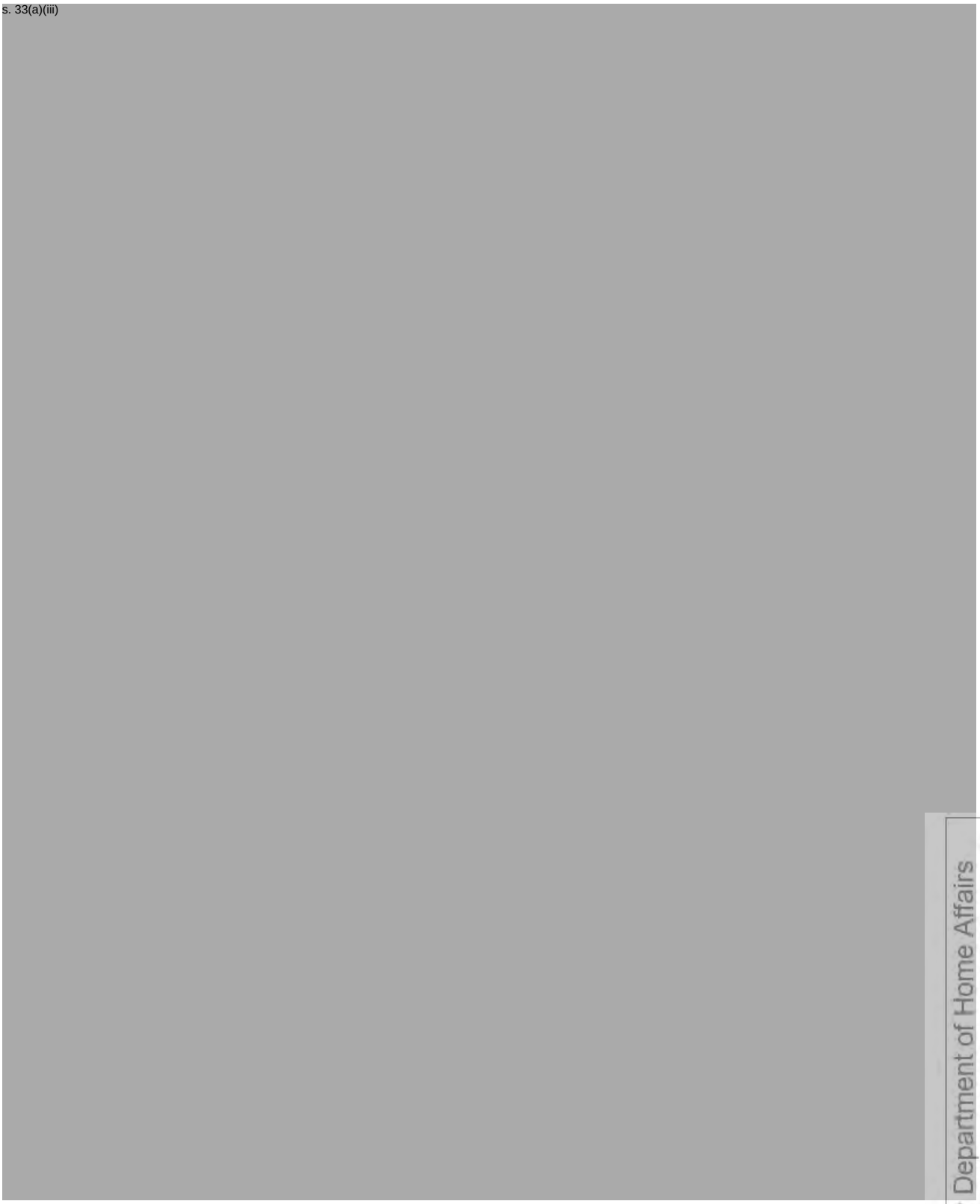
1. General observations and photographic summary
2. Basic descriptive dimensions of the building
3. Relative humidity and ambient temperature – inside and outside
4. Moisture content of selected areas
5. Air quality parameters ($PM_{2.5}$ and PM_{10}) of the internal room volume at different locations within the tent
6. ATP surface hygiene of the internal and external surfaces of the room at different locations
7. Viable mould sampling to PDA of (i) air (ii) surface swabs - inside office surfaces

General Observations of RPC1 – PsyCare Office #1

This office is used by Dr. Kerryann Cook. These offices are of modular type construction and are of size: 2.814m length x 2.835m width x 2.558m high. Each office is air-conditioned. On entry to this office there is a very strong smell of mould. The room feels cool (due to the AC) but the smell is pervasive and characteristic of fungi. The walls are covered in some sort of plastic material which shows definite moisture intrusion in multiple locations.

s. 33(a)(iii)

s. 33(a)(iii)



Environmental Parameters of RPC1 – PsyCare Office #1

The following areas were sampled:

1. Outdoor Control
2. Inside Office

Location	Relative Humidity	Temperature
Outdoor Control	94.56 ± 2.30	23.95 ± 0.38
Mean Indoor Levels	84.63 ± 2.87	22.50 ± 0.12

Table 6.2. Comparison of the outdoor relative humidity and temperature inside this PsyCare office #1 relative to the outdoor ambient air and humidity. This office is airconditioned.

Note that the relative humidity was too high for accurate readings to be taken for particle counting, so no results were collected since the unit does not operate with relative humidity levels this high outdoors.

ATP Results of RPC1 – PsyCare Office #1

The following areas were sampled:

ATP readings were taken of the following areas:

1. Indoor Office Wall
2. Indoor Office Ceiling
3. Indoor Office Bulkhead A/C Vent Output
4. Indoor Office Bulkhead A/C Vent Inlet (on underside)
5. Indoor Office Window Glass (internal)

Location – RPC1 – PsyCare Office #1	ATP Result	Interpretation
Indoor Office Wall IMAGE MISSING INTENTIONALLY BLANK	214 rlu	Medium 1.4-times higher than normal Nearly acceptable at ~150rlu threshold
Indoor Office Ceiling	7108 rlu	High Unacceptable >47-times higher than

s. 33(a)(iii)

[redacted]

s. 33(a)(iii), s. 47C(1)

[redacted]

Biological Sampling – Culture-Based Analysis of RPC1 – PsyCare Office #1

Fungi:

The following areas were sampled to PDA:

1. Outdoor Control Air
2. Indoor Office Air
3. Indoor Ceiling Swab
4. Indoor Bulkhead Swab
5. Indoor Wall Swab
6. External Aluminium Cladding Swab

PDA AGAR – RPC1 PsyCare – Office #1		
Day 3	**Day 4**	**Day 5**

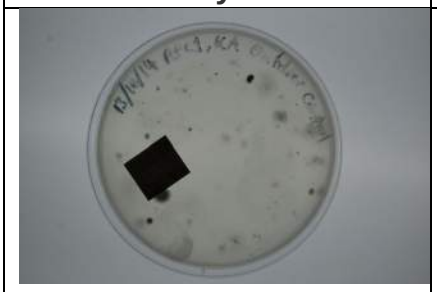
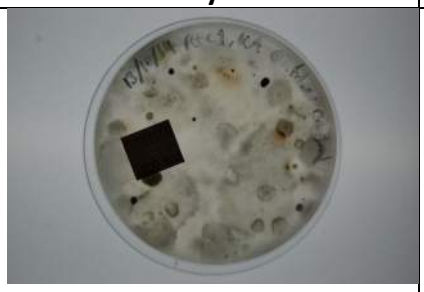
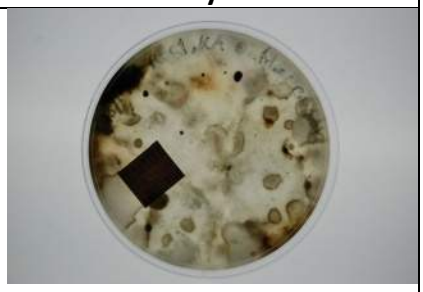

		

Fig 1a. Outdoor Control #1 Air Sample CFU = 62	Fig 1b. Outdoor Control #1 Air Sample CFU = 46	Fig 1c. Outdoor Control #1 Air Sample CFU = 35 *Candida sp., Aspergillus niger, Microsporum sp., Chaetomium, Chrysosporium, Cladosporium, Aspergillus flavus*

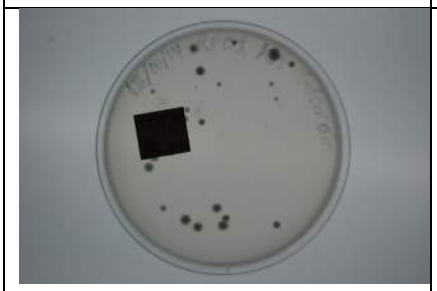
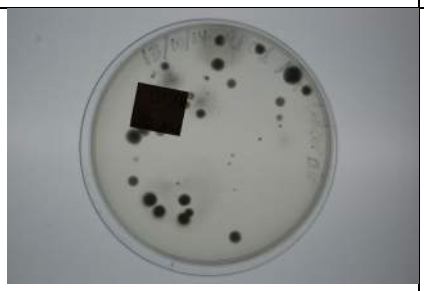
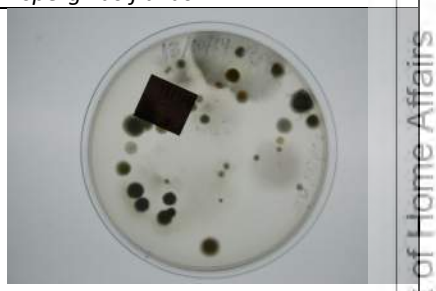

		

Fig 2a. Indoor Office, Air Sample Air Sample CFU = 34	Fig 2b. Indoor Office, Air Sample Air Sample CFU = 42	Fig 2c. Indoor Office, Air Sample Air Sample CFU = 45 *Cladosporium, Aspergillus flavus, Penicillium, Candida sp., Aspergillus tereus, Aspergillus versicolor, Alternaria*

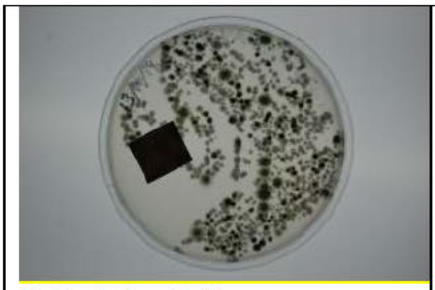
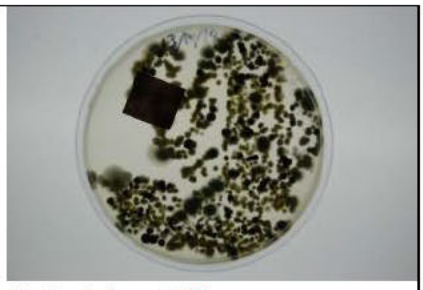
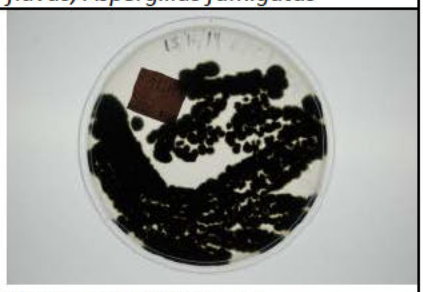
		

Fig 3a. Indoor Ceiling Swab Sample CFU = >200	Fig 3b. Indoor Ceiling Swab Sample Air Sample CFU = >200	Fig 3c. Indoor Ceiling Swab Sample Air Sample CFU = >200 *Aspergillus versicolor, Aspergillus flavus, Aspergillus fumigatus*
		
Fig 4a. Indoor Bulkhead Swab Sample CFU = >300	Fig 4b. Indoor Bulkhead Swab Sample CFU = >300	Fig 4c. Indoor Bulkhead Swab Sample CFU = >300 OD = 65.96 Mode = 4 *Aspergillus flavus* [pure, single-strain isolate]
		
Fig 5a. Indoor Wall Swab Sample CFU = >200	Fig 5b. Indoor Wall Swab Sample CFU = >200	Fig 5c. Indoor Wall Swab Sample CFU = >200 OD = 95.1 Mode = 4 *Aspergillus flavus, Aspergillus fumigatus, Penicillium*

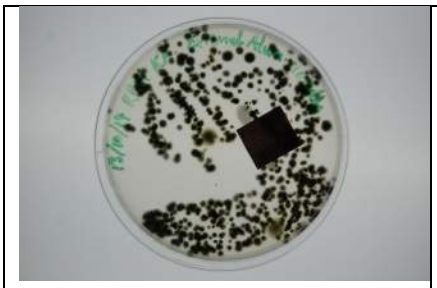
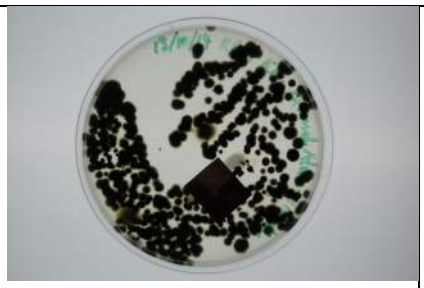
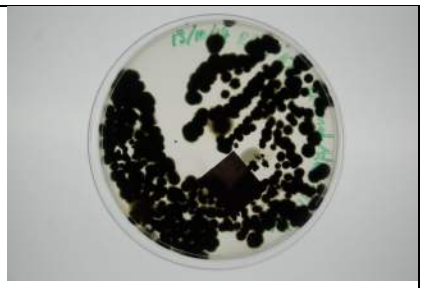
		

Fig 5a. External Aluminium Cladding Swab Swab Sample CFU = ~200	Fig 5b. External Aluminium Cladding Swab Swab Sample CFU = ~200	Fig 5c. External Aluminium Cladding Swab Swab Sample CFU = ~200 OD = 75.4 Mode = 4 *Aspergillus flavus,* *Phaeoacremonium*

Table 6.4. The air outside was compared to the air inside as well as swan sampling of walls, floors and ceilings. It is concluded that all surfaces are contaminated with viable fungi. Interestingly, the external cladding is also shown to be heavily colonized by fungi. It is likely that the high outdoor ambient humidity and temperature leads to regular condensation effects on surfaces that in turn leads to biofilm formation outside. Colonies were identified to Genus and or Species for each plate at Day 5 for fungi that grew on PDA media. Colonies that grew on the other differential media were already selective for specific types of microorganisms and were scored as appropriate for that medium.

The smells indoors are most likely due to moisture trapped within the wall since the walls appeared actually damp to the touch and there was weeping water through and across the walls in some sections. It is very likely that the wall core that is wood or a wood composite/oriented strand board is being degraded by moisture and mould. It is highly recommended that all offices be subjected to a combination of hydrogen peroxide and ozone vapor decontamination. This will not decontaminate hidden mould within walls, but will minimize the health risks from inhalation and dermal contact.

7. RPC 1 – PsyCare Office #2

This office was located second from the end of the span of offices and is referred to as the SE Corner Office. This office is considered the worst affected and has peeling wall covering material of unknown composition to expose the wooden substrate underneath that presents with very obvious and heavy mould growth. Some of the walls also weep with moisture similar to what was seen PsyCare Office #1. Data was collected for analysis that included:

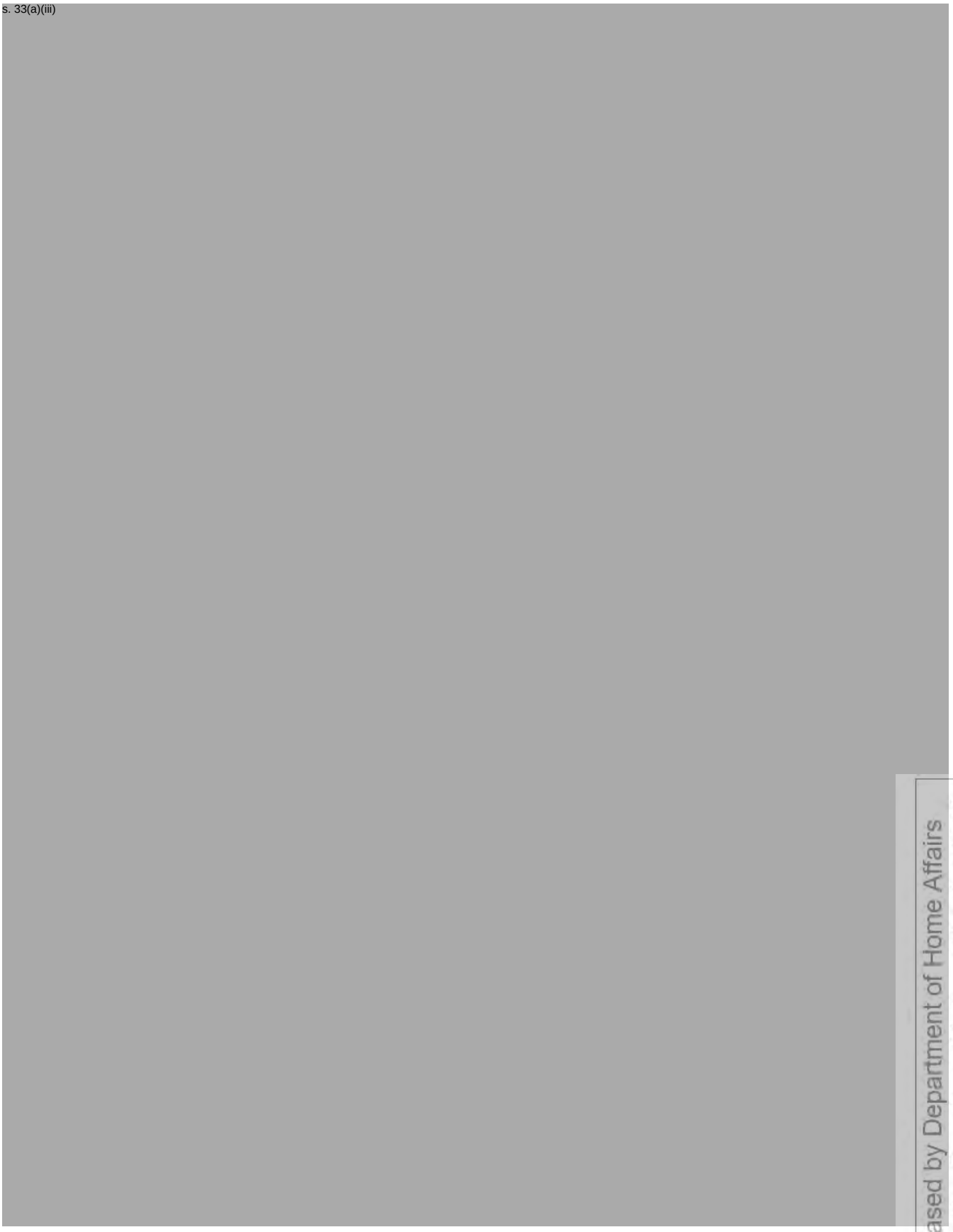
1. General observations and photographic summary
2. Basic descriptive dimensions of the building
3. Relative humidity and ambient temperature – inside and outside
4. Air quality parameters ($PM_{2.5}$ and PM_{10}) could not be collected since the relative humidity outdoors prevented the unit from operating.
5. ATP surface hygiene of the internal and external surfaces of the room at different locations
6. Viable mould sampling to PDA of (i) air (ii) surface swabs - inside the offices (walls and ceiling) and (iii) surface swabs
7. Viable bacterial sampling to CHROM- AGAR and NC-AGAR of (i) air (ii) surface swabs - inside room surfaces (walls and ceiling) and (iii) surface swabs - external tent surfaces (walls and roof)
8. Surface sampling (inside and outside) to Bio Tape-Lifts for microscopic examination
9. Infra Red thermal imaging of the office – inside and outside

General Observations of RPC1 – PsyCare Office #2

This office is used by Dr. Kerryann Cook. These offices are of modular type construction and of size: 2.814m length x 2.835m width x 2.558m high. Each office is air conditioned. This office also smells very strongly of mould and damp. It appears that this office is not being used and there is a lack of office effects like in PsyCare Office #1. The wall material is breaking down and there is significant evidence of moisture intrusion.

s. 33(a)(iii)

s. 33(a)(iii)



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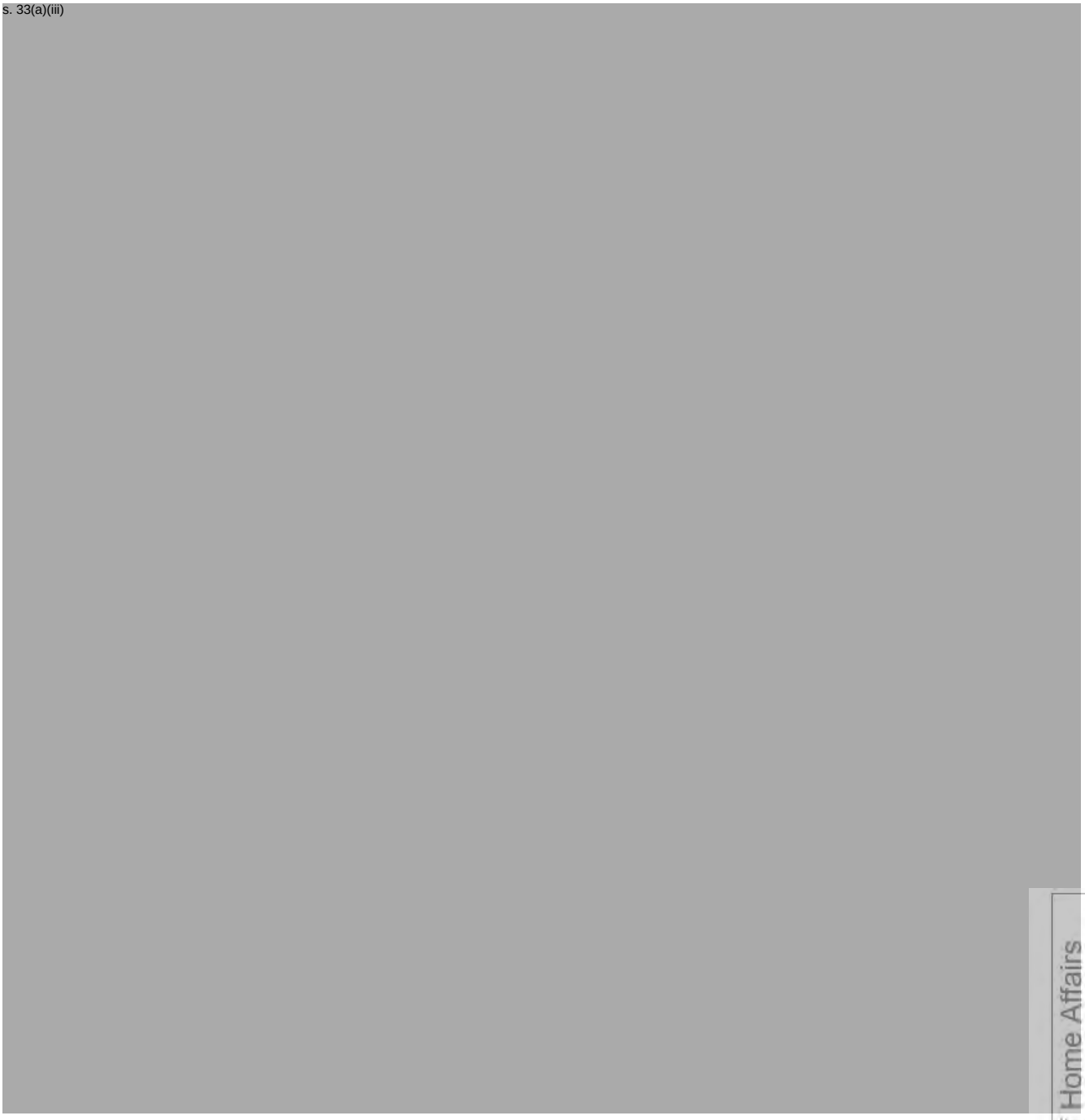


Environmental Parameters of RPC1 – PsyCare Office #2

The following areas were sampled:

1. Outdoor Control
2. Inside Office

Location	Relative Humidity	Temperature
Outdoor Control	93.30 ± 1.05	24.95 ± 0.41
Mean Indoor Levels	64.00 ± 1.81	27.67 ± 0.15

Table 7.2. Comparison of the outdoor relative humidity and temperature inside this PsyCare office #2 relative to the outdoor ambient air and humidity. This office is airconditioned. The relative humidity indoors is lower in this office (#2) than in the earlier examined office (#1) and is on the absolute limit for indoor relative humidity according to the Standard 55-2013 -- Thermal Environmental Conditions for Human Occupancy (ANSI Approved). The outdoor relative humidity is very high.

Note that the relative humidity was too high for accurate readings to be taken for particle counting, so no results were collected since the unit does not operate with relative humidity levels this high outdoors.

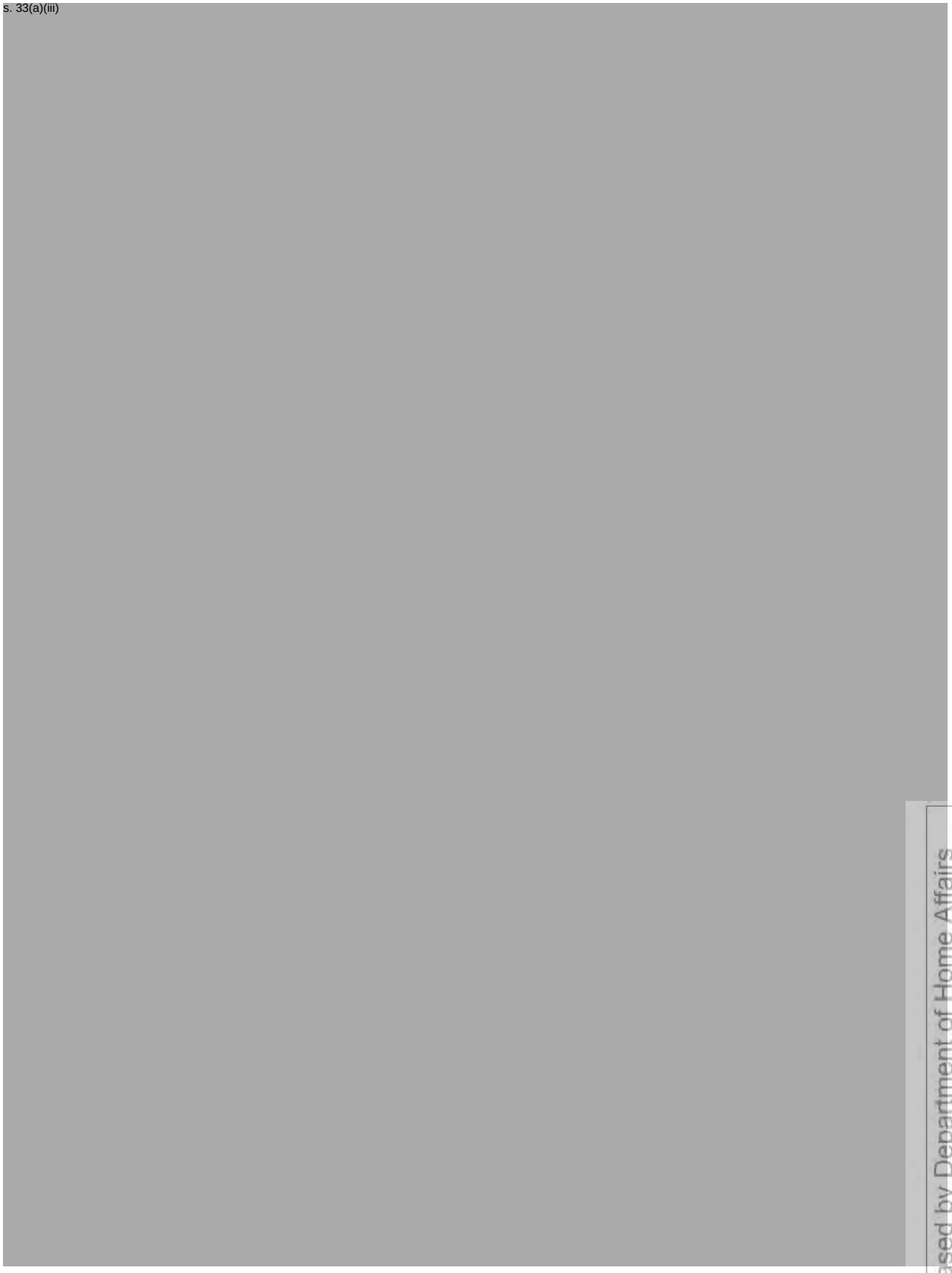
ATP Results of RPC1 – PsyCare Office #2

ATP readings were taken of the following areas:

1. Indoor Office Wall
2. Indoor Office Ceiling
3. Indoor Office Bulkhead A/C Vent Output
4. Indoor Office Bulkhead A/C Vent Inlet (on underside)
5. Indoor Office Window Glass (internal)
6. Wooden Plywood Internal Wall Surface (behind plastic wall coating)
7. Underside of Table
8. Small Ceiling Vent
9. Floor/Coving
10. External Cladding Location #1
11. External Cladding Location #2
12. External Black Vent

s. 33(a)(iii)

s. 33(a)(iii)



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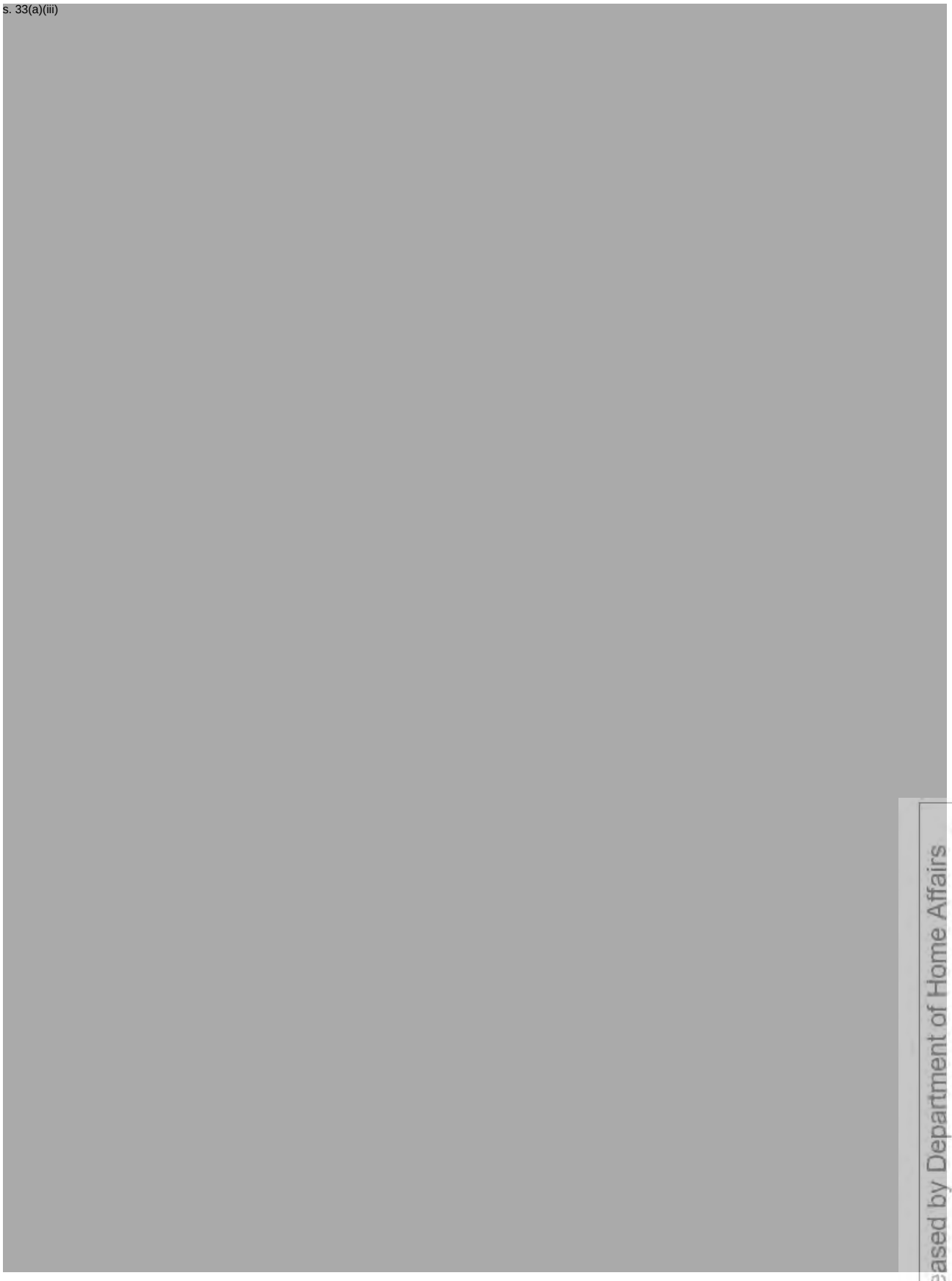


s. 33(a)(iii)

s. 33(a)(iii), s. 47C(1)

Biological Sampling – Culture-Based Analysis of RPC1 – PsyCare Office #2

Fungi:

The following areas were sampled to PDA:

1. Outdoor Control Air
2. Indoor Office Air
3. Indoor Ceiling Swab
4. Indoor Bulkhead Swab
5. Indoor Wall Swab
6. Indoor Exposed Wooden Wall Swab
7. External Aluminium Cladding Swab

PDA AGAR – RPC1 PsyCare, SE Corner Office		
Day 3	**Day 4**	**Day 5**

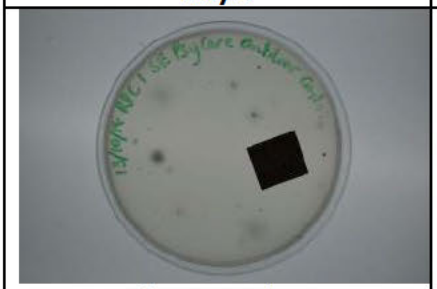
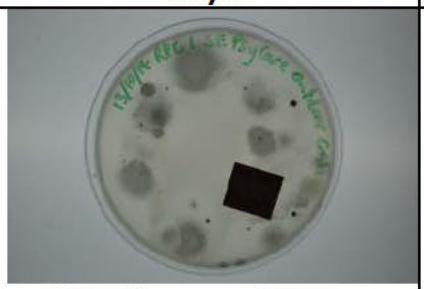

	

Fig 1a. Outdoor Control #1 Air Sample CFU = 29	Fig 1b. Outdoor Control #1 Air Sample CFU = 31	Fig 1c. Outdoor Control #1 Air Sample CFU = 29 Chaetomium, Fusarium, Cladosporium, Unidentified yeasts, Candida sp.

