Indoor Air Quality Plan

The Courtyard Building

SWECO

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Limitations and Exceptions

This report and its findings should be considered in relation to the terms and conditions proposed and scope of works agreed between Sweco UK Ltd and the Client.

The Conclusions section of the report provide an overview and guidance only and should not be specifically relied upon until considered in the context of the whole report.

This report provides available factual data for the Site and the surrounding area at the time of the study and as obtained by the means described in the text. The data is related to the Site on the basis of the Site location information provided by the Client.

It should be appreciated that the information that has been made available to date, is not necessarily exhaustive and that further information relevant to the proposed Site usage may be provided which could change the overall findings.

This report is prepared and written in the context of the proposals stated in the introduction to this report and should not be used in a differing context. Furthermore, new information, improved practices and legislation may necessitate an alteration to the report in whole or in part after its submission. Therefore, with any change in circumstances or after the expiry of one year from the date of the report, the report should be referred to us for re-assessment and, if necessary, re-appraisal.

1. Introduction

1.1 General

Sweco UK Ltd was commissioned by Great Portland Estates ('Client') to prepare an Indoor Air Quality Plan (IAQP), in fulfilment of the requirements of Building Research Establishment Environmental Assessment Method (BREEAM) 2014 Technical Manual Credits Hea02, for the proposed refurbishment at 1 Alfred Place, London, WC1E 7EB ('Site').

The scheme consists of a redevelopment of three currently separate buildings into one cohesive commercial offering. The scheme seeks to provide high quality commercial reception and retail use at ground and basement levels, four floors of flexible office space, and rooftop space consisting of boardroom type offices, terraces, and amenity spaces (herein referred to as 'Proposed Development').

1.2 Location and Description

The Site is located between Tottenham Court Road and Alfred Place, London. The approximate grid reference of the Site is 529645 (Easting) and 181731 (Northing). The surrounding area comprises predominantly commercial properties.

The Site falls within the administrative area of London Borough of Camden (LBC).

1.3 Objectives

Within the BREEAM Technical Manual (version SD216 – Issue: 2.0 – Issue Date: 03/11/2020) for the BREEAM UK Refurbishment and Fit-out 2014[1] there is a prerequisite for an IAQP to be produced under the Hea02 – 'Indoor Air Quality' credit.

This IAQP satisfies the corresponding requirements for the IAQP credit as set out within the HEA02 section of the BREEAM Technical Manual (version SD216 – Issue: 2.0 – Issue Date: 03/11/2020) for the BREEAM UK Refurbishment and Fit-out 2014.

1.4 Report Structure

This document is structured in such a way to address the following topics, as required in the aforementioned BREEAM Technical Manual:

- 1(a) Removal of contaminant sources.
- 1(b) Dilution and control of contaminant sources.
- 1(c) Procedures for pre-occupancy flush-out.
- 1(d) Protection of Heating Ventilation and Air Conditioning (HVAC) systems from sources of pollution during refurbishment/fit-out works e.g. dust.

[1] BRE GLOBAL LTD, 2020. BREEAM UK Refurbishment and Fit Out 2014: Technical Manual SD216 (Non-domestic buildings)

- 1(e) Procedures for protecting the indoor air quality for areas outside of the refurbishment or fit-out zone that may be affected by the refurbishment/fit-out works.
- 1(f) Procedures for identifying and implementing third part testing and analysis required to ascertain that the contaminant sources have been removed effectively before occupancy.
- 1(g) Commitments for maintaining indoor air quality in-use, e.g. maintenance and cleaning of the HVAC system, ductwork and filters.

In addition to these minimum requirements, this IAQP includes a review of likely ambient air quality at the Site and makes recommendations to promote good indoor air quality.

2. Removal of Contaminant Sources

A review of potential sources of airborne contamination will enable the identification and minimisation or elimination of sources of indoor air pollution that should be taken into consideration as part of the Proposed Development.

2.1 Ambient Air Quality

Indoor air quality is affected by the external ambient air quality through the ways in which external air mixes with internal air via natural or mechanical means. External air quality is comprised of a combination of local pollutant emission sources, such as road transport emissions, or emissions from combustion processes through a stack/chimney, and pollutant emissions that are transported into the area from further away by meteorological conditions (background concentrations).

The proximity to, and quantity of emissions from each local source, combined with the effects of meteorology (e.g. wind speed and direction) and character of the surrounding landscape (urban canyon, rural fields, etc.) dictate the level of ambient air quality at sensitive receptors.

