b give strong support for London's higher and further education institutions and their development, recognising their needs for accommodation and the special status of the parts of London where they are located, particularly the Bloomsbury/Euston and Strand university precincts'

2.5 Local Policy

The London Borough of Camden has prepared Core Strategy and Development Policies documents as part of the Local Development Framework (LDF). The documents have been submitted for consultation to the Secretary of State in January 2010. The Core Strategy outlines the key elements of planning strategy for development and Development Policies set out the policies when determining planning applications in Camden. The Core Strategy gives due regard to the national and Mayor of London's planning policies.

The Core Strateg's policy, CS16 Improving Camden's health and well-being, identify the health impacts resulting from poor air quality and reaffirms to *implement Camden's Air Quality Action Plan to reduce air pollution levels.*

A number of Core Strategy policies support successful development of the growth areas, including Euston, to improve opportunities and benefits for the local community and the borough. The Strategy recognises that Euston will be one of the areas for the largest development growth as it is based around a large transport interchange and its development would contribute towards the development of Central London and to *London's national and international role*.

Development Policy DP32 – Air Quality and Camden's Clear Zone, now supersedes UDP saved policy SD9 and states:

'The Council will require air quality assessments where development could potentially cause significant harm to air quality. Mitigation measures will be expected in developments that are located in areas of poor air quality.'

3 The London Borough of Camden's Air Quality Review and Assessment

The LAQM regime was first set down in the 1997 National Air Quality Strategy (NAQS)[18] and introduced the idea of local authority 'Review and Assessment'. The Government subsequently published policy and technical guidance related to the Review and Assessment processes in 1998. The guidance has since been reviewed and the latest documents include the Policy Guidance (LAQM.PG(09)) and the Technical Guidance (LAQM.TG(09)). The guidance lays down a progressive, but continuous, framework for the local authorities to carry out their statutory duties to monitor, assess and review air quality in their area and produce action plans to meet the air quality objectives. The latest technical guidance also provides many new tools and methodologies for local air quality assessment such as background maps, NO_2/NO_x conversion tool and model verification methodology.

3.1 Summary of Review and Assessment Undertaken by the London Borough of Camden

Camden is located within Central London. The area is predominantly urban in character interspersed with parks and recreation areas.

London Borough of Camden completed the first round of review and assessment in 2002, with the conclusion that concentrations of two pollutants, NO_2 and PM_{10}, were in exceedence of air quality objectives across the Borough. As a result, the entire borough was declared an Air Quality Management Area (AQMA) and an Air Quality Action Plan (AQAP) was drawn up.

The necessary updating and screening assessments (USA) and progress reports have been carried out since the declaration of the AQMA. The last USA was produced in 2009. These have shown the need for continuance of the AQMA and the annual NO_2 objective is still being exceeded at background sites in the south of the borough.

3.2 Air Quality Monitoring

In 2009, the Council operated three automatic monitoring stations. The data from automatic sites are provided in Table 2 for NO_2 and in Table 3 for PM_{10}. The concentrations exceeding the relevant objective are highlighted in bold.

Table 2 Annual Mean NO_2 Concentrations ($\mu g/m^3$) and the Number of Hourly Exceedences at Automatic Monitoring Sites in the London Borough of Camden

Site Id	Location, OS Coordinates (X,Y)		2007	2008	2009	Data Capture % 2009
London Bloomsbury (UB)	530120, 182034	Annual mean	**61**	**55**	**54**	98
		No of hours >200 $\mu g/m^3$	6	0	2	
Swiss Cottage (Finchley Rd) (KS)	526633, 184392	Annual mean	**77**	**76**	**84***	92
		No of hours >200 $\mu g/m^3$	**113**	**70**	**217**	
Shaftesbury Avenue (RS)	530060, 181290	Annual mean	**75**	**80**	**87****	74
		No of hours >200 $\mu g/m^3$	**24**	9	11	

UB= Urban Background, RS = Roadside, KS = Kerbside
*Capture rate less than 90% (74%)
** Data not fully ratified

18 DoE, 1997, 'The United Kingdom National Air Quality Strategy', The Stationary Office

Table 3 Annual Mean PM_{10} Concentrations ($\mu g/m^3$) and the Number of Daily Mean Exceedences at Automatic Monitoring Sites in the London Borough of Camden

Site Id		2007	2008	2009	Data Capture % 2009
London Bloomsbury (UB)	Annual mean	26	23*	19	98
	No of days > 50 $\mu g/m^3$	22	13*	9	
Swiss Cottage (Finchley Rd) (KS)	Annual mean	30	27	36**	91
	No of days > 50 $\mu g/m^3$	**37**	19	5	
Shaftesbury Avenue (RS)	Annual mean	33	30	32***	9
	No of days > 50 $\mu g/m^3$	33	20	19	

UB= Urban Background, RS = Roadside, KS = Kerbside
*Capture rate less than 90% (80%)
** Capture rate less than 90% (9%)
*** Data not fully ratified

The monitoring results for NO_2 show consistent exceedence for the annual mean objective at all the sites including the urban background site. The results also show large exceedences of the hourly objective at the Swiss Cottage site during all the three years and at Shaftsbury Avenue site in 2007.

The results in Table 3 show that the annual mean air quality objective for PM_{10} havse been achieved at all the threes sites. The Swiss Cottage site shows exccedence of the 24-hour mean objective in 2007.

In addition to automatic monitoring, the Council also undertakes monitoring of NO_2 using passive diffusion tubes. The bias adjusted results for diffusion tubes within 1km of the site are presented in Table 4. The data marked bold indicates an exceedence of the relevant air quality objective.

Table 4 – Bias Corrected NO_2 Results from Diffusion Tubs within 5km Radius of the Site

DT ID	OS Grid Ref: X, Y		Annual mean concentration, $\mu g/m^3$		
	X	Y	2007	2008	2009
CA1 (RS)	530210	182762	**50.2**	**51.9**	**49.9**
CA2 (RS)	529133	182695	**48.2**	**48.2**	**49.4**
CA4 (RS)	530110	182795	**91.2**	**93.3**	**87.1**
CA5 (RS)	529395	182567	**48.1**	**46.2**	**50.9**
CA6 (UB)	530430	182430	**49.6**	37.8	39.4
CA9 (RS)	529671	181970	**94.9**	**73.0**	**82.6**
CA10(UB)	529880	182334	**46.3**	**46.8**	**50.1**
CA13 (UB)	529977	182809	**54.5**	**48.7**	**54.1**
CA14 (UB)	530120	182034	**44.3**	**43.6**	**44.5**
CA22 (RS)	529488	181719	**-**	**56.8**	**60.6**

* RS = Roadside, UB = Urban Background

The diffusion tube data shows that the NO_2 annual mean objective has exceeded at all the roadside locations in all the three years. The data for urban background sites also show wide spread exceedences except for CA6 in the 2008 and 2009. The results for CA6 in the 2009 are close to the objective.

