Air Quality Assessment & Indoor Air Quality Plan

Paragon Asra (PA) Housing

Strathmore Centre
Strathmore Road
Teddington
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SRE

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Executive Summary

This Air Quality Assessment and Indoor Air Quality Plan has been produced by SRE Ltd to address the London Plan, London Borough of Richmond Upon Thames' (LBRuT) Planning Policy and draft Air Quality SPD as well as BREEAM New Construction 2018 HEA02 Criteria for the proposed mixed-use development at Strathmore Centre, Teddington.

The Proposed Development is within the Air Quality Management Area (AQMA) declared by LBRuT for exceedances of both the NO_2 and PM_{10} objectives.

Construction-phase and use-phase impacts on air quality have been considered and will be minimised as far as possible for both the internal air quality of the Proposed Development, and any contributions to external air quality.

The energy strategy for the nursery does not incorporate a gas-fired or solid-/oil-fuelled strategy, therefore there are no associated NO_x and PM_{10} emissions. The residential units have a gas-fired energy strategy for heating and hot water. However, low NO_x boilers[1] will be implemented in line with Planning Policy and BREEAM requirements.

The Proposed Development is 'air quality neutral' according to the Greater London Authority's (GLA) benchmarking assessment methodology for building emissions. A range of mitigation measures have been discussed and will be implemented where the transport emissions exceed the benchmark emissions.

For this reason, the overall impact of the Proposed Development on air quality is therefore judged to be not significant.

[1] <40mg/kWh as specified within the Sustainable Design and Construction SPG

1.0 Introduction

Air pollution is the presence of materials or substances in the air which can cause detrimental effects to both human health and the environment. The most dangerous forms of air pollution are Particulate Matter (PM_{10}) and Nitrogen Dioxide (NO_2) due to their high concentrations and negative impact on health. In the UK, power generators and transport are the largest human-made sources of Particulate Matter (PM). NO_2 is also a human-made pollutant released through combustion processes such as heating, power generation and vehicle/ship engines[2].

This Air Quality Assessment (AQA) and Indoor Air Quality Plan (IAQP) has been written by SRE Ltd to address the planning policy and BREEAM requirements for the 'Proposed Development' at the Strathmore Centre, Teddington.

The site is located within an Air Quality Management Area (AQMA) due to the Borough's high levels of NO_2 and PM_{10}[3] and the Proposed Development is considered a major development. The site is 350m east of Fullwell train station and is surrounded by predominantly low-rise education and residential buildings.

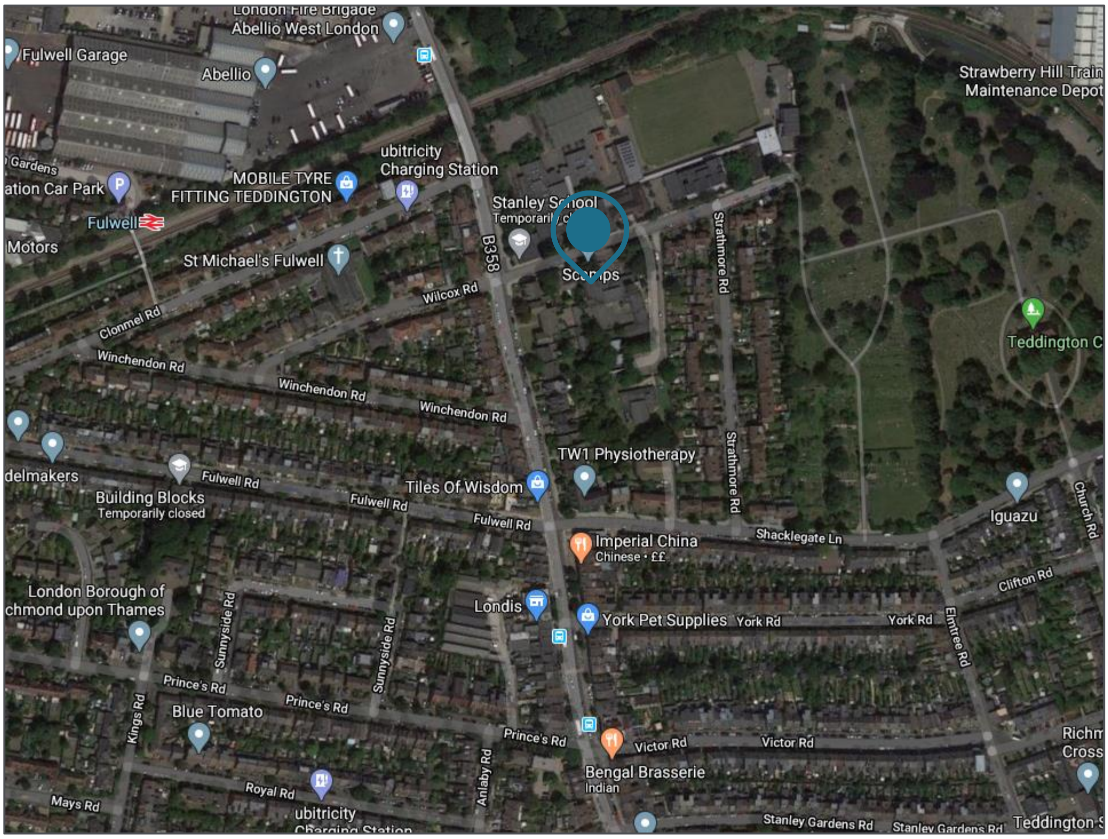

Figure 1 - Location of Proposed Development in Teddington.

1.1 Proposed Development

The site is located on Strathmore Road on the outskirts of Teddington town centre, currently occupied by the Scamps Nursery. The Proposed Development consists of three buildings – Block A and B are three-storey residential buildings, while the other is a single-storey, nursery to replace the existing 'Scamps Nursery' on-site. The two residential blocks will provide a range of 1-3 Bedroom flats, in total 30 no. new dwellings. All units will

[2] Demystifying Air Pollution in London: Full Report, January 2018.
[3] London Borough of Richmond Upon Thames Air Quality Action Plan 2019-2024

be affordable and will include 80% London Affordable Rent and 20% Shared Ownership. The development will also contain on-site parking and turning space, cycle and refuse storage, and soft landscaping.

See Appendix A for a site plan and the architect's drawings for further details.

Figure 2 – Block A residential space North Elevation (living-architects)

Primarily a multi-residential development, it is essential that indoor air quality allows the residents occupying the building to live in a clean environment which is not detrimental to their health. The nursery space must also provide functional, safe, and healthy conditions for its staff and children, while also minimising any potential impact on the surrounding area.

1.2 Planning Context

As the Proposed Development is located within the London Borough of Richmond upon Thames, the London Plan, and LBRuT Local Plan and draft Air Quality SPD apply to the site. Table 1 summarises the policies regarding air quality for the Proposed Development.

