air QUALITY PLAN

BREEAM ASSESSMENT EXPERTS

Air Quality Assessment for Planning Purposes

124 Theobalds Road
18/06/2024





Air Quality Assessment for Planning Purposes

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1. Background Information – Property

Introduction

This Air Quality Assessment has been prepared by Air Quality Plan Ltd on behalf of Theobald Investment Ltd ('the Applicant') in support of a full planning application for the refurbishment and extension of the existing commercial building at 124 Theobalds Road, London, WC1X 8RX ("the Site"). The proposals are for 589sq.m uplift of office floor space and a small café. The proposals are not for a "major" planning application, nor do they introduced the combustion of biomass materials or gas fired CHP plant, as such the AQA is required to consider the potential air quality for future occupiers in an area of poor air quality.

Description of Property

The project involves refurbishment of the existing office building at 124 Theobalds Road in the London Borough of Camden. This includes refurbishment and extension of the existing building to provide additional commercial, business and service use (Class E) including external alterations, introduction of a rooftop terrace, new hard and soft landscaping, provision of cycle parking, provision of publicly accessible café space, and other associated works.

The existing building has a single level basement, ground floor, office floors 1 – 8, a substantial atrium, stepped terraces and roof plant area. The current project involves stripping the site back to largely shell and core and then completion of various modifications and refurbishments to provide CAT A office space. The completed building is to include a new centralised mechanical ventilation system.

The site is located in the centre of London and in a busy city centre environment. Theobald's Road itself is a busy throughfare utilised by cars lorries and buses and the site is surrounded by densely populated road networks. The site has car parking adjacent and a loading bay to the rear. As such there is the potential for vehicle pollution.

The site is also located less than 500m from Holborn and Russel Square underground stations which serve Piccadilly and Central underground lines. Train links can also be a source of airborne pollution, primarily from track wear generated particulates.

The site is located within the Camden Air Quality Management Area (AQMA) which has been in force for Nitrogen Dioxide and Particulate Matter (PM10) pollution since 2002.

External Air Pollution

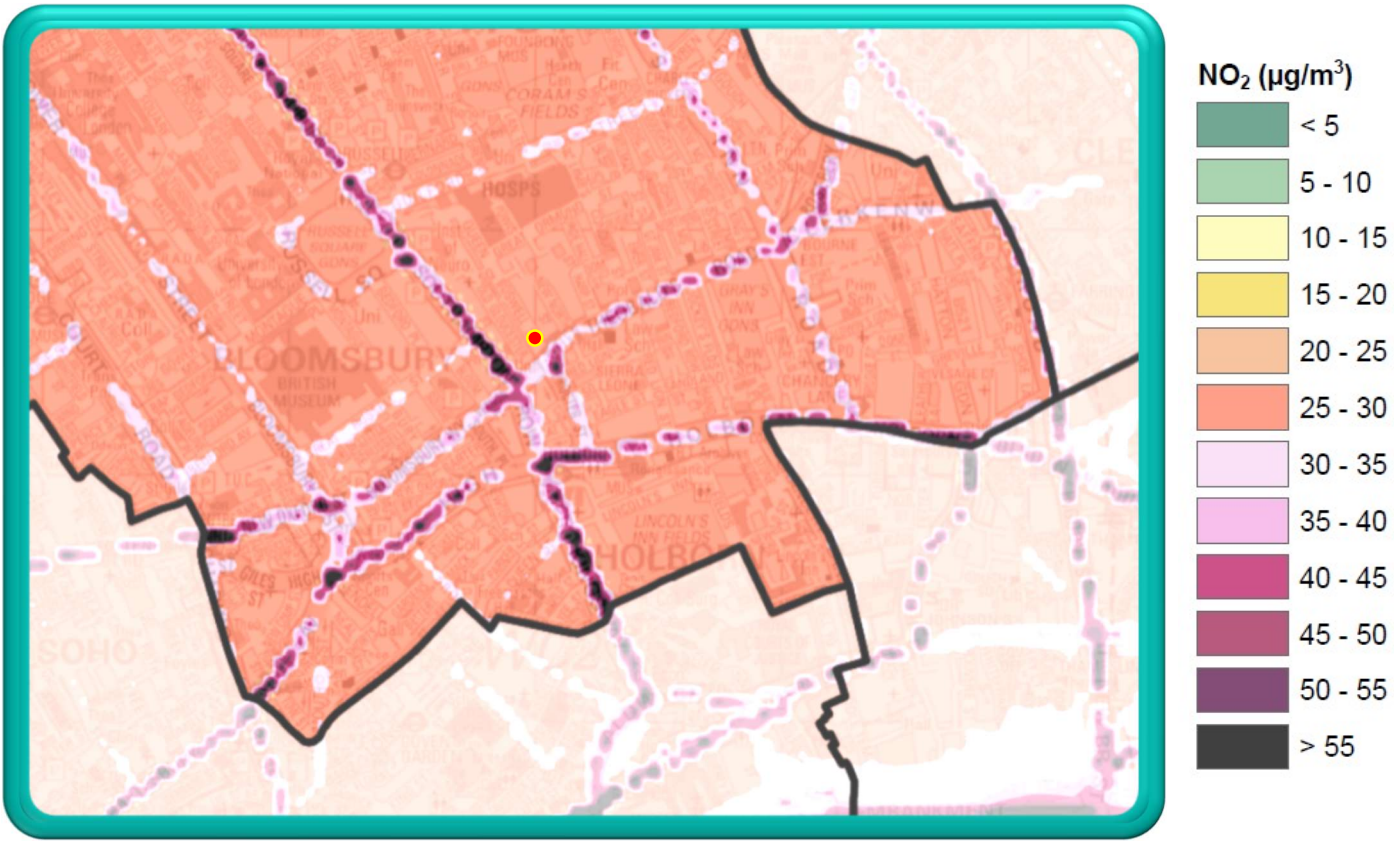
The external air quality of the site has been assessed using results and forecasts from the London Atmospheric Emissions Inventory (LAEI) 2019 and using www.londonair.org.uk. These extracts should be considered in the design of the ventilation strategy in order to provide the best possible indoor air quality.

Determinant	Measurement Type	Result (2019 Measured)	Result (2025 Forecast)
Nitrogen Dioxide (NO_2)	Annual Mean	35-40 ug m^3	25-30 ug m^3
Ozone (O_3)	Annual Mean	32 ug m^3	N/A
PM_{10}	Annual Mean	20-25 ug m^3	15-20 ug m^3
$PM_{2.5}$	Annual Mean	12.5-15 ug m^3	10-12.5 ug m^3

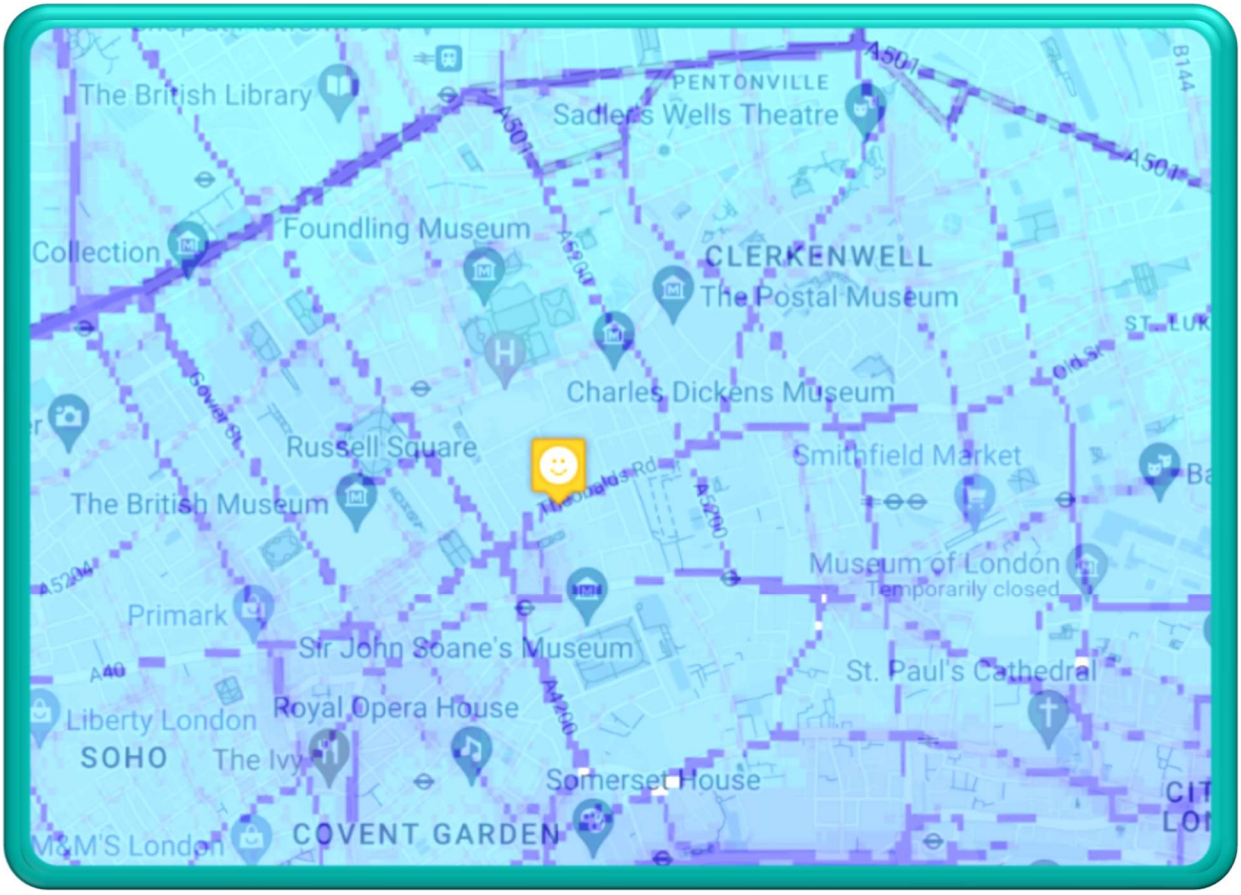
Nitrogen Dioxide (NO2)