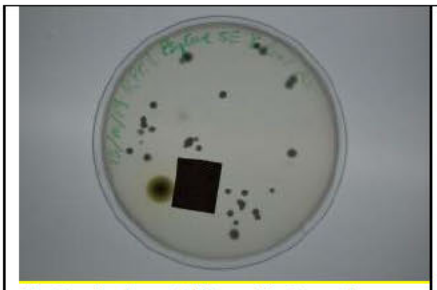
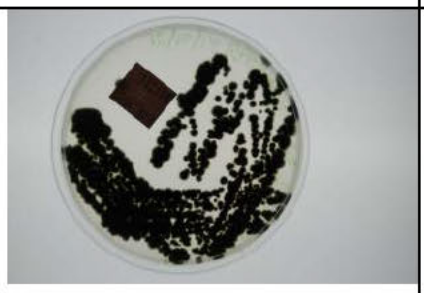


Fig 2a. Indoor Office, Air Sample Air Sample CFU = 38	Fig 2b. Indoor Office, Air Sample Air Sample CFU = 46	Fig 2c. Indoor Office, Air Sample Air Sample CFU = 46 *Epicoccum sp., Cladosporium, Aspergillus flavus, Penicillium, Candida sp., Aspergillus tereus, Aspergillus versicolor, Alternaria, Chaetomium*
		
Fig 3a. Indoor Ceiling Swab Sample CFU = >200	Fig 3b. Indoor Ceiling Swab Sample Air Sample CFU = >200	Fig 3c. Indoor Ceiling Swab Sample Air Sample CFU = >200 OD = 84.00 Mode = 7 *Aspergillus flavus, Aspergillus tereus, Aspergillus fumigatus, Cladosporium*
		
Fig 4a. Indoor Bulkhead Swab Sample CFU = >200	Fig 4b. Indoor Bulkhead Swab Sample CFU = >200	Fig 4c. Indoor Bulkhead Swab Sample CFU = >200 OD = 78.67 Mode = 4 *Aspergillus flavus* [pure, single-strain isolate]

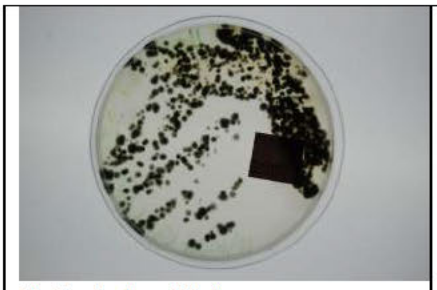
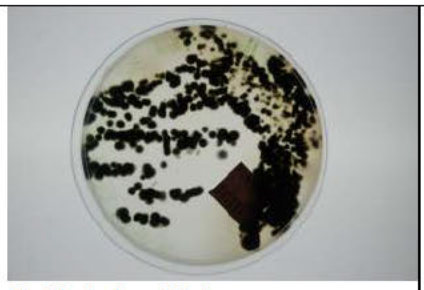
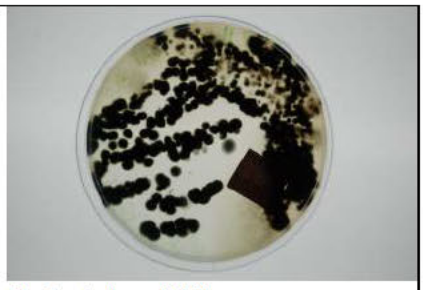
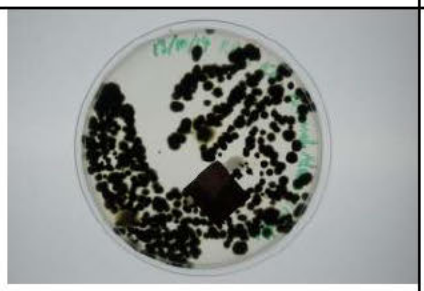
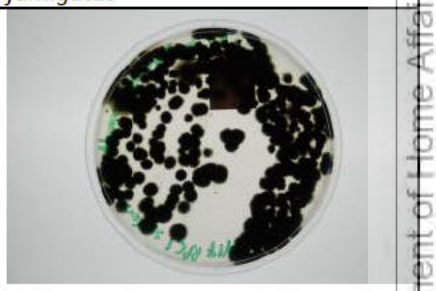
		

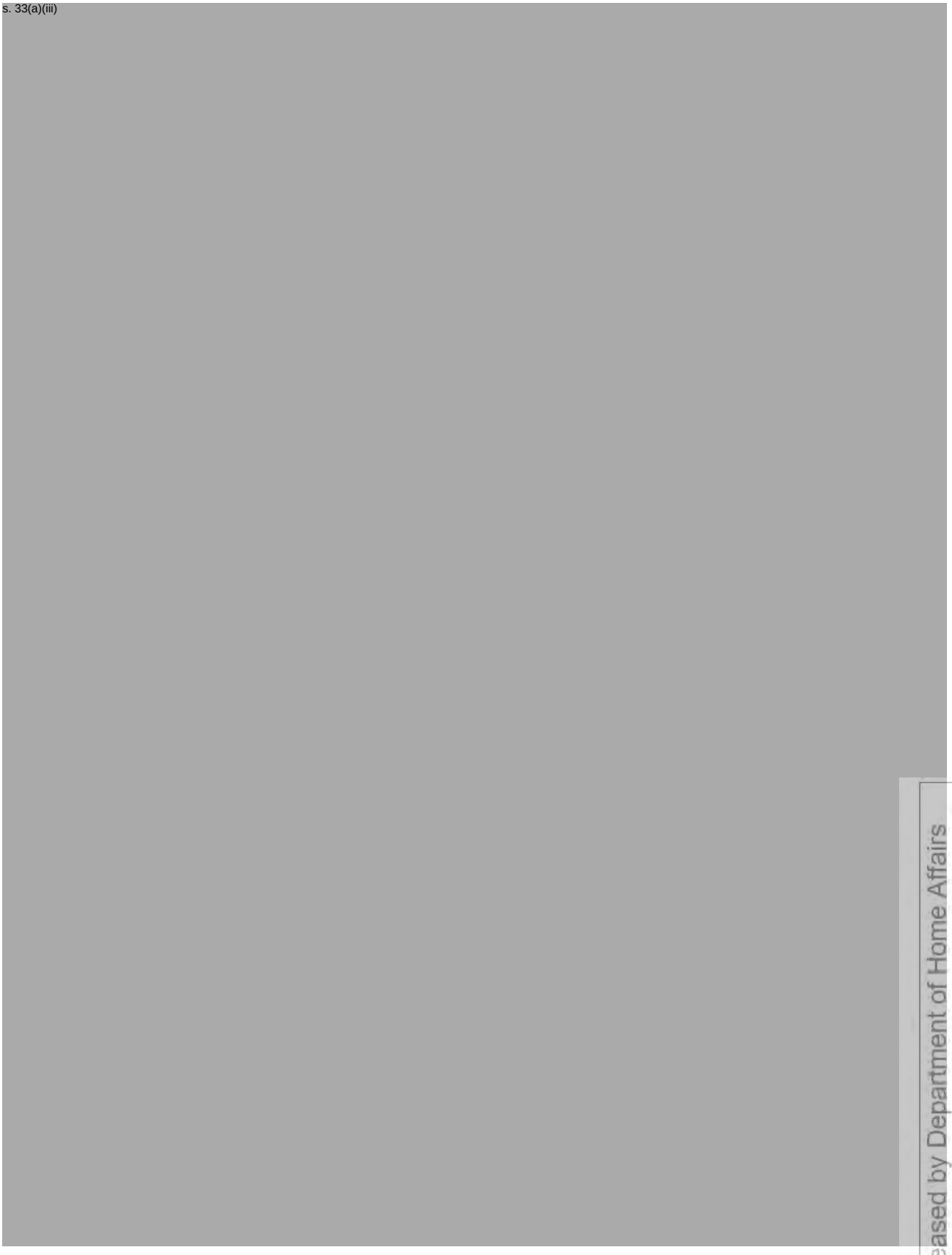
Fig 5a. Indoor Wall Swab Sample CFU = >200	Fig 5b. Indoor Wall Swab Sample CFU = ~200	Fig 5c. Indoor Wall Swab Sample CFU = >200 OD = 89.37 Mode = 4 *Aspergillus flavus, Aspergillus versicolor, Aspergillus fumigatus, Trichoderma, Candida sp.*
		
Fig 6a. Indoor Exposed Wooden Wall Swab Sample CFU = >300	Fig 6b. Indoor Exposed Wooden Wall Swab Sample CFU = >300	Fig 6c. Indoor Exposed Wooden Wall Swab Sample CFU = >300 OD = 91.78 Mode = 208 *Aspergillus flavus, Aspergillus tereus, Penicillium, Aspergillus fumigatus*
		
Fig 7a. External Aluminium Cladding Swab Swab Sample CFU = >200	Fig 7b. External Aluminium Cladding Swab Swab Sample CFU = >200	Fig 7c. External Aluminium Cladding Swab Swab Sample CFU = >200 OD = 83.67 Mode = 4 *Aspergillus flavus,*

		Phaeoacremonium *Unidentified black yeasts*

Table 7.4. The air outside was compared to the air inside as well as swan sampling of walls, floors and ceilings. It is concluded that all surfaces are contaminated with viable fungi. Interestingly, the external cladding is also shown to be heavily colonized by fungi. It is likely that the high outdoor ambient humidity and temperature leads to regular condensation effects on surfaces that in turn leads to biofilm formation outside. Colonies were identified to Genus and or Species for each plate at Day 5 for fungi that grew on PDA media. Colonies that grew on the other differential media were already selective for specific types of microorganisms and were scored as appropriate for that medium.

Again as for PsyCare Office #1, the same conclusions and recommendations are given. The smells indoors are most likely due to moisture trapped within the wall since the walls appeared actually damp to the touch and there was weeping water through and across the walls in some sections. This was verified using infra red thermal imaging. It is very likely that the wall core that is wood or a wood composite/oriented strand board is being degraded by moisture and mould. It is highly recommended that all offices be subjected to a combination of hydrogen peroxide and ozone vapor decontamination. This will not decontaminate hidden mould within walls, but will minimize the health risks from inhalation and dermal contact.

s. 33(a)(iii)



s. 33(a)(iii)

Environmental Parameters of RPC1 – Immunisation & Pathology Room

The following areas were sampled:

1. Inside Health Centre

Location	Relative Humidity	Temperature
Mean Indoor Levels	57.15 ± 0.97	24.20 ± 0.34

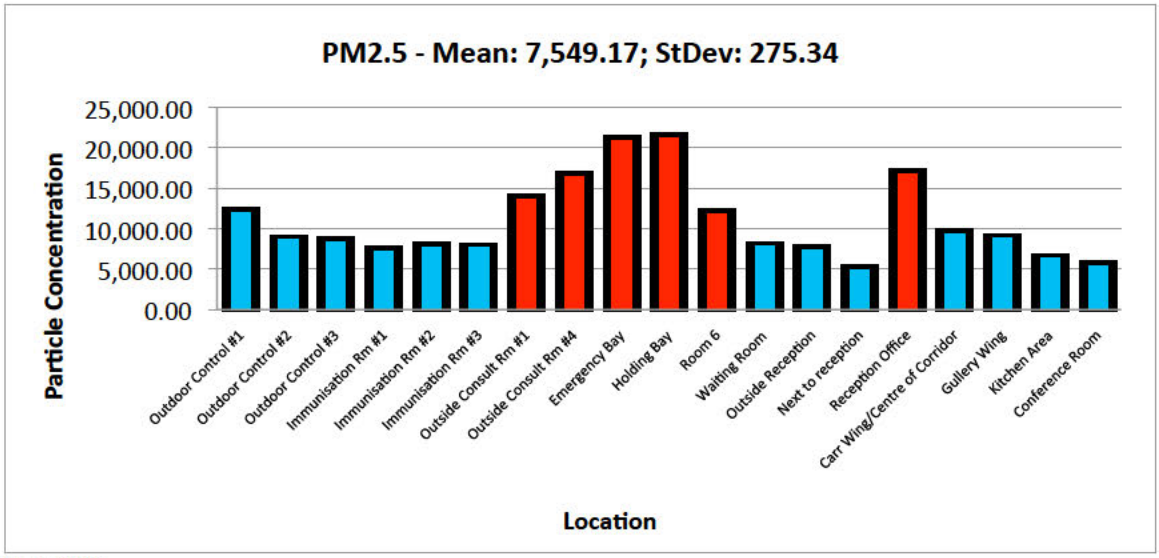
Table 8.2. Several readings were taken inside the Health Centre to derive a mean result. This building is airconditioned.

Air Quality Testing of RPC1 – Immunisation & Pathology Room

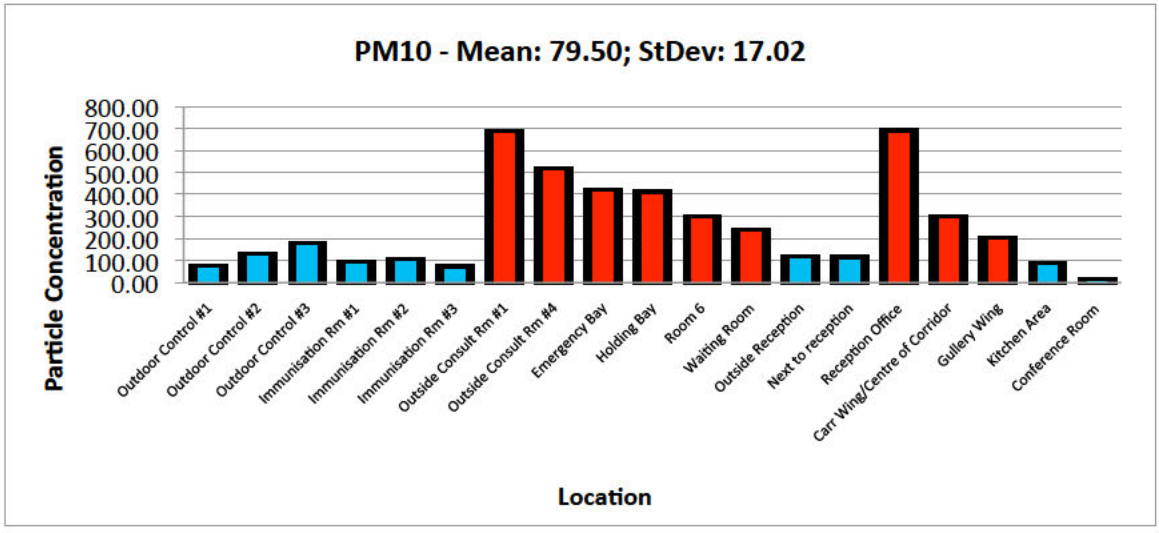
The following areas were sampled:

1. Outdoor Control #1
2. Outdoor Control #2
3. Outdoor Control #3
4. Immunisation Rm #1
5. Immunisation Rm #2
6. Immunisation Rm #3
7. Outside Consult Rm #1
8. Outside Consult Rm #4
9. Emergency Bay
10. Holding Bay
11. Room 6

12. Waiting Room
13. Outside Reception
14. Next to reception
15. Reception Office
16. Carr Wing/Centre of Corridor
17. Gullery Wing
18. Kitchen Area
19. Conference Room



s. 33(a)(iii), s. 47C(1)



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ATP Results of RPC1 – Immunisation & Pathology Room

1. Indoor Office Wall
2. Indoor Office Ceiling
3. Indoor Office Floor
4. Indoor Office A/C Vent
5. Indoor Corridor Ceiling Leading to Emergency Room

s. 33(a)(iii)

s. 33(a)(iii)

s. 33(a)(iii), s. 47C(1)

Biological Sampling – Culture-Based Analysis of RPC1 – Immunisation & Pathology Room

Fungi:

The following air areas were sampled to PDA:

1. Outdoor Control (taken outside Health Centre Entry Doorway)
2. Inside IHMS/Immunisation Room
3. Outside IHMS/Immunisation Room in Corridor
4. Outside in Corridor (Outside Consultation Room #4)
5. Outside Holding Bay/Emergency

PDA AGAR – RPC1 – Immunisation & Pathology Room in Health Centre		
Day 3	**Day 4**	**Day 5**

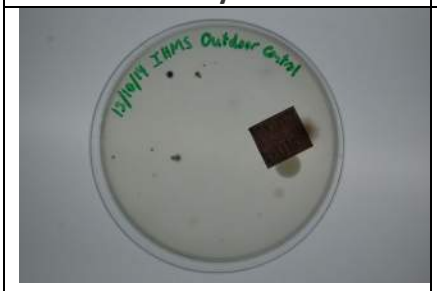



Fig 1a. Outdoor Control #1 Air Sample CFU = 19	Fig 1b. Outdoor Control #1 Air Sample CFU = 25	Fig 1c. Outdoor Control #1 Air Sample CFU = 23 *Candida sp., Aspergillus flavus, Penicillium, Microsporum sp., Fusarium, Scedosporium*

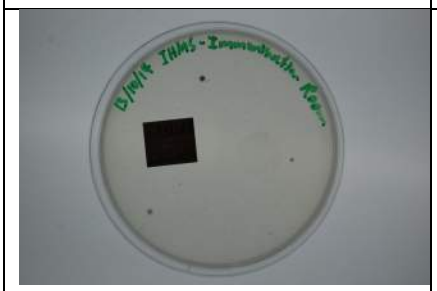
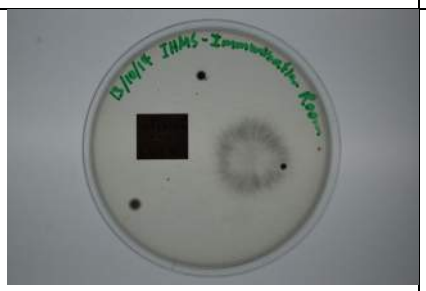

	

Fig 2a. Inside IHMS/Immunisation Room, Air Sample CFU = 8	Fig 2b. Inside IHMS/Immunisation Room, Air Sample CFU = 10	Fig 2b. Inside IHMS/Immunisation Room, Air Sample CFU = 10 *Cladosporium, Exherohilium, Candida sp.*
		
Fig 3a. Outside IHMS/Immunisation Room in Corridor Air Sample CFU = 12	Fig 3a. Outside IHMS/Immunisation Room in Corridor Air Sample CFU = 18	Fig 3a. Outside IHMS/Immunisation Room in Corridor Air Sample CFU = 26 Aspergillus flavus, Aspergillus glaucus complex, Trichophyton *(possibly:* T. megnini, T. rubrum, T. ajelloi), Sporothrix

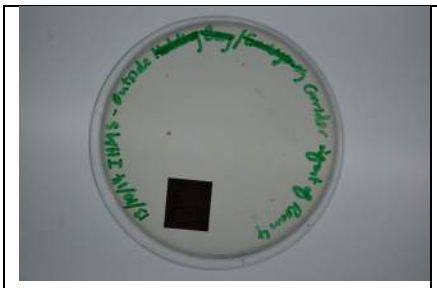
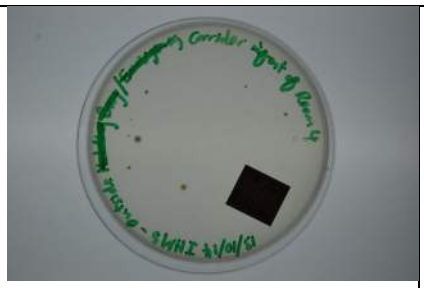
	

Fig 4a. Outside in Corridor (Outside Consultation Room #4) Air Sample CFU = 5	Fig 4b. Outside in Corridor (Outside Consultation Room #4) Air Sample CFU = 8	Fig 4c. Outside in Corridor (Outside Consultation Room #4) Air Sample CFU = 12 *Trichosporon, Aspergillus versicolor, Bipolaris, Penicillium*
		
Fig 5a. Outside Holding Bay/Emergency Air Sample CFU = 9	Fig 5b. Outside Holding Bay/Emergency Air Sample CFU = 14	Fig 5c. Outside Holding Bay/Emergency Air Sample CFU = 17 *Aspergillus versicolor, Aspergillus flavus, Aspergillus fumigatus, Penicillium, Scedosporium, Aureobasidium, Sporothrix*

Table 8.4. The air outside was compared to the air inside. This shows that the air inside the Health Centre is clean and the numbers of culturable fungi indoors is less than outdoors excepting for the air sample taken from the corridor outside the Immunisation room. Colonies were identified to Genus and or Species for each plate at Day 5 for fungi that grew on PDA media. Colonies that grew on the other differential media were already selective for specific types of microorganisms and were scored as appropriate for that medium.

This is a good result and overall the hospital air quality is good. The number of culturable fungi was less than the outdoors in the majority of the areas tested. However, the peaks in the graphs for the particulate matter (Figures 8.1 and 8.2) reveal that some improvements could be made. For example, it was noted that deliveries appear to enter straight through the emergency and holding bay and is clearly reflected in the peaks in the graph for the $PM_{2.5}$ particulates.

9. RPC 1 – Mess Hall

Data was collected for analysis that included:

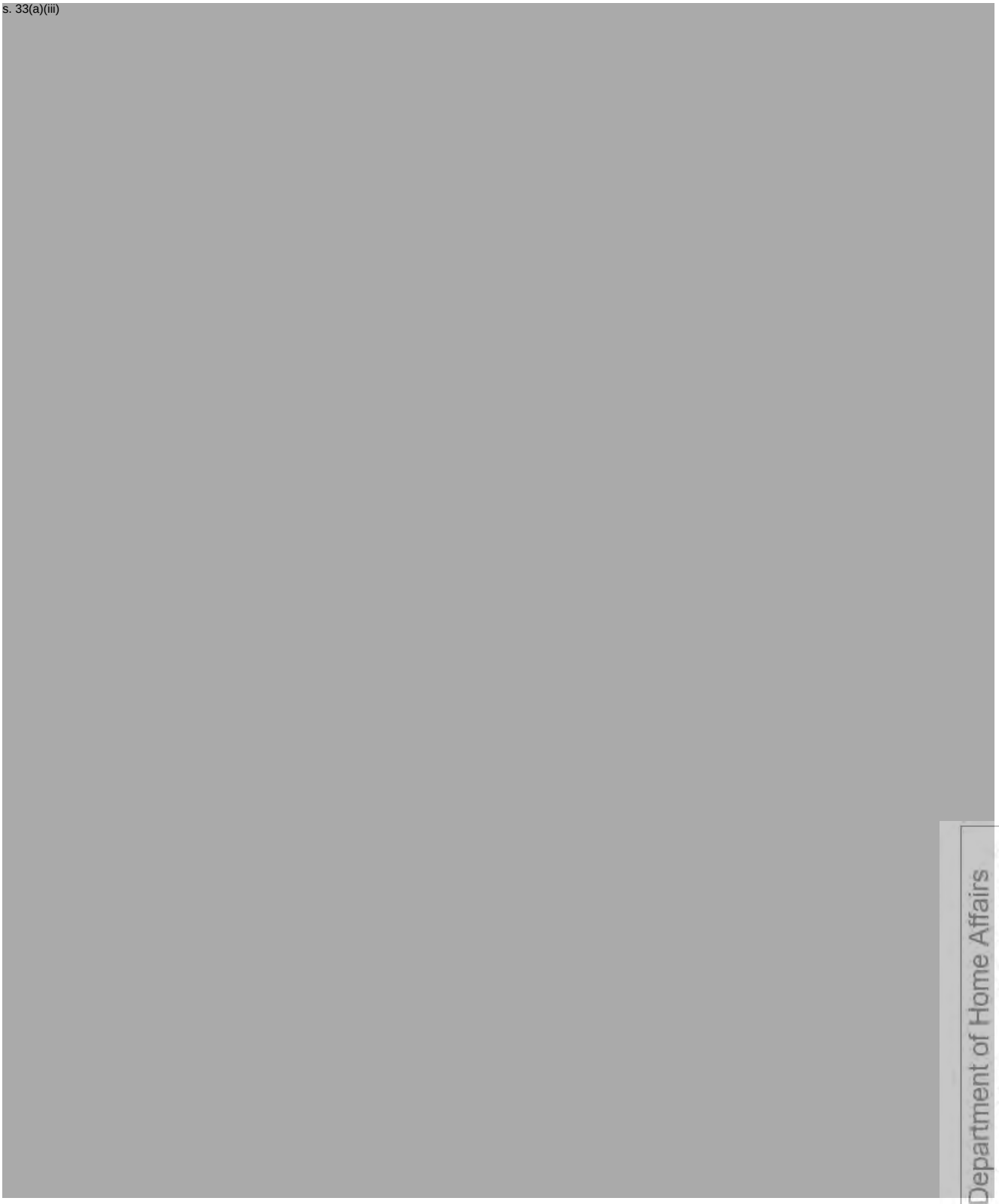
1. General observations and photographic summary
2. Sampling grid methodology
3. Air quality parameters ($PM_{2.5}$ and PM_{10}) of the internal Mess Hall volume at different locations within this building
4. ATP surface hygiene of the internal and external surfaces of the Mess Hall at different locations
5. Viable mould sampling to PDA of (i) air (ii) surface swabs and limited viable bacterial sampling to CHROM- AGAR and NC-AGAR

General Observations of RPC1 – Mess Hall

The Mess Hall is a communal space used by all Transfield personnel as well as other agencies such as Save the Children and IHMS. The building is of modular type construction. Al persons enter through one door, wash their hands and enter the main Mess hall area where persons self-serve food. Food is available towards the rear of the Mess hall where there is a server, the commercial kitchens and the cold storage areas. On entry to the Mess hall there are obvious signs of visible mould on some of the ceilings as well as signs of bubbling on the ceiling membrane. Towards the servery there is heavy visible mould behind the food server area on ceilings and heavy mould in the dishwashing area directly in front of where all the dishes are cleaned by hand. After hand cleaning all dishes pass onto and into a commercial dish washer, however the wall in front of this plant and equipment is completely mould covered. This is presumably caused by the intense steam and humidity and high ambient temperature.

s. 33(a)(iii)

s. 33(a)(iii)



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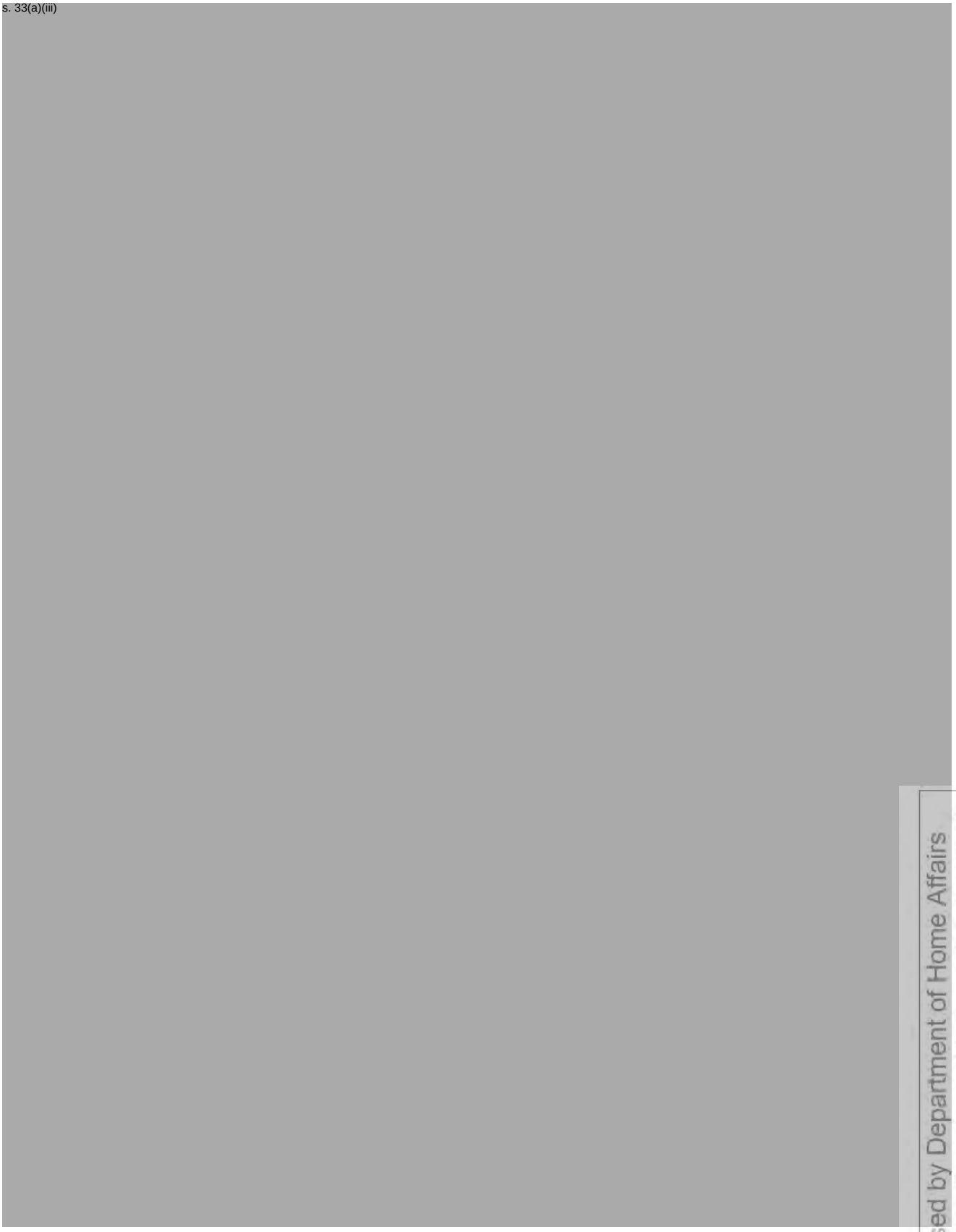


s. 33(a)(iii)

Sampling Grid

A consistent sampling method was followed. Figure 9.2 shows the general sampling grid locations for the different regions of the Mess Hall and Servery.