As such, it is important to quantify the likely external air quality at the Site to understand the potential impacts on indoor air quality. Sources of information to identify the likely external air quality at the Site include:

- Local authority monitoring data.
- Department of Environment Food and Rural Affairs' (Defra) 1km x 1km background pollutant concentration maps.

Furthermore, a review of the nearby potential pollutant sources, including road transport, combustion plant or industrial processes is necessary to determine if the fresh air intakes into the Proposed Development, such as openable windows or air inlets for the mechanical ventilation system, are suitably located, or are mitigated to an extent where the pollutant source will not adversely impact indoor air quality.

2.1.1 National Air Quality Objectives

Following the UK's exit from the EU, the *Environment (Legislative Functions from Directives) (EU Exit) Regulations 2019*[2] sets legally binding limits for ambient concentrations of air pollutants that impact public health such as particulate matter (PM_{10} and $PM_{2.5}$) and nitrogen dioxide (NO_2).

The Air Quality Strategy (AQS) establishes the UK framework for air quality improvements and reflects the increasing understanding of the potential health risks associated with poor air quality and the benefits that can be gained from its improvements. In England, the *2007 AQS*[3] has now been replaced with *The Air Quality Strategy for England 2023*[4].

[2] The Environment (Amendment etc.) (EU Exit) Regulations 2019 No.458

[3] Defra (2007) Air Quality Strategy

[4] Defra (2023) The Air Quality Strategy for England

The National Air Quality Objectives (NAQOs) for the aforementioned key pollutants considered in this assessment are enacted by the *Air Quality (England) Regulations 2000*[5] and are given in **Table 2.1.** The national objectives are numerically identical to the European limit values, enacted through the *Air Quality Standards Regulations 2010*, with the exception of $PM_{2.5}$. For $PM_{2.5}$, the limit value was amended (tightened) in 2020 by The *Environment (Miscellaneous Amendments and Revocations) (EU Exit) Regulations 2020*[6].

Following the departure of the UK from the EU, the *Environment Act 2021*[7] makes provision about targets, plans, and policies for improving the natural environment, including air quality. The Act gives the Secretary of State the power to set long-term, legally binding air quality targets of at least 15 years in duration. Long-term targets have been set within the first *Environmental Improvement Plan 2023* (EIP)[8] pursuant to Section 10(6) of the Act. These legal targets specifically relate to $PM_{2.5}$ and have been transposed into law via The Environmental Targets (Fine Particulate Matter) (England) Regulations 2023:

- Annual Mean Concentration Target - a maximum concentration of 10 µg/m^3 to be met across England by 2040.
- Population Exposure Reduction Target - a 35% reduction in population exposure by 2040 (compared to a base year of 2018).

The EIP also sets an interim annual mean concentration target of 12 µg/m^3, to be achieved by January 2028, but is not legally binding. Under the Environment Act 2021, the environment secretary will be required to review the UK Air Quality Strategy at least every five years, and to publish an annual progress report to parliament.

Under Part IV of the Environment Act 1995[9], local authorities must review and document local air quality within their area by way of staged appraisals and respond accordingly, with the aim of meeting the air quality objectives defined in the *Air Quality Regulations*. This is referred to as the Local Air Quality Management (LAQM)[10] regime.

The LAQM regime requires that local authorities that identify exceedances of any air quality objective(s) within their geographical area must designate an Air Quality Management Area(s) (AQMA) and produce an Air Quality Action Plan (AQAP) setting out measures they intend to take to work towards the objectives.

[5] The Air Quality (England) Regulations 2000 No. 928
[6] The Environment (Miscellaneous Amendments and Revocations) (EU Exit) Regulations 2019 No.559
[7] UK Government (UK) (2021) Environment Act 2021. Available at: https://www.legislation.gov.uk/ukpga/2021/30/contents/enacted
[8] Defra (2023) Environment Improvement Plan. Available at: https://www.gov.uk/government/publications/environmental-improvement-plan
[9] The Environment Act 1995. UK Parliament.
[10] Local Air Quality Management overview. Available at: https://laqm.defra.gov.uk/

Table 2.1: Relevant objectives set out in the Air Quality Strategy for the protection of human health

Pollutant	Averaging period	Concentrations (μg/m³)	To be achieved by
Nitrogen Dioxide (NO_2)	Annual mean	40	31st December 2005
	1-hour mean	200 (not to be exceeded more than 18 times per year)	31st December 2005
Particulate Matter (PM_{10})	Annual mean	40	31st December 2004
	24-hour mean	50 (not to be exceeded more than 35 times a year)	31st December 2004
Particulate Matter ($PM_{2.5}$)	Annual Average	20	1st January 2020
	Annual Mean (Legal Target)	10	1st January 2040
	Annual Mean (Interim Target) *	12	1st January 2028
**** Interim target** for $PM_{2.5}$ is not legally binding.*			

The NAQOs apply to ambient air where there is relevant exposure to the public over the associated averaging period(s). LLAQM technical guidance[11] published by Defra, states where the NAQOs apply, as detailed in **Table 2.2**.