Planning Policy	Requirement
The (draft) New London Plan (2019) (Due to be adopted in 2020)	Policy SI1 (formerly Policy 7.14 of The London Plan (2016)) Design solutions to prevent or minimise increased exposure to existing air pollution and make provision to address local problems of air quality. Developments should at least be Air Quality Neutral. Reduce emissions from the demolition and construction of buildings following '*The control of dust and emissions for construction and demolition SPG'*. Ensure that where emissions need to be reduced, this is done on-site.
London Borough of Richmond Upon Thames Local Plan	Policy LP 22 Non-residential development >100sqm to achieve BREEAM 'Excellent'. Residential development to complete Sustainable Construction Checklist SPD. Consider the installation of low or ultra-low NO_x boilers.
	Policy LP 10 Secure at least 'Emissions Neutral' development.

Table 1 - Planning policy summary for the Proposed Development

1.3 BREEAM

To address the Planning Policy of LBRuT LP 22, the Proposed Development is undertaking a BREEAM assessment for the nursery element using BREEAM NC 2018 methodology. An IAQP is required to achieve one credit within the Health and Wellbeing category (HEA02) for the scheme and has been written with the objective of minimising indoor air pollution once the building is occupied in order to encourage and support a healthy internal environment in line with the requirements of BREEAM.

The following items will be considered in the IAQP:

- Removal of contaminant sources
- Dilution and control of contaminant sources
- Procedures for pre-occupancy flush out
- Third party testing and analysis
- Maintaining good indoor air quality in-use.

1.4 Building Regulations Approved Document F: Ventilation.

The Proposed Development is being designed as mechanically ventilated for the residential blocks and will follow the requirements detailed in *Building Regulations Approved Document F: Ventilation* where applicable.

2.0 Removal of contaminant sources

This section explores the potential sources of indoor air pollutants and aims to diminish their potential impacts on indoor air quality. Through this approach, this should reduce the requirement to remove or dilute pollutants through ventilation strategies.

2.1 External Sources

The Proposed Development is located on a one-way public road, which leads to the busier Stanley Road (B358) in Teddington and is surrounded by the educational buildings (Stanley School) and other residential units.

Background Pollution Levels

Local background concentrations of Particulate Matter (PM_{10}/$PM_{2.5}$) and Nitrogen Dioxide (NO_2/NO_x) are relatively high in Teddington. In 2015, mean background concentrations were 15.45µg m^{-3} PM_{10}, 10.15µg m^{-3} $PM_{2.5}$, 22.34µg m^{-3} NO_2, and 33.04µg m^{-3} NO_x (Figure 3)[4]. According to the latest version of BREEAM (BREEAM NC 2018 methodology issue POL02 – Local Air Quality), these concentrations classify the area as a 'High Pollution Location' due to the high NO_x and PM_{10} emission levels.

Figure 3 - Concentrations of PM_{10}, $PM_{2.5}$, NO_2, NO_x (DEFRA UK Ambient Air Quality Interactive Map)

[4] DEFRA UK Ambient Air Quality Interactive Map

Furthermore, in 2000, the whole borough of Richmond Upon Thames was classified as an Air Quality Management Area (AQMA) due to historically high levels of NO_2 and PM_{10} pollutants[5]. Levels of NO_2 and PM_{10} failed to meet the National Air Quality Objectives concentration (Table 2) at some monitoring stations in Richmond, with exceedances predominantly located along the major road network and in town centres[6].

The majority of the air pollution in the AQMA derives from road traffic, although boilers (both domestic and industrial) and other more minor sources are also contributors[6]. Figure 4 shows the concentration of measured elevated NO_2 levels on the main roads in Teddington surrounding the Proposed Development[7].

Pollutant	Concentration ($\mu g\ m^{-3}$)	Averaging Period	Permitted exceedance each year
$PM_{2.5}$	25	1 year	N/A
PM_{10}	50	24 hrs	35
	40	1 year	N/A
NO_2	200	1 hour	18
	40	1 year	N/A

Table 2 - EU limit levels and National Air Quality Objectives for pollutants

Figure 4 - Average measured NO_2 in Teddington in 2016 (LAEI)[7]

[5] London Borough of Richmond Upon Thames's Draft Air Quality SPD
[6] London Borough of Richmond Upon Thames's Air Quality Action Plan 2019-2024
[7] GLA and TfL partnership to produce air quality datasets forming the London Atmospheric Emissions Inventory (LAEI).

Roads

Generally, the adjacent roads will have significant traffic levels and resulting pollutants may impact on the indoor environment of the Proposed Development. The site is located on a one-way street leading to the B358 which leads down to Teddington town centre and up to Fullwell town centre, so pollution levels as a result of nearby vehicular movement may be significant, as shown in Figure 4.

Car parking for the Proposed Development is being provided in line with the Richmond Parking Standards and London Plan, whereby there will be 30 no. residential spaces including 3 no. disabled bays and 6 no. electric car charging spaces, plus 4 no. visitor spaces. The nursery will provide 2 no. car parking spaces for staff, plus 2 no. additional drop-off spaces. This encourages the majority of building users to use the public transport systems or the excellent cycling facilities provided on site.

There are a limited public car parks nearby to the Proposed Development – namely the Fulwell Train Station Car Park, 350m west, however there is also some limited on-street parking on the adjacent roads.

According to the Transport Assessment written for the Proposed Development, there will likely be <u>no change</u> to the number of vehicle trips associated with the nursery, since this aspect is replacing the existing building and intends to function in the same way with no change in the number of staff or pupils[8].

The residential units of the Proposed Development will increase the number of total vehicle trips to the area with an estimated 75 no. vehicle trips generated over the course of a 12-hour day[8]. However, the transport assessment concludes that these are relatively small changes in traffic generation and will therefore have no material impact in terms of safety or operation of the local highway network. Therefore, there should be a limited increase in onsite pollution levels derived from domestic or servicing vehicular movement.

Section 8.0 uses the estimated number of trips to calculate the transport emissions for the Proposed Development as part of the Air Quality Neutral Assessment.

The Transport Assessment written by SW Transport Planning Ltd provides further details regarding the traffic and transport impacts of the Proposed Development, while measures to support sustainable travel will be set out in the Travel Plan for the site.

Wind

Based on 30 years of hourly weather model simulations, the main wind direction is predominantly from the South West (Figure 5). Thus, pollution from Central London is not blown towards the Proposed Development for most of the year, however some pollution from Heathrow Airport (to the north west) will likely be blown in the direction of the Proposed Development.

The largest proportion of air pollutants in Richmond comes from road transport sources, with smaller sources deriving from domestic heating and construction processes[9]. Any further air pollution produced from the site is also likely to be blown towards Central London due to the predominant south westerly wind. Thus, it is essential that pollution is minimised as far as possible to avoid any transfer to, and further pollution of Central London.