2019 Measured

2025 Forecast



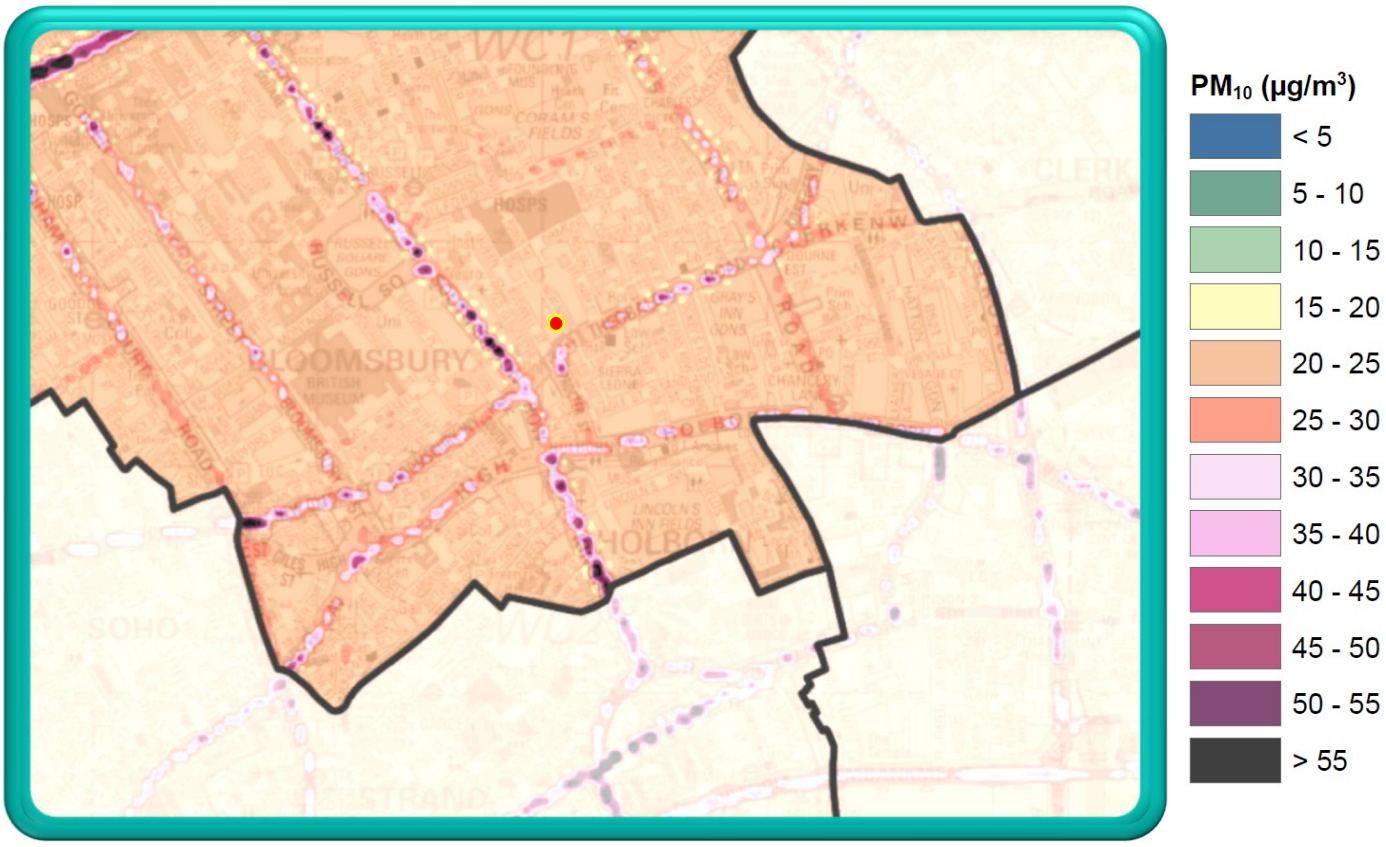
Ozone(O_3)



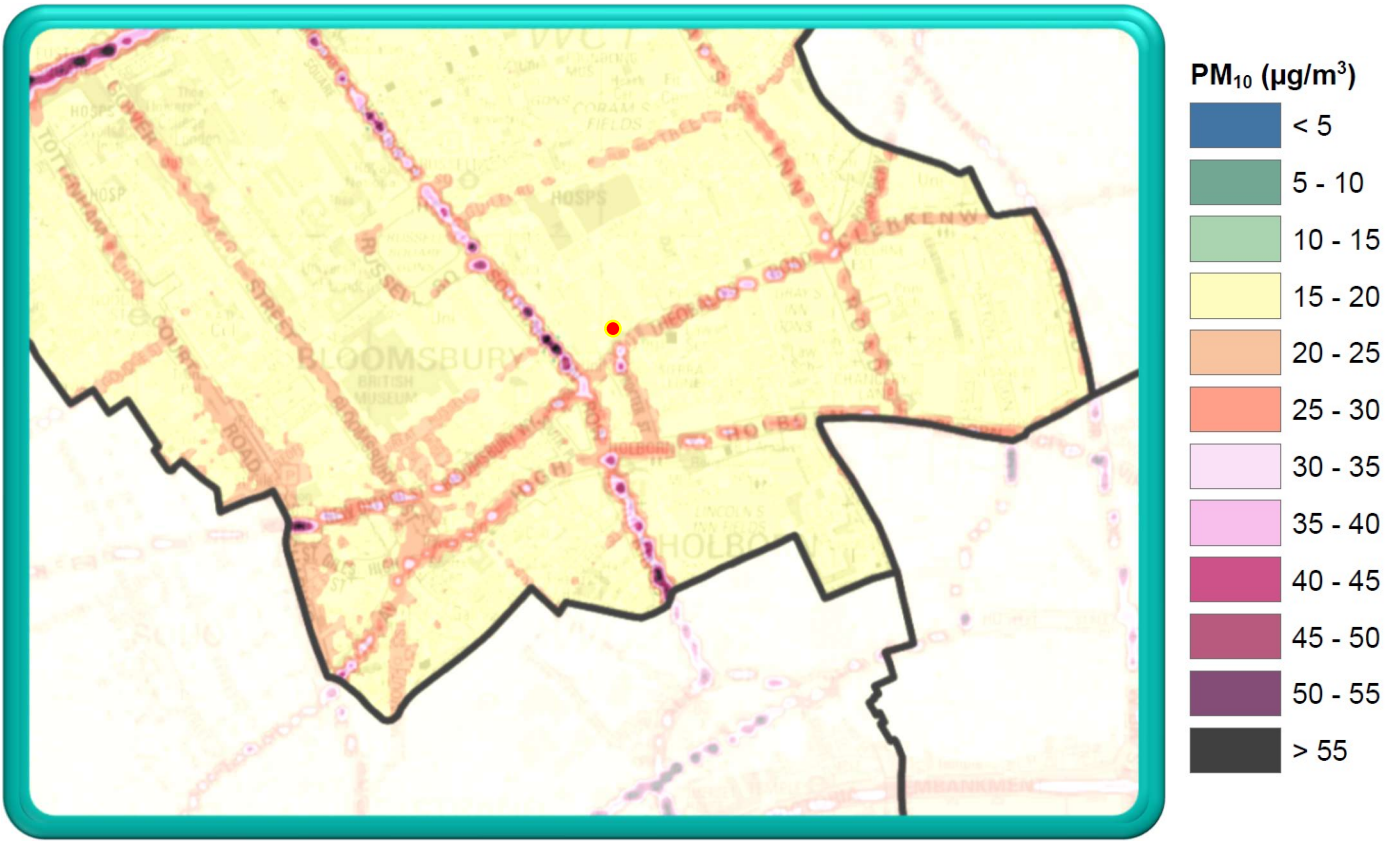
Key: Annual mean O3 air pollution for 2016, in microgrammes per metre cubed (ug/m3)