Table 2.2: Locations where air quality objectives apply

Averaging Period	Objectives Should Apply at:	Objectives Should Generally Not Apply at:
Annual mean	All locations where members of the public might be regularly exposed. Building façades of residential properties, schools, hospitals, care homes etc.	Building façades of offices or other places of work where members of the public do not have regular access. Hotels, unless people live there as their permanent residence. Gardens of residential properties. Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.

[11] London Local Air Quality Management Technical Guidance LLAQM.TG (19). October 2019. Mayor of London.

Averaging Period	Objectives Should Apply at:	Objectives Should Generally Not Apply at:
24-hour mean and 8-hour mean	All locations where the annual mean objective would apply, together with hotels. Gardens of residential properties*	Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.
1-hour mean	All locations where the annual mean and: 24 and eight-hour mean objectives apply. Kerbside sites (for example, pavements of busy shopping streets). Those parts of car parks, bus stations and railway stations etc. which are not fully enclosed, where members of the public might reasonably be expected to spend one hour or more. Any outdoor locations where members of the public might reasonably expect to spend one hour or longer	Kerbside sites where the public would not be expected to have regular access.
15-min mean	All locations where members of the public might reasonably be exposed for a period of 15 minutes.	

* – Such locations should represent parts of the garden where relevant public exposure to pollutants is likely, for example where there is seating or play areas. It is unlikely that relevant public exposure to pollutants would occur at the extremities of the garden boundary, or in front gardens, although local judgement should always be applied.

The LAQM guidance states that in the absence of site-specific monitoring, exceedance of the 1-hour mean NO_2 objective is likely to occur where annual mean concentrations are in excess of an annual mean concentration of 60 µg/m^3.

The annual mean objectives do not apply at commercial and retail receptors. Therefore, in this assessment, predicted annual mean NO_2 concentrations at identified receptors will be compared to the guideline value (60 µg/m^3) with respect to assessing potential exceedances of the 1-hour mean NO_2 objective at the Proposed Development.

2.1.2 Local Authority Review

LBC has declared the whole borough as an Air Quality Management Area (AQMA). The AQMA is declared for exceedances of the annual mean nitrogen dioxide (NO_2) and daily mean particulate matter (PM_{10}) air quality objectives.

2.1.3 Local Authority Monitoring Data

LBC undertakes monitoring of NO_2, PM_{10} and $PM_{2.5}$ using both automatic monitoring and passive diffusion tubes (NO_2) at several locations across the

Council area, details of which are discussed in the following sections. The most recent data have been obtained from LBC's Air Quality Annual Status Report for 2023[12].

Whilst the data capture at monitoring sites was largely unaffected by the Covid-19 pandemic, it is considered that the data measured during 2020 and 2021 are not representative of a normal year given the impact of lockdown measures. Therefore, 2023 is the most representative year at the time of reporting.

2.1.3.1 Automatic Monitoring

There are two automatic monitoring sites within 1km of the Proposed Development. The nearest automatic monitoring site is BL0 at Russel Square Gardens in Bloomsbury, located 0.6km to the northeast of the Proposed Development. Details of the two automatic sites are presented in **Table 2.3**.

Table 2.3: Automatic Monitoring Results

Site ID	Site Type	Distance from Site (km)	Pollutant	Annual mean µg/m^3 2019	2020	2021	2022	2023
BI0 (Russel Square Gardens)	Urban Background	0.6	NO_2	32	28	27	26	24
			PM_{10}	18	16	16	17	13
			$PM_{2.5}$	11	9	9	9	8
CD9 (Russel Square Gardens)	Euston Road	0.9	NO_2	**70**	**43**	**48**	**45**	**46**
			PM_{10}	22	18	19	21	18
			$PM_{2.5}$	14	11	11	12	9

Note: Exceedance of the annual mean NAQO of 40µg/m^3 for NO_2 are highlighted in **bold.**

The Proposed Development and the majority of properties in the surrounding area are for commercial use and, as such, it is the 1-hour mean objective for NO_2 that is applicable at the building façade. Monitoring site BI0 has not exceeded the 1 hour mean objective between 2019-2023 and is situated at an urban background location. Meanwhile, CD9 exceeded the 1 hour mean objective in 2016, 2017 and was very close to exceeding in 2018 but has remained well below the threshold since 2019. However, site CD9 is situated at a roadside location on Euston Road which experiences a greater volume of traffic than Tottenham Court Road or other roads adjacent to the Site, hence the data at CD9 are not representative.