[8] SW Transport Planning Ltd Transport Assessment – p.21-22

[9] London Borough of Richmond Upon Thames's Air Quality Action Plan 2019-2024, p.4

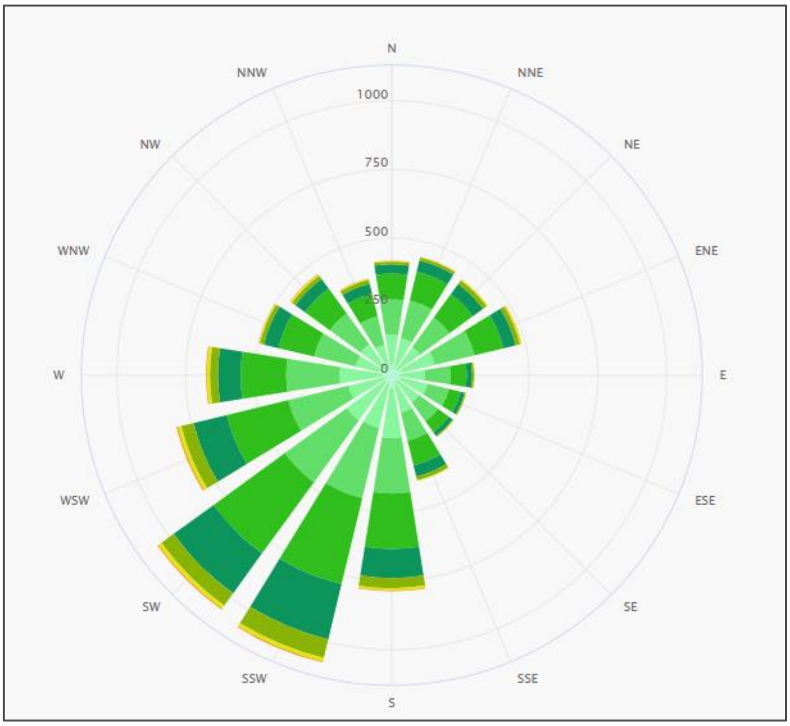

Figure 5 - Modelled wind direction for Teddington (meteoblue.com)

2.2 Internal Sources

Finishes and furnishings

New buildings or recently redecorated interiors have been associated with high concentrations of VOCs; emitted mainly from paints, carpets, materials and furniture. These emissions are highest when the building is new and reduce over time.

VOCs present a risk to the health and comfort of occupants if air concentrations exceed those known to cause adverse effects. Some are known to be toxic and can adversely affect children, particularly those in vulnerable groups (such as those who suffer asthma and allergies). At the levels common to residential buildings, the most likely health impact from VOCs is short-term irritation of the eyes, nose, skin and respiratory tract. Odour generated by VOCs can also be a concern to the occupants. Common indoor VOCs include formaldehyde, decane, butoxyethanol, isopentane, limonene, styrene, xylenes, perchloroethylene, methylene chloride and toluene.

These products are often used within modern construction and could impact the indoor air quality of the building.

The following are ways to mitigate this risk:

- Avoid pollutant emissions by choosing interior finishes which adhere to BREEAM HEA02 criteria Emissions from Construction Products, details of which can be found in Appendix A.
- Dispose of product containers safely and purchase only as much as is necessary to reduce waste and unnecessary release of VOCs.
- Sequence work to ensure that absorbent surfaces (e.g. carpets) are not installed until work that emits high levels of VOCs (e.g. varnishing) is complete.
- Protect HVAC equipment and ductwork from dust and other pollutants during installation and when near to other construction or installation works.
- Check and clean ventilation systems and ductwork prior to and during commissioning, so that pollutants are not released into the building.

- Identify and if possible, remove the source of formaldehyde as this is one of the few pollutants that can be readily measured. If it is not possible to remove, exposure can be reduced by using a sealant on all exposed surfaces of panelling and other furnishings.

Cleaning and storerooms

VOCs and other pollutants contained within cleaning products may evaporate, contaminating the surrounding air. This can be controlled by ensuring that any cleaning products are stored in areas with high levels of ventilation to ensure adequate dilution and removal. Any storerooms should have mechanical extract to promote dilution. Natural cleaning solutions should be used wherever possible and workers should always exercise caution and wear protective equipment when handling harsh chemical cleaning solutions.

HVAC equipment

The Proposed Development is using a gas-based energy strategy for the residential elements and an all-electric scheme for the nursery. The residential units will use either low or ultra-low NO_x emission boilers in line with Planning Policy[1]. There will be no associated NO_x emissions released from the nursery due to using an all-electric scheme for heating and hot water provision.

However, the proposed ASHP technology for the nursery will use a refrigerant which is a pollutant. The global warming potential (GWP) of the refrigerant will depend on the model chosen, however the BREEAM methodology for POL 01 will be used to select refrigerants that have a low GWP, and by looking to specify leak detection on the equipment.

Kitchens

Kitchens can be a significant source of indoor air pollution due to the pollutants given off by cookware, appliances and refrigeration units, harsh chemical degreasers and cleaning solvents that may be used during the cooking and preparation of food. Carbon monoxide and other poisonous fumes may be produced within the residential kitchen areas as all hobs will be gas with open flames. Particulates from cooking, such as grease and fat, also need to be extracted as they can cause respiratory illnesses and become a fire risk. Odours will also be produced through the preparation and cooking of food which can cause discomfort and upset to neighbouring spaces/buildings, particularly other residential units. All kitchens within both the residential and nursery areas are of a standard size for domestic or small/scale use and are therefore not assumed to significantly contribute to external pollution. Standard mechanical extracts, and MVHR in the residential units, are proposed within each kitchen to maintain indoor air quality.

Tobacco

Smoking is not permitted in any communal indoor spaces – communal residential areas and the nursery. Therefore, the risk of indoor air pollution from tobacco (for example Benzene, a known human carcinogen) is low in these spaces. In the residential units, it is the residents' choice as to whether they smoke inside their own dwelling. The use of MVHR will promote suitable air changes in the units.

People

People, as users of the building, will generate moisture, CO_2, and odours which contribute to the indoor air quality of the site. CO_2 is an indicator of indoor air quality including odour. Exhaled air and cooking are usually the principal sources of CO_2 in multi-residential spaces. CO_2 levels inside are affected by several factors including the number of occupants and their activity levels, time spent in a room, and the ventilation rate. Through the provision of standard extract and natural ventilation, these levels will be minimised.

Removal of contaminant sources summary:

There are a variety of both internal and external pollutants that may affect the indoor air quality of the Proposed Development. Construction products and finishes with low VOCs and formaldehyde content will be selected in line with BREEAM HEA02.

Ventilation will be present in all wet rooms of the nursery spaces and throughout the residential units to remove pollutants derived from people and kitchens. When in the vicinity of the construction and installation works, HVAC equipment is to be protected and ventilation systems are to be checked and cleaned prior to and during commissioning to avoid releasing pollutants into the building.

A nominated person within the Design Team will be responsible for ensuring that these targets are achieved and will create a VOCs schedule supported by drawings and datasheets confirming their testing and emission levels.

3.0 Construction and Demolition

Demolition will take place to remove the existing nursery and any other hard standing on-site, prior to the construction of Proposed Development. There will also be excavation and piling associated with eh ground works and foundations. These activities may result in the following air quality impacts:

- Visible dust plumes;
- Dust deposition;
- Elevated PM_{10} and $PM_{2.5}$ concentrations; and
- Increased concentrations of nitrogen dioxide.