4 Air Quality Assessment

The development is not anticipated to result in additional traffic flows on the local road network. Hence, the approach used in this assessment is based on considering the potential exposure of the occupants of the development to ambient NO_2 and PM_{10} concentrations in the year of completion of the development. The sources included in the assessment include emissions from the traffic on nearby roads and the stack of the proposed CHP plant. The concentrations of NO_2 and PM_{10} for the baseline year, 2009, have been predicted to verify and adjust model output. The predictions have also been made for the proposed year of completion, 2012, to assess the exposure of the occupants of the development.

4.1 Assessment Methodology

The following sections provide details of assessment methodology used for road traffic and stack emission sources

4.1.1 Assessment of Road Traffic Emissions

Advanced dispersion model, ADMS-Roads[3], has been employed to predict air quality concentrations resulting from road traffic emissions. The model calculates pollutant contributions from the road links included in the assessment, the background concentrations then have been added to predict total ambient pollutant levels. The model was used to predict air quality at the specific receptors placed at the facade of the development along Euston Road and Stephenson Way.

The model has been used to predict annual mean and 99.8th percentile NO_x contribution from road traffic. The 99.8th percentile concentrations are used as a surrogate for the NO_2 hourly mean objective. The latest NO_x/NO_2 converter tool provided by Defra has been used to convert modelled NO_x to NO_2. The methodology proposed in the technical guidance issued by Defra, LAQM.TG(09) has been used to obtain road contribution and total NO_2.

The model has been used to predict road contribution for PM_{10}. To calculate total ambient concentrations, the background PM_{10} is added. The number of exccedences of 24-hour mean objective for PM_{10} are calculated from the total predicted concentrations using equation provided in the technical guidance:

Number of 24-hour mean exceedences = -18.5+ (0.00145*[PM_{10} ^3] + (206/[PM_{10}]) ,

Where [PM_{10}] is the total predicted concentration

Although, the street width at the site location is greater than the typical building height, however, street canyon option provided in ADMS-Roads has been used to represent restricted air dispersion and would result in higher predicted pollutant concentrations.

4.1.2 Assessment for Stack Emissions

The ADMS 4 dispersion model[19] (Version 4.1) has been used for this study, which is the most up-to-date version of the model at the time of this study.

The ADMS model has been widely validated for industrial point sources, and is accepted as being 'fit-for-purpose' for environmental impact assessments of stack releases. It is regularly tested against other dispersion models by the Environment Agency's (EA) Air Quality Modelling and Assessment Unit (AQMAU), and is recognised as being suitable for environmental impact assessments. The model incorporates the latest understanding of boundary layer meteorology and dispersion. The

[19] ADMS4 Atmospheric Dispersion Modelling System, User Guide, CERC, June 2007

assessment has only been carried out only for NO_x, NO_2 as the gas fired boiler associated with the CHP does not emit PM_{10}.

The stack contribution to local ground level concentrations of NO_x are predicted using the dispersion model. There is a need to consider what proportion of the NO_x is oxidised to NO_2 when the plume reaches the ground. The atmospheric oxidation rate of NO to NO_2 in the plume depends on prevailing oxidant levels (e.g. O_3).

For an assessment against the NO_2 annual mean objective, a conservative assumption may be made that 70% of the NOx emitted from the stack has been oxidised to NO_2 at ground level.

4.2 Input Data

To predict the pollutant contributions from road traffic and stack source, the model requires various input data such as traffic flows, background pollutant concentrations and meteorology data and stack and building parameters. The following sections describe the input data used for this assessment.

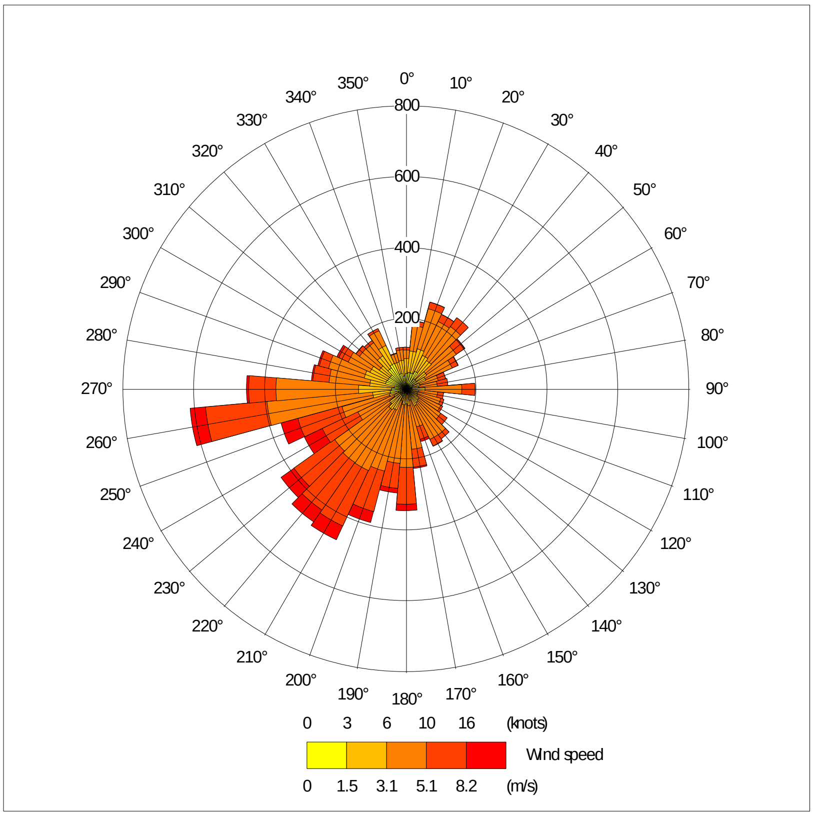
4.2.1 Meteorology Data

The atmosphere serves as a medium for the dispersion of pollutants once these are released within it. Atmospheric turbulence is defined as an indication of how easily a parcel of air can rise. If the parcel rises easily the atmosphere is termed as ‘convective or unstable’ and if the parcel moves with difficulty the atmosphere is termed as ‘stable’. A number of parameters are used by the ADMS4 model to define atmospheric turbulence such as wind speed and direction, Monin-Obukhov length, surface roughness length and boundary layer height.

The Monin-Obukhov length (L_{MO}) defines atmospheric stability across a continuous scale, rather in discrete classes. It is the height above ground where the vertical turbulence is in equilibrium, that is, the air parcel cannot rise any further. Boundary layer height (h) is defined as the height in meters of the air layer near ground influenced by mainly diurnal heat and momentum changes at surface.

Dispersion of pollutant emissions is dependent upon the release conditions from the stack (e.g. temperature of the gas-stream, velocity, height of release) and the prevailing meteorological conditions at the time of release from the stack. Hourly sequential meteorological data for year 2009 from Heathrow Airport have been used in this study. The wind rose is presented in Figure 2.