For PM_{10}, the 24-hour mean objective is applicable at the building façade for commercial receptors. There were no exceedances of the 24-hour mean objective for PM_{10} between 2019-2023 at either monitoring sites.

[12] Available at: https://www.camden.gov.uk/documents/d/guest/camden-2023-air-quality-annual-status-report-final-v2

2.1.3.2 Diffusion Tube Monitoring

In 2023 LBC undertook diffusion tube monitoring at 262 sites across Camden. There are 31 diffusion tube locations within 1km of the Proposed Development.

The diffusion tube data for those sites for 2019-2023 is presented in **Table 2.4.**

Table 2.4: Diffusion Tube Monitoring 2019-2023

Site ID	Site Type	Distance from Site (km)	Annual Mean NO_2 Concentration ($\mu g/m^3$)				
			2019	2020	2021	2022	2023
CAM81	Kerbside	0.1	**62.6**	**43.3**	**44.2**	**40.0**	**43.9**
CAM15	Roadside	0.2	-	-	24.1	24.3	26.5
CAM13	Roadside	0.2	-	-	23.0	22.6	24.5
CAM14	Roadside	0.3	-	-	26.2	27.0	31.7
CAM86	Kerbside	0.3	**49.6**	29.5	32.9	30.8	29.5
CAM310	Roadside	0.5	-	-	-	-	34.4
CAM79	Urban Background	0.6	33.9	26.8	22.2	23.9	21.3
CAM311	Roadside	0.7	-	-	-	-	28.5
CAM241	Roadside	0.7	-	34.2	33.1	31.3	32.6
CAM243	Roadside	0.7	-	30.3	27.1	26.8	32.0
CAM242	Roadside	0.7	-	32.1	27.9	28.5	26.4
CAM80	Roadside	0.7	**49.5**	35.3	34.3	30.2	27.7
CAM245	Roadside	0.7	-	35.9	30.2	31.0	35.9
CAM252	Roadside	0.7	-	27.7	25.2	25.6	27.5
CAM248	Roadside	0.8	-	**44.4**	37.9	**42.6**	**50.9**
CAM251	Roadside	0.8	-	29.3	23.9	26.6	29.3
CAM312	Roadside	0.8	-	-	-	-	**40.5**
CAM189	Roadside	0.8	**40.0**	32.2	29.6	29.7	32.5
CAM249	Roadside	0.8	-	29.4	26.8	28.4	31.9
CAM247	Roadside	0.8	-	31.3	25.7	26.6	29.6
CAM246	Roadside	0.8	-	**46.3**	38.1	**43.9**	**49.6**
CAM244	Roadside	0.8	-	31.0	25.0	26.9	29.4
CAM313	Roadside	0.8	-	-	-	-	29.3
CAM250	Roadside	0.8	-	26.7	23.7	25.5	30.0
CAM182	Roadside	0.8	**43.8**	32.0	27.6	29.6	30.1
CAM319	Roadside	0.9	-	-	-	-	31.5
CAM316	Roadside	0.9	-	-	-	-	34.9

Site ID	Site Type	Distance from Site (km)	Annual Mean NO_2 Concentration ($\mu g/m^3$)				
			2019	2020	2021	2022	2023
CAM196	Roadside	1.0	38.6	30.1	27.2	26.2	28.5
CAM71	Roadside	1.0	**65.3**	**46.6**	**46.5**	**43.2**	**47.5**
CAM301	Roadside	1.0	-	-	-	27.9	27.2
CAM46	Roadside	1.0	-	-	23.8	22.9	23.1

Note: Exceedance of the annual mean NAQO of 40µg/m^3 for NO_2 are highlighted in **bold**.

The closest monitoring location to the Proposed Development is CAM81 situated on Tottenham Court Road at a kerbside location. This diffusion tube exceeded the annual mean objective of 40 µg/m^3 consistently over the period reviewed. However, due to its proximity to the road it will have likely measured higher concentrations than at the façade of the Site facing Tottenham Court Road. After 2019 all concentrations are below 60µg/m^3, indicating that there are no exceedances of the 1 hour objective.

Other monitoring locations CAM13, CAM14 and CAM15 are also within approximately 300m of the Proposed Development at roadside locations. These diffusion tubes all began monitoring in 2021 and have recorded concentrations well below the annual mean objective. These locations are also on more minor roads that would be more representative of the Alfred Place facade of the Site.