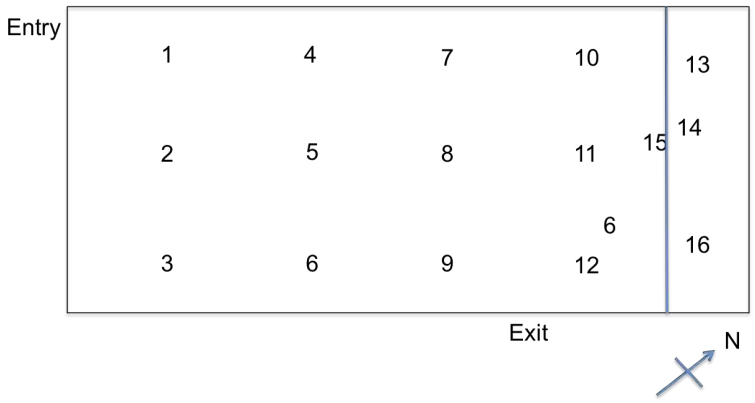


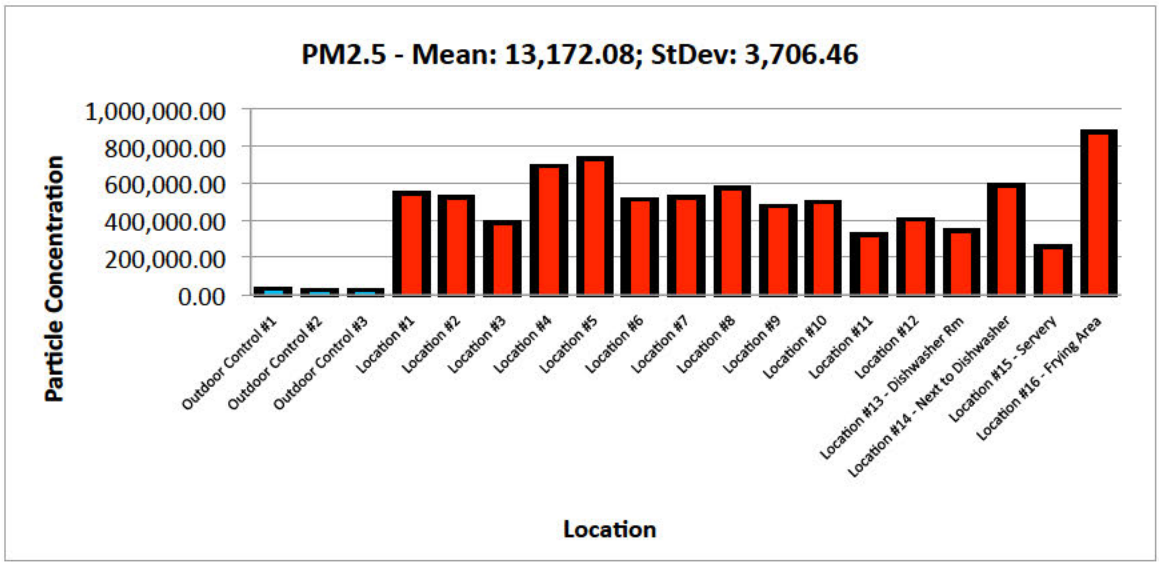
Figure 9.2. Sampling for particulate matter for the Mess Hall followed these numbered locations.

Air Quality Testing of RPC1 – Mess Hall

The following areas were sampled. The main seating area of the hall was divided into 4 sections of 3 rows, so particulate matter counts were taken of each area as follows:

1. Outdoor Control #1
2. Outdoor Control #2
3. Outdoor Control #3
4. Location #1

5. Location #2
6. Location #3
7. Location #4
8. Location #5
9. Location #6
10. Location #7
11. Location #8
12. Location #9
13. Location #10
14. Location #11
15. Location #12
16. Location #13 - Dishwasher Rm
17. Location #14 - Next to Dishwasher
18. Location #15 – Servery
19. Location #16 - Frying Area



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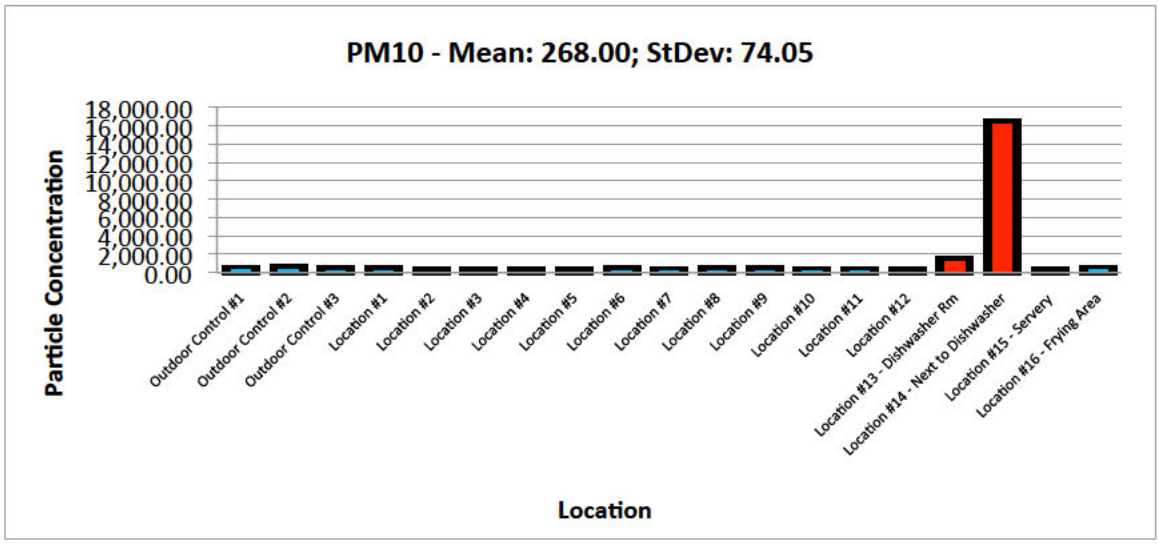

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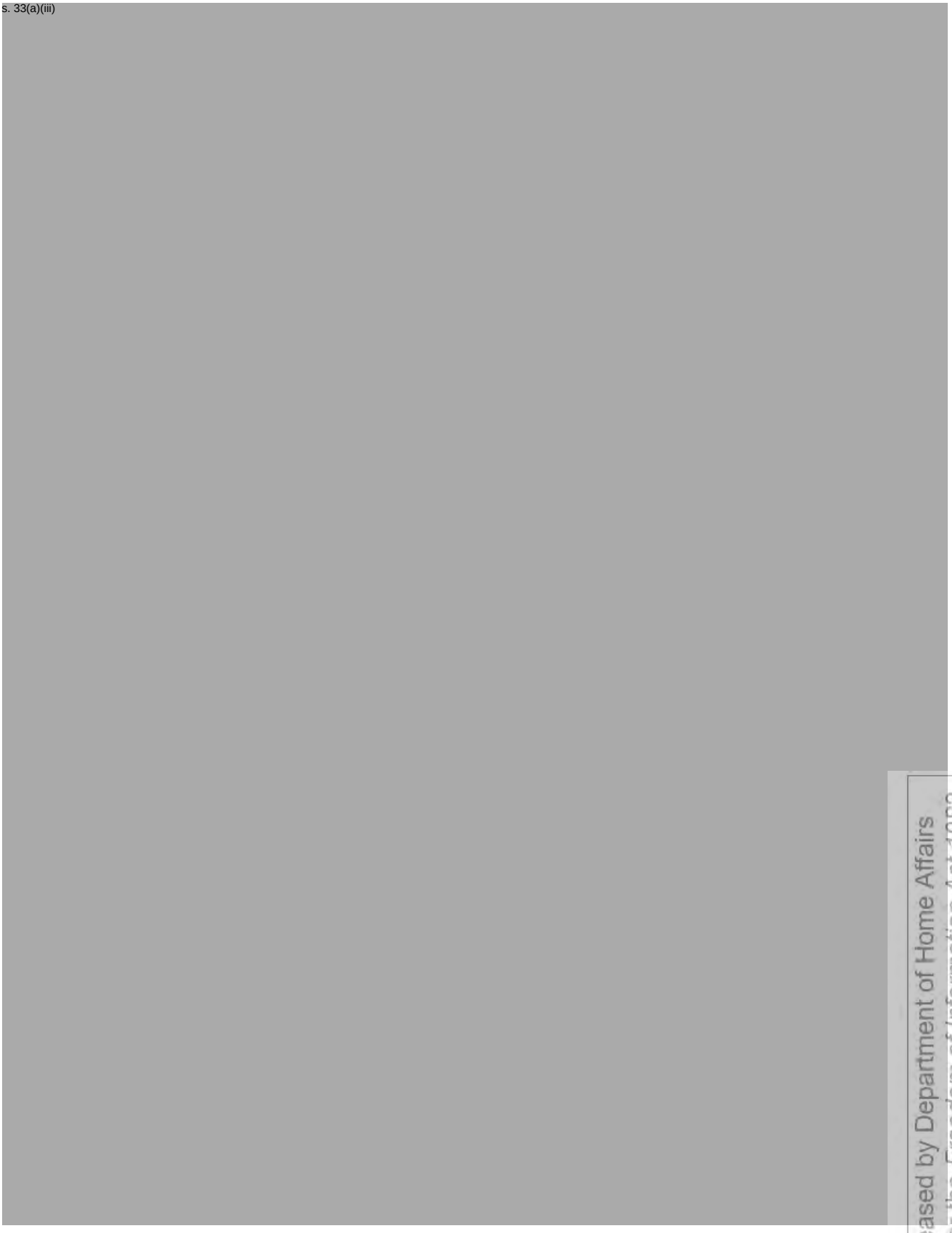
[redacted]

ATP Results of RPC1 – Mess Hall

ATP readings were taken of the following areas:

1. Mess Hall Wall – Location #1 (SW)
2. Mess Hall Wall – Location #2 (NW)
3. Mess Hall Wall – Location #3 (NE)
4. Mess Hall Wall – Location #4 (SE)
5. Mess Hall Ceiling – Location #1 (2nd tier of benches)
6. Mess Hall Ceiling – Location #2 (3rd tier middle)
7. Mess Hall Wall at Rear – Location #1, Dish/Cutlery Washing Up Area
8. Mess Hall Wall at Rear – Location #2, In Front of Sink
9. Mess Hall Wall at Rear – Location #3, Where Staff Collect Plates/Cutlery
10. Mess Hall A/C Vent Front Output
11. Mess Hall A/C Vent at Top of Unit

s. 33(a)(iii)



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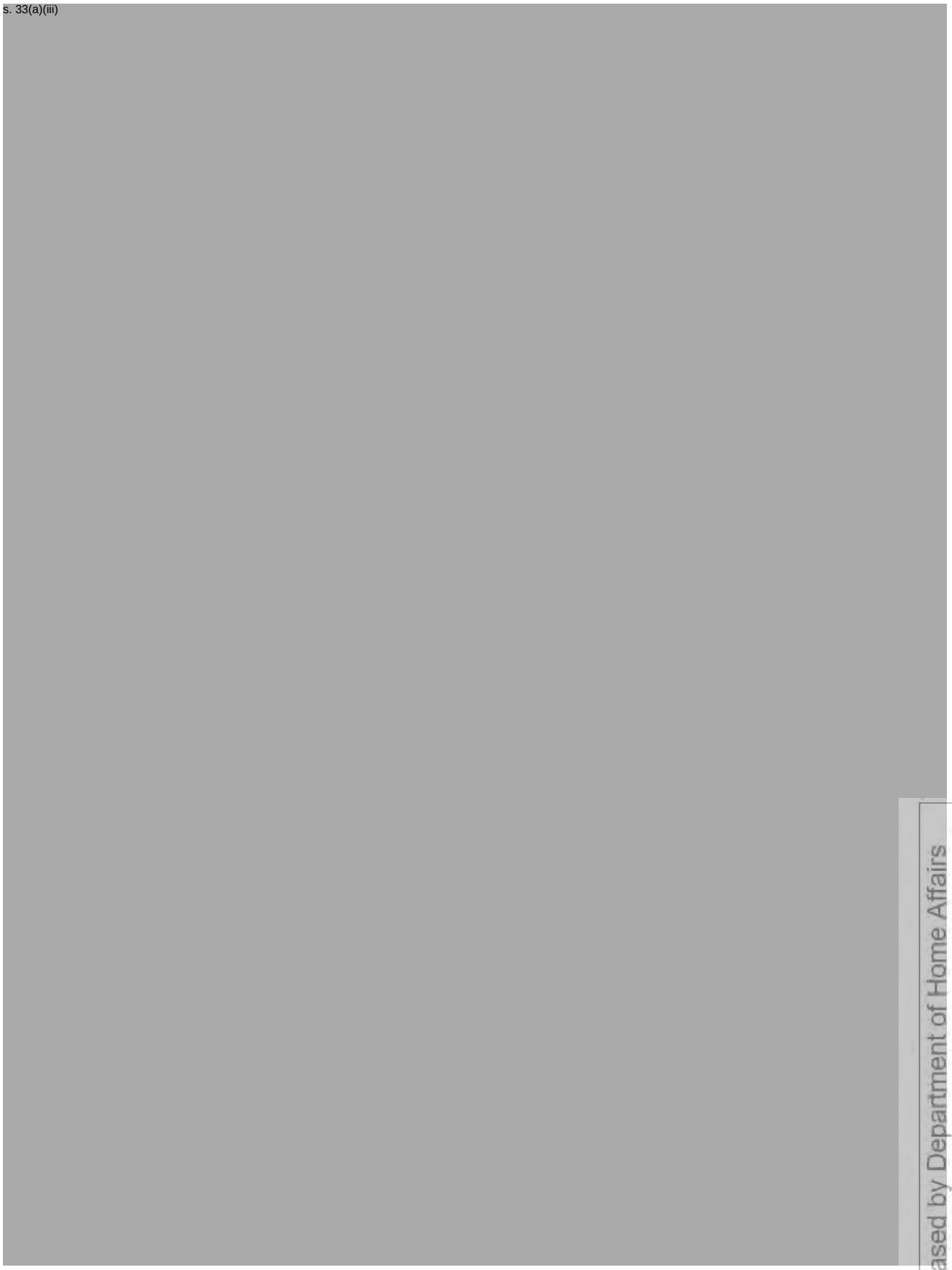


s. 33(a)(iii)

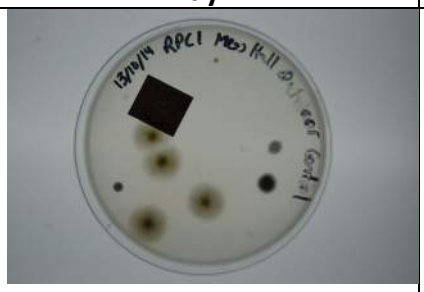
s. 33(a)(iii), s. 47C(1)

The following samples were taken to Petri-plate media (PDA, NC-agar and CHROMagar).

1. Mess Hall Outdoor Control Air Sample
2. Inside Mess Hall – Front Half Air Sample
3. Inside Mess Hall – 2nd Half (towards food collection area) Air Sample
4. Mess Hall Ceiling Swab
5. Washing Up Room Air Sample
6. Mess Hall Wooden Wall near Empty Plates Return Swab Sample
7. Washing Up Room Wall near Sink Swab Sample
8. Washing Up Room near Automated Dishwasher Swab Sample of Wall
9. CHROM-AGAR: Mess Hall Washing Up Room Wall
10. NC-AGAR: Mess Hall Washing Up Room Wall

Biological Sampling – Culture-Based Analysis of RPC1 – Mess Hall

Fungi:

PDA AGAR, NC Agar and CHROM Agar Tests – RPC1 – Mess Hall		
Day 3	**Day 4**	**Day 5**
		
Fig 1a. Mess Hall Outdoor Control Air Sample CFU = 9	Fig 1b. Mess Hall Outdoor Control Air Sample CFU = 11	Fig 1c. Mess Hall Outdoor Control Air Sample CFU = 26 *Aspergillus tereus, Aspergillus flavus, Candida sp., Penicillium*
		
Fig 2a. Inside Mess Hall – Front Half Air Sample, Air Sample Air Sample CFU = 36	Fig 2b. Inside Mess Hall – Front Half Air Sample, Air Sample Air Sample CFU = 32	Fig 2c. Inside Mess Hall – Front Half Air Sample, Air Sample Air Sample CFU = 33 *Trichophyton, Aspergillus tereus, Aspergillus fumigatus, Chrysosporium*

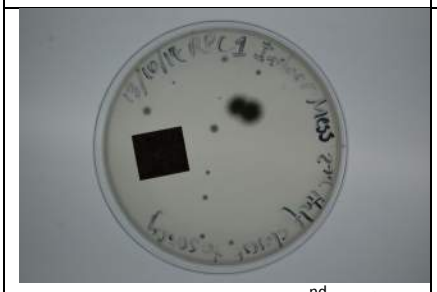



Fig 3a. Inside Mess Hall – 2nd Half (towards food collection area) Air Sample CFU = 13	Fig 3b. Inside Mess Hall – 2nd Half (towards food collection area) Air Sample CFU = 16	Fig 3c. Inside Mess Hall – 2nd Half (towards food collection area) Air Sample CFU = 32

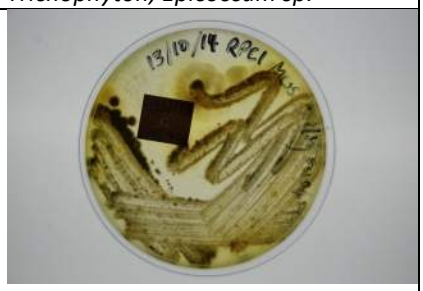
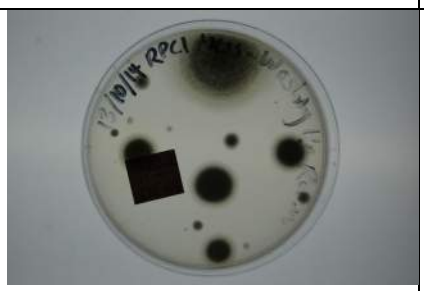
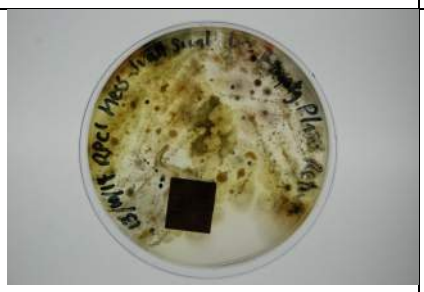
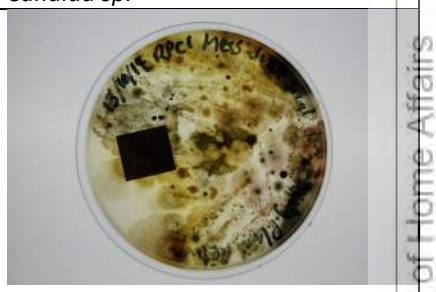
		Aspergillus tereus, Aspergillus fumigatus, Microsporium, Trichophyton, Epicoccum sp.
 Fig 4a. Mess Hall Ceiling Swab Swab Sample CFU = >300	 Fig 4b. Mess Hall Ceiling Swab Swab Sample CFU = >300	 Fig 4c. Mess Hall Ceiling Swab Swab Sample CFU = >300 *Trichoderma, Aspergillus flavus, Candida sp., Aspergillus tereus*
 Fig 5a. Washing Up Room Air Sample CFU = 12	 Fig 5b. Washing Up Room Air Sample CFU = 19	 Fig 5c. Washing Up Room Air Sample CFU = 31 *Epicoccum sp., Rhizopus, Aspergillus flavus, Penicillium, Aspergillus fumigatus, Aspergillus versicolor, Candida sp.*
 Fig 6a. Mess Hall Wooden Wall near Empty Plates Return Swab Sample CFU = >200	 Fig 6b. Mess Hall Wooden Wall near Empty Plates Return Swab Sample CFU = >250	 Fig 6c. Mess Hall Wooden Wall near Empty Plates Return Swab Sample CFU = >300 *Trichoderma, Chaetomium, Epicoccum sp., Candida sp., Aspergillus flavus, Cladosporium*

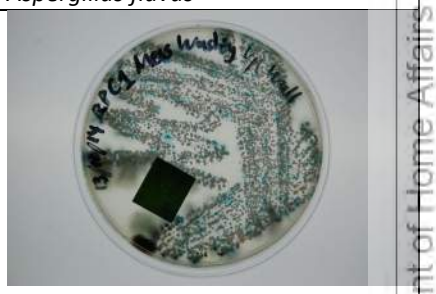
		
Fig 7a. Washing Up Room Wall near Sink Swab Sample CFU = >300	Fig 7b. Washing Up Room Wall near Sink Swab Sample CFU = >300	Fig 7c. Washing Up Room Wall near Sink Swab Sample CFU = >300 *Aspergillus nidulans, Unidentified yeasts, Candida sp., Aspergillus flavus, Trichoderma*
		
Fig 8a. Washing Up Room near Automated Dishwasher Swab Sample of Wall Swab Sample CFU = >200	Fig 8b Washing Up Room near Automated Dishwasher Swab Sample of Wall Swab Sample CFU = >300	Fig 8c. Washing Up Room near Automated Dishwasher Swab Sample of Wall Swab Sample CFU = >300 *Candida sp., Unidentified black yeasts, Aspergillus flavus, Alternaria, Exherohilium, Chaetomium, Aspergillus flavus*
		
Fig 9a. CHROM-AGAR: Mess Hall Washing Up Room Wall Swab Sample CFU = >300	Fig 9b. CHROM-AGAR: Mess Hall Washing Up Room Wall Swab Sample CFU = >300	Fig 9c. CHROM-AGAR: Mess Hall Washing Up Room Wall Swab Sample CFU = >300

		
Fig 10a NC-AGAR: Mess Hall Washing Up Room Wall Swab Sample CFU = >300	Fig 10b NC-AGAR: Mess Hall Washing Up Room Wall Swab Sample CFU =>300	Fig 10c NC-AGAR: Mess Hall Washing Up Room Wall Swab Sample CFU = >300

Table 9.4. Air samples were taken at the different locations and incubated for 3-5 days and inspected daily. Samples were taken and plated out onto PDA for moulds, onto CHROM Agar for candida sp. and onto NC Agar for visualizing the haemolysis reaction for other potentially human-pathogenic bacteria. Some swab samples were also taken of selected surfaces in the Mess Hall area. The air samples show that the number of viable moulds is elevated compared to outdoors, but not more than twice, so I am confidant that the risk from airborne levels of mould is increased, but not significantly higher tan the outdoor levels. However, the surface swabs of the washing room wall show that this room is highly toxic and there are strains of pathogenic bacteria that need to be dealt with. As well, the facing built structure onto which staff put their empty plates also showed high levels of mould on swabs (Figure 6c) so this side of the room also needs to be decontaminated. Colonies were identified to Genus and or Species for each plate at Day 5 for fungi that grew on PDA media. Colonies that grew on the other differential media were already selective for specific types of microorganisms and were scored as appropriate for that medium.

10.RPC 1 – Cold Storage

Data was collected for analysis that included:

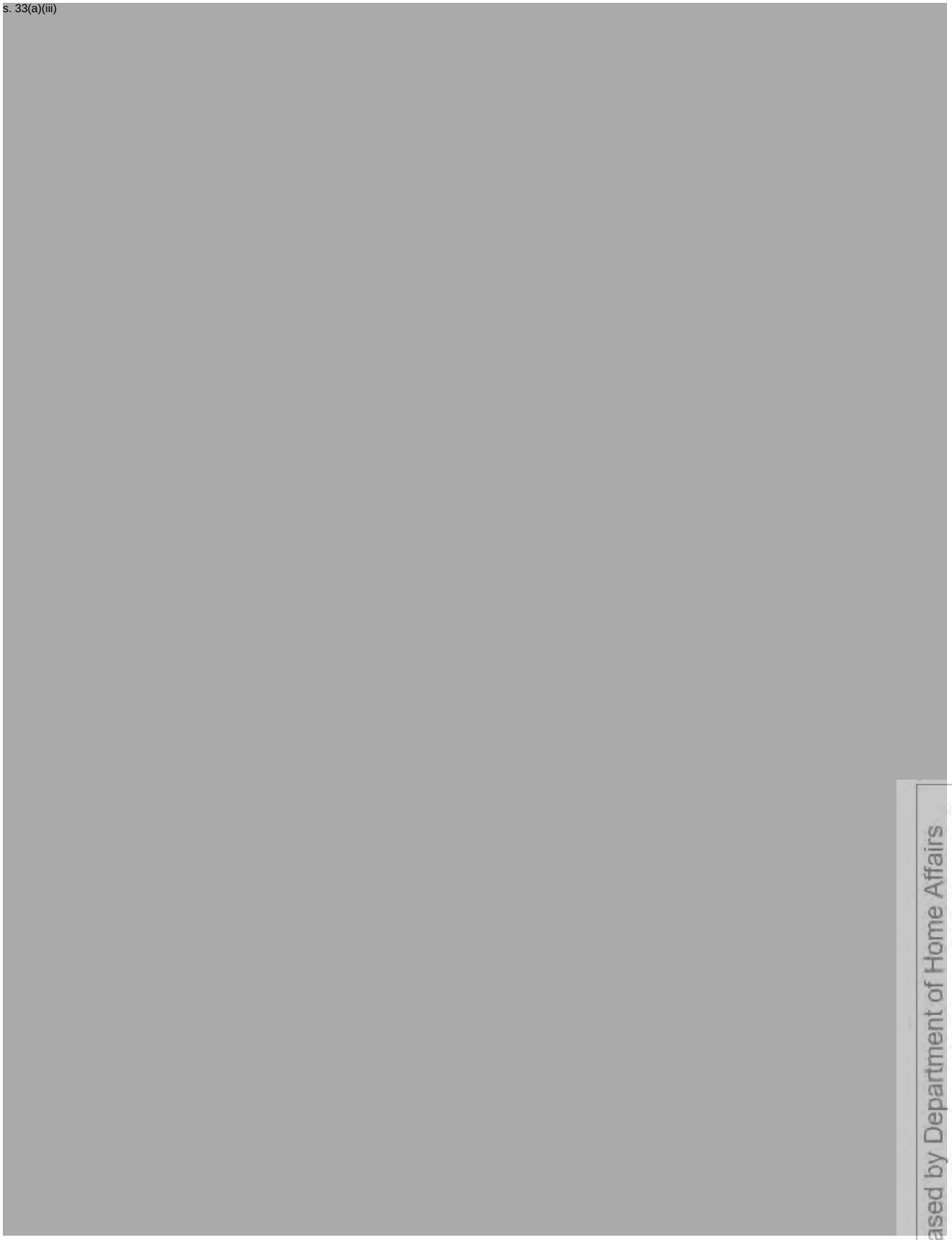
1. General observations and photographic summary
2. ATP surface hygiene of the internal and external surfaces of the tent at different locations
3. Viable mould sampling to PDA of (ii) surface swabs of several fridge/freezers and wall areas
4. Limited viable bacterial sampling to CHROM- AGAR and NC-AGAR of surface swabs – typically of freezers/fridges and walls.

General Observations of RPC1 – Cold Storage

The cold storage area is at the extreme rear of the Mess Hall and is of solid wall construction. This is where all the food that is flown in is stored in typical cold storage freezers and fridges. The external surfaces of many of these freezers and fridges are covered in mould. OIN fact, the painted corridor with cold storage facilities on both sides is covered in mould and visible condensation in many places. The kitchen staff told me that they had run out of disinfectant. However, the problem has been compounded by having had some walls newly painted and the paint has degraded due to the excessive condensation due to high outdoor air temperature and cold fridge/freezer doors and walls.

s. 33(a)(iii)

s. 33(a)(iii)



s. 33(a)(iii)

ATP Results of RPC1 – Cold Storage

The following samples were taken:

1. Fridge #1 Recently Cleaned with Disinfectant
2. Wall Between Fridge 2 and 3
3. Freezer #7 (used for storage of chicken)
4. A/C Above Freezer #18
5. Wall Between Freezers 17 and 18

s. 33(a)(iii)

s. 33(a)(iii)

[redacted]

s. 33(a)(iii), s. 47C(1)

[redacted]

The ATP results confirm that all the tested surfaces have levels of cellular matter that is unacceptable and well beyond what would be considered clean and hygienic.

Biological Sampling – Culture-Based Analysis of RPC1 – Cold Storage

Fungi:

The following samples were taken to Petri-plate media (PDA, NC-agar and Chrom agar).