Figure 2 - Wind-rose of 2009 Heathrow Airport Meteorology Data



4.2.1.1 Source and Type of Data

The supplier of the meteorological data used for this study was MeteoGroup. Data are derived from the closest and most representative observing stations providing all the parameters required by the dispersion model. While many stations provide temperature, wind direction and wind speed, there are fewer sites providing cloud cover (or similar measurements) that are required by new-generation models such as ADMS4, in order to estimate the profile of boundary layer (by means L_{mo} and h).

For this study, MeteoGroup advised the use of observational data on wind speed, direction, and temperature from Heathrow Airport, which is at a distance of approximately 20km from Bentley House.

4.2.2 Building Data for Assessment of Stack Emissions

Buildings can have a significant effect on the dispersion of pollutants, particularly if they are at least 30-40% of the height of the stack. If tall buildings are close to a stack, the plume can be entrained in the cavity zone downwind of the building. This can lead to higher ground concentrations near the stack than would be expected and can affect the dispersion of pollutants in the atmosphere. The downwash effects can be taken into account by the ADMS4 dispersion modelling.

In this study, downwash effects were taken into account for the dominant buildings for which information on heights has been available to BV, in the vicinity of the exhaust stack. A total of four buildings have been considered (Table 5).

Table 5 - Building Inputs to the ADMS4 Model

Building ID	Building Description	Height (m)	OS Grid Co-ordinate Centre-point of building		Length (m)	Width (m)
			X	Y		
1	Bentley House	23	529478	182468	29.9	34.0
2	194-198 Euston Rd	30	529514	182478	41.4	13.0
3	Building to SW of Bentley House	30	529451	182452	32.4	34.8
4	Building on opposite side of Euston Rd to Bentley House	37	529476	182396	98.6	21.1

4.2.3 Stack Modelling Parameters

Stack release parameters and pollutant release rates were provided by Watermans are presented in Table 6. The CHP plant is intended to be operated continuously, therefore results are based on the worst-case scenario of continuous operation.

Table 6 - Stack Parameters

	Volumetric flow-rate of gas stream in stack, at standard reference conditions (Nm^3/h)	Actual Flow-Rate of gas stream in stack (Am^3/s)	Stack Height (m)	Equivalent stack exit diameter (m)	Temp. of release (^oC)	Pollutant emission rates (with catalyst in place) NOx (g/s)
Exhaust Stack	475	0.1899	26	0.2	120	0.033

4.2.4 Traffic Data

Traffic data, traffic flows, vehicle split and vehicle speed, used in this assessment has been obtained from London Atmospheric Emissions Inventory (LAEI[20]). LAEI provides traffic data for 2006, 2010 and 2015 and assumes that traffic flows will not increase in inner London, hence, the traffic data for the three years provided in LAEI is same. Therefore, same traffic data has been used for 2009, baseline year, and 2012, year of completion. The traffic data used in the assessment for road links used in model verification and in prediction at the development site is provided in Table 7.

Table 7 – Traffic Data from LAEI Used in the Assessment for 2009 and 2012

	LAEI (2006, 2010, 2015)		
	AADT	%HDVs	Avg. speed, kph
Links for Model Verification			
Euston Road	50794	10.4%	18
Judd Street	5044	5.5%	13
Midland Road	6616	6.1%	19
Links for AQ Assessment at Development			
Euston Road	46860	46860	23

[20] LAEI_2006 (March 2009) – London Atmospheric Emissions Inventory provided by GLA

	LAEI (2006, 2010, 2015)		
	AADT	%HDVs	Avg. speed, kph
Melton Street/ Euston Square	13710	13710	20
Euston Square/Euston Road	10841	10841	16
Gordon Street	12617	12617	15
AADT = Annual Average Daily Traffic, HDV = Heavy Duty Vehicle includes HGVs (Heavy Goods Vehicles) and buses and coaches			

4.2.5 Background Concentrations

The model has been used to calculate the pollutant concentrations due to the modelled source. The background level concentrations (arising from sources other than traffic) has been added to derive the total pollutant concentrations at the receptors of concern.

The background concentrations either can be obtained from appropriate monitoring stations or from Defra modelled maps of background pollutant concentrations. It is preferable to use background data from appropriate monitoring where available.

Defra has recently provided the updated maps at a resolution of 1x1 km for the entire UK for the years 2008-2020. The maps are available from the UK Air Quality Archive[21]. The urban background monitoring station of Bloomsbury is less than 1km from the site. The data for 2009 from this site has been used for the assessment of pollutant concentrations for the baseline year, 2009. The background for 2012 has been calculated from this data using factors obtained from the Defra modelled maps data for the same grid square in which the monitoring station is located for 2009 and 2012. The background data used in the assessment is shown in Table 8.

Table 8– Background Pollutant Data Used in the Assessment

	2009	2012
NO_2	54.0	47.8
NO_x	92.3	79.0
PM_{10}	19.0	18.0

4.2.6 Receptor Locations

Twenty eight receptors have been selected at four locations, two at the front façade and two at the rear façade, of the Bentley House to assess air quality from road traffic at the development site. Air quality has also been assessed at these receptors from stack emissions of the proposed CHP plant in the proposed year of completion. The prefix of these receptors is denoted by R (Roadside). Roadside receptors have been selected at various heights to investigate the exposure at different storeys of the proposed residential scheme. The suffix G and 1-6 represent floor numbers (ground, 1….6). These locations will be subject to a significant contribution from road traffic emissions, and the contribution of the stack emissions are added to the modelled road traffic contribution

In addition to 28 receptors as described above, predictions of local pollutant concentrations have also been made for 20 specific receptor locations in the vicinity of Bentley House (S1 – S20) to model the wider impacts of stack emissions. These receptors represent locations where exposure is relevant, i.e. building facades of flats/apartments. One receptor was selected at the diffusion tube CA4 for model verification purposes. The location of the modelled receptors is shown in Figure 3 and the details of these receptors are provided in Table 9.

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[21] The National Air Quality Information Archive website http://www.airquality.co.uk/archive/laqm/tools.php?tool=background