As the Proposed Development is commercial, the 1 hour mean objective applies at this location. An annual mean above 60µg/m^3 would indicate a likely exceedance of the 1 hour mean. As all concentrations near to the Site were below 60µg/m^3 in 2022 and 2023 (post-covid), there are no likely exceedances of the NO_2 1 hour mean.

2.1.4 Defra Background Concentrations

The Defra background maps[13] were used to assess the current background concentrations of NO_2, PM_{10} and $PM_{2.5}$ in the study area. The resource provides estimated annual mean background concentrations of key pollutants at a resolution of 1x1km for the UK. Mapped background concentrations from the grid squares within the study area for the current year of 2024 for NO_2, PM_{10} and $PM_{2.5}$ are 35.9 µg/m^3, 18.6 µg/m^3 and 12.1 µg/m^3, respectively.

2.2 Local Sources of Air Pollution

Local pollutant sources in the vicinity of the Proposed Development's air inlets can influence the quality of indoor air quality. Details of the proposed ventilation system have been provided by the Client.

A review of the nearby transport (road, rail and aviation) sources, energy and industrial sources which could impact the air inlets is provided in the sections below.

[13] Available at: https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2018

2.2.1 Transport Emissions

The closest road emission sources to the Proposed Development are Tottenham Court Road, Store Street and Alfred Place. There is no car parking on Site.

The nearest London Underground station entrance is Goodge Street, located approximately 130m to the northwest of the Site.

The Proposed Development is not situated close to aviation sources. The nearest airport is London City Airport, located approximately 12.5km to the east of the Site.

Air inlets to the building should be located as far as practicable from the source of emissions. There are no primary concerns over the locations of the proposed vents on the basement and ground floors which face Alfred Place provided the ambient monitoring has indicated NO_2 concentrations well below the objective.

2.2.2 Major Industrial Sources

A review of the available information held by the Environment Agency (EA) indicates that there are no major industrial sources (Part A1 processes) in LBC. Any Part B processes within the LBC administrative area will be regulated by LBC and controlled under the Environmental Protection Act 1990.

2.2.3 Other Sources

Outdoor smoking should be prohibited within 10 meters of the façade of the building, especially from entrances and air inlet locations for the mechanical ventilation system.

2.3 Internal Sources

Building and fit-out materials can be a significant source of volatile organic compounds (VOCs) and formaldehydes, which may adversely affect indoor air quality and the wellbeing of occupants. Potential sources of VOCs and formaldehydes should be removed from the building by the specification of low VOC materials, wherever practicable.

2.3.1 Recommended Measures to Minimise Indoor Air Pollution

The following criteria should be specified within any contracts agreed with the subcontractors:

- Zero or low VOC drywall primer/sealer, paint, caulks, adhesives, sealants and wood finishes applied on the Site.
- Paints used in kitchens, toilets, locker rooms or other areas of rooms where water may be used, should contain substances affording fungal and algal resistance, in compliance with the BREEAM guidance. Alternatively, it is recommended that the requirement for resistant paint is ‘designed out’ of kitchen areas for example by the use of splashbacks. It is recommended that any such design measures are approved by the BREEAM assessor.
- Formaldehyde-free composite wood products including plywood and plasterboard.
- Flooring that does not contain phthalate compounds.
- Furnishings that do not emit VOCs or formaldehydes.

- Chairs free of polybrominated diphenyl ether (PBDE) based flame retardants.
- Any residual or waste paints and solvent should be removed from the Site as soon as practicable following completion of the required work (if possible, on a daily basis).

The relevant TVOC and Formaldehyde emission standards for materials to be used during the construction are provided in **Appendix A**.

3. Dilution and Control of Contaminant Sources

This section focuses on minimising the ingress of external pollutants and removing/minimising the sources of internal pollutants to reduce and regulate levels of indoor air pollutants in buildings. Moreover, consideration should be provided on the building ventilation and its mitigating impact upon indoor air quality levels.

3.1 Proposed Ventilation

Office ventilation

Office area ventilation shall be provided by five Air Handling Units (AHUs) at roof level which have local intake and exhaust air connections to each floor. These will supply fresh air to a raised floor via heat recovery AHUs (with integrated heat pumps) or through ceiling mounted fan coil units in other areas.

There is a life safety generator currently located on the roof however this will only turn on the event of a fire when AHUs will automatically turn off. The need for the generator may also be omitted at the next planning stage.

Some of the existing windows are openable but they are not being used as part of the ventilation strategy.

Basement ventilation

Basement area ventilation shall be provided by an Air Handling Unit (AHU) with air intake and exhaust air connections located on the façade facing Alfred Place at basement level.

