Air Quality Assessment:
Middlesex Street Estate Car Park, City of London

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Experts in air quality
management & assessment

Document Control

Client	City of London Corporation	**Principal Contact**	Joshua Nixon

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Report Prepared By:	Jack Buckley and Ricky Gellatly

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Air Quality Consultants Ltd
23 Coldharbour Road, Bristol BS6 7JT Tel: 0117 974 1086
119 Marylebone Road, London NW1 5PU Tel: 020 3873 4780
aqc@aqconsultants.co.uk

Registered Office: 23 Coldharbour Road, Bristol BS6 7JT
Companies House Registration No: 2814570

1 Introduction

1.1 This report describes the potential air quality impacts associated with emissions from extraction systems serving the underground car park at the Middlesex Street Estate in the City of London. The assessment has been carried out by Air Quality Consultants Ltd on behalf of the City of London Corporation.

1.2 This report utilises car park usage information and vehicle emission factors, along with specifications for the ventilation systems, to assess the likelihood of significant air quality impacts at existing residential properties as a result of emissions from vehicles using the underground car park.

2 Emissions Calculations

2.1 The underground car park comprises two main areas, each of which has the following independent ventilation systems:

- Area A - the ventilation system exhausts air extracted from the car park through a large light well roughly in the centre of Petticoat Square. Fresh air is drawn in through the car park entrance off Artizan Street; and
- Area B – the ventilation system exhausts air extracted from the car park through two louvres located at first floor level on the south western façade of Petticoat Tower. Fresh air is drawn in through another light well in Petticoat Square (separate to that used for the Area A exhaust).

2.2 The extraction system has been designed to prevent the built-up of exhaust fumes, or smoke, in the underground car park. It will routinely operate at a rate that ensures three air changes per hour (ACH) for each area of the car park, which results in air extraction rates of 5.7 m^3/s and 4.2 m^3/s for Areas A and B respectively. If the extraction system detects elevated carbon monoxide concentrations in the air being extracted, the system will double the extraction rate to achieve six ACH; if smoke is detected the extraction rate will be increased to 10 ACH.

2.3 For the purposes of this assessment, it has been assumed that the ventilation systems will operate at three ACH at all times; this is a worst-case approach, as the reduced number of air changes will result in higher pollutant concentrations in the air being exhausted. The assessment as focussed on emissions of nitrogen oxides (NOx) and PM_{10}, as these are the key pollutants of concern from vehicle emissions (noting that it is the nitrogen dioxide (NO_2) component of NOx that is of primary concern). Other pollutants, such as carbon monoxide, sulphur dioxide, volatile organic hydrocarbons and benzene are only present in trace amounts in modern vehicle exhausts, with no realistic prospect of significant impacts for these pollutants if there are none for NOx and PM_{10}.

2.4 Car park usage has been estimated by the City of London Corporation. It is estimated that approximately 15 vehicles per day enter and leave Area A (15 in, 15 out). Area B is not currently used, but it is anticipated that the future demand will be approximately 30 vehicles per day (30 in, 30 out).

2.5 Due to the layout of the car park, cars accessing Area B must pass through Area A, so this has been accounted for in the Area A vehicle emissions. As a worst-case approach, it has been assumed that all vehicles will use the parking spaces furthest from the entrance and exit ramp of the car park, thus maximising the distance travelled and emissions within the car park. Furthermore, it has been assumed that all vehicles will travel at a speed of 5 kph, which is the speed associated with maximum emissions in Defra's Emission Factor Toolkit (EFT) (v9.0) (Defra, 2020), which has been used to derive driving emissions for the cars using the car park, and is thus worst-case.

2.6 Vehicles with cold engines tend to initially emit more pollution than vehicles with warm engines; a cold start 'penalty' derived from the National Atmospheric Emissions Inventory (Ricardo Energy & Environment, 2020) has been applied to all outbound trips, making the worst-case assumption that all departing cars have cold engines. The penalty for diesel cars has been applied to all trips, which is higher than that for petrol cars. It should also be noted that these additional emissions typically take place over some distance as the engine warms up; applying them all to the short distance driven to exit the car park will have over-estimated the cold start emissions from the car park, and is thus worst-case.