Particulate Matter <10 Microns (PM10)

2019 Measured

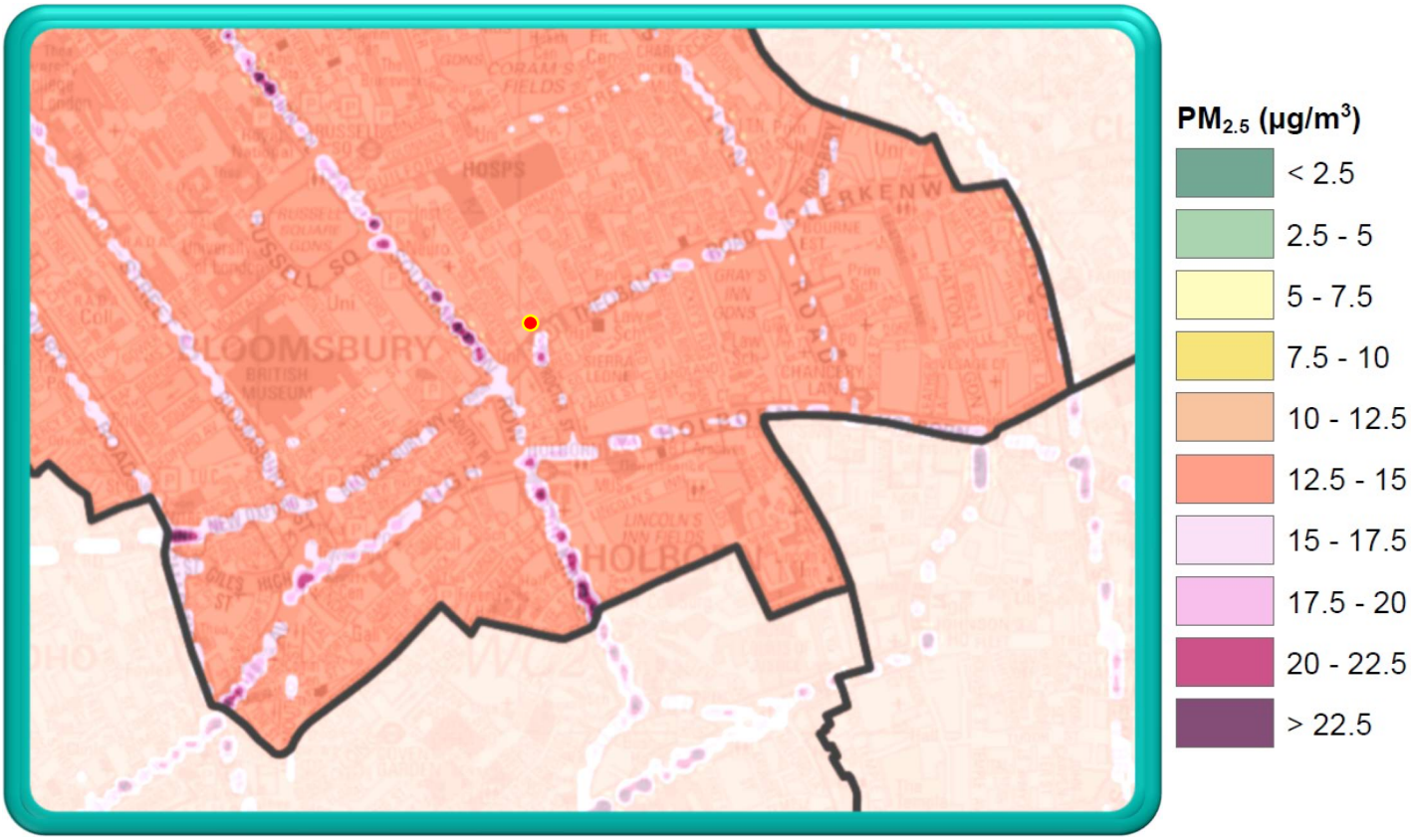


2025 Forecast

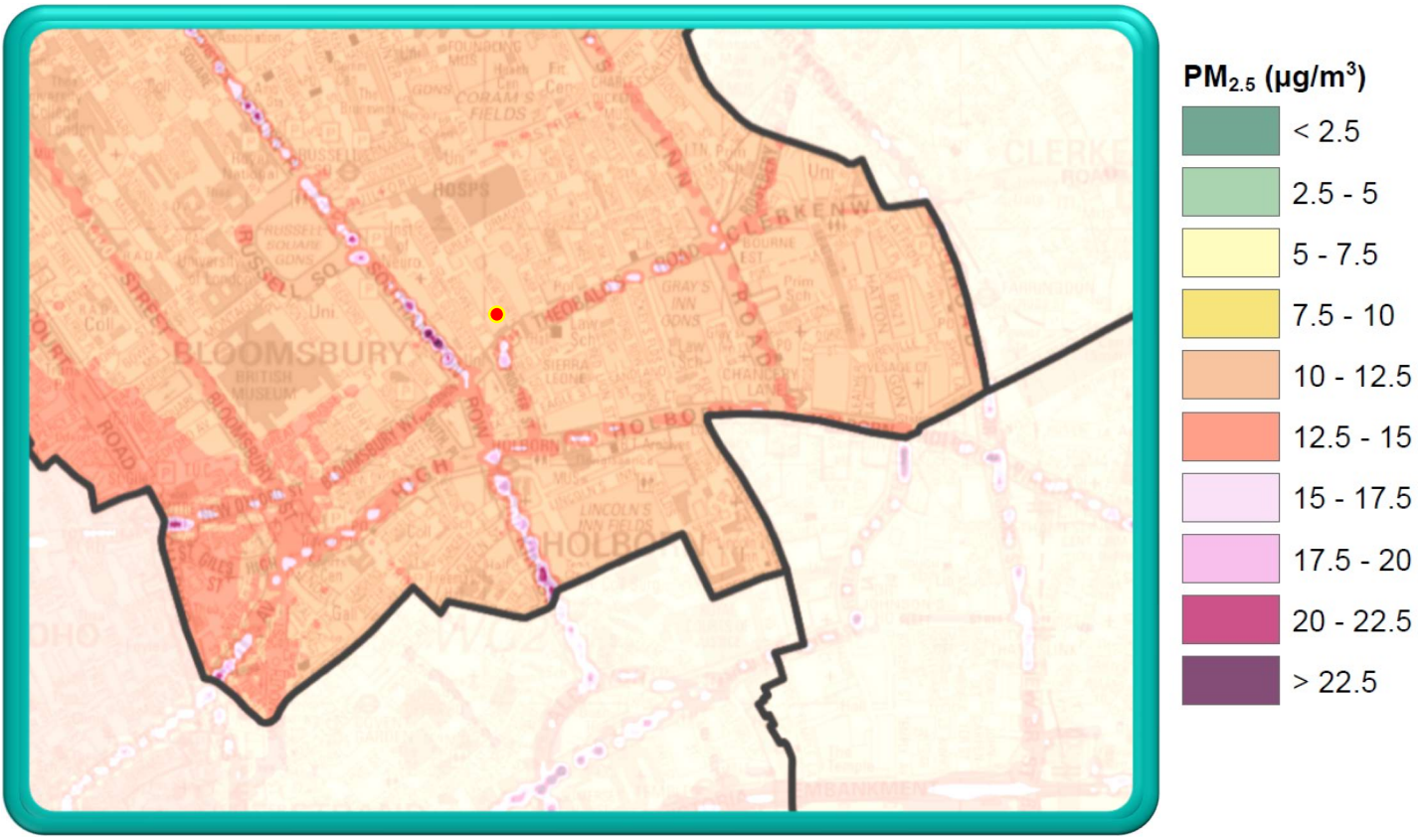


Particulate Matter <2.5microns (PM2.5)

2019 Measured



2025 Forecast



2. Background Information - Pollutants

There are many pollutants that could potentially be present inside buildings.