Air pollutants can result from on-site dust generating activities such as the breaking-up of materials and the movement of soil, as well as from the exhaust of diesel-powered machinery and vehicles, both static and non-road mobile machinery. Vehicles and people accessing and travelling across the site can also generate dust.[10]

It is therefore important that the creation or release of air pollutants is minimised as far as possible, so that both internal and external air pollution levels are not significantly elevated as a result of the works carried out on the Proposed Development.

3.1 Dust Risk Assessment

A Dust Risk Assessment will be produced to assess the risk of each phase of work, evaluate, and identify suitable mitigation measures for each risk. As per the Institute of Air Quality Management's (IAQM) Guidance, the following four categories will be used to guide the risk assessment: demolition, earthworks, construction and track out. Figure 6 summarises the steps that must be taken to produce the Dust Risk Assessment[11]:

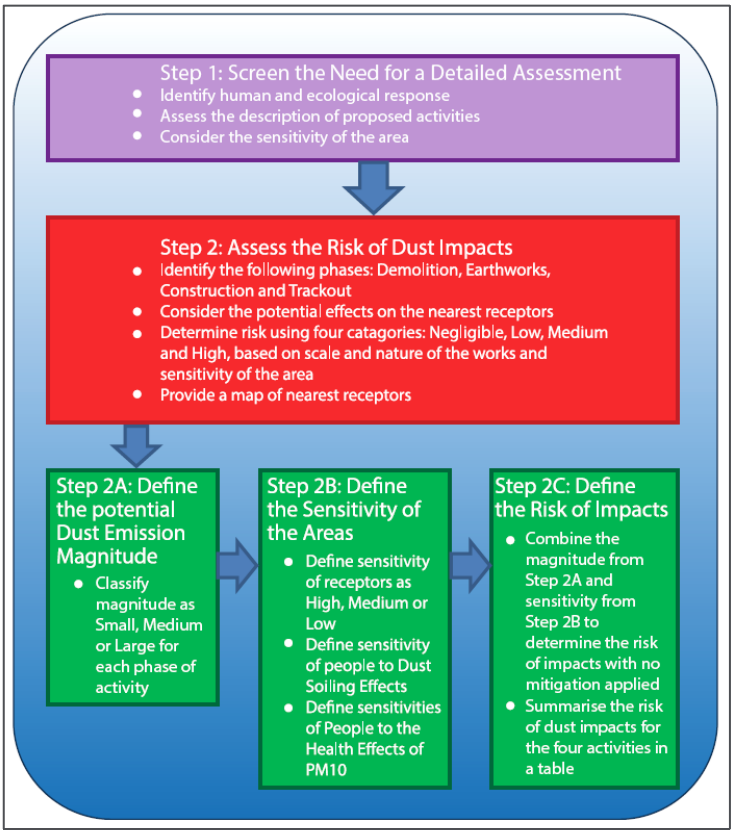

Figure 6 - Summary of Dust Risk Assessment requirements (Control of dust and emissions during construction and demolition SPG)

[10] The control of dust and emissions during construction and demolition SPG, July 2014.
[11] The control of dust and emissions during construction and demolition SPG, July 2014 – p.37

3.2 Dust control measures

As the site will be undertaking demolition, excavation, digging out and construction activities, the contractors will need to follow the details of: *The control of dust and emissions during construction and demolition SPG* [12] so that the release of emissions of gaseous and particulate pollutants into the atmosphere is limited. A brief summary of the requirements is outlined below, addressing key measures for dust control.

Site management and maintenance

Responsible site management is imperative during the demolition and construction phases, which requires stakeholder engagement and regular site inspections. The site must also be prepared through an effective site layout and implementation of green infrastructure while also maintaining runoff, cleaning, and soiling, and effectively dealing with spillages.

Vehicle emissions

The construction site will involve the use of vehicles and machinery which can significantly contribute to local air pollution. Therefore, all mobile vehicles should comply with the London Low Emission Zone, vehicle idling should be discouraged, and deliveries should be managed by a Construction Logistic Plan to effectively and efficiently deliver and remove items from site.

A travel plan will be produced for the nursery to encourage workers and future building users of the site to use public transport and/or cycle routes as alternatives to single-occupancy car journeys. Plant items for site will be from renewable or battery sources where possible to reduce the higher levels of PM and NO_x emitted from petrol or diesel powered equipment.

Operations

Cutting, grinding and sawing should be limited on site and managed by dampening with water to reduce dust generation. Where mobile crushing and concrete bashing is occurring on site, LBRuT must be notified, and best practice procedures should be followed. Skips, chutes and conveyors should be covered to limit dust escaping.

Waste

Bonfires are forbidden, and the recycling or reuse of materials will be encouraged. In line with the BREEAM WST01 methodology, the site will undertake a Pre-Demolition Waste Audit which will form part of the Resource Management Plan for the Proposed Development so that the amount of demolition and construction waste can be assessed and monitored.

3.3 Mitigation measures

Demolition activities should use either soft stripping or water suppression to damp down dust. Blasting will be avoided.

Following earthwork activities, the generation and resuspension of dust should be reduced through re-vegetating any exposed areas and any soil stockpiles to stabilise surfaces if these are on-site.

During construction, cement, sand, fine aggregates and other fine powders should be sealed after use and if necessary stored in enclosed or bunded containers or silos.

Hard surfaces or paving should be used for all haul routes and routes should be swept and dampened regularly. Vehicle wheels should be washed before leaving site and all vehicles carrying dusty materials should be securely

[12] The control of dust and emissions during construction and demolition SPG, July 2014.

covered before leaving site. Dust suppressants (calcium magnesium acetate) should be used on roadsides in line with the Transport for London (TfL) requirements.

3.4 Site monitoring

If the measures are implemented in Sections 3.2 and 3.3, then the formation of dust and harmful emissions from the construction site will be minimised. However, it is still important to continually monitor the site to manage the generation of PM_{10} and $PM_{2.5}$ and NO_x emissions during construction and demolition.

The Proposed Development will take regular energy and water meter readings during the construction phases and transport will be recorded for all deliveries to and from the site to address the BREEAM MAN03 criteria. Quantities and types of waste will also be monitored in line with the Resource Management Plan and Pre-Demolition Audit to address the BREEAM WST01 criteria.

3.5 Non-road mobile machinery

As construction will begin for the Proposed Development after 1st September 2020, any non-road mobile machinery (NRMM) used on site will be required to meet Stage IIIB of the EU Directive 97/968/EC as a minimum. This can be achieved by reorganising the NRMM fleet, replacing equipment to meet the policy (where there are non-compliant NRMM), retrofitting abatement technologies or re-engining. Using the Considerate Constructors Scheme will assist in monitoring compliance with the NRMM policy.

4.0 Dilution and control of contaminant sources

This section explores measures that control and regulate concentrations of indoor air pollutants from both external and internal sources.

Indoor concentrations of pollutants such as formaldehyde and VOCs are targeted to not exceed the limits outlined in Appendix A. The following strategy is to be implemented to dilute and control any contaminant sources.

Indoor Air Pollutant Concentrations

The WHO recommend the following maximum 1-hour indoor pollutant guidelines: NO_2 = 200 µg/m^3, CO = 35 mg/m^3, Formaldehyde = 30 min average at 0.1 mg/m^3. No safe level can be recommended for Benzene[13]. Appendix D summarises all the recommended levels of pollutants.