2.7 The total vehicle emission rates for vehicles in Area A and Area B have been divided by the extract rate for the corresponding ventilation systems to yield the concentrations of NOx and PM_{10} in the air being released at the aforementioned outlets. The emissions calculations are detailed in Table 1, with all figures representing the total emissions from all vehicles using each car park area on a given day.

Table 1: Summary of Ventilation System Emissions Calculations

	NOx		PM_{10}	
	Area A	Area B	Area A	Area B
Vehicle Emission Rate (mg/s)	0.06	0.02	0.003	0.001
Cold Start Emission Rate (mg/s)	0.06	0.12	0.004	0.009
Total Emission Rate (mg/s)	0.12	0.14	0.007	0.010
Exhaust air volume flow (m^3/s)	5.7	4.2	5.7	4.2
Concentration in Extracted Air (µg/m^3)	21.1	34.4	1.3	2.3

2.8 The exhausted air will rapidly mix with the surrounding air, diluting the pollutant concentrations considerably within metres of the point of exhaust, thus these concentrations at the point of exhaust should not be taken to represent likely concentrations at the nearest residential properties. It is, however, not considered necessary to use a dispersion model to establish the impacts as a result of the emissions; instead the exhaust concentrations can be compared to those of a typical source of emissions that is routinely located in close proximity to people's living spaces.

2.9 The total NOx emission rates have been compared to those for a typical 24 kW domestic boiler compliant with the emission limit (40 mgNOx/kWh) set out in the Greater London Authority's (GLA) Supplementary Planning Guidance on Sustainable Design and Construction (GLA, 2014). Such a boiler would have a NOx emission rate of approximately 0.29 mg/s, which is greater than the predicted car park exhaust emission rates (0.12 mg/s for Area A and 0.14 mg/s for Area B). Furthermore, as boiler emissions have a significantly smaller volume of exhaust gas (when compared to the large volumes extracted each second from the car park), the initial NOx concentration in the boiler exhaust is dramatically higher, at 41,439 µg/m^3 (which is 1,200 times that of the higher of the two car park exhausts).

2.10 Domestic boiler exhausts are routinely located on the façades of properties in every town and city, often no more than a metre or two from a home's doors or windows, whereas the car park's extraction system exhausts are located at least 6 m from the nearest residential property. Given that the emissions from the car park's extraction systems will be a fraction of those from a single boiler, and neither source will typically have a very great exit velocity (thus initial mixing rates will be broadly similar), it is clear that the emissions are extremely small and pose no risk to the health of residents of residential properties near to the extraction system exhausts.

2.11 In terms of PM_{10}, typical gas-fired domestic boilers release negligible quantities of particulate matter, so making a comparison to the predicted car park emissions, as done for NOx, is not appropriate. However, the calculated concentrations of PM_{10} in the extracted air (presented in Table 1) are not expected to significantly impact air quality at existing residential properties, as they are smaller than the NOx emission rates by approximately a factor of 15 (or a factor of about 10 if assuming that 70% of the NOx is NO_2, as is commonly assumed), yet the air quality objectives for PM_{10} and NO_2 are set at the same concentration (40 µg/m^3).

2.12 The assessment has applied a number of worst-case assumptions, thus the emission rates presented for the car park exhaust systems likely represent over-predictions. Regardless of this, the emissions form the car park extraction systems are so small that significant impacts should not be expected even if the car park usage rates detailed in Paragraph 2.4 represent under-predictions, unless drastically under-predicted (e.g. under-predicted by more than half).

3 Conclusions

3.1 The potential air quality impacts of emissions from two underground car park ventilation systems on conditions at existing residential properties in the Middlesex Street Estate have been assessed.