Studies are on-going regarding the long-term health effects of many pollutants. It is known that some individuals are more susceptible to the effects of pollutants than others, so it is difficult to ascertain definite levels at which health effects might become noticeable.

BREEAM Hea 02-Indoor Air Quality requires that particular attention is paid to Volatile Organic Compounds (VOCs) and Formaldehyde because many organic compounds (and Formaldehyde specifically) are known to cause cancer in animals.

This Indoor Air Quality Plan includes measures to address all likely sources of indoor air quality pollution.

VOCs and Formaldehyde

Volatile Organic Compounds (VOCs) are emitted as gases from certain solids or liquids and in buildings these are particularly notable when vapours off-gas from building materials and furnishings.

Sources include carpets, particle board, fabrics, paints and lacquers, cleaning supplies, pesticides, furnishings, glues and adhesives and certain types of office equipment.

Indoor concentrations are dependent on the age of the source, ventilation rate, temperature and humidity. Concentrations can vary by as much as 50% from day-to-day and season-to-season. Typically, indoor concentrations average two to five times the outdoor levels. However, during and several hours after certain activities (such as paint stripping), levels can be 1000 times higher than outdoors.

The ability of VOCs to cause health effects varies greatly from those that are highly toxic to those with no known health impact. As with other pollutants, the extent and nature of the health effect will depend on many factors including the level of exposure and the length of time exposed. Eye and respiratory tract irritation, headaches, dizziness, visual disorders and memory impairment are among the immediate symptoms that some people have experienced soon after exposure to some compounds.

Formaldehyde is a known irritant and sensitizer and hence is of particular concern.

Other Pollutants

There are many other pollutants that could potentially be present inside buildings.

As well as VOCs and Formaldehyde, BREEAM Hea02-Indoor Air Quality mentions the following to be potentially of concern:

2.1. Particulates including vehicle emissions, pollen, dust.

2.2. Gaseous oxides such as Carbon monoxide (CO), Carbon dioxide (CO_2), oxides of Nitrogen (NO_x), Sulphur dioxide (SO_2), and Ozone (O_3).

2.3. Airborne bacteria and micro-organisms and their spores.

2.4. Airborne inorganic substances such as metal fumes, Ammonia, Chlorine, Radon.

2.5. Unpleasant odours.

3. Removal of Contaminant Sources

The implications of the building location should be taken into account at the design stage in terms of potential sources of external pollution. So far as can be achieved within the scope of the project, these considerations should be taken into account in the refurbishment.

The following factors are among those that could be considered if the scope allows:

- The previous site history in terms of ground contamination from industrial or other processes.
- The nature and potential for pollution from nearby industrial processes.
- The size, usage and proximity of any adjacent farmland.
- Adjacent busy traffic routes.
- Whether the site is located in an area with an increased risk from Radon. This can be checked at www.ukradon.org/services/address_search .

The refurbishment designer should also consider the following requirements so far as can be achieved within the scope of the project:

3.1. If the mechanical ventilation provision is being replaced or up-graded, the building's air intakes and exhausts are over 10m apart to minimise recirculation and intakes are over 20m from sources of external pollution.

3.2. For naturally-ventilated buildings: openable windows/ventilators are over 10m from sources of external pollution.

3.3. The building has been designed to provide fresh air and minimise internal pollutants (and ingress of external polluted air into the building) in accordance with the criteria of the relevant standard for ventilation.

3.4. Construction materials, finishes and furnishings that emit low or zero VOCs should be chosen where possible and meet with the relevant European Standards as described within Table 20 / 21 'VOC criteria by product type' of BREEAM Hea 02- Indoor Air Quality – see Appendix Two of this report.

3.5. Areas of the building subject to large and unpredictable or variable occupancy patterns have CO_2 or air quality sensors specified and:

a. In mechanically ventilated spaces, the sensors are linked to the mechanical ventilation system and provide demand-controlled ventilation to the space.

b. In naturally ventilated spaces, the sensors either have the ability to alert the building owner/manager when CO_2 levels exceed the recommended set point, or are linked to controls with the ability to adjust the quantity of fresh air, i.e. automatic opening windows/roof vents.

3.6. HVAC equipment and ductwork should be protected from dust and other pollutants during installation and when in the vicinity of other construction/installation works.

3.7. Ventilation systems should be checked and cleaned as necessary prior to or during commissioning so that pollutants are not released into the building. There should be

a written report with photographic evidence of this, supported by surface sampling test results if the system has been cleaned.

4. Dilution and Control of Contaminant Sources

If it falls within the scope of the refurbishment project, the designer should ensure that the occupied spaces have a sufficient quantity of fresh or purified air.

If mechanical ventilation systems are installed to help achieve this, the design and maintenance of those systems must take into account the external environment and any potential for higher than normal levels of pollutants in the atmosphere. This, together with the requirements of the building users for indoor air quality (for example, healthcare premises may require higher standards) should drive the design of the ventilation system and its filtration systems. A summary of the mechanical ventilation provision at this site can be included in the Appendix section at the end of this report.

A guide to design targets for key indoor air quality indicators based on a typical office building with no unusual external or internal pollution sources is given in Table One in Appendix One of this plan. This table includes strategies for dealing with breaches of pollutant concentrations.

Recommended frequencies for a suitable monitoring programme will vary according to a number of factors, however a typical example is given in the later section of this plan entitled: Maintaining Indoor Air Quality In-Use: Indoor Air Quality Monitoring Programme.

Where low-emission building products (see Appendix Two of this report) cannot be selected or where there is uncertainty, the following guidance should be adopted during refurbishment works and fitting out:

4.1. If possible, store off-gassing furnishings and materials in well-ventilated spaces before installing. If possible, remove or at least loosen product coverings to maximise the exposed surface area of these items to fresh air for as long as possible.

4.2. Increase fresh air ventilation during construction/fitting out, especially during the use of high-emitting products such as paints, lacquers and adhesives or any product containing Methyl chloride.

4.3. Meet or exceed labelled precautions on products.

4.4. Avoid storage of opened containers of paints or similar materials within the spaces to be occupied or anywhere else for longer than is necessary.

4.5. Avoid storage of fuels in spaces to be occupied.

4.6. Do not mix products unless directed on labelling.

4.7. Minimise use of pesticides.

4.8. Making good of snagging defects should be avoided during and immediately prior to post-construction air quality testing.

4.9. Following the pre-occupancy flush-out (see below) care should be taken to avoid potential ingress of pollutants during external works that are likely to emit high levels of VOCs e.g. road surfacing with tarmac or external painting.

As part of the planning stage, consideration should be given to preventing contaminant sources which arise from the refurbishment works from affecting areas outside of the working zone.

This may include the protection of areas occupied by other tenants or under the control of the landlord.

Areas where refurbishment has already been completed should also be protected from the on-going works.

Typical measures may include as follows:

4.10. Prior to commencement of works, any centralised (i.e. landlord's) ventilation supply and extract ductwork should be capped off as necessary, with suitable controls in place to ensure that ductwork is not subject to contamination during the works. It will however be necessary to ensure that sufficient alternative ventilation is maintained within the works area and measures taken to confirm this.

4.11. Measures should be taken to prevent pollutants such as dusts, fumes etc from escaping from the works area and contaminating any areas outside of the working zone, so far as is reasonably practical.

4.12. The contractor should minimise sources of pollution arising from the works, (such as dusts) to a level as far as reasonably practical. Where appropriate to do so, the contractor should provide local exhaust ventilation equipment as necessary and ensure that this is suitably maintained and tested throughout the duration of the works.

4.13. Work areas and points of access should be segregated as far as is reasonably practical, i.e by sealing doors and ensuring contractors perform basic decontamination procedures prior to transiting from the working zone.

4.14. Procedures should be in place to ensure that waste arising from the works is covered / sealed if moved through occupied areas of the building and preferably arrangements made for waste to be moved via waste chutes externally where appropriate and practical to do so.

4.15. Once work is completed in one area, this should be protected from pollutants generated in other parts of the construction site, so far as is practicable. This can be achieved by closing and sealing doors and windows, for example.