1. Fridge #1 Front Surface
2. Wall Between Fridge 2 and 3
3. Freezer #7 (chicken) Front of Unit
4. Wall Column between Freezers 17 and 18
5. CHROM Agar: Cold Storage Freezer Door Front
6. NC Agar: Cold Storage Freezer Door Front

PDA AGAR – RPC1 – Cold Storage		
Day 3	**Day 4**	**Day 5**
MISSING IMAGE Fig 1a. Fridge #1 Front Surface Swab Sample CFU = >300	MISSING IMAGE Fig 1b. Fridge #1 Front Surface Swab Sample CFU = >300	MISSING IMAGE Fig 1c. Fridge #1 Front Surface Swab Sample CFU = >300 *Aspergillus flavus, Chaetomium, Phoma, Candida sp., Rhizopus, Trichoderma*
 Fig 2a. Wall Between Fridge 2 and 3 Swab Sample CFU = >300	 Fig 2b. Wall Between Fridge 2 and 3 Swab Sample CFU = >300	 Fig 2c. Wall Between Fridge 2 and 3 Swab Sample CFU = >300 *Aspergillus flavus* [pure, single-strain isolate]
		

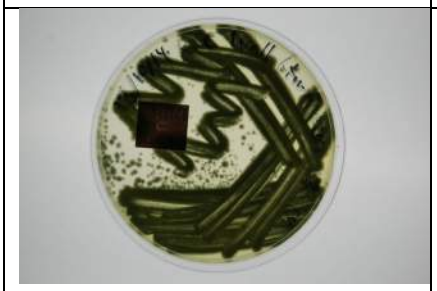
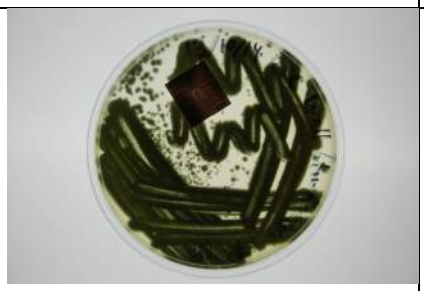
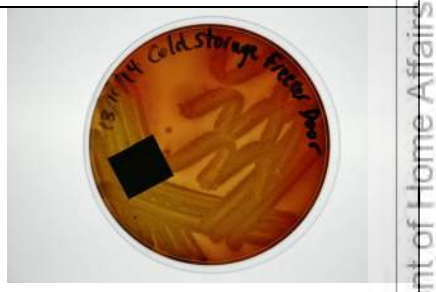
Fig 3a. Freezer #7 (chicken) Front of Unit Swab Sample CFU = >300	Fig 3b. Freezer #7 (chicken) Front of Unit Swab Sample CFU = >300	Fig 3c. Freezer #7 (chicken) Front of Unit Swab Sample CFU = >300 *Aspergillus niger, Cladosporium, Aspergillus flavus, Serratia m.*
 Fig 4a. Wall Column between Freezers 17 and 18 Swab Sample CFU = >300	 Fig 4b. Wall Column between Freezers 17 and 18 Swab Sample CFU = >300	 Fig 4c. Wall Column between Freezers 17 and 18 Swab Sample CFU = >300 *Aspergillus flavus* [pure, single-strain isolate]
 Fig 5a. CHROM Agar: Cold Storage Freezer Door Front Swab Sample CFU = >300	 Fig 5b. CHROM Agar: Cold Storage Freezer Door Front Swab Sample CFU = >300	 Fig 5c. CHROM Agar: Cold Storage Freezer Door Front Swab Sample CFU = >300
 Fig 6a. NC Agar: Cold Storage Freezer Door Front Swab Sample CFU = >300	 Fig 6b. NC Agar: Cold Storage Freezer Door Front Swab Sample CFU = >300	 Fig 6c. NC Agar: Cold Storage Freezer Door Front Swab Sample CFU = >300

Table 10.3. Swab samples were taken at the different locations and incubated for 3-5 days and inspected daily. Samples were taken and plated out onto PDA for moulds, onto CHROM Agar for Candida sp. and onto NC Agar for visualizing the haemolysis reaction for other potentially human-pathogenic bacteria. The swab samples showed that all surfaces in the cold storage area are heavily contaminated with fungi, yeast and bacteria likely to cause

infection in humans, especially from direct contact with contaminated surfaces. Colonies were identified to Genus and or Species for each plate at Day 5 for fungi that grew on PDA media. Colonies that grew on the other differential media were already selective for specific types of microorganisms and were scored as appropriate for that medium.

11.RPC 1 – *A* Building Room 103

Data was collected for analysis that included:

1. General observations and photographic summary
2. Relative humidity and ambient temperature – inside and outside
3. ATP surface hygiene of the internal and external surfaces of the room at different locations
4. Air quality parameters ($PM_{2.5}$ and PM_{10}) of the internal tent volume at different locations within the room
5. Viable mould sampling to PDA of (i) air (ii) surface swabs - inside selected room surfaces of A Building Room 103

General Observations of RPC1 – A Building Room 103

This is a typical accommodation unit used by women on RPC1. The unit was unoccupied by other adjacent units were occupied at the time of this survey. This unit could accommodate up to 3 persons wit two on bunk style sleeping and one on a mattress on the floor. Each unit was air conditioned with a wall mounted inverter.

Environmental Parameters of RPC1 – A Building Room 103

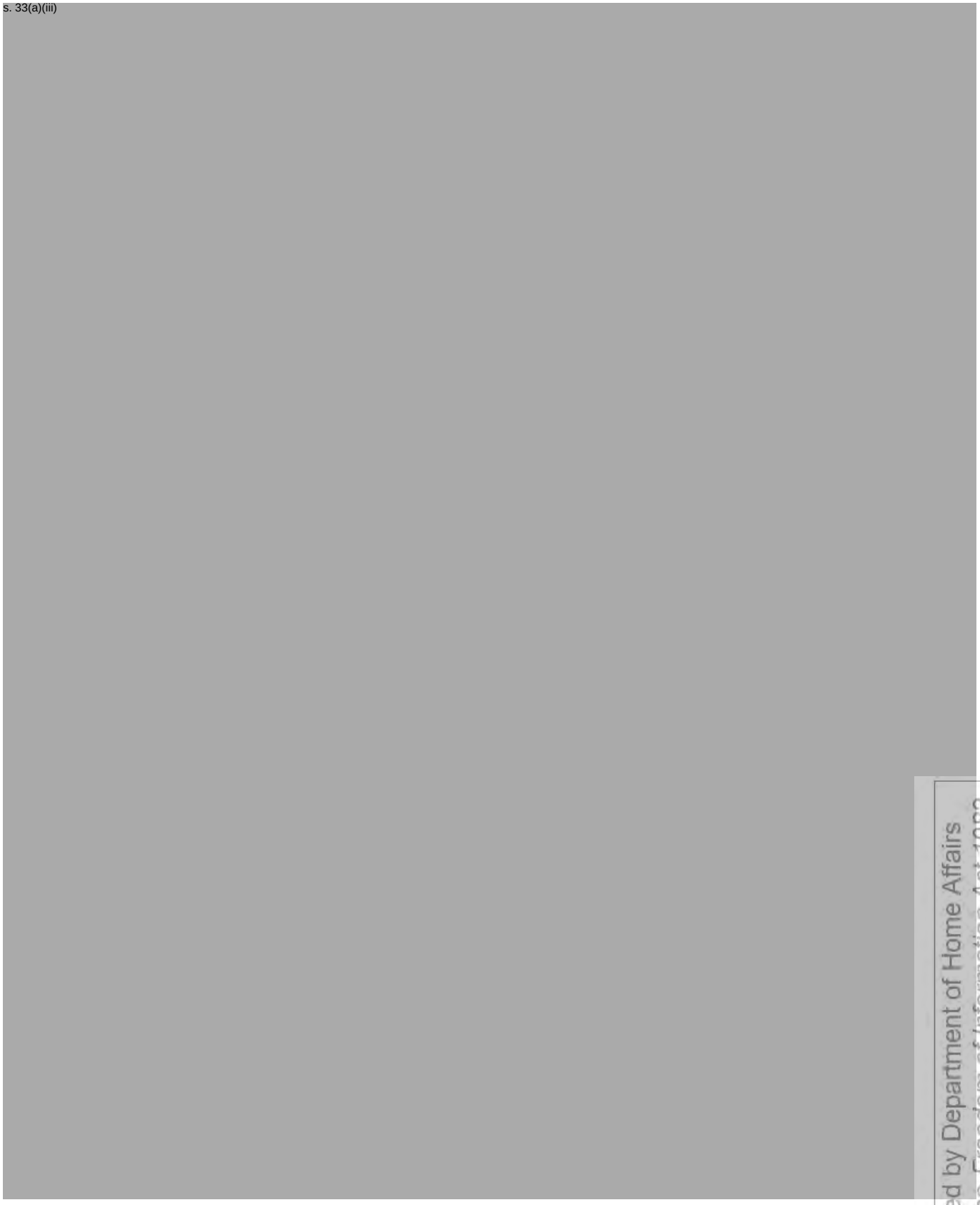
The following areas were sampled:

1. Outdoor Control
2. Inside accommodation room 103

Location	Relative Humidity	Temperature
Outdoor Control	86.10 ± 1.26	23.27 ± 0.41
Mean Indoor Levels	68.56 ± 0.75	22.80 ± 0.00

Table 7.2. Comparison of the outdoor relative humidity and temperature inside this RPC1 – A Building Room 103. This room is airconditioned. The relative humidity indoors is lower in this office (#2) but the indoor relative humidity is higher than the 65% limit according to the Standard 55-2013 - Thermal Environmental Conditions for Human Occupancy (ANSI Approved). It is acknowledged that the outdoor relative humidity is also very high.

s. 33(a)(iii)



ATP Results of RPC1 – A Building Room 103

The following ATP Swabs were taken:

1. Indoor Wall
2. Indoor Ceiling
3. Indoor A/C Vent Accessible from Front
4. Internal Window Glass
5. External Cladding
6. Internal Cloth Blind
7. External Side of Door

s. 33(a)(iii)

s. 33(a)(iii)

[redacted]

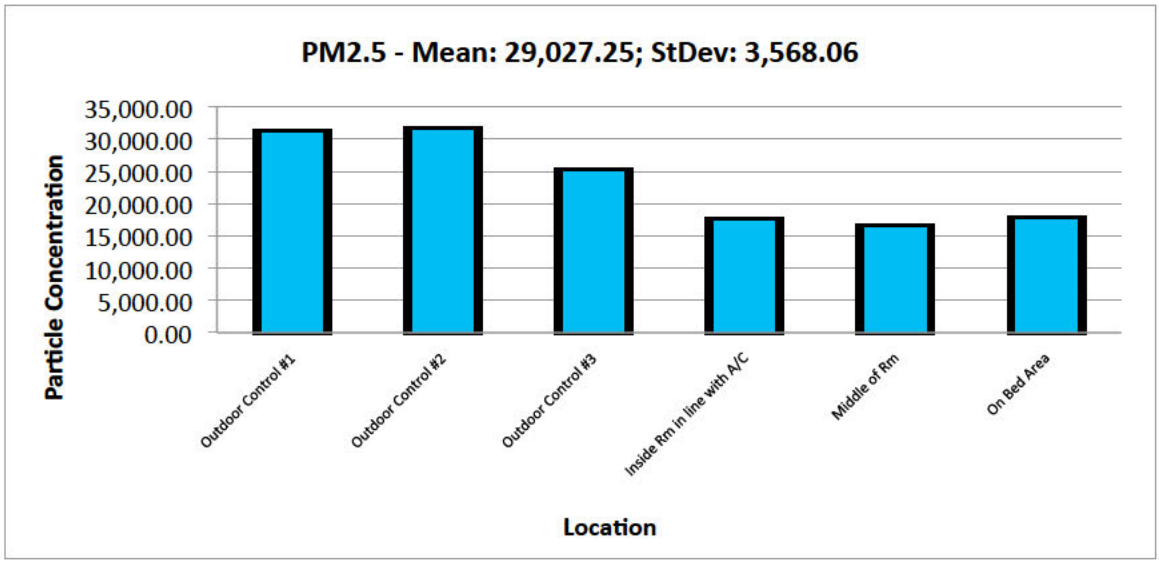
s. 33(a)(iii), s. 47C(1)

[redacted]

Air Quality Testing of RPC1 – A Building Room 103

The following areas were sampled:

1. Outdoor Control #1
2. Outdoor Control #2
3. Outdoor Control #3
4. Inside Room in line with A/C
5. Middle of Room
6. On Bed Area



s. 33(a)(iii), s. 47C(1)

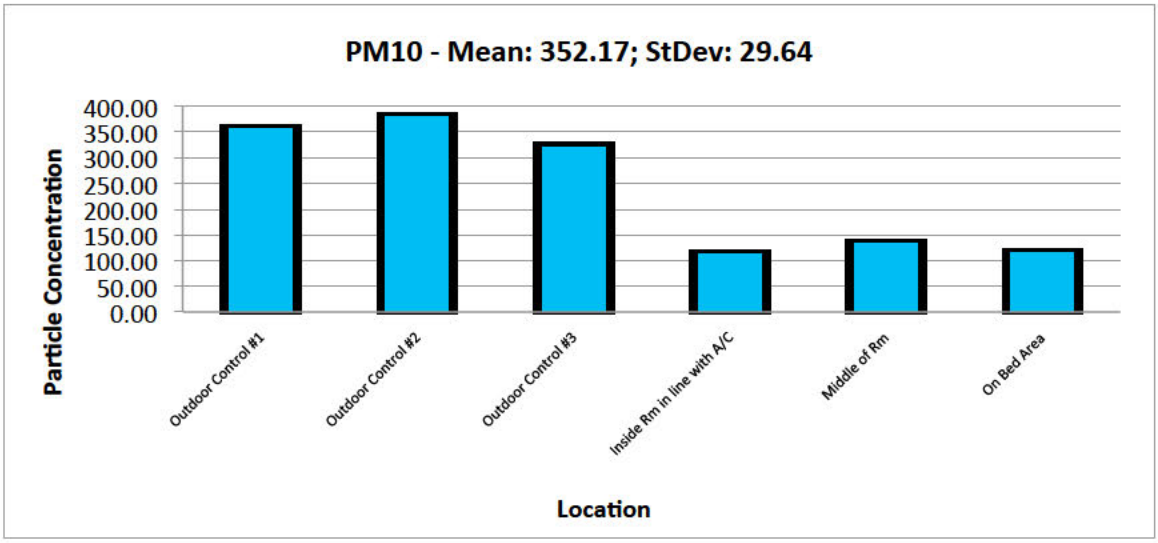


Figure 11.2. The bioaerosol distribution for the PM_{10} class of fine inside this living area for each area tested versus the three outdoor controls. *The mean and standard deviation for the three controls is provided for reference. The PM_{10} size class is the coarser fraction that generally shows mould spores and hyphal fragments. Based on this evidence, THREE of the THREE areas* or 0% of the tested areas in the building are contaminated with fine particles that exceed normal concentration levels relative to the three outdoor controls. It is concluded that there is NO evidence of an indoor air quality problem presented by coarse particles belonging to this size class grouping inside this room, and the relative difference against the controls IS NOT considered serious and is of NO cause for concern by users of this building as long as this room is typical of other rooms in this building.

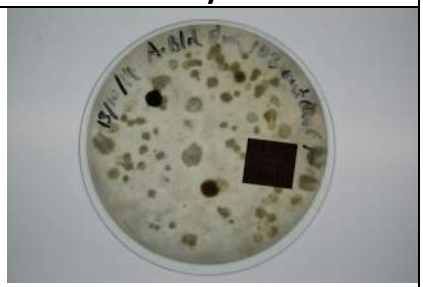
Collectively, this data confirms that for the fine particles, the $PM_{2.5}$ counts show that approx. 0% of the tested areas show any airborne contamination with small-sized, respirable particulate material (Particulate Matter – inorganic and/or bioaerosols). Comparatively, for the coarse particles belonging to the PM_{10} size class, 0% of the tested areas show any coarse-sized airborne particulates This confirms that this room overall is not a foreseeable risk to the health and safety of any occupants.

Biological Sampling – Culture-Based Analysis of RPC1 – A Building Room 103

Fungi:

The following samples were also taken:

1. Outdoor Air Sample
2. Interior of Room 103
3. Interior Wall of Room 103
4. Exterior Cladding Swab outside Room 103 with Visible Mould
5. Exterior Cladding Swab outside Room 103 without Visible Mould

Location – PDA Samples - RPC1 – A Building Room 103		
Day 3	**Day 4**	**Day 5**
		
Fig 1a. Outdoor Air Sample Air Sample CFU = 70	Fig 1b. Outdoor Air Sample Air Sample CFU = ~90	Fig 1c. Outdoor Air Sample Air Sample CFU = ~90 *Aspergillus versicolor, Chaetomium, Cladosporium, Candida sp.*

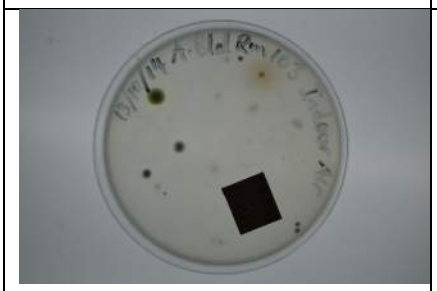
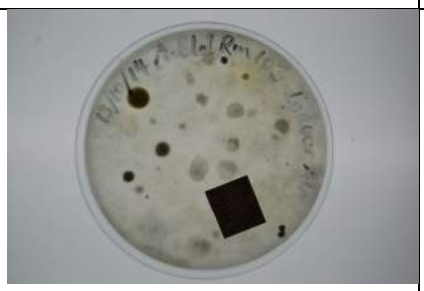

	

Fig 2a. Interior of Room 103 Air Sample CFU = 26	Fig 2b. Interior of Room 103 Air Sample CFU = 34	Fig 2c. Interior of Room 103 Air Sample CFU = 34 *Cladosporium, Penicillium, Rhodotorula, Chaetomium*

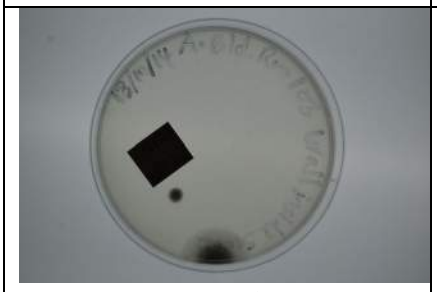
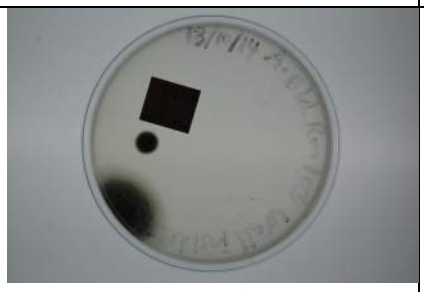
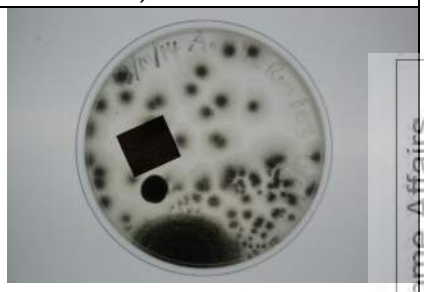

		

Fig 3a. Interior Wall of Room 103 Swab Sample CFU = 2	Fig 3b. Interior Wall of Room 103 Swab Sample CFU = 3	Fig 3c. Interior Wall of Room 103 Swab Sample CFU = 86 *Aspergillus niger, Cladosporium*

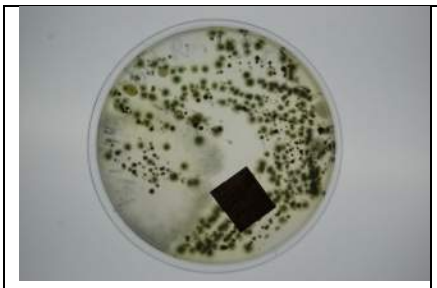
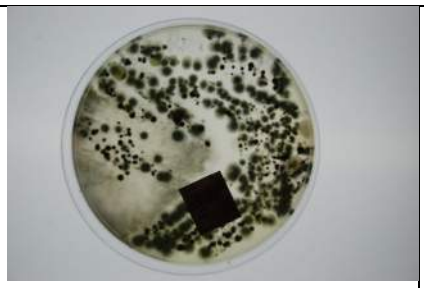
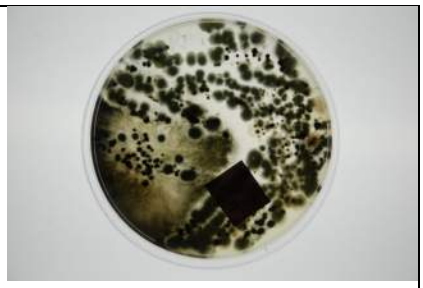
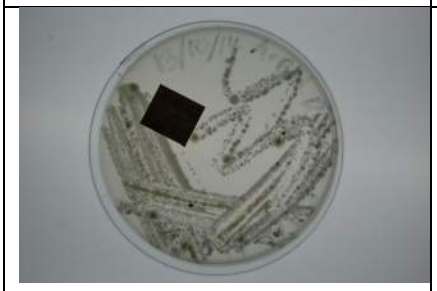
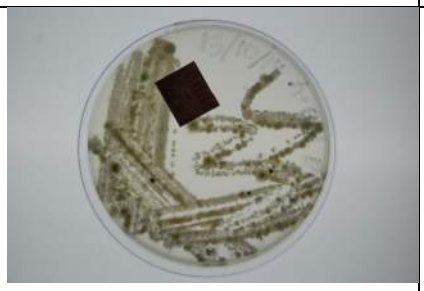
 Fig 4a. Exterior Cladding Swab outside Room 103 with Visible Mould Swab Sample CFU = >200	 Fig 4b. Exterior Cladding Swab outside Room 103 with Visible Mould Swab Sample CFU = >200	 Fig 4c. Exterior Cladding Swab outside Room 103 with Visible Mould Swab Sample CFU = >200 *Candida sp., Rhodotorula, Aspergillus flavus, Cladosporium, unidentified black yeasts, Aspergillus tereus*
 Fig 5a. Exterior Cladding Swab outside Room 103 without Visible Mould Swab Sample CFU = >300	 Fig 5b. Exterior Cladding Swab outside Room 103 without Visible Mould Swab Sample CFU = >300	 Fig 5c. Exterior Cladding Swab outside Room 103 without Visible Mould Swab Sample CFU = >300 *Rhodotorula, Aspergillus tereus, Chaetomium*

Table 11.3. The air outside was compared to the air inside and several swabs were also taken of typical surfaces. This shows that the air inside the RPC1 – A Building Room 103 is clean and the numbers of culturable fungi indoors is less than outdoors. The interior wall swab however suggests that there is significant microbial matter on the interior surfaces and the very high indoor ATP wall swab supports this. This would also go some way towards explaining the strong smell of mould in this bedroom. It is notable that the external cladding (an outdoor surface) is heavily contaminated and indicates that the general background levels of mould affecting this building object are very high and may represent normal conditions in this environment. Colonies were identified to Genus and or Species for each plate at Day 5 for fungi that grew on PDA media.

Despite the acceptable levels of airborne or surface mould, this room presents with the unmistakable odour of mould. It is concluded that this room is very likely to contain hidden mould and is actively liberating microbial volatile organics (mVOC's) that are likely to be the cause of the smell. The roof and/or wall voids are likely to contain hidden moisture.

12. RPC 1 – *H* Building Room 219

Data was collected for analysis that included:

1. General observations and photographic summary
2. Relative humidity and ambient temperature – inside and outside
3. ATP surface hygiene of the internal and external surfaces of the room at different locations
4. Air quality parameters ($PM_{2.5}$ and PM_{10}) of the internal tent volume at different locations within the room
5. Viable mould sampling to PDA of (i) air (ii) surface swabs - inside selected room surfaces

General Observations of RPC1 – *H* Building Room 219

General Observations of RPC1 – *H* Building Room 219

This is a typical accommodation unit used by men on RPC1. The unit was occupied by myself for the duration of this project and other adjacent units were also occupied at the time of this survey. This unit could accommodate up to 2 persons in a bunk style sleeping arrangement. Each unit was air conditioned with a wall-mounted inverter. The airconditioning was permanently set and could not be turned off nor adjusted.

Environmental Parameters of RPC1 – *H* Building Room 219

The following areas were sampled:

1. Outdoor Control
2. Inside accommodation room 219

Location	Relative Humidity	Temperature
Outdoor Control	85.27 ± 1.30	23.14 ± 0.55
Mean Indoor Levels	69.14 ± 0.58	22.50 ± 0.10

Table 12.1. Comparison of the outdoor relative humidity and temperature inside this RPC1 – A Building Room 219. This room is airconditioned. The relative humidity indoors is lower in this office (#2) but the indoor relative humidity is higher than the 65% limit according to the Standard 55-2013 - Thermal Environmental Conditions for Human Occupancy (ANSI Approved). It is acknowledged that the outdoor relative humidity is also very high.

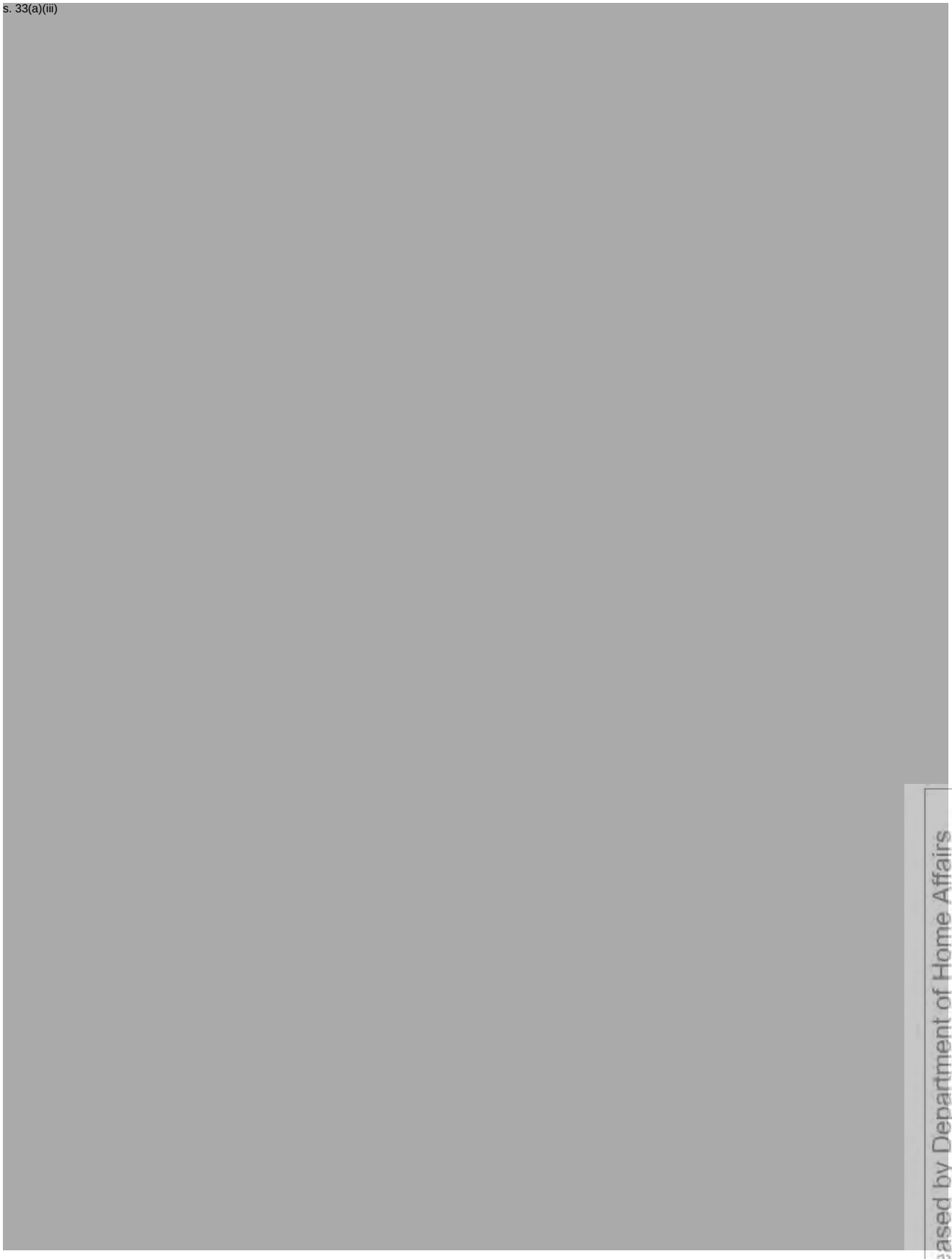
s. 33(a)(iii)

ATP Results of RPC1 – *H* Building Room 219

The following ATP Swabs were taken:

1. Indoor Wall
2. Indoor Wall Behind Bed
3. Indoor A/C Vent Accessible from Front
4. Internal Window Glass
5. External Cladding
6. External Side of Door

s. 33(a)(iii)



s. 33(a)(iii)

[redacted]

s. 33(a)(iii), s. 47C(1)

[redacted]

Air Quality Testing of RPC1 – *H* Building Room 219

The following areas were sampled:

1. Outdoor Control #1
2. Outdoor Control #2
3. Outdoor Control #3
4. Inside Room
5. Middle of Room
6. On Bed Area

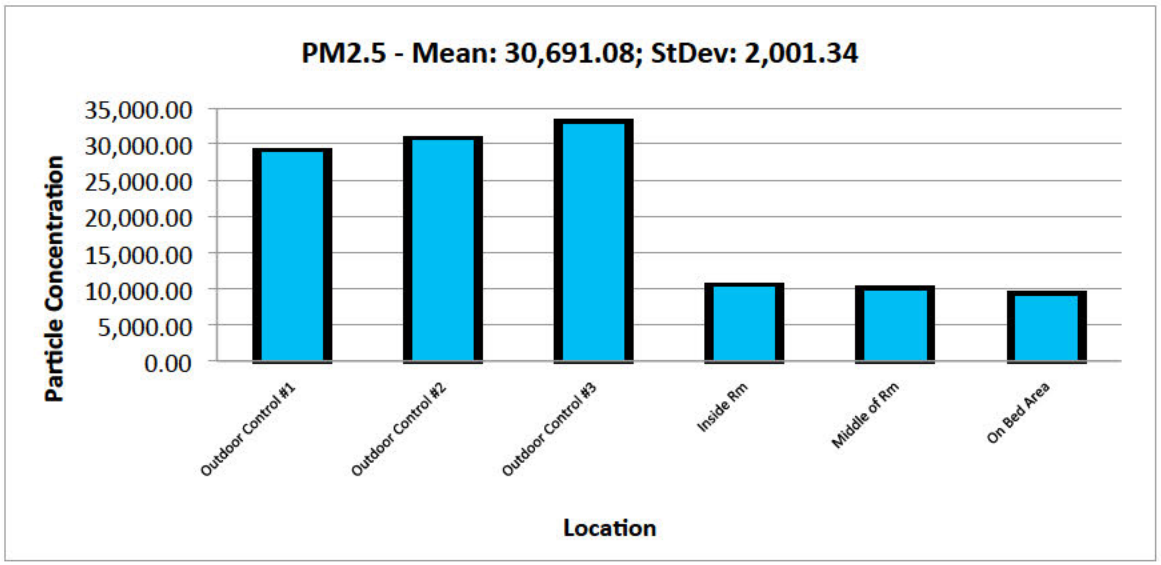


Figure 12.1. The bioaerosol distribution for the $PM_{2.5}$ class of fine particles inside this living area for each area tested versus the three outdoor controls. The mean and standard deviation for the three controls is provided for

reference. Based on this evidence, THREE of the THREE areas or 0% of the tested areas in the building are contaminated with fine particles that exceed normal concentration levels relative to the three outdoor controls. It is concluded that there is NO evidence of an indoor air quality problem presented by respirable fine particles belonging to this size class grouping inside this room, and the relative difference against the controls IS NOT considered serious and is of NO cause for concern by users of this building as long as this room is typical of other rooms in this building.