The ventilation strategy will include mechanical ventilation through extract fans in all WCs and the kitchen of the nursery. There is also proposed to be Mechanical Ventilation with Heat Recovery (MVHR) throughout each residential unit of the Proposed Development.

With the correct demand control, MVHR can reduce heating loads by recovering the heat from extracted air. Room-based MVHR systems will need to have a minimum heat recovery efficiency factor of 75% to avoid the need to use a heater battery to achieve adequate supply air temperatures in a 100% fresh air MHVR system. The heat recovery efficiency factor should be measured in accordance with BS EN 308. MVHR units should be able to maintain their specified efficiency at both low and high speeds. Although these systems use fan power to overcome duct resistance, filter replacements and ongoing maintenance; they can provide good air quality in polluted areas while windows are closed.

Filtration

Impacts from external pollutant sources on indoor air quality can be mitigated by using appropriate filters within the HVAC systems. Filtration can prevent dirt accumulating in air handling plants, including on heat exchangers and ductwork while also filtering out external pollutants. It is standard practice to fit filters to mechanical ventilation systems. CIBSE Guides A and B and BS EN 13779 recommend specifications for filters.

It is important that filters are replaced regularly to maintain good air quality. If filters are not maintained, they can become saturated leading to increased pollutant levels, potential microbial growth, odours and increased energy consumption.

Where filters are fitted, a means of warning building operators when filters are dirty and need changing is required. This can be based on differential pressure sensors, or by hours run since last filter change, altering through a local controller or a central BMS.

Kitchens

Small-scale domestic cooking will occur in the Proposed Development, therefore standard mechanical extracts are to be installed in the kitchen area of the nursery, and MVHR is proposed throughout each residential unit.

This will help protect residents and staff from any fumes and particles/particulates that may be detrimental to health and will also control potent cooking smells that may be a nuisance.

[13] WHO guidelines for indoor air quality: selected pollutants, 2010 - http://www.euro.who.int/__data/assets/pdf_file/0009/128169/e94535.pdf

Bathrooms/WCs

Bathrooms/WCs will have a local extract ventilation rate of at least 8l/s continuous extract or 15l/s intermittent extract to provide extraction of primarily odours, humidity, and pollutants from cleaning products.

Air Intakes and Exhausts

Approved Document F Appendix D states that air intakes should be located as far as possible from (and at a lower height than) heat source and generator flues, and where there are high levels of traffic.

BREEAM NC 2018 issue HEA02 credit 2 'Ventilation' states that the building's air intakes and exhausts should be at least 10m apart to avoid recirculation. Air intakes should also be at least 10m from external sources of pollution. This should be considered and ideally incorporated into the design of the HVAC system.

The fresh air supply rate is recommended to not fall below 5-8 l/s, per occupant of the building. Exhaust locations should:

- minimise re-entry to the building through natural and mechanical intakes
- avoid adverse effects to the surrounding area
- be located downstream of intakes where there is a prevailing wind direction and discharge away from air conditioning condensers.

Air tightness

An air permeability of $5m^3/hr/m^2$ or less is to be targeted for the Proposed Development. This is considerably more stringent than the Building Regulations limit of $10m^3/hr/m^2$ and helps minimise infiltration of more polluted ground-level air, while also reducing energy consumption.

Printers

According to Building Regulations Approved Document F, printers are thought to also emit VOCs and ozone. If printers are used for more than 30 minutes at a time, they should be within a separate, mechanically ventilated room with an air extract rate of at least 20 l/s per machine. However, it is unlikely that anything more than a small domestic printer will be located within the nursery area of the Proposed Development.

Dilution and control of contaminant sources summary

To minimise the impact of pollutants on indoor air quality, the WHO guidelines for maximum concentrations should be targeted. The Proposed Development will use mechanical ventilation with appropriately positioned intakes and exhausts, filter maintenance and pollutant monitors to dilute and control both internal and external contaminant sources. The air permeability of the building is to be $<5m^3/hr/m^2$. Washrooms should have a local extract ventilation rate of at least 8l/s continuous extract or 15l/s intermittent extract. Standard kitchen extraction will be implemented to minimise odours and air pollution from the small-scale kitchens.

5.0 Procedures for pre-occupancy flush out

This section explores how the pre-occupancy flush out can remove residual levels of pollutants that may have accumulated in the building during construction. The flush out helps to ensure that the indoor air quality of the building is at an acceptable level when the building is occupied, and that post construction testing is carried out in conditions that are representative of the indoor air quality when occupied.

Upon completion of the construction process and once all relevant elements have been fitted which must comply with BREEAM Table 18 (Appendix A), the building will undergo a period of 'flush out'. During this period, all extracts and comfort cooling systems will be activated and purged as part of the commissioning process. Each zone of the building should be flushed-out once construction (including painting, carpet and other finishes) and the cleaning of ventilation systems have been completed, but before the zone is occupied.

In line with best practice[14], an initial flush out of 1,066m^3 of outdoor air per m^2 of floor area is to be carried out prior to occupation. All openable windows will be opened in order to assist in the removal of any minor levels of VOCs and/or formaldehyde which may have accumulated during the fit-out period.

To avoid ingress of pollutants where construction has not been completed in other areas of the site, it is essential that the areas being flushed out and tested are kept isolated from any other construction work.

Where snagging occurs and some parts of the building need rectifying, there will be a secondary flush out after these final touches have been made. Any changes to the building finishes and furnishings should remain in line with the HEA02 criteria as outlined in this IAQP.

If, after the flush out and testing, levels of VOCs and formaldehyde are still found to be above the recommended levels, then the following two options will be considered:

- Either the site enters an extended flush out period prior to occupancy, in which 4,266m^3 per m^2 is required. The building cannot be occupied until this flush out is complete.
- Or a second flush of 3,200m^3 of outdoor air per m^2 of floor area will be carried out post occupancy. Between the two flushes, the ventilation system will provide at least 0.1m^3 per minute of outdoor air per m^2 of floor area at all times.

The preferred option is to have an extended flush out period prior to occupancy, should the building not meet the VOC and formaldehyde recommended levels. This is so that the residents, staff and nursery children can use the building at its completed state rather than risk working in and occupying the building with poor air quality while it is being flushed.

[14] The WELL Building Standard v1 with Q1 2018 addenda

6.0 Third party testing and analysis

This section explores how the third-party testing and analysis of indoor air uses a recognised method of testing for each air pollutant of interest, while providing impartial and objective measurement of the levels of indoor air quality in the newly constructed building. The air quality of the building should be assessed after construction works have finished and after the initial flush-out has been completed.

All organisations used for sampling and analysis of indoor air or for analysis of emissions from construction products will be accredited to ISO/IEC 17025 with specific accreditation covering:

- Sampling: Pumped sampling for formaldehyde in air; Pumped sampling for VOCs in air
- Chemical analysis: Determination of formaldehyde; Determination of VOCs.