5. Minimisation of internal air pollution through building design

The existing building ventilation and heating philosophy is “basement-up” – this permitted ductwork and services to ‘taper’ in sympathy with the building design, and typically achieves a proportional riser size on each floor. It does though draw fresh air at ground level where it is most polluted, and exhausts at roof level, impacting any modern WELL rating. Typically, air needs to be drawn above 4th to 5th floor level to be below acceptable pollution levels and achieve a suitable WELL rating. Major plant such as boilers and calorifiers were located in the basement, which occupies potentially lucrative lettable floor area.

A modern energy-efficient design solution is in contrast top-down; this requires roof-mounted plant and permits fresh, clean air to be drawn from roof level. This can combine with an electric-only strategy, replacing carbon-contributing fossil fuel plant with high efficiency air conditioning. We must consider that supply and extract ducts intertwine in risers, requiring increased plant and riser space at the upper levels and more consistent riser dimensions on each floor. Basement smoke ventilation requirement is also key – currently the building achieves this by natural ventilation and break-out panels.

The “top-down” ventilation strategy results in a key early design requirement to finalise major roof-top plant locations and associated risers, and permit supply and extract plant to be adjacent on the roof. This will maximise energy heat recovery using a heat-flywheel or similar, to minimise HVAC energy use.

Plant items are generally located in roof plant areas, with minimal basement plant. It is a key objective for the project to maximise lettable basement area, while also accommodating a reasonable roof terrace space. Extract ventilation fans are then positioned at roof level and the associated exhaust ductwork must terminate above the roof. This includes:

- WC extract.
- Smoke extract for the firefighting lobbies.
- Office tenant kitchenette extract.
- Plant space allocation for potential tenant commercial kitchen extract.

Office Ventilation

Centralised ventilation will be provided to all levels with Cat A office space. 4 no. AHUs will serve the office area, 2 no. units located on the 9th Floor plant deck, 1 no. unit on the 7th floor roof and 1 no. unit in the basement, viz:

Mech Plant	Location	Serving	Intake	Exhaust	Hyperlink
AHU-1	9th Floor plant deck	Central core west	9th	9th	9th Floor Main plant deck
AHU-2	9th Floor plant deck	Central core east	9th	9th	9th Floor Main plant deck
AHU-3	7th Floor terrace area	North East wing	9th	9th	AHU on 7th Floor
AHU-4	Basement	South West wing	7th	Basement	Basement MEP plant

Rooftop AHUs will be placed by crane during construction. Additionally, AHUs have been specified as sectional for ease of placement, and the ability to fit into lifts when these are available during construction, and for future maintenance.

The supply and extract air will be delivered through various risers as indicated on riser drawings and schedules.

To maximise floor to ceiling height in office areas, and avoid ducting running under the beams, it is proposed to locate horizontal supply ducts in the floor void. The floor void ductwork will be flat oval type, without flanges, with maximum height of 76mm to fit within the existing 100mm floor void. Supply air will be delivered to office space via floor grilles located at the perimeter of the space.

The extract on-floor duct will exit the riser at high level and finish locally with a bell mouth, thus avoiding large ducts running under the beams. These will be provided with motorised VAV boxes to allow an out-of-hours purge function where localised ventilation rates can be increased to 4 ACH. This is achieved by fully opening the VAV boxes to the zones that require purging whist closing the VAV boxes to other zones on the same system.

The supply ductwork will not be insulated as the air will be supplied at ambient temperatures, pre-heated by the AHU tempering coils which are supplied LPHW from the ASHPs. The centralised systems will, in addition to offices, provide ventilation to other areas including basement, ground and first floor common area, reception and atrium. The air handling units will include flywheel heat recovery and filtration to grade WELL F7, which equates to ASHRAE 52.2 MERV 13-14.

Toilet Ventilation Systems

A number of toilet ventilation systems will be provided.

- The main system will serve the central toilet core from 2nd floor to 8th Floor and will discharge at roof level. The duty /standby fan will be located in the roof plantroom. The system will run as a constant volume system. Makeup air for the extract will be via passive transfer from the office area.
- The 9th floor Pavilion WCs will have a local extract fan.
- The basement office superloo's will have a system to minimise duct runs. The duty / standby fan will be located in the plant area and will discharge via a basement floor high level louvre into the lightwell. The system will run as a constant volume system.
- Makeup air for the extract will be via passive transfer from the atrium area.
- The Ground floor disabled toilet at Reception will be connected to the basement shower/toilets extract system which is directly below.

Basement Showers Extraction

Due to the size of the basement shower / changing facility and the general dampness within the area, a standalone AHU and associated supply and extract system has been included for this area. The system discharges via duty/standby fans located at high level within the Bicycle storage area and subsequently discharges to the west basement light well. All individual cubicles and shower enclosure are provided with direct extract grilles. A branch connection will be provided to the ground floor reception toilets as this is located directly above the Shower rooms.

6. Procedures For Pre-Occupancy Flush-Out

After completion of refurbishment and application of finishes and ideally again after the installation of furnishings, the air in the building should be flushed out.

Windows and doors should be opened for as long as is reasonably practicable to maximise the release of any build-up of pollutants in the atmosphere. This should be for at least one working day and preferably for 24 hours.

This flushing out procedure can be enhanced by subsequently operating any mechanical ventilation system with minimal re-circulation (i.e. maximising the introduction of fresh air and the exhausting of circulated air).

A record should be made of these events and the length of flushing out time. This information will help in the event of any of the subsequent air sample tests showing a raised result.

If potential pollutants (e.g. sealants) are introduced after the flushing out procedure has taken place, consideration should be given to sealing off those areas so as not to affect air quality test results in any other locations. This should include isolating any re-circulating ventilation system. If these areas cannot be isolated, the presence of these additional pollutants should be noted.

7. Third Party Testing and Analysis – Timing

If testing for VOCs and Formaldehyde is to take place, this is usually commissioned by the developer prior to handover. However, depending on the terms of the contract, this testing may be completed by the future occupier. For example, if the developer only fits out to a shell finish, with completion works carried out by the prospective occupier.

Testing should whenever possible be carried out prior to occupation. This should ideally take place after the pre-occupancy flush-out as described in the previous section of this plan.

Indoor air quality testing should not take place at the same time as air tightness testing due to materials used in that process.

Prior to measurements being taken, the ventilation and heating systems should be operating for a period of time to ensure the relevant spaces in the building reach equilibrium in terms of their internal environmental conditions. Typically, this may take 12-24 hours.

The use of sealants should not be applied less than five days before testing takes place as these generate concentrated and relatively high levels of VOC.

If new finishes, fittings or furnishings that are likely to emit VOCs are installed after flush-out and equilibrium has been achieved (and assuming it is not practical to achieve equilibrium again before testing), the presence of any such materials should be noted at testing, so far as is practicable.

If new finishes, fittings or furnishings that are likely to emit VOCs are installed at a later date after testing, then testing should be repeated.

It is usually best for VOC and Formaldehyde testing to take place during the week leading up to handover.

Regarding other pollutants of potential concern, reference should be made to the later section of this plan entitled: Maintaining Indoor Air Quality In-Use: Indoor Air Quality Monitoring Programme.

8. Third Party Testing and Analysis – Method

If testing for VOCs and Formaldehyde is to take place, in order to satisfy the BREEAM (Building Research Establishment Environmental Assessment Method) scheme the testing and analysis for VOCs and Formaldehyde should be done in accordance with the following standards:

8.1. BS ISO 16000-4:2011 Diffusive sampling of Formaldehyde in air

8.2. BS ISO 16000-6:2011 VOCs in air by active sampling

8.3. BS EN 16017-2:2003 VOCs – Indoor, ambient and workplace air by diffusive sampling

8.4. BS ISO 16000-3:2011 Formaldehyde and other carbonyls in air by active sampling

BS ISO 16000-6 is equivalent to HSE MDHS 96 and BS ISO 16000-3 is equivalent to HSE MDHS 102. These are the most appropriate methods in this case.

9. Third Party Testing and Analysis – Locations

Samples should be taken in representative rooms that are likely to be occupied regularly (this therefore excludes storerooms, toilet areas, plant rooms, stairwells, corridors etc). One sample in a cellular office will suffice for all rooms of a similar size and specification. In larger rooms such as open-plan areas, further sampling locations might be appropriate to understand the homogeneity of the atmosphere.

Occupied rooms with significant differences in specification (for example different ventilation methods or different wall or floor finishes) should each be sampled.