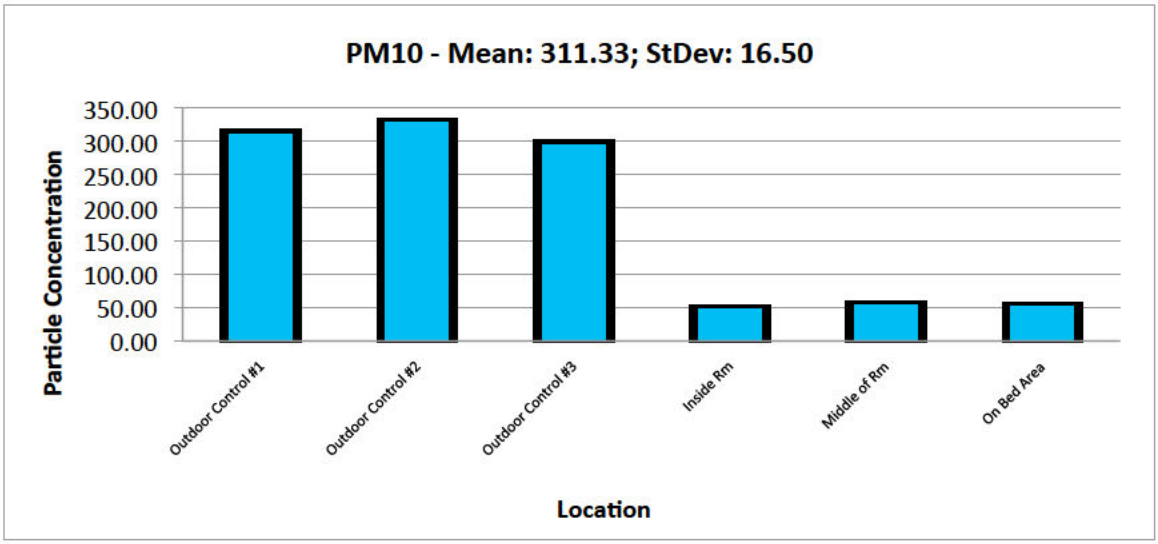


Figure 12.2. The bioaerosol distribution for the PM_{10} class of fine inside this living area for each area tested versus the three outdoor controls. The mean and standard deviation for the three controls is provided for reference. The PM10 size class is the coarser fraction that generally shows mould spores and hyphal fragments. Based on this evidence, THREE of the THREE areas or 0% of the tested areas in the building are contaminated with fine particles that exceed normal concentration levels relative to the three outdoor controls. It is concluded that there is NO evidence of an indoor air quality problem presented by coarse particles belonging to this size class grouping inside this room, and the relative difference against the controls IS NOT considered serious and is of NO cause for concern by users of this building as long as this room is typical of other rooms in this building.

Collectively, this data confirms that for the fine particles, the $PM_{2.5}$ counts show that approx. 0% of the tested areas show any airborne contamination with small-sized, respirable particulate material (Particulate Matter – inorganic and/or bioaerosols). Comparatively, for the coarse particles belonging to the PM_{10} size class, 0% of the tested areas show any coarse-sized airborne particulates This confirms that Room 219 room overall is not a foreseeable risk to the health and safety of any occupants from particulate matter.

Biological Sampling – Culture-Based Analysis of RPC1 – *H* Building Room 219

Fungi:

The following samples were also taken:

1. Outdoor Air Sample
2. Interior of Room H.219
3. Interior Wall of Room H.219
4. Exterior Cladding Swab outside Room H.219

Location – RPC1 – Room H. 219		
Day 3	**Day 4**	**Day 5**
		
Fig 1a. Outdoor Air Sample Air Sample CFU = ~14 (same species of *N. crassa*)	Fig 1b. Outdoor Air Sample Air Sample CFU = >20 (same species of *N. crassa*)	Fig 1c. Outdoor Air Sample Air Sample CFU = >30 (same species of *N. crassa*) *Aspergillus flavus, Neurospora crassa*

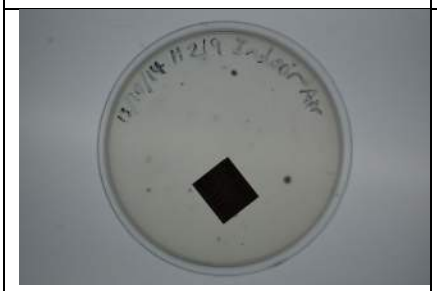



Fig 2a. Interior of Room H.219 Air Sample CFU = 24	Fig 2b. Interior of Room H.219 Air Sample CFU = 80	Fig 2c. Interior of Room H.219 Air Sample CFU = ~70 *Candida sp., Aspergillus fumigatus, Cladosporium, Chrysosporium*

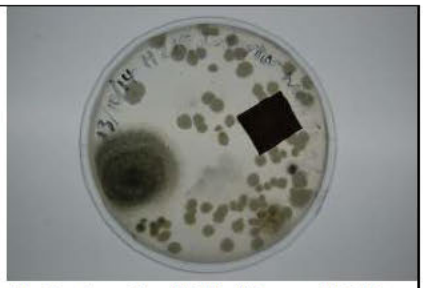
 Fig 3a. Interior Wall of Room H.219 Swab Sample CFU = 92	 Fig 3b. Interior Wall of Room H.219 Swab Sample CFU = 99	 Fig 3c. Interior Wall of Room H.219 Swab Sample CFU = >95 *Rhizopus, Candida sp., Aspergillus flavus, Aspergillus tereus*
 Fig 4a. Exterior Cladding Swab outside Room H.219 Swab Sample CFU = >200	 Fig 4b. Exterior Cladding Swab outside Room H.219 Swab Sample CFU = >200	 Fig 4c. Exterior Cladding Swab outside Room H.219 Swab Sample CFU = >200 *Microsporum sp., Candida sp., Aspergillus niger, Chrysosporium, Cladosporium, Aspergillus flavus, Chaetomium, Rhodotorula*

Table 12.4. The air outside was compared to the air inside and several swabs were also taken of typical surfaces. This shows that the air inside the RPC1 – H Building Room 219 is clean and the numbers of culturable fungi indoors is less than outdoors. The interior wall swab however suggests that there is significant microbial matter on the interior surfaces and the very high indoor ATP wall swab supports this. This would also go some way towards explaining the strong smell of mould in this bedroom. It is notable that the external cladding (an outdoor surface) is heavily contaminated and indicates that the general background levels of mould affecting this building object are very high and may represent normal conditions in this environment. Colonies were identified to Genus and or Species for each plate at Day 5 for fungi that grew on PDA media.

In a similar way to what was observed in RPC1 – A Building Room 103, this accommodation room (H 219) has acceptable levels of airborne or surface mould. However, the room definitely presents with the unmistakable odour of mould. It is concluded that this room is also very likely to contain hidden mould and is actively liberating microbial volatile organics (mVOC's) that are likely to be the cause of the strong smell on entry to the room. The roof and/or wall voids are likely to contain hidden moisture.

13. RPC 1 – The School Building

Data was collected for analysis that included:

1. General observations. A photographic survey was not taken of this building due to time constraints.
2. Relative humidity and ambient temperature – inside and outside
3. Air quality parameters ($PM_{2.5}$ and PM_{10}) of the internal School/Various classroom room volumes on both levels of the building. All classrooms that could be accessed (i.e not locked) were sampled.
4. Viable mould sampling to PDA of (i) air some limited (ii) surface swabs inside the School.

General Observations of RPC1 – The School Building

The School is over two levels and is not of modular or portable construction. This survey was conducted at night, so we have not provided any photographs but the building appears much older than all of the other buildings on RPC1.

Environmental Parameters of RPC1 – The School Building

The following areas were sampled:

1. Outdoor Control
2. Inside accommodation room 219

Location	Relative Humidity	Temperature
Outdoor Control	84.83 ± 0.21	27.20 ± 0.10
Mean Indoor Levels	76.50 ± 1.22	28.20 ± 0.00

Table 13.1. Comparison of the outdoor relative humidity and temperature inside this RPC1 – School Building over both levels. The relative humidity indoors is lower in this School but the indoor relative humidity is higher than the 65% limit according to the Standard 55-2013 - Thermal Environmental Conditions for Human Occupancy (ANSI Approved). It is acknowledged that the outdoor relative humidity is also very high.

Air Quality Testing of RPC1 – The School Building

The following areas were sampled:

1. Outdoor Control #1
2. Outdoor Control #2
3. Outdoor Control #3

4. U/S - Entrance to Maths Lab/F11
5. U/S - Maths Lab/F11 at Whiteboard
6. U/S - Rm 212 (F10) Secondary 2
7. U/S - Rm 211 (F9)
8. U/S - Rm 210
9. D/S - Rm 115
10. D/S - Rm 114
11. D/S - Rm 111

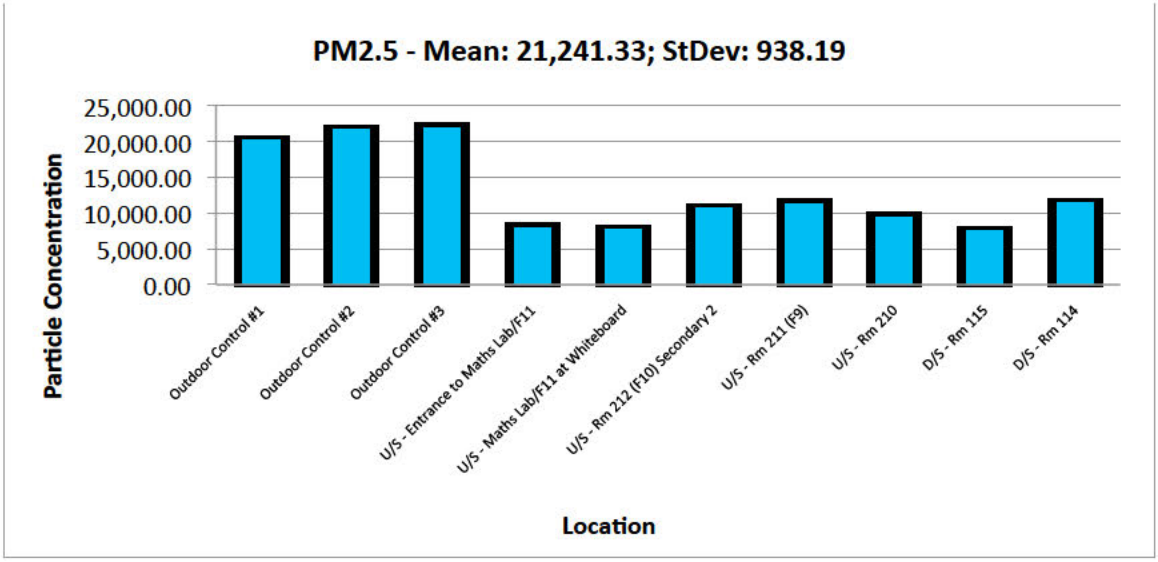


Figure 13.1. The bioaerosol distribution for the $PM_{2.5}$ class of fine particles inside different locations within the School Building versus the three outdoor controls. The mean and standard deviation for the three controls is provided for reference. Based on this evidence, ZERO of the SEVEN areas or 0% of the tested areas in the building are contaminated with fine particles that exceed normal concentration levels relative to the three outdoor controls. It is concluded that there is NO evidence of an indoor air quality problem presented by respirable fine particles belonging to this size class grouping inside this room, and the relative difference against the controls IS NOT considered serious and is of NO cause for concern by users of this School building.

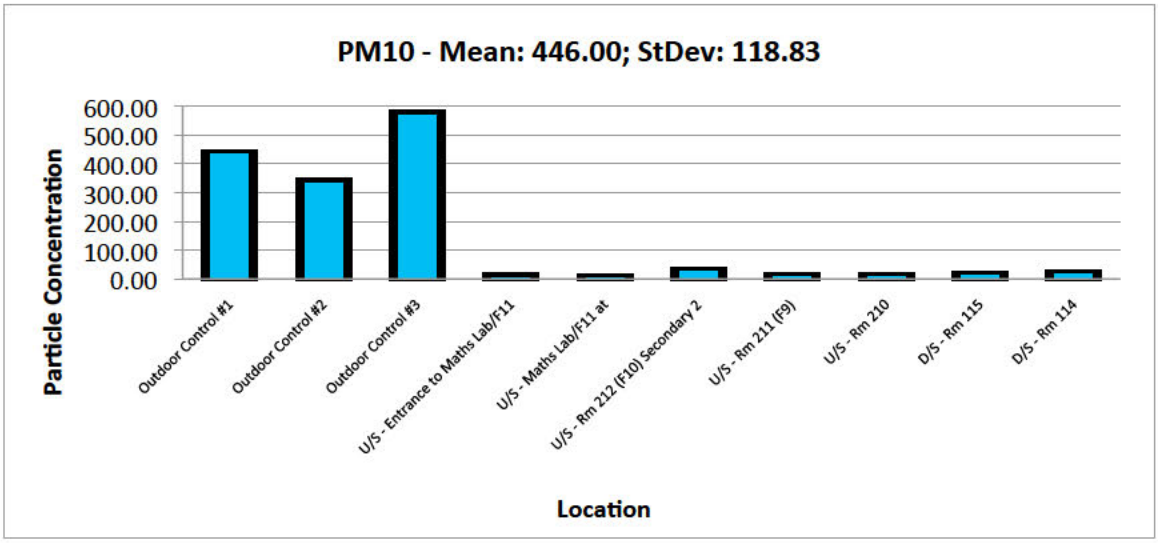


Figure 13.2. The bioaerosol distribution for the PM_{10} class of fine particles inside different locations within the School Building versus the three outdoor controls. The mean and standard deviation for the three controls is provided for reference. Based on this evidence, ZERO of the SEVEN areas or 0% of the tested areas in the building are contaminated with coarse particles that exceed normal concentration levels relative to the three outdoor controls. It is concluded that there is NO evidence of an indoor air quality problem presented by respirable fine particles belonging to this size class grouping inside this room, and the relative difference against the controls IS NOT considered serious and is of NO cause for concern by users of this School building.

Collectively, this data confirms that for the fine particles, the $PM_{2.5}$ counts show that approx. 0% of the tested areas at the School show any airborne contamination with small-sized, respirable particulate material (Particulate Matter – inorganic and/or bioaerosols). Comparatively, for the coarse particles belonging to the PM_{10} size class, 0% of the tested areas show any coarse-sized airborne particulates This confirms that the School overall is not a foreseeable risk to the health and safety of any users or occupants from particulate matter.

Biological Sampling – Culture-Based Analysis of RPC1 – The School Building Fungi:

The following samples were taken:

1. Outdoor Control Air Sample
2. Maths Lab Air Sample
3. Room 212 Air Sample
4. Room 115 Air Sample
5. Room 111 Air Sample
6. Room 115 Swab from A/C
7. Room 115 Swab from Wall

Location – RPC1 School		
Day 3	Day 4	Day 5

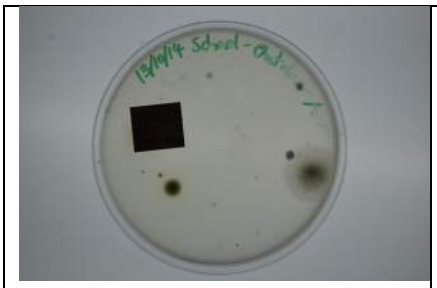


Fig 1a. Outdoor Control Outdoor Control Air Sample CFU = 22	Fig 1b. Outdoor Control Air Sample CFU = 42	Fig 1c. Outdoor Control Air Sample CFU = 42 *Aspergillus niger, Aspergillus flavus, Cladosporium, Epicoccum, Candida sp.*
		
Fig 2a. Maths Lab Air Sample Air Sample CFU = 1	Fig 2b. Maths Lab Air Sample Air Sample CFU = 6	Fig 2c. Maths Lab Air Sample Air Sample CFU = 6 *Microsporum sp., Trichophyton, Chrysosporium, Candida sp.*

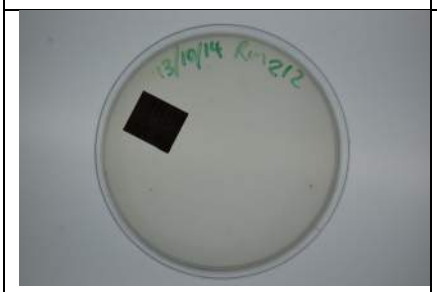
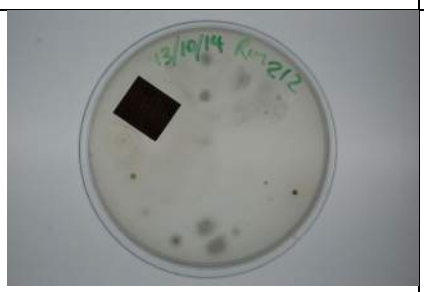

	

Fig 3a. Room 212 Air Sample CFU = 2	Fig 3b. Room 212 Air Sample CFU = 23	Fig 3c. Room 212 Air Sample CFU = 21 *Microsporum sp., Trichophyton, Chrysosporium, Candida sp.*

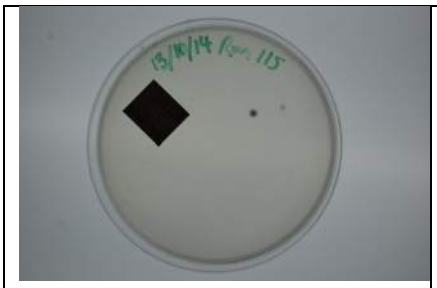
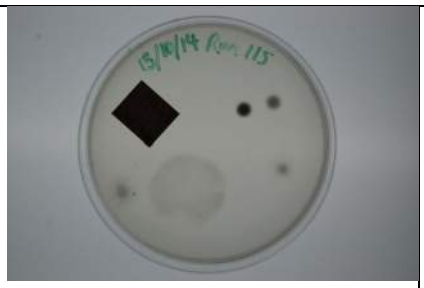
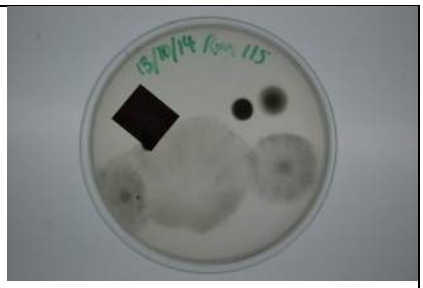
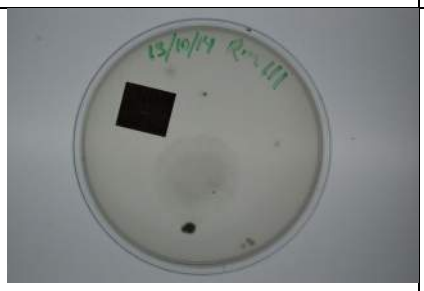
		

Fig 4a. Room 115 Air Sample CFU = 3	Fig 4b. Room 115 Air Sample CFU = 7	*Fig 4c. Room 115* *Air Sample* *CFU = 7* *Aspergillus flavus, Cladosporium, Chaetomium*
		
Fig 4a. Room 111 Air Sample CFU = 6	Fig 4b. Room 111 Air Sample CFU = 10	Fig 4c. Room 111 Air Sample CFU = 12 *Aspergillus tereus, Aspergillus fumigatus, Candida sp., Microsporum sp., Trichophyton sp.*

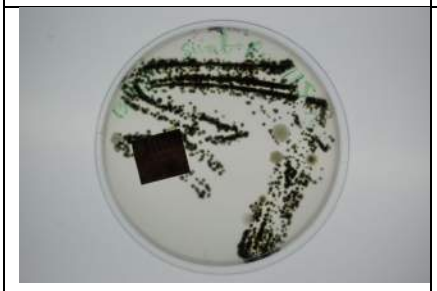
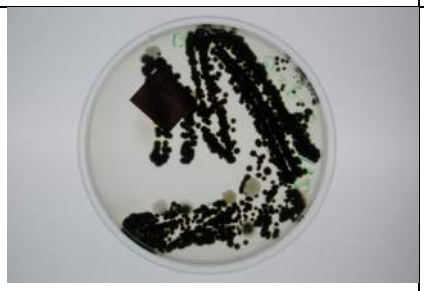
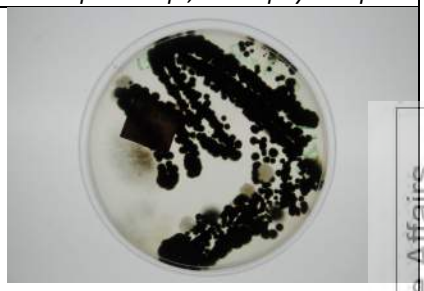

		

Fig 4a. Room 115 Swab from A/C Swab Sample CFU = >200	Fig 4b. Room 115 Swab from A/C Swab Sample CFU = >250	Fig 4c. Room 115 Swab from A/C Swab Sample CFU = >300 *Phaeoacremonium, Cladosporium, Bipolaris, Aspergillus tereus, Alternaria, Candid sp.*

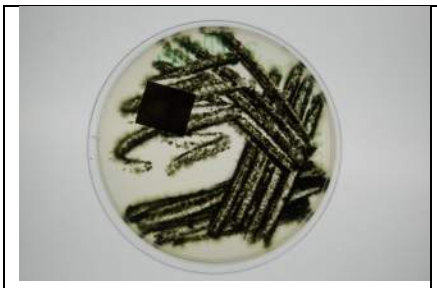


Fig 4a. Room 115 Swab from Wall Swab Sample CFU = >300	Fig 4b. Room 115 Swab from Wall Swab Sample CFU = >300	Fig 4c. Room 115 Swab from Wall Swab Sample CFU = >300 *Aspergillus flavus, Phialemonium, Phaeoacremonium*

Table 13.1. The air outside was compared to the air inside and several swabs were also taken of typical surfaces. This shows that the air inside the RPC1 The School Building is clean and the numbers of culturable fungi indoors is less than outdoors. The interior wall swab (Classroom 115) and that taken from the airconditioning unit (also from Rm 115) demonstrate that these two surfaces, and presumably others like it in the School are heavily contaminated with mould and spores at extremely high concentrations. Colonies were identified to Genus and or Species for each plate at Day 5 for fungi that grew on PDA media.

s. 33(a)(iii), s. 47C(1)

s. 33(a)(iii), s. 47C(1)

[redacted]

s. 33(a)(iii), s. 47C(1)

[redacted]

15. Mould Damage Classification System

The *Australian Mould Guideline* provides a guide for persons to help them judge whether they are competent in managing the full extent of the remediation job. The following seven building classifications covers different types of mould damage. I quote directly from the Guideline below:

GRADE 1 – NORMAL

7.1 This is considered the normal situation in most houses and buildings without mould damage. Mould may still be present indoors in these situations and concentrations will be below outdoor levels and all species detected indoors should closely reflect those occurring outdoors. No indoor sources oif mould should be present. Grade 1 situations can be entered using Level 1 PPE.

GRADE 2 – VISIBLE MOULD GROWTH TO LESS THAN 1M^2

7.2.1 VISIBLE MOULD GROWTH

This grade of mould damage refers to the initial inspection and sample taking process and to very small areas of visible mould growth that can be effectively cleaned using relatively simple methods. In particular this refers to either small areas of visible mould growth less than 1m2 in area, or if the conditions normally experienced during an initial site assessment on small jobs when taking samples or drilling inspection holes for borescopes etc.

7.2.2 PPE

Grade 2 situations should only be entered using Level 2 PPE. Containment of the entire work area should not be necessary. The work area should not be occupied during inspections, cleaning or removal of contents or materials. It should not be necessary to evacuate people in adjacent areas except those with prescribed illness as listed in Section 2.

7.2.3 CONTAINMENT

Local areas for mould cleaning or removal generally do not require containment but where required they can be contained within a plastic (poly) containment barrier.

7.2.4 REMEDIATION

Remediation can be performed by normal building maintenance personnel that have been trained in Mould Hazard Awareness, PPE, and effective methods for cleaning mould. The entrance and exit locations used by the remediation/cleaning personnel should be cleaned with a HEPA vacuum cleaner and damp wiped with a cloth and vinegar solution. All areas should be left dry and free from visible mold contamination and debris. No final mould clearance testing would normally be necessary.

GRADE 3 – VISIBLE MOULD GROWTH TO FROM 1M^2 TO 10M^2

7.3.1 VISIBLE MOULD GROWTH

This grade of mould damage concerns an indoor environment that has sustained serious mould damage over a period of time. The visible mould growth would be clearly visible on less than 25% of all surfaces or not greater than 10m^2.

7.3.2 PPE

Grade 3 situations should only be performed using Level 3 PPE. The work area should not be occupied during cleaning, removal of contents or materials or during inspections. It should not be necessary to evacuate people in adjacent areas except those with prescribed illness as listed in Section 2.

7.3.3 CONTAINMENT

Containment of the entire work area from floor to ceiling should be performed before mediation commences. This will include covering the work area with plastic sheeting (poly) and sealing the edges with tape or other method to contain dust and remediation debris. All building air vents should also be covered. Dust suppression methods should be applied to any material before it is disturbed. Negative pressure should be applied to the contained area. The waste should be carefully collected and wrapped and sealed in plastic and disposed of off-site.

7.3.4 REMEDIATION

Remediation can be performed by building maintenance personnel that have been trained in Mould Hazard Awareness, PPE, and effective methods for cleaning mould and remediating building materials. The entrance and exit locations used by the remediation/cleaning personnel should be cleaned with a HEPA vacuum cleaner and damp wiped with a cloth and vinegar solution. All areas should be left dry and free from visible mould contamination and debris. Final mould clearance sampling is highly recommended and should include several air and surface samples. Occupants should be cautioned not to return to the remediated area until after mycological analysis has determined that target species have been controlled or eliminated.

GRADE 4 – VISIBLE MOULD GROWTH GREATER THAN 10M^2

7.4.1 VISIBLE MOULD GROWTH

This grade of mould damage concerns an indoor environment that has sustained severe mould damage that has affected the structural integrity of building materials such as wall and ceiling linings. Visible mould growth occurs on greater than 25% or more than 10m2 of interior surfaces. Structural materials most likely have high moisture contents and will require specific drying.

7.4.2 PPE

Grade 4 situations should only be performed using Level 4 PPE. The work area should be clearly marked with a sign stating “Biohazard Do Not Enter” during the entire remediation period. A list of remediation works and a completion schedule should be posted near the Biohazard sign. Hazard communication measures listed in Section 2 should be made available to all people in adjacent areas.

7.4.3 CONTAINMENT

Containment of the entire work area should be performed before remediation commences. This will include covering the work area from floor to ceiling with heavy grade plastic (poly) sheeting and sealing the edges with tape or other method to contain dust and remediation debris. HVAC, ventilation and exhaust ducts should be sealed with plastic and the edges taped to prevent mediation dust from further contaminating them.

The work area should be placed under negative pressure by the use of an exhaust fan with a HEPA filter. The negative air should be exhausted to the outside in a way that will not cause cross contamination to adjacent areas. Air scrubbers can be used as an area dust and spore suppression method. The entrance to the work area should be controlled through an air lock and decontamination room. These can be constructed from plastic sheeting over a demountable frame. Al edges should be sealed with tape.

The work area should not be occupied during cleaning, removal of contents or materials or during inspections. It may be necessary to evacuate people in adjacent areas especially those with prescribed illness as listed in Section 2.

7.4.4 REMEDIATION

Any materials or contents that cannot be cleaned should be removed by wrapping in plastic bags. The outside of the plastic bags should be HEPA vacuum cleaned in the decontamination chamber before transporting through

uncontaminated areas for disposing off-site in normal rubbish disposal. Dust suppression methods should be applied to any material before it is disturbed. Remediation should be performed by personnel that have been trained in handling hazardous materials. The remediation area and the air lock and decontamination chamber and their immediate surrounds should be left dry and free from visible mould contamination and debris.
Extensive air and surface monitoring should be conducted in the remediated area after mycological analysis has determined that the area is fit to re-occupy.

GRADE 5 – STRONG INDICATION OF MOULD BUT NO VISIBLE EVIDENCE

7.5 This grade of mould damage might be characterized by any of the following situations:

1. Complaints of ill health symptoms with no visible growth
2. Complaints of obnoxious mouldy odours with no visible growth
3. Signs of structural weakness such as visible destruction to timber or dry rot
4. Evidence of previous moisture damage that was dried but there are complaints of odours or symptoms but no visible growth
5. Other consultants have measured high concentrations of parameters such as MVOCs (microbial volatile organic compounds) or VOCs (volatile organic compounds) without any obvious source.

The source for symptoms in this situation needs to be thoroughly investigated.

7.5.1 PPE

The level of PPE required to enter a Grade 5 situation for investigation will vary according to the situation at hand.

- Level 2 PPE should be used where there is little evidence of widespread damage and no ill health complaints.
- Level 3 PPE should be used where there have been some ill health symptoms reported by individuals, or mouldy odours etc exist.
- Level 4 PPE should be used if there have been serious symptoms or strong odours reported or where the investigator is to remain in the building for more than 30 minutes.

7.5.2 CONTAINMENT

The work area should not be occupied during inspections. It may be necessary to warn people in adjacent areas of the potential hazards especially those with prescribed illness as listed in Section 2.

7.5.3 REMEDIATION

No remediation should proceed until the building has been thoroughly assessed by a qualified mould inspector or IAQ assessor.

GRADE 6 – CROSS CONTAMINATION

7.6 This grade of mould damage concerns an indoor environment that was Grade 1, but has been contaminated by spores and dust that originated from a Grade 2, 3 or 4 situation. This can occur where remediation has been performed to adjacent areas and the containment procedures have not been followed, or where containment barriers have failed.

This may include small areas of visible mould (colonies less than 1mm diameter) that have occurred from the recent settling of spores, which have encountered sufficient moisture to begin growth.

This situation can only be returned to Grade 1 if the cross contamination is dealt with in a timely manner. If this situation is left for a period greater than 48 hours, or when widespread visible mould growth occurs, then the remediation works will need to be conducted as either Grade 2, 3 or 4 depending on the extent of the damage.