Figure 3– Location of Specific Receptors

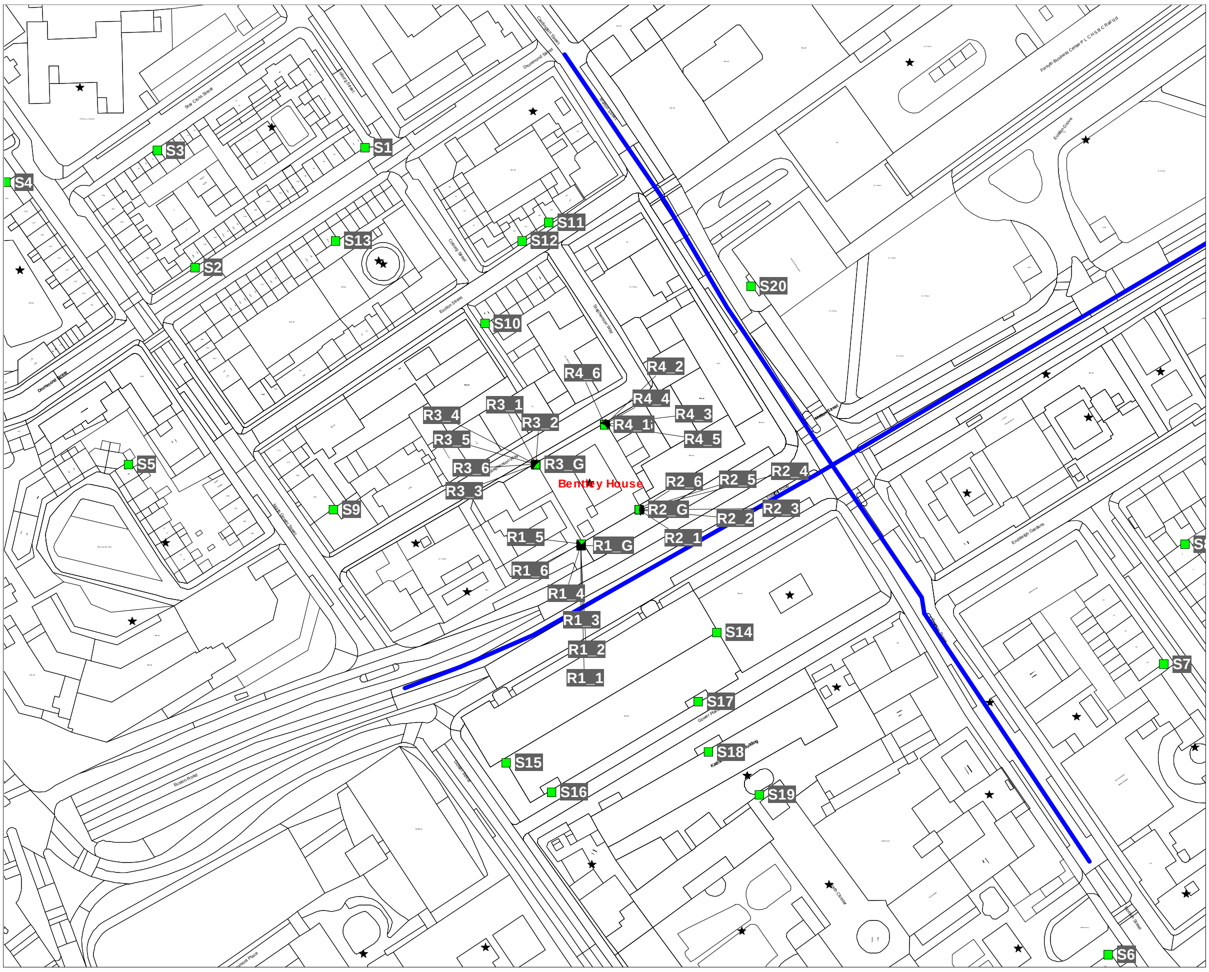

Table 9 – Details of Selected Specific Receptors

Receptor ID	Address	Easting	Northing	Height
R1_G	200 Euston Road, Euston Road facade	529473	182445	1.5
R1_1	200 Euston Road, Euston Road facade	529473	182445	4.5
R1_2	200 Euston Road, Euston Road facade	529473	182445	7.5
R1_3	200 Euston Road, Euston Road facade	529473	182445	10.5
R1_4	200 Euston Road, Euston Road facade	529473	182445	13.5
R1_5	200 Euston Road, Euston Road facade	529473	182445	16.5
R1_6	200 Euston Road, Euston Road facade	529473	182445	19.5
R2_G	200 Euston Road, Euston Road facade	529495	182458	1.5
R2_1	200 Euston Road, Euston Road facade	529495	182458	4.5
R2_2	200 Euston Road, Euston Road facade	529495	182458	7.5
R2_3	200 Euston Road, Euston Road facade	529495	182458	10.5
R2_4	200 Euston Road, Euston Road facade	529495	182458	13.5
R2_5	200 Euston Road, Euston Road facade	529495	182458	16.5
R2_6	200 Euston Road, Euston Road facade	529495	182458	19.5
R3_G	200 Euston Road, Stephenson Way facade	529456	182475	1.5
R3_1	200 Euston Road, Stephenson Way facade	529456	182475	4.5
R3_2	200 Euston Road, Stephenson Way facade	529456	182475	7.5
R3_3	200 Euston Road, Stephenson Way facade	529456	182475	10.5
R3_4	200 Euston Road, Stephenson Way facade	529456	182475	13.5
R3_5	200 Euston Road, Stephenson Way facade	529456	182475	16.5
R3_6	200 Euston Road, Stephenson Way facade	529456	182475	19.5
R4_G	200 Euston Road, Stephenson Way facade	529482	182490	1.5
R4_1	200 Euston Road, Stephenson Way facade	529482	182490	4.5
R4_2	200 Euston Road, Stephenson Way facade	529482	182490	7.5
R4_3	200 Euston Road, Stephenson Way facade	529482	182490	10.5
R4_4	200 Euston Road, Stephenson Way facade	529482	182490	13.5
R4_5	200 Euston Road, Stephenson Way facade	529482	182490	16.5
R4_6	200 Euston Road, Stephenson Way facade	529482	182490	19.5
S1	60-68 Coburg Street	529392	182594	1.5
S2	120a Drummond Street	529328	182549	1.5
S3	13 Star Cross Street	529314	182593	1.5
S4	231 North Gower Street	529257	182581	1.5
S5	8a Talmer's Square	529303	182475	1.5
S6	26 Gordon Street	529671	182291	1.5
S7	24 Taviton Street	529692	182400	1.5
S8	1 Taviton Street	529700	182445	1.5

Receptor ID	Address	Easting	Northing	Height
S9	162 North Gower Street, rear facade	529380	182458	1.5
S10	William Hill, Euston Road, rear facade	529437	182528	1.5
S11	60 Euston Street	529461	182566	1.5
S12	64 Euston Street	529451	182559	1.5
S13	131 Drummond Street	529381	182559	1.5
S14	215 Euston Road	529524	182412	1.5
S15	Gower Street facade	529445	182363	1.5
S16	Gower Street façade west	529462	182352	1.5
S17	Gower Street façade east	529517	182386	1.5
S18	Kathleen Lonsdale Building	529521	182367	1.5
S19	UCL Building	529540	182351	1.5
S20	Grant Thornton House	529537	182542	1.5

4.3 Impact Significance

The significance of the air quality impacts due to stack emissions proposed for the development are described based on the predicted change in the annual average NO_2 concentrations.

The significance of impacts has been assessed based on the latest EPUK guidance document[22] to determine the significance of the impacts taking into account:

i. the magnitude of the change (% change for annual mean).

ii. the concentration relative to the air quality objective (above or below the relevant air quality objective);

iii. the direction of change (adverse – increase with scheme - or beneficial – decrease with scheme); and

Taking account of these changes, the impact assessment is described at each receptor as Negligible, Slight, Moderate and Substantial, and whether the change is Beneficial or Adverse. The impact significance is applicable only to those receptors, which are locations where the relevant objectives apply.