Ground floor and basement ventilation

Ground floor area ventilation shall be provided by an Air Handling Unit (AHU) with air intake and exhaust air connections located on the façade facing Alfred Place at higher ground floor level.

3.2 Recommended Measures to Minimise Ingress of External Pollutants

As detailed in Section 2.1, pollutant concentrations are not predicted to exceed the 1-hour mean NO_2 air quality objective. The 1-hour mean objective is applicable to buildings falling under land use class A (office). The main source of pollution to the Proposed Development is likely to be from road transport sources from Tottenham Court Road.

Buildings should be designed to provide sufficient ventilation to maintain satisfactory indoor air quality. This is reflected in requirement F1 of approved document F of the Building Regulations 2010, which indicates that "…*There shall be adequate means of ventilation provided for people in the building*".

Approved Document F Appendix D states that air intakes should be located as far as possible from boiler and generators flues and preferably at a lower height. Air intakes should be located as far as possible from air handler exhausts.

Hea 02 ‘Minimising sources of air pollution’ states that the buildings air intakes and exhausts should be at least 10m apart to avoid recirculation. Air intakes should be at least 10m from sources of pollution.

3.2.1 Dilution of Contaminant Sources

The ventilation strategy of a building should be effective in both removing pollutants as well as diluting them. Several factors need to be taken into account when designing the ventilation strategy such as:

- Hygiene areas, toilets, shower areas, cleaners’ rooms, areas holding soiled clothes and laundry should be mechanically ventilated and slightly negatively pressurised relative to adjacent spaces. This also assists odour control.
- Recirculation of air contaminated by anything other than from normal human activity (i.e. CO_2, moisture from exhalation) such as from kitchens and fume cupboards, should be prevented.
- Extract outlets should be designed to avoid risk of unintentional recirculation into a supply inlet or natural ventilation opening. Extract systems or transfer arrangements should be designed to ensure there is a minimum possibility of back draughts from one area to another.
- Areas of buildings with large and unpredictable or variable occupancy patterns should be fitted with CO_2 sensors to ensure adequate ventilation is maintained. However, the Proposed Development is not considered likely to experience ‘large and unpredictable or variable occupancy’ as the development consist of commercial use only.

4. Procedures for Pre-Occupancy Flush Out

This procedure aims to ensure that the pre-occupancy flush out process removes residual sources of pollution which may have accumulated in the building during construction, and higher concentrations of pollutants which may be released by new products such as sealants, pressed wood and textiles (when they are installed). This makes sure that any subsequent testing is carried out in conditions which are representative of indoor air quality, this should be when the building is completed and has been cleaned.

There should be an allowance for a minimum of seven days between instigating the flush-out procedure and occupying the building. ‘Flushing Out’ is typically carried out for a minimum of seven days. ‘Flushing Out’ should be conducted in consultation with the M&E engineer, by operating the mechanical air supply and extraction system continuously (24 hours per day). Normal air temperatures and humidities should be maintained in the building during flush out. This would flush out any contaminant from any internal sources.

5. Measures to Protect Ventilation System from Contaminant Sources

The ventilation system (in particular, the ductwork) delivered to the Site should be protected to prevent accumulation of dust, moisture and/or other contaminants during storage on the Site before installation. Measures could include wrapping units with plastic sheets or allowing parts to remain in their delivery boxes.

Openings for ventilation system should be protected (sealed or covered) once installed.

Where possible, pollutant sources (paints, sealers, adhesives, caulking, cleaners etc.) should be located away from supply ducts and absorptive materials.

6. Protecting Indoor Air Quality

As buildings near completion, the generation of dust and other air pollutants during the remaining construction activities should be minimised, to reduce the quantity of pollutants present in the building at ‘handover’ and the start of the occupation phase.

Temporary protective dust curtains should be provided to separate the work area from completed spaces. Additional measures, as detailed below, would help to prevent deposition of dust in the completed spaces:

- Walk-off mats should be provided for workers to prevent tracking dust and contaminants from the construction areas.
- The work areas should be kept dry to prevent condensation and minimise the potential for mould growth.
- Overshoes should be worn inside buildings to prevent the ‘track-in’ of mud.
- Dust movement within the buildings should be minimised and any visible dust should be cleaned up.
- Completed areas should be isolated from active construction as far as practicable.
- Paint should be allowed to dry for at least 48 hours before carpets are installed in the painted area.
- Carpets and other porous materials should also be covered and kept dry (during the subsequent fit-out stage).
- Timber, unless stored indoors, should be covered with a waterproof coating and stored off ground away from standing water.
- Regular cleaning of completed areas should be undertaken to prevent the build-up of dust.
- No materials intended for dry installation should be installed when wet.
- Materials should not be stored in rooms containing air-handling equipment unless they are to be used in that room.
- Measures to mitigate water ingress, such as temporary water barriers, should be utilised where required.
- Any standing water should be removed as soon as practicable.