7.6.1 PPE

Grade 6 situations should only be remediated according to the level of contamination:

- Level 2 PPE should be used where there is minor evidence such as low concentrations of target species detected on surface or in airborne samples.
- Level 3 PPE should be used if there is moderate or high evidence such as high levels of target species from the adjacent remediation area in surface and/or airborne samples.

The work area should not be occupied during remediation. IN cases of high evidence of cross contamination, it may be necessary to warn or evacuate people in adjacent areas due to potential hazards, especially those with prescribed illness as listed in Section 2.

7.6.2 CONTAINMENT

Large areas with high concentrations of target species should be sealed with plastic and taped at the edges to prevent further cross contamination during cleaning. All cleaning should be thorough and meticulous with a high efficiency vacuum cleaner with a HEPA filter and a damp cloth and vinegar solution.

7.6.3 REMEDIATION

Remediation should be a thorough and meticulous cleaning with a high efficiency vacuum cleaner with a HEPA filter and a damp cloth and vinegar solution on all surfaces to remove settled spores and dust.

The entrance and exit locations used by the remediation/cleaning personnel should be thoroughly and meticulaously cleaned with a high efficiency vacuum cleaner with a HEPA filter and a damp cloth and vinegar solution.

GRADE 7 – CLEAN ROOM

7.7 This grade of mould damage is for absolute sterilized clean room environments such as those used in pharmaceuticals and computer component manufacture. Only highly qualified and experienced engineers and IAQ experts should be consulted in these situations. Protocols for handling Grade 4 remediation work should be followed.

SECTION 2 HAZARD CLASSIFICATION:

It is highly recommended that the people who fit into one of the following health categories should be advised to temporarily relocate during the cleaning and/or remediation:

1. Infants and children less than 2 years old
2. People with compromised immune systems
3. People with chronic inflammatory lung disease such as:
   a. Asthma
   b. Hypersensitivity pneumonitis, and
   c. Severe allergies
4. People recovering from recent surgery.

PPE CLASSIFICATION SYSTEM

This classification system details the personal protection equipment (PPE) required to minimize exposure to fungal spores and/or fungal gaseous by-products during inspection and remediation works.

The person performing an inspection or in charge of remediation works should use their judgement and increase their level of PPE to suit the conditions at hand.

The respiratory protection shall be selected according to "AS/NZ 1715:2009 Selection, use and maintenance of respiratory protective equipment".

8.1 PPE LEVEL 1

A respirator should not be required. NO protective clothing should be required. Level 1 PPE is intended for initial inspections or sampling routines in Grade 1 buildings where there is

- No visible mould growth;
- No health complaints;
- No mould odours;
- No cross contamination; and
- No known or obvious moisture damage

8.2 PPE LEVEL 2

Level 2 PPE is intended for initial inspections or sampling routines where mould growth is suspected due to known water damage or limited visible growth. There should be no serious health complaints related to mould or time spent in the building. A minimum of a P2 dust mask or a half face respirator mask with disposable HEPA filters is recommended for extended periods. Where there are strong or obnoxious odours, then an activated carbon or organic vapour filter should be used in addition to the HEPA filter. NO protective clothing such as overalls should be required. Respiratory and gloves should be taken off outdoors.

8.3 PPE LEVEL 3

Level 3 PPE is for small fungal contamination that relates to Grade 3 mould damage. The objective of this level of PPE is to limit exposure to fungal spores and gaseous by-products. A P2 dust mask or a half face respirator with HEPA filters and splash goggles should be worn at all times. Where there are strong or obnoxious odours, then a full face respirator should be used with an activated carbon or organic vapour filter in addition to the HEPA filter. PPE should include disposable overalls and gloves.

8.4 PPE LEVEL 4

Level 4 PPE is for a maximum of 2hrs exposure to a large area of fungal contamination that relates to Grade 4 mould damage. Level 4 should eliminate exposure to fungal spores and gaseous by-products. PPE should include disposable overalls, gloves and shoe protectors. All joins at ankles and wrists where gloves and shoe protectors meet the disposable overalls should be sealed with tape. Full face respirator with HEPA filtration with an activated carbon or organic vapour filter should be used at all times.

16. Recommendations & Scope of Works

Transfield Services aims to provide a standard and range of maintenance services to manage, maintain and ensure assets fulfill their intended purpose and design life that is the best available under the unique circumstances at Nauru. To this end, the following recommendations have been developed in response to the data presented and analyzed in this baseline survey of fungal, bacterial and yeast-contaminants. It is anticipated that Transfield Services will be able to begin implementing many of these recommendations. This will no doubt strengthen and improve on existing plans for maintenance management, cleaning services, work health and safety, environmental management, use of hazardous substances, and health and food safety. It is anticipated that these recommendations will also be used to identify assets that may need to be disposed of, written-off or replaced with new. Therefore, the following recommendations are presented as a practical guide for cleaning and maintenance of infrastructure. These recommendations acknowledge that mould cannot be eliminated but that microbiological risks can nevertheless be minimized.

1. Reducing human exposure risks from fungi and other bioaerosols or surface biofilms will be achieved using a combination of universal precautions, engineering controls and changes to work practices. This will involve a degree of education and consultation with different groups to discuss the aerobiology risks that have been identified at Nauru. Although the climate is hot and humid, the need for common access and careful use of PPE when working in mould-contaminated environments, especially for personnel who will be involved with cleanup is considered mandatory.

s. 33(a)(iii), s. 47C(1)

2. The overarching 3-way aim of this task for the tents will be to clean then disinfect or surface sterilize then apply a biological and/or chemical retardant or biofilm inhibitor. Cleaning may be achieved using an enzyme-based cleaner, followed by an approved disinfectant. Correct use of dwell times and suitability for use at high ambient temperatures and humidity must be confirmed by lab scale or small-scale pilot testing before more widespread deployment. Sufficient barrier containment works will need to be applied at any stage of decontamination to prevent cross contamination.

3. A documented remediation action plan (RAP) will need to be developed for all 13 and more areas explicitly or representatively covered in this report. The RAP must include a way to address the moisture conditions that caused the mould to grow in the first place, include a complete and systematic approach to cleaning each area and provide a practical methodology to remove mould-contaminated materials from the site. It is envisioned that the initial RAP will be broad in scope but include several key milestones including several 'proof-of-concept' work plans and may be defined through work plans, scope of task, project specifications, type of specifications, remediation roles and risk communication. This will include development of safe work method statements and job safety analysis. Transfield existing SOP's should be reviewed and improved on as appropriate.

4. Suitable personnel at Nauru (or on rotation) will need to be trained; possibly remotely on methods to quantitatively evaluate bioaerosols and send materials back to Australia for analysis or self-monitor on-site. Such persons may also be responsible for liaising with BHS for the sharing of decontamination results.

5. s. 33(a)(iii), s. 47C(1)

6. It is recommended that any area that will be remediated (i.e. cleaned and disinfected or better) of mould be unoccupied during such works.

7. Persons who fit into any of the categories of the 'Section 2 Hazard Classification' should be temporarily relocated during cleaning/remediation. In addition it would be prudent to remove pregnant women during any form of remediation and before from foreseeably contaminated environments. Failing to inform or evacuate persons with these conditions may lead to a serious breach of duty of care.

8. A biohazard communication strategy will need to be developed. This will provide a mechanism to inform occupants, advise stakeholders and describe proposed works with explanations along with a schedule for completion.

9. On the way towards developing and implementing a RAP, it will be necessary to reduce the risks through containment. The aim here is to use any method to minimize the aerosolization of mould or spores and minimize their dispersal as mould or particulates into the surrounding areas. Containment strategies include:

- Limiting access to contaminated or potentially contaminated areas
- Only doing remediation tasks that are considered to limit aerosolisation and spore disruption
- Isolating the problem through the use of plastic barriers, tape and drop sheets on floors.
- Maintain ventilation control by closing windows, locking doors, switching off fans or air conditioners and sealing any entry points for ventilation that could bring in or allow exit of moulds or spores to adjacent areas
- Implement dust and Particulate Matter suppression using HEPA (high efficiency particulate air) in all affected areas
- Use of negative pressure to exit contaminated air outside
- Implement "limited" or "full containment" as required using single or double layers of 6mm polyethylene sheeting affixed with duct tape around the affected area.
- Consider the potential of encapsulation where removal may not be feasible.

10. Broadly, decontamination methods involve: (i) physical work (including containment and structural remediation), (ii) chemical work (iii) radiation effects and (iv) containment methods that impact on the population dynamics of microbial communities. In all cases, the aim is to remove the primary or secondary moisture source, remove affected building materials and then deal with the airborne and surface pathogen risk. Removal of the primary moisture source at Nauru is not possible, since the ambient temperature, humidity, dew point and precipitation is a feature of the local environment. Therefore, the broad aim will be to minimize moisture retention on and in building materials and then develop and implement practical methods to disinfect, sanitize or sterilize a range of surfaces and room volumes.

Cleaning strategies are based on the types of materials present. The following list (a-n) reviews the main methods that will need to be considered for implementation at Nauru:

(a) Air Cleaning Technologies. HEPA air filtering in combination with germicidal irradiation (UVGI).

Example References:

- Health Quality Ontario. (2005). Air cleaning technologies: an evidence-based analysis. *Ont Health Technol Assess Ser*. 5(17): 1-52.
- Boyce, J.M., Havill, N.L. & Moore, B.A. (2011). Terminal decontamination of patient rooms using an automated mobile UV light unit. *Infect Control Hospi Epidemiol*. 32(8): 737-742.

- Wright, L.S. and Phipatanakul, W. (2014). Environmental remediation in the treatment of allergy and asthma: Latest updates. *Curr Alergy Asthma Rep*. 14(3): 1-15
- Du, L., Batterman, S., Parker, E., Godwin, C., Chin, J.Y., O'Toole, A., Robins, T., Brakefield-Caldwell, W. and Lewis, T. (2011). Particle concentrations and effectiveness of free-standing air filters in bedrooms of children with asthma in Detroit, Michigan. *Build Environm* 46(11): 2303-2313.

(b) Chlorine Dioxide Gas.

Example Reference:

- Hsu, C.S. & Huang, D.J. (2013). Disinfection efficiency of chlorine dioxide gas in student cafeterias in Taiwan. *J Air Waste Manage Assoc*. 63(7): 796-805.

(c) Hydrogen Peroxide vapour/aspiration.

Example References:

- Doan, L., Forrest, H., Fakis, A., Craig, J., Claxon, L. & Khare, M. (2012). Clinical and cost effectiveness of eight disinfection methods for terminal disinfection of hospital isolation rooms contaminated with Clostridium difficile 027. *J Hosp Infect*. 82(2): 114-121.
- Kaspari, O., Lemmer, K., Becker, S., Lochau, P., Howaldt, S., Nattermann, H. and Grunow. (2014). Decontamination of a BSL3 laboratory by hydrogen peroxide fumigation using three different surrogates for *Bacillus anthracis* spores. *J. Appl. Microbiol*. 117(4): 1095-1103.
- Rastogi, V.K., Wallace, L., Smith, L.S., Ryan, S.P. and Martin, B. (2009). Quantitative method to determine sporicidal decontamination of building surfaces by gaseous fumigants, and issues related to laboratory-scale studies. *Appl. Environ Microbiol*. 75(11): 3688-3694.

(d) Other Aerosolized Disinfectants/Decontaminants.

Example References:

- Thorn, R.M.S., Robinson, G.M. and Reynolds, D.M. (2013). Comparative antimicrobvail activities of aerosolized sodium hypochlorite, chlorine dioxide, and electrochemically activated solutions evaluated using a novel standardized assay. *Antimicrob Agents Chemother*. 57(5): 2216-2225.
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Example References:

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(j) Pressure Wash-Based Removal

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Example References:

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Example References:

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- s. 47(1)(b) [redacted]

11. Under a strict reading of the *Australian Mould Guideline* (2010), all tents on RPC2 and RPC3 should be discarded and replaced with new. In the event this is not possible, then all tents or buildings on RPC2 or 3 that show either visible mould or present with mould odour should be cleaned and remediated using the classification framework given in table 14.1. Exposed wooden flooring on RPC2 or RPC3 should be treated using a disinfectant spray.

12. All persons should be removed from tent-based accommodation and restricted from entering tents on RPC2 and RPC3. All tents appeared to show greater than 10m^2 of visible mould (inside and outside) covering walls and ceilings and the external roof. Representative tents on RPC2 and RPC3 were examined and found to be categorized as GRADE 4 buildings.

13. If it is not possible to remove persons from tent accommodation, then harm minimization must include the use of chemical and engineering controls. Chemical controls refer to any method of controlling microbial growth using a sanitizer, disinfectant or sterilant. Engineering controls include the use but are not limited to: introduction of air conditioning into all tents on RPC2 and RPC3, installation of hard-wired HEPA (high efficiency particulate air) purifiers, installation of well-designed and installed (i.e fully baffled) ultraviolet germicidal tubes across the ceilings of each tent to provide at least upper airspace air disinfection to a limited extent. It is known that HEPA air filters can reduce particulate matter concentrations by an average of 69-80% (Du et al., 2011). It is anticipated that at least two industrial-sized air filters would be required per tent. It is also likely that in the short-term these units may need to be portable, since they are only realistically suitable to use during the day due to noise. The aim is to remove a percentage of the particulate matter to reduce contact with persons. The benefits of HEPA in reducing the risks from allergy and asthma induced by moulds and other particulates have recently been reviewed (Wright and Phipatanakul, 2014).

14. Dermal and inhalation contact with the internal or external walls and floor are likely. Therefore, all tents should be fitted with containers of antibacterial hand-gel or similar that does not require water for use as a hand disinfectant. Appropriate signage should be displayed. Containers should be placed at both ends of the tents.

15. A cold foam sterilant or pH-adjusted bleach or enzyme cleaner should be used to treat all tent surfaces before encapsulation with s. 47(1)(b)

16. An s. 47(1)(b) mould retardant paint should be applied to the external surface of a test tent and depending on interaction with the high humidity environment should then be applied to all tents inside and out. BHS is actively developing this capability and a bench-scale project should be actioned to develop this for pilot-scale deployment.

17. All portable buildings on RPC1 that show either visible mould or present with mould odour should be remediated using the classification framework given in table 14.1.

18. Painted walls and fridge/freezer doors on RPC1 should be media blasted after primary disinfection and only with suitable containment, negative pressure and HEPA air extraction to remove mouldy paint and get the material back to a non-contaminated surface, prior to application of s. 47(1)(b) paint.

19. All portable building units or accommodation areas on RPC1 that as part of monitoring are shown or are known to have visible moulds or mould-odours should be treated with hydrogen peroxide vapour and/or ozone. Each room volume should also be decontaminated using portable UVGI units. BHS has all equipment to do this, and a pilot-scale decontamination of several offices/accommodation units should be actioned. It should be understood that the aim of this decontamination will be to kill and neutralize surface-bound mould. Mould that may be growing behind walls and behind surface plastic materials on internal walls is not going to be reachable by the decontaminant agent. The aim will be to disinfect and or sterilize internal room volumes to at least minimize the pathogen-transfer risk when the rooms are in use.

20. Tests should be performed in multiple-test-chambers to simulate the tent and mould growth and then test methods to decontaminate. These test chambers should be situated at the BHS lab in Melbourne. This is a secure P2 microbiology lab. Protocols will generally follow: Buttner, M.P. & Stetzenbach, L.D. (1993). Monitoring airborne fungal spores in an experimental indoor environment to evaluate sampling methods and the effects of human activity on air sampling. *Applied and Environmental Microbiology*. **59**(1): 219-226.

21. While it is tempting to consider the use of dry ice or similar (media blasting) to

remove the mould on the exterior tent surfaces. There is significant industry-caution regarding this practice since the aggressive disturbance of mould through blasting agitation will cause higher airborne mould concentrations compared with manual removal methods. However, some research into the practicality of media blasting of mould on tents at Nauru could be warranted, but the known caveats and hazards as detailed in Appendix C of the Environmental Abatement Coucil of Ontario's (EACO) Mould Abatement Guidelines (2010) should be followed (URL: www.eacoontario.com/pdf/2010/eaco_mould-abatement-guidelines_book.pdf)

22. All the fungi isolated as part of this microbiological survey are currently in fridge storage at the BHS lab and should be further streaked to obtain as many wild-type isolates as possible. It is notable that this is to our knowledge the first culture collection of viable environmental fungi from Nauru. The only other published report is for plant-associated fungi reported on in 2014 but based on collection in 1980 (McKenzie, 2014). Depending on what Transfield Services decides, it would be preferred if this culture collection were transferred to liquid nitrogen storage and formally defined as the Nauru culture collection. If this is not done, then cultures will be autoclaved.

23. An environmental field lab should to be set up on Nauru for the purpose of "Aerobiology Monitoring and Environmental Health". At minimum this needs a full-time dedicated staff member having at minimum environmental health or similar qualifications. s. 47F(1) would be suitable for this role. Equipment should include but is not limited to a portable ATP tester, sampling pumps and media for taking air and surface samples. It is likely that all samples will be sent to BHS for analysis, excepting for analysis of ATP that can be done on-site. A weather station should also be set up on RPC1, RPC2 and RPC3 to data-log temperature, wind speed, rainfall, UV index, dew point, humidity, solar radiation and barometric pressure. This information should be collected as part of standard environmental monitoring of this facility considering the unavoidable limitations from environmental circumstances of Nauru.

24. A commercial rapid-test swab kit for fungi should be purchased and validated against the culture collection at the BHS labs before being deployed by Transfield Staff for periodic self-monitoring of fungal-cleaning at Nauru.

25. Mechanical air conditioning should be installed into all tents on RPC1 and RPC2. This should assist with maintenance of indoor humidity levels and reducing these to be well-less than <65%. In the event that this is not feasible then all tents should be provided with ceiling-mounted fans. The results comparing RPC2 – Main Admin Tent (air conditioned) with RPC2 – Tent #18 (ceiling-mounted fans) versus the RPC2 – Tent #37-40 (no ceiling mounted fans, at best small portable fans) showed that there were was a clear and significant increase in internal surface mould on tent fabric in moving from mechanical air conditioning towards little to no mechanical air

movement inside tents.

26. Relative humidity in occupied spaces should be controlled to less than 65% to reduce the likelihood of conditions that can lead to microbial growth. (ASHRAE Standard 55-2013 – Thermal Environmental Conditions for Human Occupancy). This should be achievable in portable/modular housing on RPC1 but may not be possible for tent accommodation. Nevertheless the lack of indoor mould seen in the Admin Tent on RPC2 that is airconditioned, suggests that the mould issues seen inside other tents could be manipulated by controlling relative humidity and temperature using air conditioning.

27. Internal window mould in living quarters on RPC1 should be cleaned using a chemical wipe such as acidified bleach (pH-adjusted) and persons should be educated on self-cleaning of wall mounted inverter units. This may take the form of liaison with the on-site AC personnel at Nauru to develop a method/s to assist with manual cleaning of inverter units as part of routine maintenance and personal vigilance of personal living or workspaces.

28. The mould-contaminated wall in the Mess Hall Washing up area should be dismantled and a new wall constructed that is made from impervious material. It would be prudent to construct a steel frame and minimize the use of wood paneling. The wooden front section facing into the Mess hall where personnel come to drop off used plates/cutlery should also be removed and re-built from impervious materials that are resistant to moisture. The washing up room should also be fitted with a baffled UVGI fitting that should be motion activated to germicidally illuminate when persons exit the room. This UVGI approach may also be suitable for in-office decontamination prior to wall-degradation in for example the PsyCare offices.

29. The mould on some of the walls in the PsyCare offices needs to be cut out or encapsulated. There is likely to be a long-term condensation problem with these portables that is allowing the internal wood wall to become damp from thermal condensation transfer inside the wall that leads to mould growth inside the wall. Odour control and disinfection should be easily possible from the use of ozone and/or vaporous hydrogen peroxide, but the problem of the wall construction and its use in such tropical conditions is likely to be a long-term problem. There may be some utility in looking at aerogel polymer coatings for the internal walls to drastically reduce thermal temperature contact transfer. It is not likely to be possible to remediate any portable or modular office or building that already has mould growing within walls or roof voids. The best that can be hoped to achieve is wall or ceiling surface disinfection to minimize person-surface contact with contaminants.

30. Toilets and shower areas on RPC2 and RPC3 would benefit from routine steam disinfection using a portable steam generator/cleaner that is implemented as part of

an improved cleaning regime. Media blasting with for example CO_2 may have some potential after primary cleaning and disinfection to maintain shower wall and floor surfaces quickly and efficiently.

31. While works are occurring in tents on RPC1 and RPC2 sections of the camp may need to be contained with physical containment barriers to prevent unauthorized entry until tents-works are complete.

32. No contents testing (porous personal belongings) was performed as part of this survey, so until this is performed I cannot comment on the current level of contamination or what steps may be required to ensure safe use of personal possessions by Transferees. An investigation into techniques for cleaning mould contaminated personal contents has found however that bleach/detergent washing was more effective overall at reducing spore or mycotoxin levels compared with other approaches (Wilson et al., 2004).

33. Wet carpet was not observed at Nauru during this inspection. However, it is possible that carpet may be in use in some locations and could potentially become wet and mould-contaminated. If this occurs, recent research shows that steam vapour is superior to detergent-hot water or high-flow hot-water extraction (Ong et al., 2014).

34. Further microbiological and air quality surveys must be performed during and after any decontamination works as part of validation and ongoing aerobiological monitoring.

35. No re-occupation of decontaminated buildings should occur until post clearance validation is provided.

36. Safe work methods will need to be developed for removal of hazardous mould affected building materials and all contractors will need to follow methods for safe handling of contaminated materials in line with the Australian Mould Guideline for mould decontamination.

37. s. 47(1)(b) [redacted]

38. A Research Project #2 with BHS should develop a properly maintained culture collection of already collected fungi, bacteria and yeasts (including black yeasts) for R&D and validation. This is also of particular importance in developing suitable

strategies for control since such thermotolerant (heat-loving) fungi are likely to produce unusual enzymes that may interfere with predicted disinfection targets (De Oliveira et al., 2015; Ahearn and Stulting, 2014).

Table 16.1 on the next page provides a graphical summary of the 38 recommendations focusing on what should be done inside and outside the different buildings.

Location	Treatment - Inside	Treatment - Outside
RPC2 – Main Admin Area Tent	• Monitoring	• Monitoring • pH-adjusted bleach wash • Application of s. 47(1)(b)
RPC2 – Sample Tent #18	• Monitoring • Air-conditioning • pH-adjusted bleach wash • application of s. 47(1)(b) • Baffled ceiling UVGI • HEPA air scrubbing	• Monitoring • pH-adjusted bleach wash • Application of s. 47(1)(b)
RPC3 – Sample Tent #37	• Monitoring • Air-conditioning + fans • pH-adjusted bleach wash • application of s. 47(1)(b) • Baffled ceiling UVGI • HEPA air scrubbing	• Monitoring • pH-adjusted bleach wash • Application of s. 47(1)(b)
RPC3 – Tent #39	• Monitoring • Air-conditioning + fans • pH-adjusted bleach wash • application of s. 47(1)(b) • Baffled ceiling UVGI • HEPA air scrubbing	• Monitoring • pH-adjusted bleach wash • Application of s. 47(1)(b)
RPC3 – Tent #40	• Monitoring • Air-conditioning + fans • pH-adjusted bleach wash • application of s. 47(1)(b) • Baffled ceiling UVGI • HEPA air scrubbing	• Monitoring • pH-adjusted bleach wash • Application of s. 47(1)(b)
RPC1 – PsyCare Office #1	• remove and replace mouldy wall sections with new • ozone in room decontamination • VHP in room decontamination • Manually clean AC in bulkhead • Baffled ceiling UVGI	NR
RPC1 – PsyCare Office #2	• remove and replace mouldy wall sections with new • ozone in room decontamination • VHP in room decontamination • Manually clean AC in bulkhead • Baffled ceiling UVGI	NR
RPC1 – Health Centre & Immuinisation/Pathology	• Sealed HEPA vacuum (e.g. Sauber Powerprof)	
RPC1 – Mess Hall	• Monitoring	NR

	• Remove and replace wall and counter adjacent to servery in washing up area with new impervious material • Apply antifungal disinfectant to ceiling areas showing mould • Install HEPA air filtration • Manually clean inverter air filters and fins	
RPC1 – Cold Storage	• Clean, disinfect, encapsulate walls • Apply Zinsser sealer/or similar undercoat after dry ice or similar media blasting of cold storage front walls. Note that entire corridor must be contained before dry ice blasting • Baffled UVGI	NA
RPC1 – A Building Room 103	• Monitoring • Ozone • VHP • pH-bleach wipes or other hospital grade disinfectant wipes (e.g Oxivir Tb) • self-cleaning of external AC fins • odorcide (e.g. Microban, hydroxyl generators, Odorox Boss XLS + Sahara E Turbodryer, masking agents in ductwork such as VapourShark or Vaportek.com)	NR
RPC1 – H Building Room 219	• Monitoring • Ozone • VHP • pH-bleach wipes or other hospital grade disinfectant wipes (e.g Oxivir Tb) • self-cleaning of external AC fins • odorcide (e.g. microban, hydroxyl generators, Odorox Boss XLS + Sahara E Turbodryer, masking agents in ductwork such as VapourShark or Vaportek)	NR
RPC1 - School	• Monitoring	NR

NR = Not required
NA = Not sampled
VHP = vaporous hydrogen peroxide

Table 16.1. Summary of the different treatments that should be considered for the different locations cross-referenced to the data in Table 14.1.

Final Statement

This report has evaluated the potential adverse health impacts from aerobiological contaminants by documenting their occurrence and distribution on tent-style accommodation and other buildings on the Island. Narau itself presents many challenges mainly due to high temperatures, rainfall and elevated humidity that are intrinsic circumstances of Nauru. In turn, Transfield has an ethical duty of care to minimize foreseeable risks to staff and asylum seekers. This study therefore is the first step of this process. Overall, the decontamination tasks at Nauru are challenging, but acting on these recommendations can minimize the risks from airborne and/or surface contact with mould, yeasts and bacteria in a systematic way.

Appendix 1

Many fungi were easily cultured from the air and swab samples. The following is a brief description of some of the key types that were identified from air and swab samples. It should be noted that many workers estimate that viable culture only allows for a small percentage of fungi to grow and that the actual levels of fungi and spores in the tested environment is known to be much higher.

Alternaria sp.
Common soil fungus. Known to cause chronic sinusitis and rare cases of deep infection in the immunocompromised patient.

Aureobasidium
Cosmopolitan and mainly present in temperature climates. Commonly found in humid indoor environments. A cause of keratitis or of cutaneous infection as well as some reports of deep infection of the immunocompromised patient.

Aspergillus flavus
An occasional agent of pulmonary or disseminated infection in immunocompromised individuals. Cases of sinusitis have been reported. Known especially for its mycotoxins and aflatoxin production.

Aspergillus fumigatus
The most frequently isolated organism implicated in aspergillosis in humans. Can cause pulmonary, nasal, ocular, cerebral and other organ infections in immunocompromised persons. Implicated in sinusitis. It is highly thermo tolerant and grows mainly in warm climates.

Aspergillus glaucus complex
Cosmopolitan outdoor fungus known to be allergenic and can cause post-traumatic ocular infection, cerebral abscess, otomycosis and mycetoma.

Aspergillus nidulans
Cosmopolitan isolated primarily from the soil and occasionally a cause of pulmonary and disseminated infection in the immunocompromised patient and known to cause opportunistic mycoses such as sinusitis and otomycosis.

Aspergillus niger
It is a cosmopolitan fungus known to cause aspergilloma and is often isolated in cases of chronic otitis and can cause disseminated infection and
allergic responses.

Aspergillus tereus
This fungus can cause opportunistic infections in persons with compromised immune systems. Some cases of cerebral infection and occasionally isolated from the outer ear canal. Can also cause toenail onychomycosis.

Aspergillus versicolor
Commonplace in temperate climates. Often found in buildings with humidity and ventilation problems. Can cause onychomycosis.

Bipolaris
Cosmopolitan fungus normally found in warm, humid areas. Implicated in sinusitis, keratitis, peritonitis, endocarditis, osteomyelitis and cutaneous infections.

Candida sp.
Common cause of superficial skin and nail infections, vaginitis, and in immunocompromised individuals can cause sepsis and disseminated infection. It is a common inhabitant of the normal skin and mucosa in humans.

Chaetomium
A common soil fungus. Potential for infection in immunocompromised individuals.

Chrysosporium
Very common in soil and occasional reports of skin and nail infections. Can cause disseminated infection of the immunocompromised patient.

Cladosporium
Possible causative agent for skin and nail infections. It has also been implicated in fungal meningitis and can cause sinus and lung infections. IT is a very common contaminant.

Dreschlera
Cosmopolitan and known to cause infection in humans and animals.

Epicoccum
Cosmopolitan isolate from plants, litter and wood. This fungus appears to have been implicated in at least one case of allergic fungal sinusitis. It is one of the most abundant airborne contaminants and is normally insignificant from clinical material.

Exserohilum
Cosmopolitan plant pathogen. Cases of keratitis and sinusitis have been published as well as cases of subcutaneous or deep phaeohyphomycosis.

Fusarium.
Cosmopolitan, isolated form the soil but some strains are plant pathogens. Others produce mycotoxins. A cause of keratitis, endophthalmitis, onychomycosis or mycetoma. Can cause disseminated infection in the immunocompromised patient or peritonitis in the ambulatory dialysis patient.

Gliocadium
Commonly considered to be a contaminant and not known to cause disease.

Microsporum (probably M. Audouinii)
Principally isolated from tinea infection of the scalp and the glabrous skin in prepubescent children.

Mucor
Cosmopolitan and uncommonly an agent of zygomycosis in the severely immunocompromised patient.

Neurospora crassa.
A type of orange to red bread mould. Considered relatively safe for humans and its genome has been completely sequenced.

Penicillium sp.
Not usually pathogenic but produces mycotoxins and known to induce asthma.

Penicillium marneffei.
Sites of infection include the blood, bone marrow, skin, lung, liver, lymph nodes and multiple systemic sites.

Phaeroacremonium.
A plant pathogen mainly from warmer climates. An occasional agent of infection causing subcutaneous phaeohyphomycosis, arthritis, mycetoma, endocarditis and disseminated disease.

Phialemonium
Cosmopolitan and often found in decaying vegetation and soil. Can be an opportunistic infection of the immunocompromised patient, particularly the transplant or dialysis patient. May also be associated with eye infections subsequent to trauma.

Phoma.
Cosmopolitan and isolated frequently from soil. In exceptional circumstances may cause infection in humans and animals.

Rhizopus.
Cosmopolitan and a principal cause of zygomycosis. This is rapidly spreading infection characterized by necrosis of tissues and the production of brain infarcts, infarcts of the lungs and intestines.

Rhodotorula sp.
Most often identified as contaminants. Commonly found in soil, water, and air and on plant matter, infrequently isolated from humans. Or other animals. Known to cause fungemia, often catheter-related, peritonitis, meningitis and endophthalmitis have been reported.