For this project, we will assume that all room types of a similar designation have the same or very similar finishes – if this is not the case, then additional test locations for each type will be required. On this basis, we recommend testing at the following locations:

Basement Gym

Basement Flexible Space

Basement Building Managers Office

Ground floor reception area

Ground floor office area

7th floor office area

10. Guidance on the Interpretation of Testing Results (VOC and Formaldehyde)

For the purposes of BREEAM assessment, the results should be compared to the following limits:

10.1. Formaldehyde – less than or equal to 100 µg/m3 over a 30 minute time-weighted-average (TWA).

10.2. Total Volatile Organic Compounds (TVOC) – less than 500 µg/m3 over an 8-hour TWA.

It should also be noted that The Workplace Exposure Limit (WEL) in the UK for Formaldehyde is 2 parts per million (ppm – which is roughly equivalent to 2500 µg/m3).

There are WELs for individual VOCs but not for TVOC. However, European guidance indicates that TVOC levels over 3000 µg/m3 cause discomfort and levels above 25,000 µg/m3 are considered to be toxic.

Where levels are found to exceed these limits, the project team must confirm measure that have, or will be, undertaken in accordance with the IAQ plan, to reduce the TVOC and formaldehyde levels to within the able limits. Guidance on remedial action in the event of a raised result(s) can be found in Table One in the Appendix section of this report.

If re-testing is required, consideration must be given to the effect of occupancy related activities, as this may affect the results.

11. Maintaining Indoor Air Quality In-Use: Building Maintenance

The Building User Guide should include the following guidance for building occupiers with regard to establishing policies and procedures:

11.1. Recommendations for establishing policies and procedures that minimise the use of products within the building that emit VVOCs, VOCs and other air pollutants (e.g. cleaning materials and products used in maintenance activities).

11.2. Recommendations for establishing policies and procedures for performing regular cleaning of the building interior to prevent accumulation of dust and other pollutants.

11.3. Recommendations for establishing policies and procedures for the correct use of HVAC, mechanical ventilation or natural ventilation to avoid mould growth due to unappropriated temperature and relative humidity, and accumulation of other pollutants.

11.4. Recommendations for establishing policies and procedures for the correct use of exhaust systems installed in cooking areas to prevent accumulations of pollutants.

11.5. Recommendations for establishing policies and procedures for regular cleaning and maintenance of ventilation systems, including replacing filters and cleaning of heating/cooling coil surfaces, ductwork and humidifiers.

11.6. Recommendations for monitoring indoor air quality for the pollutants of concern including frequency, methodology and appropriate sampling locations.

The guide might also include recommendations for establishing regular testing of certain indoor air quality parameters. This would enable those responsible to demonstrate that compliant levels of indoor air quality were being maintained for the health and wellbeing of the occupants throughout the life cycle of the building. An example programme of regular testing can be found in the next section of this plan.

12. Indoor Air Quality Monitoring Programme

A monitoring programme should be established by the building occupiers to ensure that likely pollutants are being kept within control parameters. This should also be included within the Building User Guide.

BREEAM states that "impartial and objective measurement" should be implemented, which suggests this work should not be undertaken by the building's maintenance or ductwork cleaning contractors.

A programme suitable for this building is shown below.

1. *Quarterly the locations set out in section 8 sample the following indoor air quality parameters and monitor on-going trends:*

    - *Dust particles*
    - *Carbon dioxide*
    - *Carbon monoxide*
    - *Nitrogen dioxide*
    - *Hydrogen sulphide*
    - *Ozone*

2. *Annually monitor as above plus the following tests (in XYZ locations):*

    - *Bacteria and fungi in air*
    - *VOCs*
    - *Formaldehyde*
    - *Dust Mites*
    - *Radon (basement or ground floor only)*

It may be appropriate to measure regularly for other pollutants. The requirement for this should be identified by COSHH risk assessment.

If the building is in an area known to have an increased level of Radon (see the section titled Removal Of Contaminant Sources in this report), then regular sampling for this gas should be added to the programme.

The results of the monitoring should be compared against guidance shown in Table One of this plan, which includes recommended actions in the event of a breach of the recommended limit.

APPENDIX ONE: Table One

TABLE ONE: A GUIDE TO DESIGN TARGETS FOR KEY INDOOR AIR QUALITY (IAQ) INDICATORS BASED ON A TYPICAL OFFICE BUILDING

IAQ Parameter	Safe working limit	Target limit Note 2	Recommended action in the event of a breach
Particulates (general dust)	10 $mg.m^{-3}$ inhalable dust or 4 $mg.m^{-3}$ respirable dust Note 1	15 million particles of 0.5µm (microns) size	If levels exceed 70 million particles of 0.5µm size urgently re-test and investigate sources of potential pollution and take remedial action. If levels exceed 35.2 million particles of 0.5µm after re-test, investigate sources of potential pollution without delay and take remedial action. If levels exceed 15 million particles of 0.5µm monitor and if trends are repeated investigate sources of potential pollution and consider appropriate remedial action.
Carbon dioxide	5000 ppm Note 1	Below 1200 ppm	If levels exceed 2700 ppm take immediate action to reduce these by opening windows and increasing fresh air make-up to the affected space. Test again (within 48 hours if levels are initially above 5000 ppm) to monitor the effect of the remedial action. Consult an engineer with a view to seeking a permanent improvement in fresh air make-up. If levels are 1800-2699 ppm increase ventilation by opening windows and review fresh air make-up provisions. If levels are 1200-1799 no remedial action is necessary except to note the occurrence and to monitor the trend of test results. If the results are repeatedly in this range, consider whether improvements to fresh air provision can be easily made.
Carbon monoxide	20 ppm Note 1	5 ppm	If levels exceed 30 ppm, evacuate the space, urgently re-test, investigate the source and take remedial action to address before re-testing. If levels exceed 10 ppm after re-testing, take action to improve fresh air make-up, investigate the likely source and rectify. If levels exceed 5 ppm on several successive regular monitoring events, investigate possible sources with a view to remedial action.
Nitrogen dioxide	0.5 ppm	3 ppm	If levels exceed 3 ppm, re-test within seven days and if repeated, take action to improve fresh air make-up, investigate the likely source and rectify.
Hydrogen sulphide	5 ppm Note 1	1 ppm	If levels exceed 5 ppm, evacuate the space, urgently re-test, investigate the source and take remedial action to address before re-testing. If levels exceed 2 ppm after re-testing, take action to improve fresh air make-up, investigate the likely source and rectify. If levels exceed 1 ppm on several successive regular monitoring events, investigate possible sources with a view to remedial action.

IAQ Parameter	Safe working limit	Target limit Note 2	Recommended action in the event of a breach
Ozone	0.2 ppm (200 ppb) Note 1	40 ppb	If levels exceed 200 ppb, evacuate the space, urgently re-test, investigate the source and take remedial action to address before re-testing. If levels exceed 80 ppb after re-testing, take action to improve fresh air make-up, investigate the likely source and rectify. If levels exceed 40 ppb on several successive regular monitoring events, investigate possible sources with a view to remedial action.
Volatile Organic Compounds (VOCs)	25,000 µg/m3	3,000 µg/m3	If levels exceed 25,000 µg/m3, immediately ventilate the affected area(s) for as long as is practical. Then promptly investigate any apparent sources of contamination and take remedial action to address these. Then repeat the full flush out procedure and re-test the affected area(s) without undue delay. If levels exceed 3,000 µg/m3, thoroughly flush the affected area with fresh air, repeating the flush out procedure and consider re-sampling, depending on the number and extent of locations where raised results have been measured.
Formaldehyde	2 ppm Note 1	100 µg/m3 30-min TWA	If levels exceed 2 ppm, evacuate the space, repeat the flush out procedure, urgently re-test, investigate the source and take remedial action to address before re-testing. If levels exceed 100 µg/m3, thoroughly flush the affected area with fresh air and consider re-sampling.
Bacteria and fungi in air	1000 cfu/m^3 Note 4	1000 cfu/m^3 Note 5	Where any one bacteria or fungi result breaches the limit shown, then investigation including possibly inspection and further sampling (either of ductwork surfaces or additional air sampling or both) should be made to identify the likely cause and to determine appropriate remedial action such as cleaning.