7. Third Party Testing and Analysis

The aim of this section is to ensure that third party testing and analysis uses a recognised and accredited method of testing for different air pollutants, in addition to providing impartial and objective measurement results, which will clearly demonstrate levels of air pollution in the newly constructed building.

Testing should be carried out for formaldehydes and total volatile organic compounds (TVOCs) post-construction (but pre-occupancy) in representative occupiable rooms.

Multiple samples at the same location may be required, depending upon the performance of the measurement methods, and the required level of confidence in the value obtained. 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.

The requirements for the results are as follows:

- Formaldehyde concentration level should be measured post-construction (but pre-occupancy) and must be less than or equal to 100µg/m^3 averaged over 30 minutes (WHO guidelines for indoor air quality: Selected pollutants, 2012).
- TVOCs concentration level should be measured post-construction (but pre-occupancy) and must be less than 300µg/m^3 over eight hours, in line with Building Regulation requirements.
- Where TVOCs and formaldehyde levels are found to exceed the limits, the project team will need to confirm the measures that have, or will be taken, in accordance with the IAQP, to achieve full compliance with the requisite standards.
- The testing and measurement of the above pollutants should be carried out in accordance with the guidance provided in the BREEAM Technical Manual, and also the following standards, wherever relevant:
    - BS ISO 16000-4: 2011[14] Diffusive sampling of formaldehyde in air;
    - BS ISO 16000-6: 2011[15] VOCs in air by active sampling;
    - BS EN ISO 16017-2: 2003[16] VOCs - Indoor, ambient and workplace air by diffusive sampling.
    - BS ISO 16000-3: 20116[17] Formaldehyde and other carbonyls in air by active sampling.

Where VOC and formaldehyde levels are found to exceed the limits defined above, the Site project team should confirm what measures have, or will be taken, in accordance with the IAQP, to reduce the levels to within these limits. Re-testing should be undertaken as a matter of 'best practice'.

[14] British Standards Institution, BS EN ISO 16000-4: 2004 Diffusive Sampling of formaldehyde in Air

[15] British Standards Institution EN ISO 16000-6 VOC in Air by Active Sampling

[16] British Standards Institution BS EN 16017 –2:2003 VOCs- Indoor, Ambient and Workplace Air by Passive Sampling

[17] British Standards Institution BS EN ISO 16000-3: 2001 Formaldehyde and Other Carbonyls in Air by Pumped Sampling

8. Maintaining Indoor Air Quality In-use

This section aims to ensure that indoor air quality levels are maintained at compliant levels throughout the building's operational life cycle, to uphold the health and wellbeing of occupants/users.

Regular housekeeping and cleaning are recommended to control levels of deposited dust and prevent resuspension.

The building should be operated to a documented management system to ensure that maintenance such as inspection and changing of filters in air handling plant is carried out appropriately and in a timely manner. All relevant documentation should be available on the Site.

The relevant document for use during the operational phase of the Proposed Development should include a section to recommend procedures for minimising the use of TVOCs/formaldehyde emitting materials or substances within the building throughout operation.

Rooms with printers and photocopiers should be provided with sufficient ventilation to prevent the build-up of pollutants emitting from these units. According to ANSI/ASHRAE Standard 62.1-2013[18], "Ventilation for Acceptable Indoor Air Quality", the ventilation rate for these rooms should be at least 2.5 litres per second.

Regular inspection and maintenance of indoor air quality equipment should be conducted, including ventilation system protection and ventilation rate.

Ductwork and humidifiers should be cleaned on a regular and fully documented.

Safety meetings, signage and subcontractor agreements should be put in place to communicate the goals of this IAQP, where applicable.

Domestic water systems may interact with indoor air quality in terms of the potential for bio aerosol, particularly of the Legionella bacterium, the causative agent of Legionelloses including Legionnaires' disease. Any domestic water systems serving the building should be designed, operated and maintained by competent persons, and a Legionellosis risk assessment should be prepared.

[18] American National Standard Institute, ANSI/ASHRAE Standard 62.1-2013: Ventilation for acceptable indoor air quality

9. Conclusion

A design stage Indoor Air Quality Plan (IAQP) has been prepared in fulfilment of the criteria for Building Research Establishment Environmental Assessment Method (BREEAM) 2014 Credit HEA02, for the Proposed Development at 1 Alfred Place.