Table 10– Definition of Impact Magnitude as Percentage Change in Annual Mean NO_2

Annual Mean	Impact Magnitude
Increase/decrease >10%	Large
Increase/decrease 5-10%	Medium
Increase/decrease 1-5%	Small
Increase/decrease <1%	Imperceptible

[22] Development Control: Planning for Air Quality, (2010 Update), Draft for Consultation, 25th February 2010

The explanation of impacts significance descriptors, applicable in this case is provided below in Table 11.

Table 11 - Descriptors for Impact Significance

Absolute Concentration in Relation to Objective	**Impact Magnitude**			
	Imperceptible	Small	Medium	Large
Above Objective with Scheme	Negligible	Slight Adverse	Moderate Adverse	Substantial Adverse

4.4 Air Quality Assessment Results

The following sections provide details of the model verification and the predicted concentrations for NO_2 and PM_{10} at the selected receptors. The NO_2 and PM_{10} concentrations for the baseline year have been predicted only from road traffic sources and for the Bentley Road receptors. In the proposed year of completion, the predictions have been made for road traffic as well as stack emission sources. For stack emissions, air quality predictions have only been made for NO_2 and NO_x.

4.4.1 Model Verification Results

The model output can be compared against local monitoring data (where available) to undertake model verification. The objectives of the model verification are:

- to evaluate model performance,
- to show that the baseline is well established, and
- to provide confidence in the assessment results

During the verification process, Bureau Veritas aim to ascertain whether all final modelled concentrations are within 25%, preferably within 10%, of the monitored concentrations. Modelled results may not compare well at some locations for a number of reasons including:

- errors in traffic flow and speed data estimates,
- model setup (including street canyons, road widths, receptor locations),
- model limitations (treatment of roughness and meteorological data),
- uncertainty in monitoring data, and
- uncertainty in emissions data.

For model verification of NO_2 2009 results from diffusion tube CA4 have been used. The diffusion tube is located about 500 away from the site along Euston Road at Camden Town hall.

Predicted NO_2 concentrations were derived from the latest NO_x/NO_2 conversion method released by Defra in Jan 2010. The model verification results are provided in Table 12. The unadjusted model predicted concentrations of NO_2 were lower by about 18%. The details of the model verification and adjustment factor are provided in Appendix 1. The model verification yielded an adjustment factor of 2.19 for road-NOx. The modelled road-NO_x contributions at the all the specific receptors have been multiplied by the adjustment factor 2.19 in the baseline year and the year of completion.

Table 12 – Model Verification Results

Site ID	Monitored NO_2, µg/m^3 (2009)	Unadjusted Modelled NO_2, µg/m^3	Adjusted Modelled NO_2, µg/m^3	Difference Adjusted Modelled/Monitored	
				µg/m^3	%
Purley Way Station	**87.1**	**71.5**	**87.1**	0.0	0.0

Currently no roadside PM_{10} monitoring takes place in the area, therefore, it is not possible to verify model for PM_{10}. However, as recommended in the technical guidance and using a conservative approach all modelled road contributions for PM_{10} have also been multiplied by the adjustment factor of 2.19, derived for road-NO_x.

4.4.2 Assessment of Nitrogen Dioxide (NO_2) from Road Traffic Sources

The predicted annual mean and 99.8th percentile concentrations for NO_2 in 2009 and 2012 from road are shown in Table 13. The predictions showing exceedence of the relative objective marked bold

Table 13 – Annual Mean and 99.8th Percentile Concentrations, µg/m^3, at the Bentley House Receptors in 2009 and 2012

Receptor ID	2009		2012	
	Annual Mean,	99.8th Percentile,	Annual Mean	99.8th Percentile
R1_G	**67.6**	115.8	**58.8**	101.4
R1_1	**62.3**	95.9	**54.3**	85.1
R1_2	**58.6**	82.5	**51.4**	72.7
R1_3	**56.7**	74.0	**49.9**	65.2
R1_4	**55.6**	68.3	**49.1**	60.2
R1_5	**55.0**	64.4	**48.6**	56.8
R1_6	**54.7**	61.7	**48.3**	54.2
R2_G	**67.0**	113.7	**58.3**	99.3
R2_1	**62.5**	97.0	**54.5**	85.3
R2_2	**59.0**	82.8	**51.7**	73.5
R2_3	**57.0**	74.3	**50.1**	65.4
R2_4	**55.8**	68.3	**49.2**	60.1
R2_5	**55.2**	64.0	**48.7**	56.3
R2_6	**54.7**	61.1	**48.4**	53.8
R3_G	**58.0**	82.3	**50.9**	72.2
R3_1	**57.6**	79.7	**50.6**	69.8
R3_2	**56.9**	76.4	**50.0**	67.1
R3_3	**56.2**	72.5	**49.5**	63.5
R3_4	**55.5**	68.5	**49.0**	60.0
R3_5	**55.0**	64.8	**48.6**	57.0
R3_6	**54.7**	62.2	**48.3**	54.6

Receptor ID	2009		2012	
	Annual Mean,	99.8th Percentile,	Annual Mean	99.8th Percentile
R4_G	**58.5**	83.5	**51.3**	73.1
R4_1	**58.0**	80.6	**50.9**	70.7
R4_2	**57.3**	77.3	**50.3**	67.6
R4_3	**56.5**	73.5	**49.7**	64.1
R4_4	**55.7**	69.4	**49.1**	60.4
R4_5	**55.2**	65.4	**48.7**	57.1
R4_6	**54.8**	62.1	**48.4**	54.3
Objective	**40**	**200**	**40**	**200**

The 2009 results for NO_2 vary between 54.7 and 67.6µg/m^3. The 2009 results show exceedence of the annual mean NO_2 objective at all the modelled receptors. In part, the exceedence is due to high background NO_2 concentrations used in the assessment. The model results are inline with the monitoring data from the roadside sites in the borough and confirm the findings of the review and assessment carried out by the Council and the designation of the AQMA for NO_2.

In 2012 the predicted annual mean NO_2 concentrations vary between 48.3 and 58.8µg/m^3. The results show exceedence of the annual mean NO_2 objective at all the Bentley House receptors.

The predicted concentrations in 2009 and 2012 show a decrease with increasing height. This is due to mixing of emissions in bigger volume as the height increases. At sixth floor, the predicted concentrations are similar to the background.

The concentrations at receptors placed along the rear façade (Stephenson Way) are lower compared to receptors placed along the front façade (Euston Road). This is due to increased distance from Euston Road. However, the difference is less prominent as height increases. The predicted concentrations at the sixth floor front or rear façade receptors are identical.

The 99.8th percentile concentrations for NO_2, which are used as surrogate for the short-term objective of NO_2 are below 200µg/m^3, which suggests that the hourly-mean objective is likely to be achieved at the site during 2009 and 2012.

The research[23] based on NO_2 monitoring from the UK and the latest technical guidance suggests that the hourly-mean objective for NO_2 is unlikely to be exceeded if the annual mean concentrations are less than 60µg/m^3. Based on this research and the predicted annual mean concentrations, indicate potential exceedence at the front façade of Bentley House in 2009. All the predicted NO_2 concentrations in 2012 are below 60µg/m^3.