NOTES TO TABLE ONE:

1. Based on UK Workplace Exposure Limits 2018 8-hour exposure (check country specific limits, UK limits taken from Directive 2017/164/EU, the fourth Indicative Occupational Exposure Limit Values (IOELV) Directive)
2. Based on an amalgamation of informed opinion and/or experience of testing in similar environments
3. Based on CIBSE Guide TM26 taking four bacteria and four fungi samples at each test location
4. Based on one sample for bacteria and one for fungi at each test location on the basis that if any result shows a cause for concern this triggers further action.
5. Ammonia, Chlorine and metal fumes are not routinely tested unless these have been highlighted in a COSHH risk assessment.
6. Radon is not routinely tested unless the building is situated in a geographical area with an increased risk as mentioned earlier in this plan.

APPENDIX TWO: Table 20 / 21 (VOC criteria by product type) from Hea02

TABLE 20 / 21 - BREEAM 2014 / 2015 GUIDANCE

Product category A - Paints and varnishes	
Performance requirements	VOC content limit
Compliant performance standard	EU Directive 2004/42/CE ('Paints Directive')
Compliant testing standard	BS EN ISO 11890-2:2013 – Paints and varnishes – Determination of VOC content, Part 2 – Gas Chromatographic method
Manufacturer also to confirm	Paint to be fungal and algal resistant in wet areas e.g. bathrooms, kitchens, utility rooms

Product category B - Wood panels (including particle board, fibreboard including MDF, OSB, cement bonded particle board, plywood, solid wood panel and acoustic board)	
Option 1	
Performance requirements	Formaldehyde E1 class
Compliant performance standard	BS EN 13986:2004 Wood-based panels for use in construction - Characteristics evaluation of conformity and marking
Compliant testing standard	In accordance with Annex B of BS EN 13986:2004
Manufacturer also to confirm	The absence of prohibited wood preservatives/biocides.
Option 2	
Performance requirements	Formaldehyde level of 0.1mg/m^3
Compliant performance standard	1. BS EN ISO 16000-9:2006 Indoor air - Part 9: Determination of the emission of volatile organic compounds from building products and furnishing - Emission test chamber method. **OR** 2. Standard method for the testing and evaluation of volatile organic chemical emissions from indoor sources using environmental chambers, version 1.1 - Emission testing method for California Specification 01350, Californian Department for Public Health, 2010. Note: For either method the resultant emission/surface area obtained from the chamber test method must be extrapolated to predict what the emissions would be in a theoretical model room (as detailed in the standard) and this extrapolated emission rate compared with the required formaldehyde level of 0.1mg/m^3.
Manufacturer also to confirm	The absence of prohibited wood preservatives/biocides.

Product category C- Timber structures (e.g. glue laminated timber)	
Option 1	
Performance requirements	Formaldehyde E1 class
Compliant performance standard	BE EN 14080:2005 Timber structures - Glues laminated timber - Requirements
Compliant testing standard	In accordance with Annex B of BS EN 13986:2004
Option 2	
Performance requirements	Formaldehyde level of 0.1mg/m^3
Compliant performance standard	1. BS EN ISO 16000-9:2006 Indoor air - Part 9: Determination of the emission of volatile organic compounds from building products and furnishing - Emission test chamber method. **OR** 2. Standard method for the testing and evaluation of volatile organic chemical emissions from indoor sources using environmental chambers, version 1.1 - Emission testing method for California Specification 01350, Californian Department for Public Health, 2010. Note: For either method the resultant emission/surface area obtained from the chamber test method must be extrapolated to predict what the emissions would be in a theoretical model room (as detailed in the standard) and this extrapolated emission rate compared with the required formaldehyde level of 0.1mg/m^3.

Product category D - Wood flooring (e.g. parquet)	
Option 1	
Performance requirements	Formaldehyde E1 Class
Compliant performance standard	BS EN 14342:2005+A1:2008 Wood flooring - Characteristics, evaluation of conformity and marking
Compliant testing standard	In accordance with Annex B of BS EN 13986:2004
Option 2	
Performance requirements	Formaldehyde level of 0.1mg/m^3
Compliant performance standard	1. BS EN ISO 16000-9:2006 Indoor air - Part 9: Determination of the emission of volatile organic compounds from building products and furnishing - Emission test chamber method. **OR** 2. Standard method for the testing and evaluation of volatile organic chemical emissions from indoor sources using environmental chambers, version 1.1 - Emission testing method for California Specification 01350, Californian Department for Public Health, 2010. Note: For either method the resultant emission/surface area obtained from the chamber test method must be extrapolated to predict what the emissions would be in a theoretical model room (as detailed in the standard) and this extrapolated emission rate compared with the required formaldehyde level of 0.1mg/m^3.

Product category E - Resilient textile and laminated floor coverings (e.g. vinyl, linoleum, cork, rubber, carpet, laminated wood flooring)	
Option 1	
Performance requirements	Formaldehyde E1 Class
Compliant performance standard	BS EN 14041:2004 Resilient, textile and laminate floor coverings - Essential characteristics
Compliant testing standard	In accordance with Annex B of BS EN 13986:2004
Option 2	
Performance requirements	Formaldehyde level of 0.1mg/m^3
Compliant performance standard	1. BS EN ISO 16000-9:2006 Indoor air - Part 9: Determination of the emission of volatile organic compounds from building products and furnishing - Emission test chamber method. **OR** 2. Standard method for the testing and evaluation of volatile organic chemical emissions from indoor sources using environmental chambers, version 1.1 - Emission testing method for California Specification 01350, Californian Department for Public Health, 2010. Note: For either method the resultant emission/surface area obtained from the chamber test method must be extrapolated to predict what the emissions would be in a theoretical model room (as detailed in the standard) and this extrapolated emission rate compared with the required formaldehyde level of 0.1mg/m^3.

Product category F - Suspended ceiling tiles	
Option 1	
Performance requirements	Formaldehyde E1 Class
Compliant performance standard	BS EN 13964:2004+A1:2006 Suspended ceilings - Requirements and test methods
Compliant testing standard	In accordance with Annex B of BS EN 13986:2004
Option 2	
Performance requirements	Formaldehyde level of 0.1mg/m^3
Compliant performance standard	1. BS EN ISO 16000-9:2006 Indoor air - Part 9: Determination of the emission of volatile organic compounds from building products and furnishing - Emission test chamber method. **OR** 2. Standard method for the testing and evaluation of volatile organic chemical emissions from indoor sources using environmental chambers, version 1.1 - Emission testing method for California Specification 01350, Californian Department for Public Health, 2010. Note: For either method the resultant emission/surface area obtained from the chamber test method must be extrapolated to predict what the emissions would be in a theoretical model room (as detailed in the standard) and this extrapolated emission rate compared with the required formaldehyde level of 0.1mg/m^3.

Product category G - Flooring adhesives	
Performance requirements	Carcinogenic or sensitising volatile substances are substantially absent
Compliant performance standard	BS EN 13999-1:2013 Adhesives - Short term method for measuring the emission properties of low-solvent or solvent-free adhesives after application - Part 1: General procedure
Compliant testing standard	1. BS EN 13999-1:2013 Adhesives - Short term method for measuring the emission properties of low-solvent or solvent-free adhesives after application - Part 1: General procedure 2. BS EN 13999-2:2013 Adhesives - Short term method for measuring the emission properties of low-solvent or solvent-free adhesives after application - Part 2: Determination of volatile organic compounds 3. BS EN 13999-3:2007+A1:2009 Adhesives - Short term method for measuring the emission properties of low-solvent or solvent-free adhesives after application - Part 3: Determination of volatile aldehydes. 4. BS EN 13999-4:2007+A1:2009 Adhesives - Short term method for measuring the emission properties of low-solvent or solvent-free adhesives after application - Part 4: Determination of volatile diisocyanates.

Product category H - Wall coverings	
Performance requirements	• Vinyl chloride monomer (VCM) content • Formaldehyde level • Migration of heavy metals
Compliant performance standard	1. BS EN 233:1999 Wallcoverings in roll form - Specification for finished wallpapers, wall vinyls and plastic wall coverings 2. BS EN 234:1997 Wallcoverings in roll form - Specification for wallcoverings for subsequent decoration 3. BS EN 259-1:2001 Wallcoverings in roll form - Heavy duty wallcoverings - Part 1: Specifications
Compliant testing standard	BS EN 12149:1998 – Wall coverings in roll form. Determination of migration of heavy metals and certain other elements, of vinyl chloride monomer and of formaldehyde release.