The building indoor environment may be tested and analysed by a third party should the BREEAM assessment require testing of VOC and formaldehyde levels. The following is from the BREEAM NC 2018 Manual under the 'post-construction indoor air quality measurement' credit requirements:

"The formaldehyde concentration in indoor air is to be measured post construction (but pre-occupancy) and will not exceed 100μg/m³ averaged over 30 minutes. The formaldehyde sampling and analysis will be performed in accordance with ISO 16000-2 and ISO 16000-3.

The total volatile organic compound (TVOC) concentration in indoor air is to be measured post construction (but pre-occupancy) and will not exceed 500μg/m³ over 8 hours. The TVOC sampling and analysis will be performed in accordance with ISO 16000-5 and ISO 16000-6 or ISO 16017-1.

If levels are found to exceed these limits, the project team will use this IAQP to inform the measures that will be undertaken to reduce the TVOC and formaldehyde levels to within the above limits.

The measurement of formaldehyde and TVOC must be made in accordance with the relevant standards (as listed in the criteria). ISO 16000-2 and ISO 16000-5 provide guidance on sampling strategies for formaldehyde and VOCs, respectively. Sampling should be performed in rooms that will be occupied for long periods of time e.g. classrooms. A representative number of rooms should be sampled, rather than every room in the building. For example, in this case, sampling one practice room should suffice to assess the indoor air quality for that type of habitable space in the building (assuming the other practice rooms have the same materials specification and ventilation strategy). In larger rooms, such as classrooms, additional sampling locations may be required in order to understand the homogeneity of the indoor environment.

Uncertainties in sampling and analysis are inevitable and unavoidable, therefore it is recommended that replicate samples are taken at each sampling location (ideally a minimum of three samples for each measurement parameter). Before sampling, naturally ventilated rooms should be intensively ventilated for 15 minutes and then outer doors and windows closed for at least 8 hours (e.g. overnight) before sampling begins with the room still closed off. For mechanically ventilated rooms, the ventilation system should be running under standard operating conditions for at least for 3 hours before sampling begins. Sampling locations should be at least 1m to 2m from a wall and at a height of between 1m to 1.5m."[15]

[15] BREEAM NC 2018 guide, Hea 02 Indoor Air Quality, Post-construction indoor air quality measurement.

7.0 Maintaining indoor air quality in-use

This section outlines the commitments and measures in place to maintain indoor air quality at acceptable levels throughout the Proposed Development's operational life.

Nursery staff will be provided with technical and non-technical Building User Guides to inform them of how to properly use the HVAC controls within the nursery building. This includes information on cleaning and maintaining the building interior and ventilation filters and ducts to prevent the accumulation of dust and other pollutants, how to monitor indoor air quality and how any changes to the occupant density or working practices may require additional air quality maintenance.

Residents will also be provided with Home User Guides to inform them of how to correctly use and maintain the HVAC equipment within their dwellings/the wider building.

The O&M manual will also contain relevant instructions should extra information be required by the facility management and end users of the Proposed Development.

If there are any comments or complaints regarding the indoor air quality of the building, these are to be recorded in a logbook so that the air quality can be monitored and improved where necessary. This might include any comments made by nursery staff and residents about odours or any side effects that appear to be correlated with the indoor air quality – e.g. reports of headaches from several members of staff.

8.0 Air Quality Neutral

The Proposed Development is to be at least Air Quality Neutral, in line with the London Plan and the Mayor's Air quality Strategy. Benchmarks have been produced (using Appendices 5 and 6 of the *Sustainable Design and Construction SPG*) for buildings' operation and transport across London based on the latest technology. Developments that do not exceed these benchmarks will be considered to avoid any increase in NO_x and PM emissions across London as a whole and therefore be 'air quality neutral'[16].

The air quality neutral assessment for the Proposed Development compares the operational emissions against calculated benchmark values based upon floor space, land use and energy demand, in accordance with the Air Quality Neutral Planning Support Document.

8.1 Operational Emissions – Buildings

The Building Emissions Benchmarks (BEB) for the Proposed Development are calculated using the Gross Internal Area (GIA) for each land-use class, multiplied by default emission factors for each land-use category, as shown in Table 3. The Gross Internal Areas for the respective land use classes have been calculated using the drawings provided by Living-Architects, dated November 2019.

Land Use Class	Area (m^2)	NO_x Benchmark (g/m^2)	NO_x Building Emission Benchmark (g/m^2/annum)	Total NO_x Building Emission Benchmark ($kgNO_x$/annum)
Crèche (D1 (b))	293.7	75.0	22,028	22
Residential (C3)	2,119	26.2	55,517.8	56
Total NO_x BEB (kg/annum)				**78**

Table 3 - Calculation of Building Emissions Benchmark for NO_x

The total annual building NO_X emissions for proposed land uses has been calculated based on the proposed energy strategy and plant room appliances as discussed in Section 2.2. Building-related emissions for the proposed development are presented in Table 4 and have been derived from the anticipated energy usage for heating and hot water (gas) for the site and the London Atmospheric Emissions Inventory (LAEI) default NO_x emission factor for residential land-uses as specified in the Air Quality Neutral Planning Support Document.

Type	Energy Usage (kWh/annum)	Emission Factor (kg NO_x/kWh)	NO_x (kg/annum)
Crèche[17]	0	0.000194	0
Residential[18]	109,033	0.0000785	8.56
Totals			**8.56**

Table 4 - Calculation of Building Emissions

[16] Sustainable Design and Construction SPG, Section 4.3: Air Pollution

[17] Commercial default emission factor – (Box 2 of Air Quality Neutral Planning Support Document)

[18] Using the Domestic default emission factor – (Box 2 of Air Quality Neutral Planning Support Document)

The BEBs are compared with the Total Building Emissions in Table 5 to assess whether the building emissions for the Proposed Development are within the benchmark.

	NO_x (kg/annum)
Total Building Emissions (kg/annum)	8.56
Total Building Emissions Benchmark (Assessment Criteria) (kg/annum)	78

Table 5 - Comparison between total Building Emissions and Building Emissions Benchmark

There is only to be a gas-fired energy strategy for the residential units of the Proposed Development (gas boilers to each unit), thus the associated NO_x building emissions have not exceeded the benchmark. Furthermore, there is no solid fuel-, biomass- or oil-based heating strategy proposed, so the proposed plant will not result in an increase in PM_{10}. Therefore, the Proposed Development is considered to be 'Air Quality Neutral' with respect to building emissions and no further abatement will be required.

8.2 Operational Emissions – Transport

The Transport Emission Benchmarks have been calculated using the using the Gross Internal Area (GIA) or number of dwellings for each land-use class, multiplied by default emission factors for each land-use category, as shown in Table 6 and Table 7.