The predicted concentrations for 2012 compared to 2009 are systematically lower. This is due to the inherent assumptions in modelling that the background concentrations and emissions - due to improvement in vehicle technology – would go down in the future years and would result in lower ambient NO_2 concentrations. However, the monitoring data from Camden and London for last many years do not show this downward trend. The monitored concentrations are generally staying flat. If the current trend in monitoring continues in the future, then the predicted decreases in NO_2 concentrations would not occur and the concentrations in 2012 would remain similar to predicted for 2009.

[23] AEAT (May 2008) Analysis of the relationship between annual mean nitrogen dioxide concentration and exceedences of the 1-hour mean AQS Objective. A report produced for the Department for Environment, Food and Rural Affairs, the Scottish Government, the Welsh Assembly Government and the Department of the Environment in Northern Ireland.

4.4.3 Assessment of Nitrogen Dioxide (NO_2) from Stack

The assessment of stack emissions has only been carried out for 2012 when the CHP plant would be operational. The predictions have only been made for NO_2 and NO_x as PM_{10} emissions would not result from the plant.

The dispersion model predicts the ground level[24] concentrations of the emitted pollutant contributed by the stack serving the CHP plant. The modelled stack contribution for NOx are summarised in for the selected specific receptors.

Emissions of oxides of nitrogen from combustion processes are typically 95% nitric oxide (NO) or greater. Atmospheric reactions with ozone and oxygen cause the oxidation of NO to NO2. For the purposes of the modelling exercise, it has been assumed that there is 70% conversion of NO to NO_2 for long term impacts[25]. This is in accordance with guidance provided by the EA. Short-term impacts have been calculated using Defra Technical Guidance LAQM.TG(09) equations, allowing for background and the road-traffic contribution.

Table 14 – Stack Contributions for NO_2

Receptor ID	Annual mean NO_2[26] ($\mu g/m^3$)
R1	1.02
R2	1.26
R3	1.07
R4	0.95
S1	0.07
S2	0.06
S3	0.04
S4	0.03
S5	0.05
S6	0.04
S7	0.08
S8	0.09
S9	0.06
S10	0.08
S11	0.13
S12	0.11
S13	0.08
S14	0.07
S15	0.09
S16	0.08
S17	0.11
S18	0.08
S19	0.08
S20	0.19
Objective	**40**

[24] Throughout this study, ground level means at a height of 1.5 m above ground i.e. to represent inhalation

[25] EA/SEPA. 2003, *Environmental Assessment and Appraisal of BAT*, Horizontal Guidance Note IPPC H1, Environment Agency, Bristol.

[26] Allowing for 70% conversion of NOx to NO_2 on an annual basis

The results show that at the Bentley House receptors the stack contributions for the annual mean NO_2 vary between 0.95 and 1.27µg/m^3. At all other receptors the contributions are imperceptible, generally below 0.1µg/m^3 NO_2.

To assess the impact significance due to stack emissions the criteria described in Section 4.3 has been used. The impact significance results are presented in Table 15.

Table 15 – Impact Significance Due to Stack Emissions

Receptor	Modelled, Concentration, µg/m^3*	Stack Contribution, µg/m^3	Total Modelled Concentration, µg/m^3 **	% Change	Impact Magnitude	Significance
R1_G	58.8	1.02	59.82	1.7%	Small	Slight Adverse
R2_G	58.3	1.26	59.56	2.2%	Small	Slight Adverse
R3_G	50.9	1.07	51.97	2.1%	Small	Slight Adverse
R4_G	51.3	0.95	52.25	1.9%	Small	Slight Adverse
S1	-	0.07	-	<1%	imperceptible	Negligible
S2	-	0.06	-	<1%	imperceptible	Negligible
S3	-	0.04	-	<1%	imperceptible	Negligible
S4	-	0.03	-	<1%	imperceptible	Negligible
S5	-	0.05	-	<1%	imperceptible	Negligible
S6	-	0.04	-	<1%	imperceptible	Negligible
S7	-	0.08	-	<1%	imperceptible	Negligible
S8	-	0.09	-	<1%	imperceptible	Negligible
S9	-	0.06	-	<1%	imperceptible	Negligible
S10	-	0.08	-	<1%	imperceptible	Negligible
S11	-	0.13	-	<1%	imperceptible	Negligible
S12	-	0.11	-	<1%	imperceptible	Negligible
S13	-	0.08	-	<1%	imperceptible	Negligible
S14	-	0.07	-	<1%	imperceptible	Negligible
S15	-	0.09	-	<1%	imperceptible	Negligible
S16	-	0.08	-	<1%	imperceptible	Negligible
S17	-	0.11	-	<1%	imperceptible	Negligible
S18	-	0.08	-	<1%	imperceptible	Negligible
S19	-	0.08	-	<1%	imperceptible	Negligible
S20	-	0.19	-	<1%	imperceptible	Negligible

* - Background + road contribution, ** Background + road contribution + stack contribution - for Bentley House receptors only

The results show that the stack would result in about 2% increase in annual mean NO_2 concentration at Bentley House receptors. The impact at these receptors has been adjudged as 'Slight Adverse' at all other receptors the impact is 'Negligible'.

4.4.4 Assessment of Particles (PM_{10})

The predicted annual mean concentrations and number of exceedence days for PM_{10} in 2009 and 2012 are shown in Table 16.

The predicted annual mean concentrations for PM_{10} in 2009 vary between 19.1 and 22.3µg/m^3. In 2012 the predicted annual mean concentrations vary between 18.1 and 20.7µg/m^3. The maximum number of days with PM_{10} concentrations >50µg/m^3 are 7 in 2009 and 4 in 2012. The results indicate that that both the annual and daily mean objectives for PM_{10} are likely to be achieved in 2009 and 2012 at the development site. The predicted concentrations for PM_{10} are systematically lower in 2012 compared to 2009 for the same reasons as described for NO_2.

Table 16 –Predicted Annual Mean Concentrations, µg/m^3, and Number of Exceedence Days for PM_{10} in 2009 and 2012

Receptor ID	2009		2012	
	Annual mean concentration, µg/m^3	No. of days, concentration >50µg/m^3	Annual mean concentration, µg/m^3	No. of days, concentration >50µg/m^3
R1_G	22.3	7	20.7	4
R1_1	20.9	5	19.5	3
R1_2	20.0	3	18.8	2
R1_3	19.6	3	18.5	2
R1_4	19.3	3	18.3	2
R1_5	19.2	3	18.2	2
R1_6	19.1	2	18.1	1
R2_G	22.1	7	20.5	4
R2_1	20.9	5	19.6	3
R2_2	20.1	4	18.9	2
R2_3	19.6	3	18.5	2
R2_4	19.4	3	18.3	2
R2_5	19.2	3	18.2	2
R2_6	19.2	2	18.1	1
R3_G	19.9	3	18.7	2
R3_1	19.8	3	18.6	2
R3_2	19.6	3	18.5	2
R3_3	19.5	3	18.4	2
R3_4	19.3	3	18.3	2
R3_5	19.2	3	18.2	2
R3_6	19.1	2	18.1	1
R4_G	20.0	3	18.8	2
R4_1	19.9	3	18.7	2
R4_2	19.7	3	18.6	2
R4_3	19.5	3	18.4	2
R4_4	19.4	3	18.3	2
R4_5	19.2	3	18.2	2
R4_6	19.2	2	18.1	2
Objective	**40**	**35**	**40**	**35**

5 Building Mitigation Approaches

5.1 Generic Mitigation Measures

The following generic mitigation measures are available in terms of site and building design for the protection of occupant health from poor air quality.