3.2 The assessment has applied a number of worst-case assumptions, thus the emission rates presented for the car park exhaust systems likely represent over-predictions.

3.3 The worst-case predicted NOx emission rates for the two ventilation systems have been shown to be significantly smaller than that for a single typical domestic boiler (which would often be installed considerably closer to living spaces than the car park ventilation exhausts are), thus it can be inferred that there is no risk of adverse impacts as a result of emissions from these systems.

3.4 With regards to PM_{10}, emissions from the car park extraction systems are considerably lower than those for NOx, and also not of concern. NOx and PM_{10} are the key pollutants of concern from vehicle emissions, thus it can be concluded that if the impacts for these pollutants will be insignificant, the same will be true for any other pollutants in the vehicle exhausts.

3.5 Significant impacts should not be expected even if the car park usage rates used in the assessment represent under-predictions, unless the under-prediction is extreme (e.g. under-predicted by more than half).

3.6 The overall air quality effects of emissions from the underground car park are judged to be not significant.

4 References

Defra (2020) *Local Air Quality Management Support Website*

GLA (2014) *Sustainable Design and Construction Supplementary Planning Guidance*

Ricardo Energy & Environment (2020) *National Atmospheric Emissions Inventory Emission factors for transport*

5 Glossary

ACH	Air Changes per Hour
AQC	Air Quality Consultants
Defra	Department for Environment, Food and Rural Affairs
EFT	Emission Factor Toolkit
GLA	Greater London Authority
kph	Kilometres Per hour
kW	Kilowatt
kWh	Kilowatt-hour
$\mu g/m^3$	Microgrammes per cubic metre
NO_2	Nitrogen dioxide
NOx	Nitrogen oxides (taken to be NO_2 + NO)
PM_{10}	Small airborne particles, more specifically particulate matter less than 10 micrometres in aerodynamic diameter

6 Appendices

A1 Professional Experience

Guido Pellizzaro, BSc (Hons) MIAQM MIEnvSc PIEMA

Mr Pellizzaro is an Associate Director with AQC, with more than 14 years' experience in the field of air quality management and assessment. His main experience relates to managing and delivering air quality assessments for major planning applications and EIA development. Guido is a Member of the Institute of Environmental Sciences and of the Institute of Air Quality Management, and a Practitioner of the Institute of Environmental Management and Assessment.

Ricky Gellatly, BSc (Hons) CSci MIEnvSc MIAQM

Mr Gellatly is a Principal Consultant with AQC with over eight years' relevant experience. He has undertaken air quality assessments for a wide range of projects, assessing many different pollution sources using both qualitative and quantitative methodologies, with most assessments having included dispersion modelling (using a variety of models). He has assessed road schemes, airports, energy from waste facilities, anaerobic digesters, poultry farms, urban extensions, rail freight interchanges, energy centres, waste handling sites, sewage works and shopping and sports centres, amongst others. He also has experience in ambient air quality monitoring, the analysis and interpretation of air quality monitoring data, the monitoring and assessment of nuisance odours and the monitoring and assessment of construction dust. He is a Member of the Institute of Air Quality Management and is a Chartered Scientist.

Jack Buckley BSc (Hons) MSc AMIEnvSc AMIAQM

Mr Buckley is a Consultant with AQC with two years' experience in the field of air quality. Prior to joining AQC in June 2019, he worked as a Consultant at Capita, where he gained experience in the assessment of air quality impacts for a range of projects, including road and rail infrastructure schemes, residential developments and industrial facilities sizes. He has experience in producing air quality assessments for EIA schemes, using qualitative and quantitative methods, including ADMS-Roads and air quality neutral calculations, and has undertaken diffusion tube monitoring studies. Prior to joining Capita, Jack completed a BSc (Hons) in Chemistry and an MSc in Environmental Science and Management, with both dissertations investigating the performance of low-cost air quality sensors. He is an Associate Member of both the Institute of Air Quality Management and the Institution of Environmental Sciences.