Land Use Class	Area (m^2) / no. of dwellings	NO_x Benchmark (g/m^2) / (g/dwelling)	NO_x Transport Emission Benchmark (g/annum)	Total NO_x Transport Emission Benchmark ($kgNO_x$/annum)
Crèche (D1 (b))[19]	293.7	249	73,131	73
Residential (C3)	30	1,553	46,590	47
Total NO_x TEB (kg/annum)				**120**

Table 6 - Calculation of NO_x Transport Emissions Benchmark

Land Use Class	Area (m^2) /no. of dwellings	PM_{10} Benchmark (g/m^2) / (g/dwelling)	PM_{10} Transport Emission Benchmark (g/annum)	Total PM_{10} Transport Emission Benchmark (kg PM_{10}/annum)
Crèche (D1 (b))[19]	293.7	42.9	12,600	13
Residential (C3)	30	267	8,010	8
Total PM_{10} TEB (kg/annum)				**21**

Table 7 - Calculation of PM Transport Emissions Benchmark

[19] Assumes Retail (A1) Land use category benchmark/value as most comparable for D1 (b) use.

The Proposed Development's estimated trip generation per day for each land-use class has been provided by SW Transport Planning Ltd, the Client's transport consultant. See Appendix B for the summary of the trip calculation.

The number of vehicles trips per year have been used to calculate the annual transport emissions of NO_x and PM_{10} for each land use class (Table 8). Emission factors and average distance per trip for 'Outer London' have been selected in this assessment, in line with the Air Quality Neutral Planning Support Document[20].

Land Use Class	Trips per day	Trips per annum	Average distance per trip (km)	Distance travelled (km/annum)	Emission Factors (g/vehicle-km)[21]	Transport Emission (kg/annum)	
						NO_x	PM_{10}
Crèche (D1 (b))[19]	121	23,537	5.4	127,100	NO_x: 0.353 PM_{10}: 0.0606	45	8
Residential (C3)	90	32,850	11.4	374,490		132	23
Total	**211**	**56,387**	-	-		**177**	**31**

Table 8 - Calculation of the NO_x and PM_{10} Transport Emissions for each land use category

The TEB is compared with the total transport emissions in Table 9 to assess whether the transport emissions for the Proposed Development are within the benchmark.

	NO_x (kg/annum)	PM_{10} (kg /annum)
Total Transport Emissions (kg/annum)	177	31
Total Transport Emissions Benchmark (Assessment Criteria) (kg/annum)	120	21
Difference	**+57**	**+10**

Table 9 - Comparison between total Transport Emissions and Transport Emissions Benchmark

As the application site is in an area with a PTAL score of 2, the predicted trips for the new residential units is greater than those used to calculate the benchmark figures.

As the total TTEs (177kg NO_x /annum and 31kg PM_{10} /annum) are greater than the TEBs (120kg NO_x /annum and 21kg PM_{10} / annum), the Proposed Development's transport emissions are not within the benchmarks.

Therefore, further mitigation has been considered to off-set excessive emissions of NO_x and PM_{10} for this source of emissions when considered in isolation (detailed in Section 8.3 below). However, the transport emissions associated with the trip generation for the nursery has not changed from the existing nursey which is to be replaced.

[20] Tables 8 and 10 of Air Quality Neutral Planning Support Document (GLA 80371)

8.3 Mitigation measures

There are a variety of ways in which the Proposed Development has and can promote sustainable travel in an attempt to reduce the number of vehicle trips associated with both the residential units and the nursery, thus mitigating the NO_x and PM_{10} emissions associated with exceeding the benchmark.

A Transport Assessment has been completed for the scheme, assessing the site location, and current and future transport options for the building users of the Proposed Development.

Car parking has been provided in line with LBRuT LP45 and the London Plan, meeting minimum and maximum requirements as detailed in the Planning Policy.

For the residential scheme, a minimum of 6 no. car parking spaces (20%) are proposed to be electric vehicle (EV) charging points, alongside 54 no. long-stay, secure cycle storage spaces and 1 no. short-stay space for the residents' use. Therefore, the use of EV and cycles for trips will reduce both NO_x and PM_{10} directly.

Details of the public transport measures available for residents, including car sharing groups and local transport networks, will be included within the Home User Guide to encourage the use of more sustainable travel, rather than local car trips.

The nursery will have a public transport information system established to promote sustainable travel by staff and users. In addition, 1 no. EV charging point is proposed and 4 no. cycle storage spaces and facilities in the form of changing spaces and lockers for staff to use. Cycle storage spaces will be secure, covered and lit.

Other measures to promote sustainable travel, such as designated parking spaces for low emission vehicles and providing vouchers for alternatives to private car use, will be considered for the residential scheme by the Client.

Ecological improvements will be made to the site, including the consideration of evergreen infrastructure which will help to reduce particulates and other pollutants.

The Transport Assessment details the traffic and transport opportunities for the site in further detail, and the Travel Plan will further establish sustainable means of travel for the nursery building users of the Proposed Development.

Wider mitigation measures have previously been suggested through reducing the impact on air quality through the construction and operational processes of the Proposed Development.

Where it is thought not possible to fully mitigate the air quality impacts of the Proposed Development on-site, a financial contribution to the Borough's Air Quality Action Fund (AQAF) through a Section 106 agreement will be made, as necessary.

8.4 Air Quality Neutral Assessment Summary

As the benchmarks for the building emissions have not been exceeded by the proposed building emissions, the Proposed Development is therefore considered to be 'Air Quality Neutral' in this respect.

Where the proposed transport emissions exceed the transport benchmarks, mitigation measures have been proposed and will be implemented.

A travel plan will further detail the measures to improve sustainable transport for the Proposed Development, to further mitigate the exceedance of the transport benchmarks.

9.0 Summary

This AQA and IAQP addresses the requirements of London Borough of Richmond Upon Thames's planning policy and draft Air Quality SPD for the whole development and BREEAM NC 2018 HEA02 criteria for the nursery building. Baseline air quality conditions indicate that the Proposed Development is within a 'High Pollution Location' and is officially within an AQMA.

As with any development, there are associated construction-phase and use-phase impacts on air quality that have been considered and will be minimised as far as possible for both the internal air quality of the Proposed Development, and any contributions to external air quality.

The external sources of pollution have been identified as background concentrations of pollutants and road traffic. Internal sources are likely to be VOCs from the use of paints, varnishes and finishes as part of the construction works, and the building users themselves. To reduce the quantity of VOCs on the air quality of the building, low content products will aim to be specified that meet the BREEAM HEA02 criteria.

To dilute and control the contaminant sources, mechanical ventilation will be included into the building design, with MVHR throughout each residential unit within the Proposed Development and standard extracts in the nursery. All HVAC systems will be cleaned and maintained in accordance with the O&M to ensure the longevity of the contaminant control. Construction and demolition on site will be carried out in line with the *Control of Dust and Emissions during Construction and Demolition SPG* to minimise air pollution derived from these activities.

After building completion but before occupancy, the building will be flushed out prior to any air quality testing. To maintain good levels of indoor air quality, residents and nursery staff will be provided with Home/Building User Guides that detail measures to keep the HVAC systems working efficiently and sustainably.

The Proposed Development has undergone an Air Quality Neutral Assessment, achieving an 'Air Quality Neutral' result for building emissions, as the proposed building emissions have not exceeded the benchmark emissions. Mitigation measures have been suggested and will be implemented where the proposed transport emissions have exceeded the benchmark emissions, including, by way of an example, EV charging spaces, secure cycle storage and promotion of car sharing and public transport information.