An overall ventilation strategy for the building may be considered in respect of the requirements of best practice set out in the following CIBSE publications:

- CIBSE Guide A 1999 Environmental Design (Chapter 4. Air infiltration)
- CIBSE Guide B2 2001 Ventilation and air conditioning
- CIBSE AM10 Natural ventilation
- CIBSE TM13 Mixed mode ventilation
- CIBSE TM21 Minimising pollution at air intakes

Ventilation systems are typically described as natural, mechanical or mixed mode. Mechanical ventilation and air conditioning systems that incorporate filtration are often used but rarely designed to reduce common external pollutants. Mechanical ventilation systems have high capital outlay and running costs through energy consumption and increased emissions of CO_2 (a greenhouse gas). The growing pressure to meet the CO_2 emission reduction targets agreed by Government under international protocols means that encouraging the design of energy efficient buildings using natural or mixed-mode ventilation where possible is preferable. Natural ventilation is relatively inexpensive, needs minimal maintenance and can make a contribution to a low energy strategy for a building. However, it does not allow for the treatment of incoming air in order to minimise the level of pollutant ingress from the outside. This can be offset by first identifying the sources of pollution around a building (in this case road traffic) and positioning air inlet devices in a sensible way.

Mixed-mode systems attempt to exploit the benefits of both natural and mechanical ventilation. They can provide benefits in urban areas where, for example, mechanical ventilation with filtration can be used during periods of high outdoor pollutant concentrations. There is currently little guidance available on minimising indoor air pollution from outdoor sources beyond that highlighted above; namely, the placement of ventilation inlets away from much localised pollution sources. Until guidance becomes available, there is uncertainty with respect to the most appropriate mitigation measures that may be adopted in order to protect sensitive environments. However, a number of measures could be discussed with the relevant planning authority and environmental health professionals in order to form a consensus on those that are most likely to reduce the ingress of pollutants from the outside. These are as follows:

- Sealed or limited opening of windows on the roadside façade of the building;
- Location of air intakes on top of tall buildings;
- Air intakes that close during peak-hour traffic flows (i.e. when pollution is at its highest) – Mixed-mode ventilation systems; and
- Mechanical ventilation systems with in-built filtration

5.2 Mitigation Provided by Design

As mentioned in Section 1.2, Bentley House is set back by about 10m from the kerb of Euston Road. The road impact tends to decrease exponentially moving away from the road. The boiler proposed for the development is one of the low emitting, which contributes about 1µg/m^3 to annual mean NO_2, compared to typical boilers that contribute 2-3µg/m^3. However, as the predicted concentrations are above the annual mean objective of NO_2, therefore, the following mitigation measures have been provided in the design to minimise these impacts.

- Sealed windows to the Euston Road bedrooms.
- Euston Road bedrooms to be supplied with filtered air from a roof mounted AHU.

6 Construction Impacts Assessment

The construction and demolition activities are associated with generating nuisance dust. The occurrence of nuisance dust will mainly depend upon the nature and scale of the work and type of activities. For example, demolition projects adjacent to sensitive areas such as hospitals, schools or residential properties might cause an increased risk of nuisance dust compared to design and build activities. The demolition and construction activities are estimated to contribute significantly to the total PM_{10} emissions in the UK, 2.4%. These contributions locally could be far more significant. Although, the construction and demolition activities are significant contributor to total PM_{10} emissions in the UK, their contribution to larger particles is even more considerable. These large particles tend to fall out quickly; therefore, the impacts from nuisance dust are most likely to be felt within 200m of the dust-generating activity.

A number of regulatory and legislative constraints are in place to control the pollution from construction and demolition activities. The Planning Policy Statement 23 – Planning Pollution Control[27] details the Governments' policies on using planning conditions to control pollution. The Building Act 1984 and subsequent Building Regulations 2000 requires to ensure the safety of people in and around the building during work. Part III of the Environmental Protection Act (EPA) 1990 identifies the emission of dust from construction sites as having the potential to be a statutory nuisance and requires its control under section 80.

A number of documents describing the best practices and guidance to mitigate the impacts of nuisance dust from construction and demolition activities are now widely available. The Greater London Authority in partnership with London Councils has produced the document titled 'The control of dust and emissions from construction and demolition – Best Practice Guidance'[28]. Currently, this document is being updated to serve as Supplementary Planning Guidance. The guidance document recommends mitigation measures, depending upon the scale of development and its location, to control nuisance dust from various activities during construction and demolition phases. BRE (Building Research Establishment) has produced 'Control of dust from construction and demolition activities'[29] that outlines the measures to control the emissions of nuisance dust. Currently, a number of best practice guides are available[30], which provide a basis against which Codes of Construction Practice may be benchmarked.

The construction programme should outline the schedule of works and phasing of proposed construction activities. The duration and phasing of construction, the scale of the proposed development, and proximity of pollution-sensitive sites such as schools and residential properties, as well as commercial premises, will be used to assess qualitatively the impact of construction dust deposition and recommended level of control required during the construction phase.

It is expected that, through mitigation measures, the impact of construction activities can be reduced significantly. Appropriate mitigation measures that could be employed by the appointed contractor throughout the course of the schedule of works are considered below.

6.1 Proposed Mitigation Measures for Short-term Impacts

Good practice suggests that an environmental management plan would greatly reduce the likely occurrence of elevated dust levels occurring throughout the construction phase of the proposed development.

In adopting a strategy to minimise the effects of construction on adjacent land users, the appointed contractor would be requested to submit their Company Environmental Policy and specific details of pollution controls set out in a Project Specific Environmental Plan (EP), identifying all potential impacts of activities and operations. This would also include a framework and timetable for implementing work practices, procedures and management controls to eliminate potential negative

[27] http://www.communities.gov.uk/pub/918/PlanningPolicyStatement23PlanningandPollutionControl_id1143918.pdf

[28] Mayor of London (Nov 2006), The control of dust and emissions from construction and demolition - Best Practice Guidance, Produced in partnership by the Greater London Authority and London Councils

[29] V Kukadia, S Upton, D Hall (2003), Control of dust from construction and demolition activities, BRE Publications

[30] Kukadia, Upton, Grimwood and Yu (2003), BRE Pollution Control Guides: Controlling particles, vapours and noise pollution from construction sites, BRE Publications

impacts on local air quality. The elements of control for reducing the impacts on the adjacent land users could include subscribing to the Considerate Contractors Scheme and consideration to traffic and delivery management, site, road and neighbourhood cleansing, and containment and pollutant minimisation. Those specific elements that could mitigate against potential impacts on air quality include:

Considerate Contractors Scheme

A general philosophy of tidiness in the condition and appearance of the site should prevail during the construction phase. Satisfactory precautions should be taken to prevent the occurrence of pollution at site and, where appropriate, sheeting should be used to minimise the nuisance of any building operations. In addition, dust screens should be provided where necessary to minimise the nuisance from dust generating activities and vehicles carrying dusty materials on and off site should be sheeted.