Scedosporium.
Cosmopolitan an occasional agent of infections including mycetoma, cutaneous or subcutaneous invasion, otitis, sinusitis, keratitis, endophthalmitis, pneumonia, endocarditis, meningitis, osteomyelitis, cerebral abscess and disseminated infection.

Sporobolomyces.
A leaf surface inhabitant and mots likely non-pathogenic.

Sporothrix (e.g S. schenckii)
An agent of sporotrichosis which is chronic and subcutaneous or progressive and lymphocutaneous but may also be an opportunistic respiratory or disseminated infective. It can infect humans and animals.

Serratia.
This is a gram-negative facultative anaerobic bacterium. It can cause nosocomial infections and can colonize the respiratory and urinary tract causing pneumonia, meningitis and arthritis.

Trichoderma.
Cosmopolitan and isolated form the soil and of wood. Usually considered non-pathogenic. However, some cases reported for the dialysis patient or those suffering from systemic infections.

Trichophyton.
Many species cause tinea of the scalp, nails and skin of humans.

Ulocladium.
Cosmopolitan and usually considered non-pathogenic.

Unidentified black yeasts

A diverse group of microfungi that appear to have an extremotolerant life style. Some black yeasts are considered the most resistant eukaryotic organisms know to-date. They are opportunistic pathogens and can cause cutaneous or pulmonary colonization as well as proliferation of the dermis and epidermis. Subcutaneous and systemic infections may occur in otherwise healthy individuals. Infections are mostly chronic and require extended antifungal therapy and/or surgery.

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Disclaimer

The author has taken all reasonable steps to perform all on-site inspections and microbial identifications in a scientific, professional and thorough manner. The results and recommendations are presented as found. The author takes no responsibility for the use or misuse of this information. This report and recommendations is copyrighted and confidential and use of this report only transfers to the client on full and final payment of our invoice.
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MOULD & MOISTURE INVESTIGATION REPORT

OPC1 Topside Nauru

Canstruct

Project No.1915

August 2015

- Indoor Air Quality Assessments & Investigation -

- Mould Investigation -

- HVAC Hygiene Audits -

- Project Review / Consulting -

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MOISTURE & MOULD INVESTIGATION REPORT

OPC1 Topside Nauru

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MOISTURE & MOULD INVESTIGATION REPORT

OPC1 Topside Nauru

INTRODUCTION

The Offshore Processing Centre 1 (OPC1) Topside is the infrastructure site that comprises various accommodation and other operational and support buildings for the Australian Department of Immigration and Border Protection (DIBP) on Nauru. The buildings are modular design and vary in construction design depending on the original manufacturer.

Since 2013, due to the fire, many of the buildings have been replaced. Over the past few years, mould and moisture issues have been reported in a number of the modular buildings. This report provides the findings of the onsite investigation conducted in May 2015 into these issues by s. 47F(1) Principal Consultant – Eronmor. This report also includes preliminary advice and recommendations for the remediation of the buildings and for ongoing management of the moisture and mould issues.

BACKGROUND

Due to ongoing mould and moisture issues in the buildings located at OPC1 Topside, s. 47F(1) was engaged to provide moisture and mould investigation of the affected buildings and to provide advice on the causes, extent of damage and contamination as well as propose required rectification works.

As part of the investigation, various buildings on the site were inspected between the 30 h of April and 2nd of May 2015. s. 47F(1) was accompanied by appointed Canstruct representative, s. 47F(1) from OTOC who has been working on developing solutions to the ongoing issues for some time leading up to the site visit.

Climatic Region of Nauru

Nauru is an island in the southwestern Pacific Ocean, 42 kilometers south of the Equator. Nauru's climate is hot and very humid year-round because of its proximity to the equator and the ocean. Nauru experiences monsoon rains between November and February. The temperature on Nauru ranges between 26 and 35°C during the day and between 22 and 34°C at night. Nauru has an annual average rainfall 2,080mm. The highly humid climate presents many challenges for humidity control and mould prevention in buildings on the island.

Moisture & Mould in Buildings

For mould contamination to occur in buildings, there needs to be the presence of mould spores (which are everywhere), a surface to grow on and sufficient moisture. Given the tropical climate of Nauru, moisture is in abundance and mould contamination within buildings can be difficult to prevent and control.

Mould by nature is destructive and can cause significant damage to building materials and structures. Further to this, when at high enough concerntrations, many of the mould species found growing in damp or water damaged buildings can lead to health issues for occupants.

Common sense along with related international guidelines and standards dictates that mould in buildings is undesirable and needs to be addressed.

Health Impacts of Mould

When conditions are right, mould will metabolise and release odours known as Microbial Volatile Organic Compounds (MVOC). These can often be attributed to the offensive musty smells in damp buildings.

Certain species of moulds are mycotoxin and β-D-glucan producers that can have a negative impact on the health of those who are exposed.

When mould is prolific on building materials, there are also generally high levels of gram-negative bacteria that can produce endotoxins presenting a further risk to occupant health.

The health implications related to microbial contamination can be diverse depending on the mould species present, the extent of the contamination, the growth status of the mould and susceptibility of the individual exposed.

Damage to Building Materials

Mould by nature's design is destructive as its purpose is to decompose organic material. As many building materials are organic based products, when the conditions are suitable, mould can start growing on nearly all surfaces. This includes mild steel, glass, vinyl, painted surfaces, plastic, rubber, polyester and most timber products. The most susceptible wood products to moisture and mould can be manufactured timber products such as plywood, strand board (OSB), medium density fibreboard (MDF) and particleboard. The manufacturing process, along with the porous nature of these products, make them an excellent nutrient source and holders of available moisture that supports microbial growth.

Mould metabolises the material it grows on and over time, will deteriorate and can eventually compromise the integrity of the material or leave permanent unsightly damage.

EXECUTIVE SUMMARY

Due the design, operation, management and geographical location of the buildings located at OPC1 Topside, Nauru, many of the modular buildings have been adversely affected by moisture damage and mould.

The majority of the moisture and mould problems within the inspected buildings can be attributed to the operation of air-conditioning systems below 22^{o}C.

The construction of the walls, ceilings and floors of the affected modular buildings are such that when air-conditioning is operated at temperatures sub 22^{o}C, condensation is forming on various surfaces in the walls, ceilings and floors. The occurrence of condensation is resulting in damage to building materials and mould contamination.

Due to the presence of moisture damaged materials and mould contamination in some of the buildings, remediation is deemed to be required and risk assessments recommended to determine the suitability for occupancy.

If moisture and mould remain in the affected buildings, they will continue to deteriorate at an expediential rate eventually becoming uninhabitable

STATEMENT OF LIMITATIONS

This report has been prepared in accordance with the agreement between Canstruct and Eronmor.

Within the limitations of the agreed upon scope of services, this work has been undertaken and performed in a professional manner, in accordance with generally accepted practices, using a degree of skill and care ordinarily exercised by members of its profession and consulting practice. No other warranty, expressed or implied, is made.

This report is solely for the use of Canstruct, Jacobs & Department of Immigration and Border Protection (DIBP). Any reliance on this report by third parties shall be at such party's sole risk and may not contain sufficient information for purposes of other parties or for other uses. This report shall only be presented in full and may not be used to support any other objective than those set out in the report, except where written approval with comments are provided by Eronmor.

PROJECT SCOPE

s. 47F(1) travelled to Nauru to conduct onsite evaluations of buildings experiencing moisture damage and mould growth within the various buildings located at the OPC1 Topside facility.

The onsite investigation included investigation and identification of cause/s of condensation and mould including design, installation, maintenance and operation of the buildings.

The investigation considered moisture and condensation as well as mould growth on building structures as well as the air-conditioning systems. Limited destructive/invasive inspection work was conducted to verify the full extent of the issues in some areas. Authorisation was sought from the OTOC & Canstruct prior to the invasive/destructive inspection. From the assessments conducted, advice has been provided on what measures may be considered to assist with the moisture damage and mould issues.

OBJECTIVE

The objective of the investigation was to determine cause/s of condensation and mould in the buildings. The investigation, assessment and advice considers building design, installation, management and operations that may be contributing factors to the issues.

METHODOLOGY

To achieve the above objectives, the following methodology was used:

- Conducted meetings and discussions with Canstruct site personnel as well as their appointed subcontractors OTOC.
- Undertook detailed walkthrough surveys and visual inspections of the structure, systems and contents of the affected buildings.
- Quantitative testing was undertaken including – digital thermography along with relative humidity, temperature, dew points and surface moisture measurements.

DETAILS OF THE MOISTURE AND MOULD INVESTIGATION

Date of Inspection	Buildings Inspected
Thursday 30 h April	- Mess Building including kitchen, dining, cold stores, wash room/s and veg prep room (01.33 & 01.34). - Various Modular Building/Self-contained units in storage yard. - Administration Building (01.05) - Medical Building (01.03) - Property Building / Control Room - Accommodation Buildings - Blocks G, H & D - Interview Buildings 1 & 2 (01.02 & 01.02a)
Friday 1s of May	- Canstruct Project Manager Office - Mess/Dinning Area (buildings 01.33) - Various accommodation buildings including Blocks A, B, C, D, H & G (01.15, 01.21, 01.28, 01.29, 01.27, 01.22, 01.22). - Interview Buildings 1 & 2 (01.02 & 01.02a)

FINDINGS

This section of the report details the findings of the investigation in relation to the buildings inspected, the moisture affected materials and the mould growth found.

Modular Accommodation Buildings

The modular accommodation buildings are being negatively impacted by the high wall split air conditioning systems being operated at low temperatures (sub 22^{o}C). The operating of the air-conditioning within these buildings at low temperatures is causing dew point to occur leading to condensation forming on surfaces within ceilings, walls and floors. The prolonged presence of moisture on and in these building materials is leading to damage of the materials as well as visible mould growth.

Table 1. Findings in Modular Accommodation Buildings

Element Inspected	Findings - Rooms Inspected H111, H112, H115, H116, H207, H208, H212, H214, H216, H220, D104, D106, G216, G115 & G118
Walls	A penetrating moisture probe was used to measure the moisture content of the vinyl lined plywood wall cladding. Most walls measured had elevated moisture content (MC) readings above 35% with many of them being considered “wet” - over 50% MC. Normal (or non-moisture affected) internal plywood lining moisture content was determined to be approximately 11.5%. The high moisture activity in the wall materials has led to the damage of the plywood and vinyl as well as visible mould growth.

	s. 33(a)(iii) 
Ceilings	Many of the ground floor units have insulation above the ceiling helping prevent condensation forming in the ceiling space. As the underside of the floors of the level one buildings are not insulated, condensation can form and drip onto the insulation of the ceiling below causing the insulation and plaster to become wet allowing damage to the plaster and mould to growth. Due to the high moisture content in the ceiling plaster of some of the ground floor buildings, the underside of the ceilings in some rooms have visible mould growth. s. 33(a)(iii) 

	s. 33(a)(iii) [redacted]
Floors	Excessive moisture and mould is suspected on the underside of the accommodation buildings where internal room temperatures have been maintained below 22°C for prolonged periods. s. 33(a)(iii) [redacted]
Air-conditioning	The majority of high wall split air-conditioning units throughout the OPC1 have visible mould on the barrel fans, fan shrouds and some mould on the coils. s. 33(a)(iii) [redacted]

ATCO & Force 10 Buildings (B Block & C Block)

The ATCO & Force 10 buildings are of a different design and construction material to the MBS buildings. The walls of the Force 10 modular buildings are made from cool room style panels. The ATCO buildings are of similar construction to the MBS buildings however do not experience the same moisture ingress issues which is most likely attributed to the buildings having enclosed roofs and vapour barriers installed behind the external wall cladding.

Table 2. Findings - Force Ten Accommodation Buildings

Element Inspected	Findings
Walls (Internal)	Internal wall surfaces of the rooms inspected did not show any signs of moisture damage or significant mould growth. Surfaces within these rooms may still be at risk of mould growth as internal relative humidity levels can exceed 70% RH.
s. 33(a)(iii)	[redacted]
Air-conditioning	It is suspected that majority of high wall split air-conditioning units have visible mould on the barrel fans, fan shrouds and some coils.

Table 3. Findings - ATCO Buildings

Element Inspected	Findings
Walls (Internal)	Internal wall surfaces of the rooms inspected did not show any signs of moisture damage or significant mould growth. Surfaces within these rooms may still be at risk of mould growth as internal relative humidity levels can exceed 70% RH.
Air-conditioning	The majority of high wall split air-conditioning units have visible mould on the barrel fans, fan shroud

Interview Room Buildings

Some of the Interview Rooms being used as offices do not show signs of excess moisture damage and mould. This is due to the occupants of those rooms either opening the doors and windows and having the air-conditioning turned off or operating the air-conditioning at no less than 24^{o}C.
There are several rooms that have been operating the air-conditioning systems at levels sub 22^{o}C which has led to excessive moisture damage and mould growth.

Table 4. Findings – Interview Room Buildings

Element Inspected	Findings
s. 33(a)(iii)	
Floors	Condensation may be forming on the underside of many of the interview rooms and high levels of condensation and visible mould may be present.
Air-conditioning – Supply Air Only	Visible mould and corrosion is present on the internal insulation of the supply air transition duct from the cooling coil to the supply air vent. There is limited mould on the supply air vents as these may get cleaned from time to time.

s. 33(a)(iii)

MESS/DINING Building

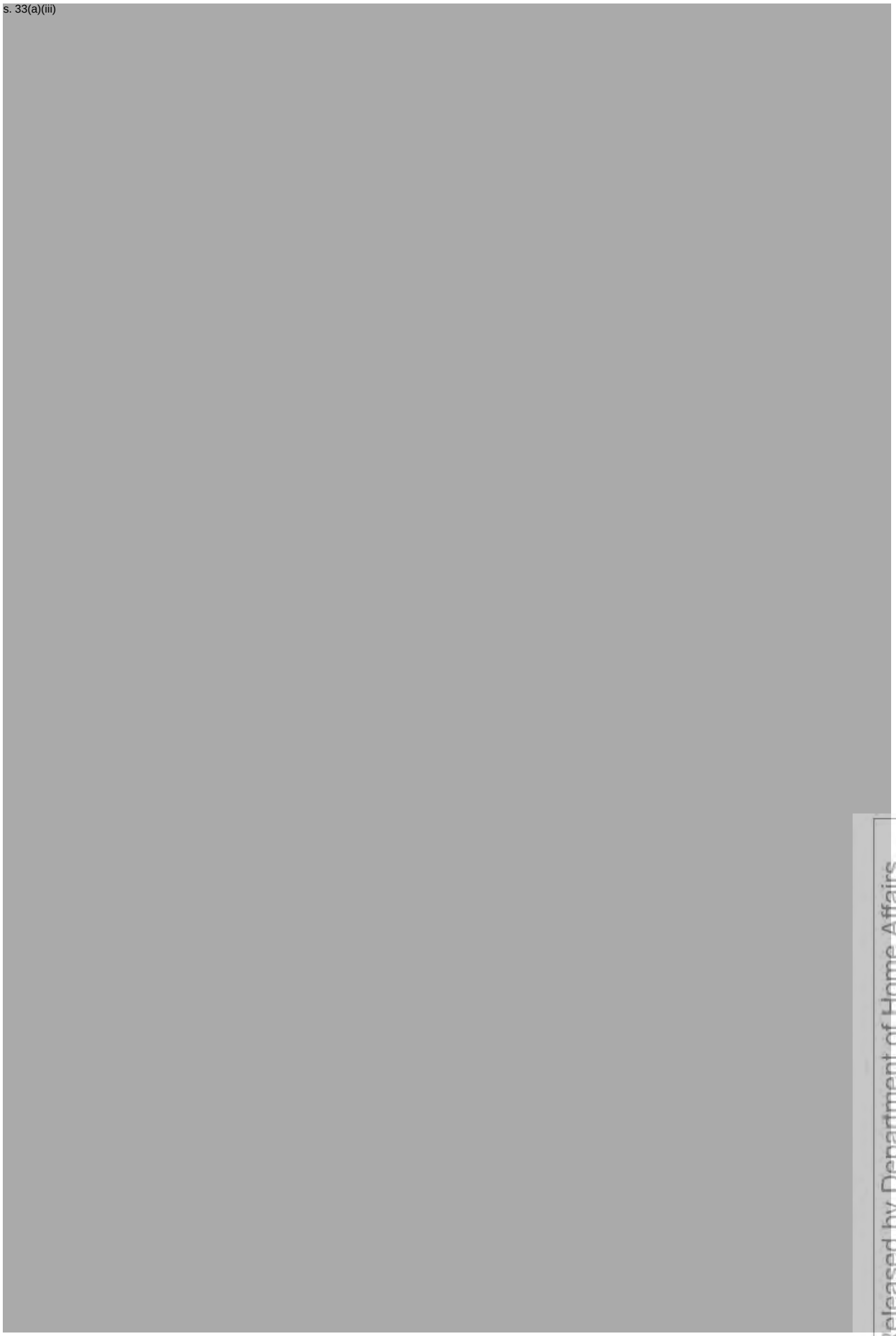
The mess/dining building has numerous areas affected by water damage and visible mould. This is due to several contributing factors including but not limited to the following;

- Blocked kitchen Make Up ("fresh air") filtration leading to negative pressurisation of the entire building.
- Being lower pressure (negative pressure) than outside allows high volumes of humid air to be drawn into the building via open doors and from the ceiling space.
- Internal relative humidity levels are too high (over 70% RH) due to lack of humidity control.
- High levels of mould growth in air-conditioning systems.
- Underfloor Insulation gaps allowing moisture and mould damage to timber flooring materials.

Table 5. Findings – Mess/Dining Building

Element Inspected	Findings
Walls	The majority of the plywood wall materials throughout the Mess area have moisture content exceeding what would be considered "normal" compared against the same materials that are not moisture affected (the dry standard). **Air-conditioning Refrigeration Pipes & Condensate Drain Lines (Within walls)** Due to the temperature differential between the refrigeration pipes and condensate drain lines and the warm humid air within the wall cavities, condensation is forming on the drains and pipes. As the condensation forms and runs off the lines, the moisture is being absorbed by the surrounding building materials in the wall. The condensation running off the condensate drains lines and refrigeration pipes is running into the steel bottom plates of the walls that act like a channel for the water to travel within the wall cavity. This is leading to standing water in the wall cavities which increases the relative humidity within the walls leading to the formation of condensate and mould on internal surfaces.

s. 33(a)(iii)

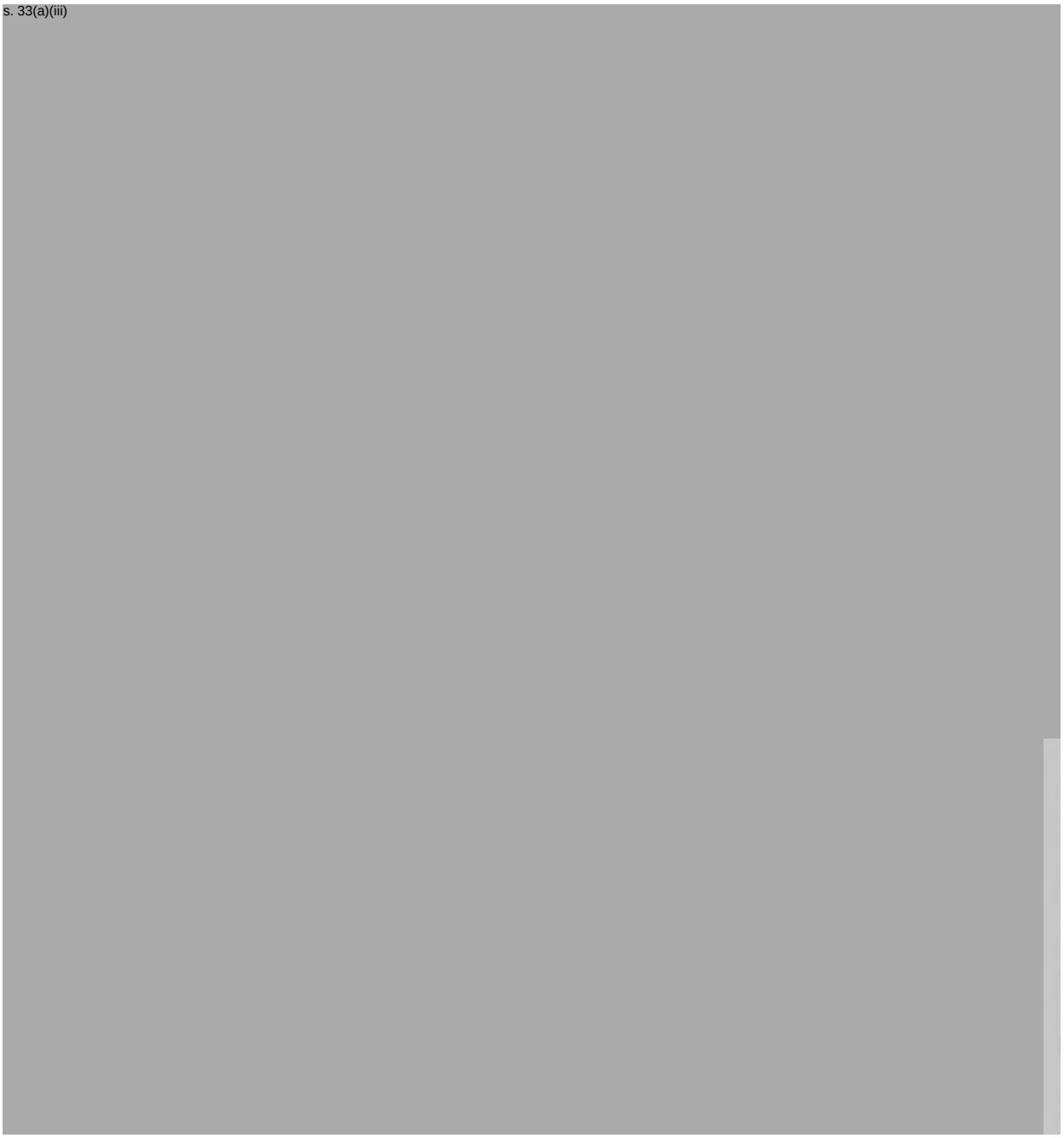


s. 33(a)(iii)

Cold Storage Area

The areas within the refrigerated cold storage rooms were not inspected however, due to condensation forming in the corridors of the cold storage areas, corrosion and limited mould was evident on the ceilings and walls.
Due to the operation of the kitchen exhaust system in the supplementary kitchen (temporary kitchen located near loading dock area), the entire cold storage corridor is under negative pressure allowing unconditioned humid air to enter the corridor leading to condensation and mould.

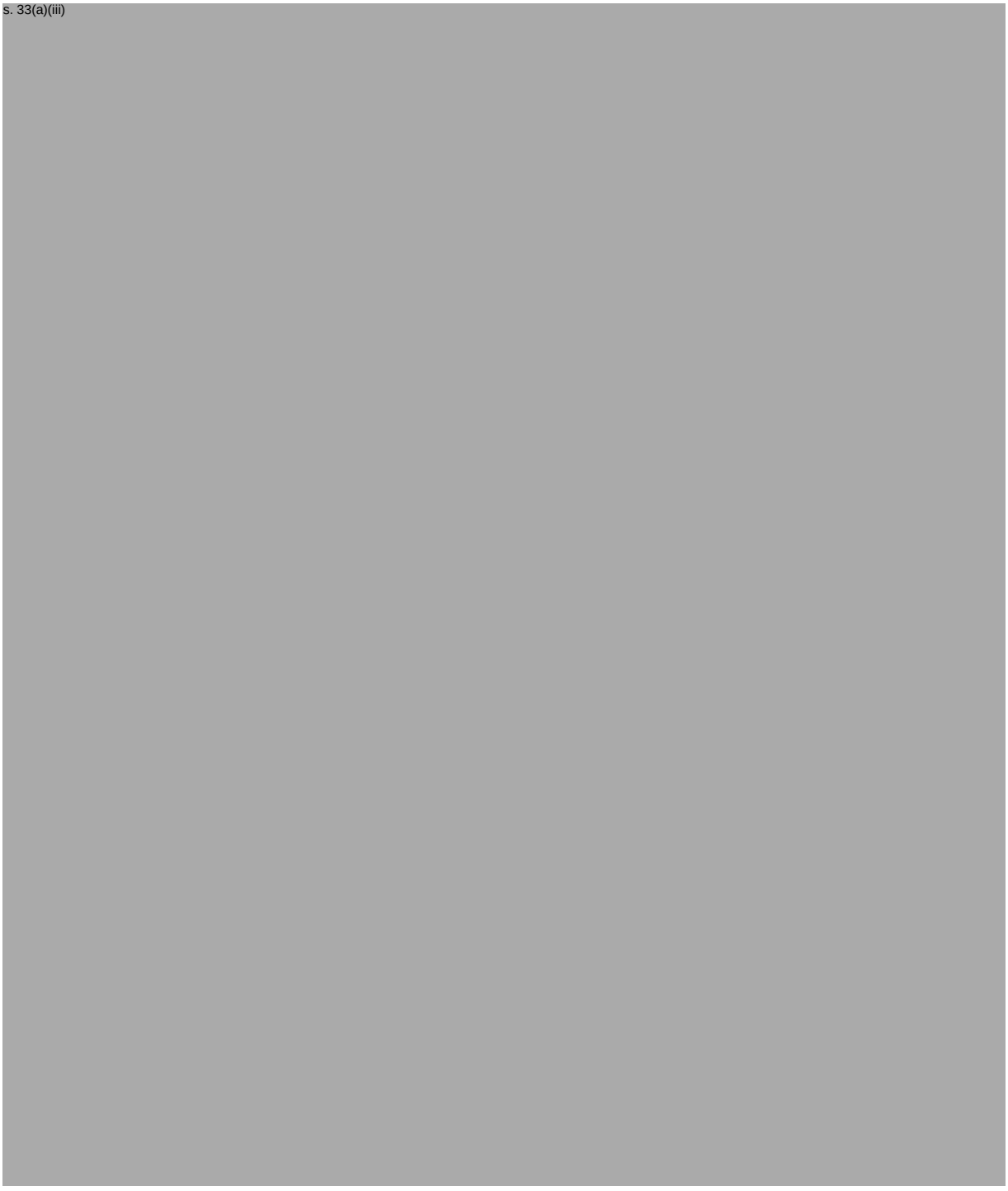
s. 33(a)(iii)



Dishwashing Room

The main dishwashing room adjoining the main mess area has high levels of visible mould present. This is largely attributed to the high levels of water activity in the area. This is by way of water (including warm or hot) being splashed onto the walls and floors as well as steam.
The ceilings, walls and air-conditioning units have high levels of visible mould.

s. 33(a)(iii)



Main Kitchen

The kitchen is segmented into several main areas, all with kitchen exhaust systems, make up ("fresh air") systems and high wall split air-conditioning.
One of the main contributing factors of mould growing in the kitchen and mess areas is the introduction of unconditioned, humid air through the kitchen's make-up air systems.

Kitchen Make Up Air Systems

The kitchen supply air systems (or Make Up air systems) are four mechanical ventilation systems designed to introduce outside air from rooftop into the main kitchen to "make-up" for the air being extracted by the kitchen's cooking exhaust systems.

The outside air passes through two low grade G3 filters located in the air intakes of each system.

At the time of the inspection, these filters were heavily contaminated with what looks to be mould growth. This mould growth on the filters is restricting air flow affecting the amount of make-up air being introduced into the kitchen. As the kitchen exhaust systems are operating at full capacity, this places the entire kitchen and mess hall under negative pressure.

These make up air systems do not have a dehumidification component to remove excess moisture from the air before ducting it into the kitchen. As such, the unconditioned, warm, humid air is delivered directly into an air-conditioned space contributing to condensation forming on any surface with a temperature of 22^{o}C or below*.

* based on a RH of 80% and temp of 26^{o}C

High levels of corrosion was noted on the filter frames, filter guide channels, filter doors and ducts compromising the integrity of the system components.

Fresh Vegetable Preparation Room

This room has several high wall split air-conditioning systems as well as two window air induction fans that bring unconditioned outside air into the room.
As such, the humidity in the room is high for prolonged periods of time leading to condensation forming and mould issues.

Medical Clinic & Transfield Offices

Aside from limited mould growth in the high wall split air-conditioning units, no significant moisture damage or mould was evident in the inspected areas of the Medical Clinic and Transfield offices buildings. This is most likely due to the installation and operation of dehumidifiers.
The average recorded Relative Humidity levels at the time of the inspection for both buildings was 53% RH.

Property Building & Control Room

The front office of the Property building has moisture damage to the walls as well as some limited visible mould present.
Due to the property storage area having natural ventilation and prolonged periods of elevated humidity, mould is able to grow on certain internal surfaces as well as on some contents.
At the time of the inspection, relative humidity within the property storage area was 80% RH.
The Control Room had no visible signs of moisture damage or mould.

s. 33(a)(iii)

DISCUSSION & RECOMMENDATIONS

Determining Safety & Habitability

The prolonged periods of high humidity and moisture activity in some buildings has led to damage of building materials and high levels of visible mould growth being present.

Certain rooms/buildings have visible mould growth present and are considered to have Condition 3 – actual mould growth according to the IICRC* S520 Standard and Reference Guide for Professional Mold Remediation and require remediation works.

**IICRC - Institute of Inspection, Cleaning and Restoration Certification*

Access to any building significantly affected by moisture damaged materials and visible mould should have adequate measures implemented to reduce the risk of exposure.

As the presence of wet and mouldy building materials may present a risk to occupant health, consideration should be given to conducting risk assessments to determine the suitability for occupancy. Any rooms/buildings affected by on-going moisture dampness issues, strong musty odours (generally associated with water damaged materials), or that have visible mould present may not be suitable for occupancy.

Eronmor understands that there is a requirement to maintain the occupancy of the modular buildings at OPC1 and therefore recommends that the suitability of occupancy be determined by conducting risk assessments or evaluations of each room and building separately.

To assist evaluating the severity of the moisture and mould contamination, Eronmor recommends the use of a recognised assessment tool such as the NIOSH** Dampness and Mold Assessment Tool. Although originally developed for schools, the tool is applicable to the modular building.

A copy of the assessment tool along with the relevant instructions for use the have been provided with this report.

***NIOSH - National Institute for Occupational Safety and Health*

For any rooms/buildings that are identified as being Condition 3 - mould affected, remediation works should be undertaken in accordance with the IICRC S520 Standard and Reference Guide for Professional Mold Remediation by competent contractors under the scope and guidance of an independent Indoor Environmental (IEP) professional.

At minimum this should incorporate the following:

- Adequate engineering controls implemented to prevent spread of contamination.
- Only suitably qualified/experienced persons should conduct mould remediation works.
- Minimum personal protective equipment (PPE) must be worn including but not limited to half face P3 respirators, disposable coveralls, gloves and enclosed eye protection.
- All moisture affected and mould contaminated materials (Condition 3 – actual mould growth) should be removed and disposed.
- Any materials that are deemed salvageable need to be visually free of mould, dried and verified to have normal moisture content.
- All internal surfaces of air-conditioning systems need to be cleaned, sanitized and treated with long term residual antimicrobial products to help prevent regrowth.
- Entire work area needs to have detailed cleaning to remove Condition 2 contamination (mould contamination such as settled spores etc. resultant from active mould growth in the area).
- Each work area should have Post Remediation Verification (PRV) undertaken prior to reinstatement works to establish materials are dry, clean and free from visible mould.