In summary, the Proposed Development has addressed the planning policy regarding air quality and is assessed to have a limited impact on both future internal and external air quality. The overall impact of the Proposed Development on air quality is therefore judged to be not significant.

Appendices

Appendix A – Site Plan

Appendix B – Trip calculation summary provided by SW Transport Planning Ltd

Strathmore Centre - AQ Traffic Calculations

SCAMPS

		Child Numbers					
Description	Time	Mon	tue	Wed	Thur	Fri	Ave Day
Breakfast Club	7am-9am	36	30	31	41	18	31.2
Little Scamps	9am-12pm	23	19	23	21	15	20.2
Wraparound	12pm-3pm	2	8	8	8	closed	6.5
After School	3pm-6.30pm	56	60	68	54	26	52.8
				Total children per day			110.7
				Ave Staff per day			10

Vehicle Trips - Scamps				
Arrivals	Departures	Daily (24Hr)	Weekly	Annual
16	16	31	156	6084
10	10	20	101	3939
3	3	7	33	1268
26	26	53	264	10296
Veh Movements - child		111	554	21,587
5	5	10	50	1,950
Veh Movements - staff		10	50	1,950
Tot Veh Movements - Scamps		121	604	23,537

[daily child numbers from Harper Planning, Planning Statement, page 7]

<u>Assumptions</u>

1. 50% of children travel by car, 50% walk (NB Stanley school achieves 68% walk mode share)
2. Scamps open 5 days per week for 39 weeks per year
3. Each drop-off and each collection results in two vehicle movements
4. 50% staff travel by car

RESIDENTIAL

Vehicle Trips - Residential		
12 Hr Daily Trips	Daily (24Hr)	Annual
74.7	90	32,719

[12hr daily trips from SWTP Transport Assessment Table 5]

<u>Assumptions</u>

1. Conversion factor from 12hr to 24hr is assumed to be 1.2
2. Annual traffic is assumed to be daily traffic X 365

Appendix C – VOC compliance

BREEAM NC 2018

Emission Limit*			Testing requirement	Additional requirements
Formaldehyde	Total volatile organic conpounds (TVOCs)	Category 1A and 1B carcinogens		
Interior paints and coatings				
≤ 0.06 mg/m³	≤ 1.0 mg/m³	≤ 0.001 mg/m³	EN 16402 or ISO 16000-9 or EN 16516 or CDPH Standard Method v1.1	Meet TVOC content limits Paints used in wet areas (e.g. bathrooms, kitchens, utility rooms) should protect against mould growth.
Wood-based products (including wood flooring)				
≤ 0.06 mg/m³ (Non-MDF) ≤ 0.08 mg/m³(MDF)	≤ 1.0 mg/m³	≤ 0.001 mg/m³	ISO 16000-9 or EN 16516 or CDPH Standard Method v1.1 or EN 717-1 (formaldehyde emissions only)	N/A
Flooring materials (including floor levelling compounds and resin flooring)				
≤ 0.06 mg/m³	≤ 1.0 mg/m³	≤ 0.001 mg/m³	ISO 10580 or ISO 16000-9 or EN 16516 or CDPH Standard Method v1.1	N/A
Ceiling, wall, and acoustic and thermal insulation materials				
≤ 0.06 mg/m³	≤ 1.0 mg/m³	≤ 0.001 mg/m³	ISO 16000-9 or EN 16516 or CDPH Standard Method v1.1	N/A
Interior adhesives and sealants (including flooring adhesives)				
≤ 0.06 mg/m³	≤ 1.0 mg/m³	≤ 0.001 mg/m³	EN 13999 (Parts 1-4) or ISO 16000-9 or EN 16516 or CDPH Standard Method v1.1	N/A

The emission limits in this table apply to the finished product, i.e. after any coating or other treatment process has been applied.

* Compliance with emission limits shall be demonstrated after 28 days in an emission test chamber or earlier as stipulated by the relevant testing requirements standard. The emission rate obtained from the chamber test method must be extrapolated to predict what the concentration would be in the air of the theoretical model or reference room (as detailed in the respective testing standard) and this extrapolated concentration compared with the emission limit in this table.

Where test results for a product exceed the TVOC emission limit, compliance with the above requirements can still be achieved where the test results demonstrate an R-value ≤ 1 after 28 days.

Product Category	Free TVOC content of ready-to-use product (g/l)	Testing requirements
Interior matt walls and ceilings (Gloss <25@60°)	10	ISO 11890-2 or ISO 17895 or Calculation based on the ingredients and raw materials
Interior glossy walls and ceilings (Gloss >25@60°)	40	
Interior trim and cladding paints for wood and metal	90	
Interior trim varnishes and wood stains, including opaque wood stains	65	
Interior minimal build wood stains	50	
Primers	15	
Binding primers	15	
One-pack performance coatings	100	
Two-pack reactive performance coatings for specific end use such as floors	80	
Multi-coloured coatings	80	
Decorative effect coatings	80	

Appendix D – WHO IAQ guidelines and UK ambient air quality standards

Pollutants	WHO Indoor Air Quality Guidelines (2010)[22]	The Air Quality Standards Regulations 2010
CO (mg/m³)	100 (15 min)	
	60 (30 min)	
	30 (1 hr)	
	10 (8 hr)	10 (8 hr)
	7 (24 hr)	
NO_2 (µg/m³)	200 (1hr)	200 (1 hr) not to be exceeded more than 18 times a calendar year
	40 (1yr)	40 (1yr)
		350 (1 hr) not to be exceeded more than 24 times a calendar year
		125 (24 hr) not to be exceeded more than 3 times a year
PM10 (µg/m³)		50 (24 hr) not to be exceeded more than 35 times a calendar year
		40 (1 yr)
PM2.5 (µg/m³)		25 (1 yr)
Ozone (µg/m³)		125 (8 hr) not to be exceeded on more than 25 days per calendar year averaged over three years
Radon (Bq/m³)	No safe level	From Ionising Radiations Regulations not AQSR: 400 (approximately equal to annual average of 270)
	Reference level: 100	
	No more than: 300	
Benzene (µg/m³)	No safe level	
		5 (1 yr)

[22] WHO Indoor Air Quality Guidelines, 2010 online at the WHO website

Trichloroethylene (µg/m^3)	No safe level	
Tetrachloroethylene		
(µg/m^3)	250 (1yr)	
Formaldehyde (µg/m^3)	100 (30 min)	
Napthalene (µg/m^3)	10 (1yr)	
PAHs (ng/m^3 B[a]P)	No safe level	1 (total content in the PM10 fraction averaged over a calendar year)
Arsenic (ng/m^3)		6 (total content in the PM10 fraction averaged over a calendar year)
Cadmium (ng/m^3)		5 (total content in the PM10 fraction averaged over a calendar year)
Nickel (ng/m^3)		20 (total content in the PM10 fraction averaged over a calendar year)

Notes:

1yr: annual mean, 24hr: 24 hour mean, 1hr: 1 hour mean, 30 min: 30 minute mean

Conversion to ppm at 25 °C and 1 atmosphere: X ppm = (Y mg/m^3) (24.45)/ (molecular weight)

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