Traffic and Delivery Control

A full traffic plan setting out all construction traffic routes, marshalling areas, holding points and banned routes should address the potential local concerns regarding congestion and safety. The plan should aim to minimise the level of vehicle movements in and around the site, thereby reducing the potential for dirt, emission, noise and congestion issues.

The appointed contractor would be requested to include consideration to selection of vehicles, plant and equipment, which minimise emissions to air and limit use to when essentially required. For example, preference would be for electrically powered rather than petrol or diesel, where possible. Consideration should also be made within the EP to restricted site parking for site workers to minimise additional vehicle movements during the construction phase.

Site, Road and Neighbourhood Cleanliness

Dust reduction techniques should be employed by the appointed contractor in order to reduce the likelihood of dust arising from the site and deposition of dust on the public highway. This would be of particular importance during the early construction phases during any site clearance/excavation activities, as the risk of dust generation is much greater. Provision of hard standing in areas where vehicle movements mostly occur would greatly assist in maintaining site cleanliness.

The orientation, shape and location of any stockpiles (if utilised) should be planned and controlled to minimise dust generation through wind action and drop height of materials onto stockpiles should be minimised.

Containment and Pollutant Minimisation

Through the employment of proven techniques such as those outlined above, the project should seek to contain as much of the movement of materials, equipment, earth and waste within the site boundary. The reduction of traffic, emissions, noise, dirt, dust and waste as outlined above will be imperative with respect to reducing the impact of the project on adjoining land users.

Potential short-term (construction) impacts

The building of the proposed development would require some demolition and significant construction, earthwork and other related activities. The proposed work would result in the generation of dust and PM_{10} , which might result in nuisance for residential, retail and commercial properties within 200 m of the site. Therefore, it is advised that a Construction Dust Management Plan is prepared for the site and consideration to monitoring of nuisance dust be made within this plan.

7 Summary and Conclusions

The report provides the results of an air quality assessment carried out for the planning permission application for a redevelopment of Bentley House on Euston Road, Camden, to provide student residential accommodation.

The development comprises of 170 student residential units. Although the development is anticipated not to alter the traffic flows on local road network, it would introduce new exposure in the area that has been declared as an AQMA. Therefore, the assessment has been carried out to identify the risk to health of the occupants of the completed development.

The air quality in the area is already in breach of air quality objectives for NO_2. Even the background used in the assessment for 2009 and 2012 is significantly above the objective.

Advanced dispersion model ADMS-Roads has been used to assess impact from road traffic. The model has been verified and adjusted against the local monitoring data. Model adjustment for NO_2 has been carried out using the methodology recommended in the technical guidance, LAQM.TG(09). Street canyons have been used to represent restricted air dispersion due to tall buildings on either side of Euston Road. ADMS-Roads has been used to predict NO_2 and PM_{10} concentrations at Bentley House resulting from road traffic sources for the baseline year, 2009, and the proposed year of completion, 2012.

A detailed dispersion modelling study using ADMS 4.1 has been carried out for releases to air from the exhaust stack of the proposed CHP plant. The methodology for this study follows best practice guidelines and has due regard to the latest Defra Technical Guidance LAQM.TG(09) and EP UK guidance on assessing significance. The contribution of the proposed stack to local air pollutant concentrations is compared against statutory air quality strategy objectives. These environmental benchmarks seek to protect against exposure arising from inhalation of polluted air. These benchmarks are set as both long-term and short-term statistics, to safeguard against chronic and acute health effects.

Twenty eight receptors have been selected at Bentley House at various heights. Additional 20 receptors have been chosen to model impacts from stack emissions over wider area.

The predicted annual mean NO_2 results for the baseline year 2009 are inline with the monitoring carried out in the borough. The results for 2009 and 2012 show exceedence of the NO_2 annual mean objective at all the Bentley House receptors.

The assessment results for stack emissions show that it would result in an increase of about 1μg/m^3 NO_2 annual mean at Bentley House receptors. This is equivalent to about 2% increase in annual mean concentration at Bentley House receptors.

The impact significance has been assigned based on the latest guidance provided by the EPUK. The significance of modelled increase in annual mean NO_2 has been adjudged as 'Slight Adverse' for Bentley House receptors. At all other modelled receptors, the increase due to stack emissions in imperceptible and its significance has been considered as 'Negligible'.

The assessment results show that the PM_{10} annual and daily mean objectives are likely to be achieved in 2009 and 2012 at the proposed development site.

The predicted NO_2 concentrations in 2012 are systematically lower compared to 2009. This is due to the anticipated reductions in the future years in pollutant background concentrations and vehicle emissions. However, the monitoring data for last 5 years from Camden and London do not show this systematic downward trend. Therefore, if the current trend exhibited in the monitoring data continues in the future years, the predicted decreases in NO_2 concentrations may not occur and NO_2 concentrations in 2012 would be similar to those predicted for 2009.

It is recommended that an increase in stack height may be considered as this would enhance the atmospheric dispersion and dilution of the NO_x emitted from the stack, to overcome the downwash and entrainment of the plume in the wake of the large buildings.

It is anticipated that the construction and demolition activities associated with the proposed development would result in nuisance dust and PM_{10}. A number of mitigation measures have been recommended to minimise impacts during construction phase of the development. Generally, the dust generation activities during construction and demolition respond quite well to these mitigation measures. It is recommended that for the development a Dust Management Plan is prepared and implemented.

A number of mitigation measures have been provided in design that are anticipated to minimise the impacts from poor air quality in the area.

Appendix 1

Table 17 – Model Verification Euston Road

Site ID	Background NO_2 (µg/m^3)	Background NO_x (µg/m^3)	Monitored Total NO_x (µg/m^3)	Monitored Road Contribution NO_x (µg/m^3)	Modelled Road Contribution NO_x (µg/m^3)	Ratio of Monitored Road NO_x/Modelled Road NO_x	Adjustment Factor for Modelled Road Contribution	Adjusted Modelled Road Contribution NO_x (µg/m^3)	Adjusted Modelled Total NO_x (µg/m^3)	Modelled Total NO_2 (µg/m^3)	Monitored Total NO_2 (µg/m^3)	% Difference NO_2 [(Modelled - Monitored)/ Monitored]
CA4	**54.0**	92.3	228.6	136.3	62.1	2.19	2.19	136.3	228.6	**87.1**	**87.1**	0.0%

In bold: exceedence of NO_2 annual mean AQS objective