Moisture Management

The key to preventing moisture damage and mould contamination within the modular buildings is air-conditioning temperature control. The primary source of moisture damage and resultant mould growth in the buildings at OPC1 is due to the air-conditioning systems being operated below 22°C.

When the internal room temperature is below 22°C, condensation is forming within the wall cavities on the backside of the wall plywood as well as behind the vinyl plywood lining which is acting as a vapour barrier.

The design of the modular accommodation buildings does not allow for the internal temperatures to be below 22°C when located in a tropical environment with extended periods of high heat (28°C - 38°C) and high relative humidity (>75% RH) without these moisture issues arising.

Condensation forms on the surfaces of building materials when dew point is reached.

During the days of the inspections, the ambient relative humidity and temperature readings were taken at various intervals throughout the day to determine dew point. The results are displayed in the table below.

Table 6. Examples of Ambient (outside) Temperature, Relative Humidity and Dew Point

Date	Time	Temperature	Relative Humidity	Dew Point
30 h April 2015	6:05pm	30.5°C	68.1%	23.9°C
30 h April 2015	6:30pm	29.8°C	67.7%	23.1°C
30 h April 2015	11:00am	26.2°C	91%	24.7°C
30 h April 2015	11:15am	26 °C	93.9%	25°C
30 h April 2015	11:30am	25.9°C	94.2%	25°C
1s May 2015	9:00am	27.8°C	87.6%	25.6°C
1s May 2015	9:15am	27.3°C	87.4%	25.2°C
Average for 2 Days		27.6 °C	84%	24.6 °C

In order to demonstrate if dew point was occurring in the wall cavities of buildings (rooms), the same measurements were taken in some of the walls cavities affected by moisture damage and visible mould,

Table 7 below provides the results from those measurements taken.

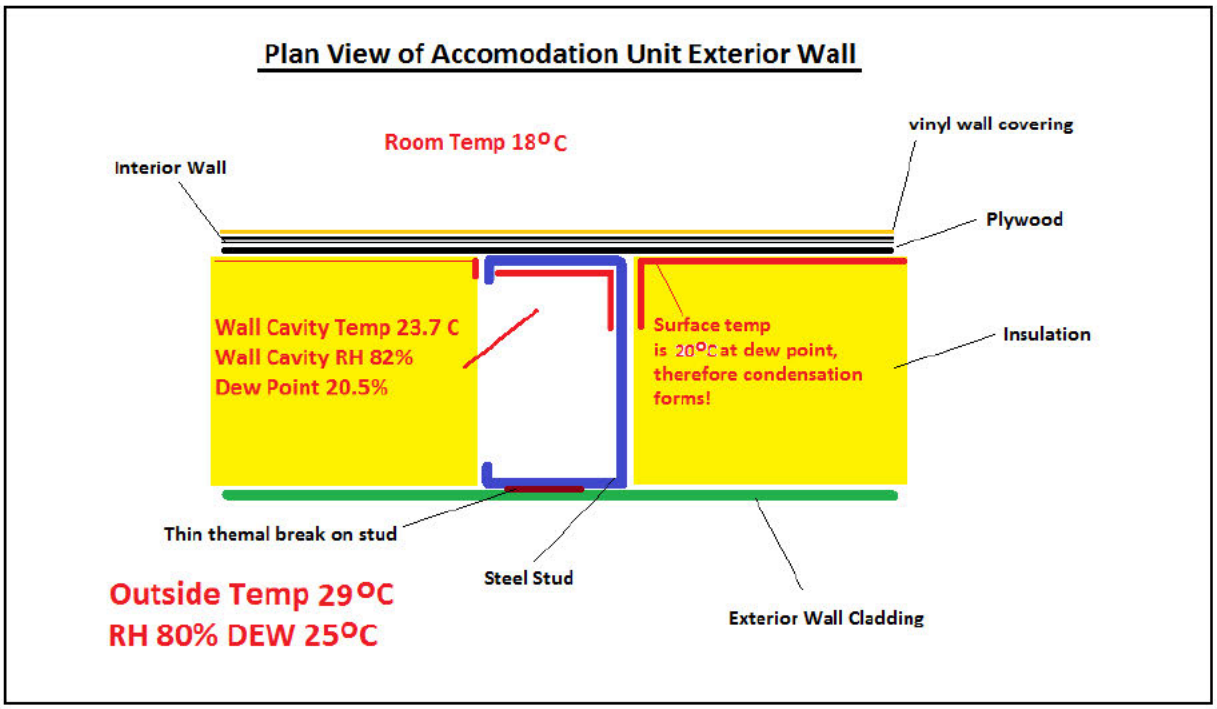
The readings taken show that at the time of testing, dew point would be reached on the internal surfaces within certain wall cavities if the surface temperatures were approx. 20°C or less.

Table 7. Example of Internal Wall Cavity Conditions in Mould Affected Rooms

Date	Time	Temperature	Relative Humidity	Dew Point
1s May 2015	8:00am	23.1°C	78.4%	19.2°C
1s May 2015	9:30am	23.7°C	82%	20.5°C

The below plan (cross section) diagram shows the typical construction of the modular building walls and the conditions that allow condensation to form in the walls leading to moisture damage and mould growth.

Diagram 1 - Plan View of typical wall construction of a Modular Building

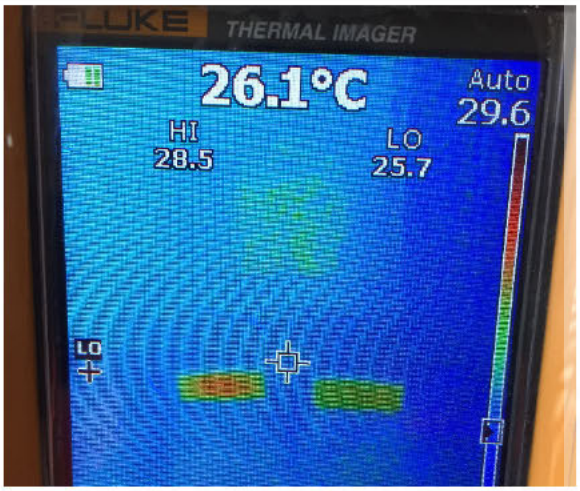


Wall Ventilation to Assist Drying through Evaporation

During the inspection process, it was noted that the internal plywood wall lining below the majority of windows in the modular accommodation rooms was at normal moisture content (approx. 11.5% MC) or significantly drier than other walls. Upon further inspection, it was discovered that the vents at the base of the windows were allowing warm air to leave the wall cavities below the windows. The ability for the warm, humid air to leave the wall cavity (through thermal stratification) creates air movement within the wall cavity helping to prevent condensation build up and drying of the materials through evaporation.

As this was consistently the case, consideration should be given to installing ventilation provisions into the top of the external surface of each wall panel in the modular buildings.

s. 33(a)(iii)



Thermal image showing heat leaving through vents below window.

Modifications to Building Design & Operation

In order to adequately address the moisture damage and mould issues within these buildings, consideration to be given to the following recommendations;

Summary of Required Control Measures for Moisture Control and Mould Prevention

- Air-conditioning set point temperature control (remove ability of occupants to lower set point temperatures below established lower limit – preferably 24^{o}C but no less than 22^{o}C).
- Insulation of ceilings and subfloor spaces of modular buildings as required.
- Remove sources of mould contamination contributing to high mould spore concentrations.
- Install passive ventilation to walls to allow air movement within wall cavities to prevent condensation within wall cavities and promote drying.
- Check insulation of refrigeration pipes and condensate drain lines to ensure proper thermal barrier.
- Conduct leak repairs to roofing materials and flashings as required preventing further water ingress.
- Install pre-conditioners to dehumidify outside air into the MESS/Dining area and ensure air pressure within the building is at either neutral or slight positive pressure to outside.

Operation of Air-Conditioning Systems

During the time of the inspection, it was noted that the temperatures in all buildings inspected (with exception to two of the Interview rooms) were lower than 22^{o}C and often below 20^{o}C.

Due the climatic region and the extended periods of high relative humidity, it is highly recommended that the set point temperature for all air-conditioning systems not be below 22^{o}C. Internationally recognised best practice guidelines and standards generally allow for internal air-conditioned buildings to be at 24^{o}C and as high as 26^{o}C in areas with ambient high temperatures.

With high ambient relative humidity levels throughout the year in Nauru, the less the temperature differential between outside and inside the buildings, the less condensation will form within walls helping to prevent moisture damage and mould growth.

Air-Conditioning Maintenance & Cleanliness

The maintenance of the air-conditioning systems should include a hygiene program that will address mould contamination and prevention thereof. This should include the regular inspection of all ducted and non-ducted air-conditioning systems to inspect for general cleanliness. Cleaning should be conducted as required. Any visible mould in any air-conditioning components must be addressed as soon as practical after it is identified or the system shut down and not operated until such time that the mould has been removed.

Air-conditioning maintenance and hygiene should be in accordance with the AIRAH* HVAC Hygiene Best Practice Guidelines and Australian Standard 3666.2 2002 Air-handling and water systems of buildings—Microbial control Part 2: Operation and maintenance.

**AIRAH - Australian Institute of Refrigeration, Air-conditioning & Heating.*

Due to the likely reoccurrence of mould in the air-conditioning systems, consideration should be given to the application of long-term residual antimicrobial products to internal components.

Subfloor & Ceiling Insulation - Accommodation Buildings

Prior to the moisture and mould investigation being conducted, contractors had been engaged to install an expanding foam insulation product to the following surfaces within the ceiling voids of D Block;

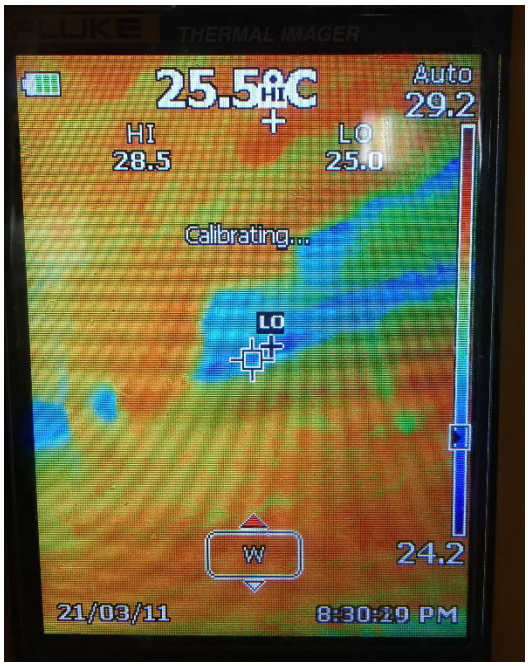
- Topside of the ceiling plaster of the ground floor rooms, and
- Underside of the flooring of the level 1 rooms.

The purpose of installing the expanding foam insulation product was to trial its effectiveness in preventing dew point occurring and condensation forming in the voids.

From the inspection conducted of the areas where the insulation product had been installed, it seems as though the application of the insulation may be an effective way to help prevent condensation forming on the surfaces.

It was noted however, that in areas where the insulation product had not been installed to completely cover the metal frame supporting the flooring and ceilings, condensation was still forming. ***See image below.***

The below image was taken by a thermal imaging camera.



The adjacent image shows areas of lower surface temperature as blue and the higher surface temperature as orange.

The orange areas are the surfaces where the insulation product has been applied.

The blue areas are the steel ceiling frame where the insulation has not been applied but does not cover all of the surfaces.

As the relative humidity and temperature levels within the ceiling voids are high for extended periods of time, condensation will still form on these surfaces.

NOTE: Prior to installation of any directly applied adhesive insulation products, the materials that it is going to be applied to must be verified as having normal moisture content. Failure to do so may trap moisture within the material and lead to further moisture damage and mould growth.

Whist the application of the foam insulation product is likely to be an effective solution to preventing condensation forming within the ceiling void, consideration needs to be given as to if it is required.

If temperatures within the affected rooms can be controlled to a level where dew point won't occur on external surfaces, the insulation product may not be required.

REMEDIATION AND RECTIFICATION WORKS

This section provides advice as to what minimum measures should be undertaken to remediate the materials and surfaces within the mould affected buildings. Advice has previously been provided as to what preventative measures can be implemented to help prevent the reoccurrence of moisture damage and mould contamination.

Due to the risk of exposure and spreading of mould contamination, it is recommend that only persons adequately trained should conduct mould remediation in accordance with recognised industry guidelines and standards such as the IICRC S520 Standard and Reference Guide for Professional Mold Remediation (USA).

Humidity Control

Many of the preventative measures listed may not be required if air-conditioning systems within the buildings are not operated below 22^{o}C (preferably 24^{o}C).

Consideration should be given to whether the recommended preventative measures will not be required if internal building temperatures can be controlled at or above 22^{o}C.

Table 8 – Remediation & Preventative Recommendations

Element	Minimum Recommended Remediation	Preventative Measures
Plywood Walls	All internal vinyl wall panels with visible mould must be removed and disposed. Any wet insulation within wall cavities should be removed and disposed. Any "sweating" air-conditioning refrigeration pipework or condensate drain lines in wall cavities should be identified and inspected for mould. If mould is present, the insulation should be removed.	Install "breathing" vents to the top of the external surface of each wall panel to allow evaporation. Any pipes in wall cavities should be insulated with product that provides adequate insulation so that condensation does not form on the outside of the insulation.
Plaster Walls Between Rooms	If plaster only has very minor (light) mould growth, the mould can be removed (wet wiping & contact vacuuming) and the area disinfected and then dried (if required). If plaster has excess moisture content, drying of the plaster will need to be done using commercial dehumidifiers and the process verified using a moisture meter fitted with insulted penetrating probes to ensure plaster are adequately dried. Any plaster that has significant visual mould growth or where the plaster's structural integrity has been compromised should be removed and disposed.	Consideration may be given to the application of long term residual treatments to surfaces to help prevent the occurrence of mould during periods of prolonged elevated relative humidity or moisture.

Element	Minimum Recommended Remediation	Preventative Measures
Ceilings	If plaster only has very minor (light) mould growth, the mould can be removed (wet wiping & contact vacuuming) and the area disinfected and then dried (if required). If plaster has excess moisture content, drying of the plaster will need to be done using commercial dehumidifiers and the process verified using a moisture meter fitted with insulted penetrating probes to ensure plaster are adequately dried. Any plaster that has significant visual mould growth or where the plaster's structural integrity has been compromised should be removed and disposed.	If plaster is determined to be "dry" or have normal moisture content, an insulation product may be applied to cover all surfaces including the plaster including beams and steel framework that are in contact with the plaster to prevent heat transfer and condensation forming. The successfulness of insulation application process should be independently verified by the client or a third party. Failure to properly insulate the surfaces properly may result in a performance and product failure and lead to significant moisture and mould damage.
Ceilings (continued)	Remove and dispose any moisture affected insulation materials. A thorough inspection should be made to the roofing materials, flashing etc to identify any potential water leaks.	Conduct any required repairs to roofing material or flashings as required. Ensure that all insulation materials are correctly installed to help prevent thermal transfer.
Floors	Any moisture damaged or mould affected timber flooring materials need to be removed and disposed.	If insulation is installed to the underside of the floor and is failing to properly insulate the floor or is allowing condensation to form between the insulation and the underside of the flooring materials, it should be removed and replaced with an alternative product that will provide adequate insulation.
Air-conditioning Systems (ducted and non ducted)	Conduct mould remediation of air-conditioning units including the removal of all visible mould and disinfecting all internal components with HVAC approved disinfectant.	Once dry, all internal components should be treated with long term residual antimicrobial products to help prevent mould growth reoccurrence. All air conditioning units should be set to a minimum operating temperature of 22^{O}C. The most preferable set point temperature is 24^{O}C.
Kitchen Outside Air Intakes (Make Up Air)	The air filters within the kitchen make up air systems should be removed and disposed and new filters installed.	The make-up air (outside air) systems should be conditioned to ensure adequate humidity control. The volume of pre-conditioned make-up air being supplied to the kitchen/mess building should exceed the amount of air being exhausted by the kitchen exhaust systems to ensure that building stays slightly pressurized.

Vegetable Prep Room	Shut down the two window mounted air intake fans to prevent unconditioned air being delivered to area.	If "fresh" or outside air is required in this area, a ducted system should be installed that provides the amount of required air but "conditions" it first to ensure proper humidity control.

Cold Store Corridor	Decontaminate mould affected surfaces and air-conditioning.	Ensure that cold store corridor is not under negative pressure to outside and relative humidity below 65% RH. This may be achieved by providing conditioned air to the corridor to make up for the air being extracted by the cooking exhaust system in the supplementary kitchen. (the operation of the kitchen exhaust system on the kitchen in the cold store area is placing the cold store corridor under negative pressure allowing high levels of humid air to be drawn in)
Contents	Any contents affected by mould need to be evaluated for salvagability. Most porous and semi-porous surfaces such as canvas, leather, paper etc affected by visible mould will generally need to be disposed. Mould growth on non-porous surfaces can generally be removed.	Keep contents dry and control relative humidity levels in buildings below 65% RH.

Post Remediation Verification

Following remediation process, Post Remediation Verification should be performed to verify and document the successful completion of the remediation works.

The above actions are intended for guidance purposes and are intended to prevent further degradation of the areas and subsequent mould growth but are not conclusive and on-going maintenance and remediation may be required.

Please contact the undersigned if you have any queries regarding this report.

Regards,

s. 47F(1)

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18 June 2015

C999991:J133542 BRM

s. 22(1)(a)(ii)
Acting Assistant Director
Offshore Service Delivery Section
Services Management Branch | Detention Services Division | Support Group
Department of Immigration and Border Protection

Dear s. 22(1)(a)(ii)

Re: Mould Remediation Plan Review. Regional Processing Centre, Republic of Nauru

This letter provides the findings of a desktop peer review undertaken on the following documents provided on 17th June 2015 by Department of Immigration and Border Protection:

- *PM Air Quality and Mould Inspection Report Nauru Regional Processing Centre* (dated Tuesday 23rd December 2015). Section 16: Recommendations & Scope of Works from a report undertaken by s. 47F(1) and
- Transfield Document: Nauru Regional Processing Centre Mould Remediation Plan (excluding Appendix A). Note: GreencapNAA understands that the Transfield Document was developed based on the recommendations of s. 47F(1) report.

The review has been undertaken by s. 47F(1), National Practice Lead – Occupational Hygiene & Certified Occupational Hygienist of GreencapNAA in accordance with internationally accepted best practice standards and guidelines for mould *IICRC S520 Standard and Reference Guide for Professional Mould Remediation IICRC S520-2008.* The review was limited to a desktop review only. Based on the findings of the review, GreencapNAA raises the following points in relation to s. 47F(1) report:

- The Recommendations & Scope of Works (SOW) does not make reference to/or entirely align with the requirements of international best practice and guidance on mould remediation as per *IICRC S520 Standard and Reference Guide for Professional Mould Remediation IICRC S520-2008.*
- The proposed recommendations rely heavily on cleaning, disinfectant and/or surface sterilization as opposed to physical removal of mould.
- While the SOW addresses "harm minimization" from a microbial perspective, the SOW does not address the potential short and long term safety, environmental and health hazards to workers/occupants from the proposed remediation techniques e.g. chlorine dioxide gas, hydrogen peroxide vapour and ozone gas.
- The report suggests that mechanical air conditioning be installed into tents on RPC1 and RPC2 and in portable/modular housing. While controlling humidity within these is critical to reducing/eliminating moisture and subsequent recontamination such structures or materials are

not necessarily designed and/or suitable for air-conditioned environment. Failure to consider this prior to installation is likely to result in condensation on surfaces, further moisture and mould growth.

- The SOW does not identify an "end point" in the proposed remediation works that all parties agree will constitute post remediation verification e.g. all identified affected structure, systems and contents being returned to "Condition 1 – normal fungal ecology" as per *IICRC S520 Standard and Reference Guide for Professional Mould Remediation ANSI/IICRC S520-2008*.
- As highlighted in the report by s. 47F(1), the assessment (and therefore remediation scope of works) did not included contents therefore the status of these remains unknown and are likely to present a cross-contamination risk if mould affected contents are moved to unaffected areas.

s. 47C(1)

Based on the findings of the review, GreencapNAA provide the following advice relating to mould assessment, remediation and post remediation verification (PRV) best practices that should be adopted:

The basis of mould remediation and to prevent recontamination is to identify, correct and control the original moisture issue followed by **physical removal** of the mould contamination from the structure and contents. Attempts to kill or encapsulate mould are not adequate to solve the problem (ACGIH 1999)[1].

The remediation of different materials depends on their porosity, their condition (1, 2 or 3) and their structural integrity. *IICRC S520 Standard and Reference Guide for Professional Mould Remediation IICRC S520-2008* states that porous material (defined as building material that easily absorb or adsorb moisture (e.g. canvas tent material, plasterboard, insulation etc.) and if organic can easily support fungal growth) that are considered Condition 3 (defined as actual visual mould growth) should be **discarded.** IICRC S520 states the following:

[1] ACGIH (1999) Bioaerosol. Assessment and Control. 16.2.3 American conference of Governmental Industrial Hygienists, Cincinnati.

Porosity*	Materials	Remediation
Porous	drywall, ceiling tiles, insulation, particle board, medium-density fiberboard (MDF), carpet and similar porous materials	discard

GreencapNAA in accordance with international best practice guidelines strongly advise that the use of antimicrobials, coatings, sealants and cleaning chemicals should not be used as the primary means of remediation. IICRC S520 states the following:

Source removal of mold contamination should always be the primary means of remediation. Indiscriminate use of antimicrobials, coatings, sealants, and cleaning chemicals is not recommended.

Antimicrobials are not to be used as an alternative to proper cleaning procedures and physical removal of mold contamination. Antimicrobials should only be used in conjunction with proper cleaning, and should not be used indiscriminately. For thoroughly cleaned non-porous building materials, antimicrobials are generally not needed. It is important to note that killing mold and fungal spores does not eliminate the contaminants or contaminated material's allergenic or toxigenic properties.

The use of ozone treatment as recommended by s. 47F(1) in the remediation scope of works is not a recognised method of mould remediation by IICRC S520 and therefore one not endorsed or recommended by GreencapNAA. With the proper removal of mould affected materials (as per IICRC S520) the use of ozone or other potential hazardous fungicides/biocides like treatments are not necessary. IICRC S520 states the following:

Gas-phase Ozone and Vapor-Phase Biocides

According to the American Conference of Governmental Industrial Hygienists (ACGIH), "No gas- or vapor- phase biocides can effectively and safely remediate a microbially contaminated building because of problems with biocide delivery, efficacy and toxicity." (ACGIH Bioaerosols 16.2.5) Studies have shown that ozone cannot be generated in sufficient concentration to kill or even suppress microbials on most structural materials, including wood and drywall. (Foarde, K.K., Van Osdell, D.W., Steiber, R.W., Investigation of Gas-Phase Ozone as a Potential Biocide, US EPA, Applied Occupational Environmental Hygiene, August, 1997) Ozone has been shown to increase submicron particles and adversely react with many compounds (Weschler, C.J, "Ozone in Indoor Environments: Concentrations and Chemistry", Indoor Air, 2000) as well as cause damage to many types of artifacts (Cass, G.R., et al, "Protection of Works of Art from Atmospheric Ozone", The Getty Conservation Institute, 1989). Ozone is a strong oxidizing agent, reactive (rubber and electrical wire insulation), and very unstable (Cole, Foarde, ACGIH Bioaerosols, 16.2.5).

If coatings and sealants are used as **secondary** means of remediation then they should only be applied **after** post-remediation evaluation and verification has verified the return to Condition 1 "normal mould ecology" IICRC S520 states the following:

Coatings and sealants should only be applied after post-remediation evaluation and verification has verified the return to Condition 1. If antimicrobials, fungicidal coatings, mold-resistant coatings or sealants are used, and concerns exist that there could be future recurrence, the use of non-pigmented (clear) coatings could permit future visual inspection of treated surfaces.

Post remediation verification (PRV) should be conducted by an indoor environmental professional (IEP) in accordance *IICRC S520 Standard and Reference Guide for Professional Mould Remediation ANSI/IICRC S520-2008.* IICRC defines PRV as:

post-remediation verification: an inspection and assessment performed by an IEP after a remediation project, which can include visual inspection, odor detection, analytical testing or environmental sampling methodologies to verify that the structure, system or contents have been returned to Condition 1.

The IEP and competency requirements are defined by IICRC as:

The IICRC S520 defines an indoor environmental professional (IEP) as an individual who is qualified by knowledge, skill, education, training, certification or experience to perform an "assessment" of the fungal ecology of structures, systems, and contents at the job site, create a sampling strategy, sample the indoor environment, submit to an appropriate laboratory or individual, interpret laboratory data, determine Condition 1, 2 and 3, and verify the return of the fungal ecology to Condition 1.

IICRC preference is independence of the IEP as an unbiased resource and the IEP engaged independent of the remediator.

It is preferable that the IEP be an unbiased resource. An IEP engaged to perform pre-remediation assessment or post-remediation verification should be independent of the remediator. In some jurisdictions, the law may require that the inspection and assessment function be performed by an individual or entity independent of the remediator. If there are complexities, complications or conflicts, a remediator may need to request additional input or guidance from the IEP.

The expectations of mould remediation is that the identified affected structure, systems and contents have been returned to **"Condition 1 – normal fungal ecology"** as per *IICRC S520 Standard and Reference Guide for Professional Mould Remediation ANSI/IICRC S520-2008*. This can be demonstrated by the following:

- No visible mould growth on any structure, systems and/or contents;
- All construction materials are dry;
- The cause of the original problem has been resolved;
- The indoor air quality and material moisture levels are within acceptable standards;
- Cross-contamination of non-affected areas has not occurred; and
- Provisions of site remediation documentation for review e.g. mould remediation procedures followed, technique used etc.

s. 47C(1)

- s. 47C(1) .

- Ensure remediation works are only undertaken by competent mould remediation contractors that can demonstrate relevant training, certification and insurances for mould remediation and structural drying.
- Engage the on-going services of an experienced, competent and **independent** indoor environmental professional (IEP) as technical advisor on the project and to undertake routine inspections, testing and post remediation verification (PRV) at the end of the project.

As a reference a guide to professional mould assessment and remediation is provided in Attachment A. The guide was developed to protect occupant health as well as mitigate losses associated with mould contamination based on internationally recognised best practice guidelines and standards.

If any further information is required or if you have any queries regarding this document please do not hesitate to contact the undersigned on (03) 9890 8811.

Yours sincerely,

s. 47F(1)

Certified Occupational Hygienist (COH)

Council-certified Microbial Consultant (CMC) & Indoor Environmental Consultant (CIEC)

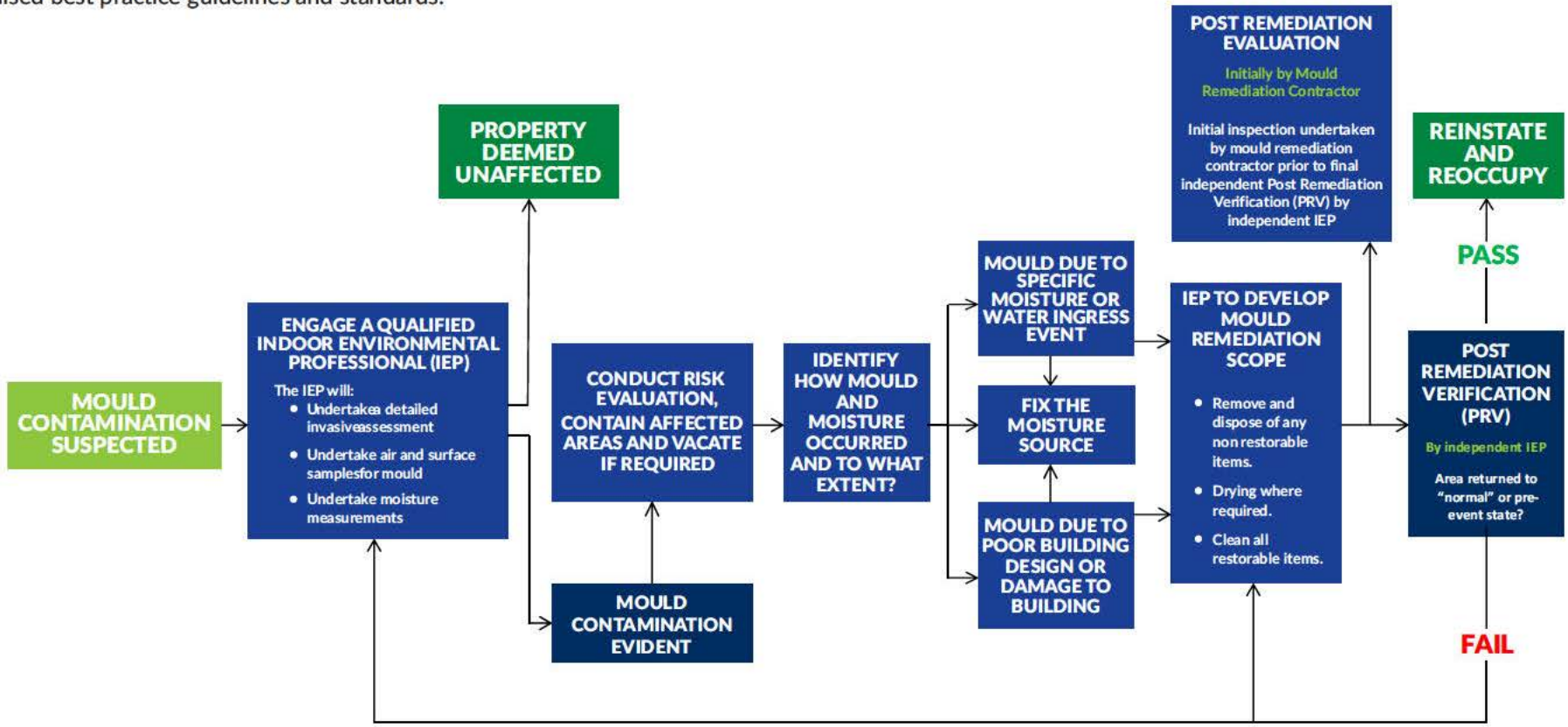
ATTACHMENT A: Guide to Professional Mould Assessment & Remediation

A GUIDE TO PROFESSIONAL MOULD ASSESSMENT & REMEDIATION

GREENCAP

INTEGRATED SERVICES
Environmental Management
Property/Hazardous Materials
Contaminated Land
Work Health and Safety
Hygiene
Training
Digital Solutions
Risk Control

A guide for property owners, managers and insurers to help protect occupant health as well as mitigate losses associated with mould contamination, based on internationally recognised best practice guidelines and standards.



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