All standards outlined in Table 20 / 21 above are standards recognised across Europe and internationally for VOC content and testing. In instances where a product is not assessed against the listed European or International standard, it is acceptable to use an alternative, nationally recognised, standard provided the following is met as a minimum:

1. *The performance level requirements required by the alternative standard are equivalent to or better than those specified in the standards in Table 20 / 21. For example, if a material containing formaldehyde has been added to the floor covering product as part of the production process, then the E1 emission measured for formaldehyde must be less than 0.124mg/m3 (as required by EN 14041:2004).*
2. *Where an alternative standard omits evaluation of a particular material, it is only acceptable to use the alternative standard in instances where the product does not contain that particular material.*

BREEAM assessors should seek confirmation from BRE Global prior to awarding credits for compliance with standards not listed in Table 20 /21 or previously approved as alternative nationally recognised standards.

Products with no formaldehyde containing materials

For some floor coverings and wood-based panels, the requirement for formaldehyde testing (referred to in the above criteria) does not apply to 'floor coverings to which no formaldehyde containing materials were added during production or post-production processing', or in the case of EN 13986:2004, wood-based panels.

As such, if a product manufacturer confirms that they have made a declaration of formaldehyde class E1 without testing (in writing or via a company product fact sheet or literature) then the product in question meets the BREEAM requirement relevant to formaldehyde testing. A declaration of E1 without testing is effectively confirmation from the manufacturer that formaldehyde emissions comply with the emission level requirements of the relevant standard(s) and therefore, evidence confirming the actual emission level(s) via testing will not be required by the assessor to demonstrate compliance with that particular requirement.

APPENDIX THREE: Pre-Occupancy Test Results (VOCs and Formaldehyde)

To be added after completion of post-construction sampling

APPENDIX FOUR: Task Assignment Planner

The tasks and responsibilities identified within this Indoor Air Quality Plan are normally assigned as follows. Assignments can be modified on a project specific basis.

Some elements may be identified as not applicable to the project, depending on final design and specifications and the scope of works.

Removal of Contaminant Sources		
Item Description	**IAQP Section**	**Responsibility** 1. Architect / Designer 2. Main Contractor 3. Consultant / Specialist
For air-conditioned and mixed-mode buildings: the building's air intakes and exhausts are over 10m apart to minimise recirculation and intakes are over 20m from sources of external pollution.	3	1
For naturally-ventilated buildings: openable windows/ventilators are over 10m from sources of external pollution.	3	1
The building has been designed to provide fresh air and minimise internal pollutants (and ingress of external polluted air into the building) in accordance with the criteria of the relevant standard for ventilation.	3	1
Construction materials, finishes and furnishings that emit low or zero VOCs should be chosen where possible and meet with the relevant European Standards as described within Table 20 / 21 'VOC criteria by product type' of BREEAM Hea 02-Indoor Air Quality.	3	1
Areas of the building subject to large and unpredictable or variable occupancy patterns have CO_2 or air quality sensors specified and: In mechanically ventilated spaces, the sensors are linked to the mechanical ventilation system and provide demand-controlled ventilation to the space. In naturally ventilated spaces, the sensors either have the ability to alert the building owner/manager when CO_2 levels exceed the recommended set point, or are linked to controls with the ability to adjust the quantity of fresh air, i.e. automatic opening windows/roof vents.	3	1
HVAC equipment and ductwork should be protected from dust and other pollutants during installation and when in the vicinity of other construction/installation works.	3	1
Ventilation systems should be checked and cleaned as necessary prior to or during commissioning so that pollutants are not released into the building. There should be a written report with photographic evidence of this, supported by surface sampling test results if the system has been cleaned.	3	2

Dilution and Control of Contaminant Sources		
Item Description	**IAQP Section**	**Responsibility** 1. Architect / Designer 2. Main Contractor 3. Consultant / Specialist
If possible, store off-gassing furnishings and materials in well-ventilated spaces before installing. If possible, remove or at least loosen product coverings to maximise the exposed surface area of these items to fresh air for as long as possible.	4	2
Increase fresh air ventilation during construction/fitting out, especially during the use of high-emitting products such as paints, lacquers and adhesives or any product containing Methyl chloride.	4	2
Meet or exceed labelled precautions on products.	4	2
Avoid storage of opened containers of paints or similar materials within the spaces to be occupied or anywhere else for longer than is necessary. Ensure that wastes are segregated and removed from site on a regular basis.	4	2
Avoid storage of fuels in spaces to be occupied.	4	2
Do not mix products unless directed on labelling.	4	2
Minimise use of pesticides.	4	2
All ventilation system components and ductwork is to be adequately sealed / protected from dust and other contaminants during installation and until commencement of testing & commissioning.	4	2
When work is completed in an area, the area should be protected from pollutants generated in other parts of the construction site so far as is practicable. This can be achieved by closing and sealing doors and windows for example.	4	2
Making good of snagging defects should be avoided during and immediately prior to post-construction air quality testing.	4	2
Following the pre-occupancy flush-out care should be taken to avoid potential ingress of pollutants during external works that are likely to emit high levels of VOCs e.g. road surfacing with tarmac or external painting.	4	2

Procedures for Pre Occupancy Flush Out		
Item Description	**IAQP Section**	**Responsibility** 1. Architect / Designer 2. Main Contractor 3. Consultant / Specialist
After completion of construction and application of finishes and ideally again after the installation of furnishings, the air in the building should be flushed out. Windows and doors should be opened for as long as is reasonably practicable to maximise the release of any build-up of pollutants in the atmosphere. This should be for at least one working day and preferably for 24 hours.	5	2
This flushing out procedure can be enhanced by subsequently operating any mechanical ventilation system with minimal re-circulation (i.e. maximising the introduction of fresh air and the exhausting of circulated air).	5	2
A record should be made of the flushing events and the length of flushing out time.	5	2
If potential pollutants (e.g. sealants) are introduced after the flushing out procedure has taken place, consideration should be given to sealing off those areas so as not to affect air quality test results in any other locations. This should include isolating any re-circulating ventilation system. If these areas cannot be isolated, the presence of these additional pollutants should be noted.	5	2

Third Party Testing and Analysis * (see note 1 below)		
Item Description	**IAQP Section**	**Responsibility** 1. Architect / Designer 2. Main Contractor 3. Consultant / Specialist
If testing for VOCs and Formaldehyde is to take place, the testing and analysis should be carried out in accordance with the following standards: BS EN ISO 16000-4:2011 Diffusive sampling of Formaldehyde in air BS EN ISO 16000-6:2011 VOCs in air by active sampling BS EN ISO 16017-2:2003 VOCs – Indoor, ambient and workplace air by passive sampling BS ISO 16000-3:2011 Formaldehyde and other carbonyls in air by pumped sampling BS ISO 16000-6 is equivalent to HSE MDHS 96 and BS EN ISO 16000-3 is equivalent to HSE MDHS 102. These are the most appropriate methods in this case. Samples should be taken in representative rooms that are likely to be occupied regularly and as stipulated within the Indoor Air Quality Plan. Testing should whenever possible be carried out prior to occupation. This should ideally take place after the pre-occupancy flush-out. Indoor air quality testing should not take place at the same time as air tightness testing due to materials used in that process. Testing locations will be identified within the Indoor Air Quality Plan. Samples should be analysed by a UKAS accredited laboratory.	6	3
Prior to measurements being taken, the ventilation and heating systems should be operating for a period of time to ensure the relevant spaces in the building reach equilibrium in terms of their internal environmental conditions. Typically, this may take 12-24 hours.	6	2
The use of sealants should not be applied less than five days before testing takes place as these generate concentrated and relatively high levels of VOC.	6	2
If new finishes, fittings or furnishings that are likely to emit VOCs are installed after flush-out and equilibrium has been achieved (and assuming it is not practical to achieve equilibrium again before testing), the presence of any such materials should be noted at testing, so far as is practicable.	6	2
If new finishes, fittings or furnishings that are likely to emit VOCs are installed at a later date after testing, then testing should be repeated.	6	2
Should testing identify non-compliant conditions, the pre occupancy flush out should be repeated. Depending on the levels measured, along with the extent of any contamination, then re-testing may be considered necessary. Formaldehyde – less than or equal to 100 µg/m3 over a 30 minute time-weighted-average (TWA). Total Volatile Organic Compounds (TVOC) – less than 300 µg/m3 over an 8-hour TWA.	6	3

*** Note 1 - If testing for VOCs and Formaldehyde is to take place, this is usually commissioned by the developer prior to handover. However, depending on the terms of the contract, this testing may be completed by the future occupier. For example, if the developer only fits out to a shell finish, with completion works carried out by the prospective occupier.**