The IAQP includes consideration of the minimum content as specified under criterion 1 of Hea02; namely:

- 1(a) Removal of contaminant sources.
- 1(b) Dilution and control of contaminant sources.
- 1(c) Procedures for pre-occupancy flush-out.
- 1(d) Protection of Heating Ventilation and Air Conditioning (HVAC) systems from sources of pollution during refurbishment/fit-out works.
- 1(e) Procedures for protecting the indoor air quality of areas outside of the refurbishment or fit-out zone that may be affected by the refurbishment/fit-out works.
- 1(f) Procedures for identifying and implementing third party testing and analysis required to ascertain that the contaminant sources have been removed effectively before occupancy.
- 1(g) Commitments for maintaining indoor air quality in-use, e.g. maintenance and cleaning of the HVAC system, ductwork and filters.

The IAQP has collated and summarised information on the building design and specification and provided measures to reduce and dilute the egress of external pollutants, measures to minimise indoor air pollution and measures to manage contaminant sources during the construction and fit out stage.

Procedures for pre-occupancy flush out have been outlined and further consultation with the M&E Consultant should be undertaken prior to operating the flush out procedure.

Appendix A- Emission Criteria by Product Type

Table A1 Emission Criteria by Product Type

Emission Limit Formaldehyde	Total Volatile Organic Compounds (TVOCs)	Category 1A and 1B Carcinogens	Testing Requirement	Additional Requirements
Interior Paints and Coatings				
≤ 0.06 mg/m^3	≤ 1.0 mg/m^3	≤ 0.001 mg/m^3	EN16402[19] or ISO 16000-9[20] or EN 16516[21] or CDPH Standard Method v1.1[22]	Meet TVOC content limits (Table 20 Hea02) Paints used in wet areas should protect against mould growth
Wood-based Products (including wood flooring)				
≤ 0.06 mg/m^3 (non-MDF) ≤ 0.06 mg/m^3 (MDF)	≤ 1.0 mg/m^3	≤ 0.001 mg/m^3	ISO 16000-9 or EN16516 or CDPH Standard Method v1.1 or EN717-1[23] (formaldehyde emissions only)	N/A
Flooring Materials (including floor levelling compounds and resin flooring)				
≤ 0.06 mg/m^3	≤ 1.0 mg/m^3	≤ 0.001 mg/m^3	ISO10580[24] or ISO 16000-9 or EN 16516 or CDPH Standard Method v1.1	N/A

[19] BS EN 16402:2013. Paints and varnishes. Assessment of emissions of substances from coatings into indoor air - Sampling, conditioning and testing. BSI; 2013
[20] BS ISO 160009:2006. Indoor air part 9: Determination of the emission of volatile organic compounds from construction products and furnishing - Emission test chamber method. ISO; 2006
[21] EN 16516:2015. Construction products - Assessments of release of dangerous substances - Determination of emissions into indoor air. BSI; 2015.
[22] California Department of Public Health (CDPH). Standard method for the testing and evaluation of volatile organic chemical emissions from indoor sources using environmental chambers. Version 1.1. 2010.
[23] BS EN 717-1:2004. Wood-based panels. Determinations of formaldehyde release - Formaldehyde emission by the chamber method. BSI; 2004.
[24] ISO 10580:2010. Resilient, textile and laminate floor coverings- Test method for volatile organic compound (VOC) emissions.

Emission Limit Formaldehyde	Total Volatile Organic Compounds (TVOCs)	Category 1A and 1B Carcinogens	Testing Requirement	Additional Requirements
Ceiling, Wall, and Acoustic and Thermal Insulation Materials				
≤ 0.06 mg/m^3	≤ 1.0 mg/m^3	≤ 0.001 mg/m^3	ISO 16000-9 or EN 16516 or CDPH Standard Method v1.1	N/A
Interior Adhesives and Sealants (including flooring adhesives)				
≤ 0.06 mg/m^3	≤ 1.0 mg/m^3	≤ 0.001 mg/m^3	EN 13999 (Parts 1-4)[25],[26],[27],[28] or ISO 16000-9 or EN 16516 or CDPH Standard Method v1.1	N/A

[25] BS EN 13999-1:2013. Adhesives. Short term method for measuring the emission properties of low-solvent or solvent-free adhesives after application - General procedure. BSI; 2013.
[26] BS EN 13999-2:2013. Adhesives. Short term method for measuring the emission properties of low-solvent or solvent-free adhesives after application - Determination of volatile organic compounds. BSI; 2013.
[27] 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 - Determination of volatile aldehydes. BSI; 2007.
[28] 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 - Determination of volatile diisocyanates. BSI; 2007