JRP Associates

Residential Development at the former William Freeman Site, Wakefield Road, Mapplewell

Air Quality Assessment

Project No. 442840/AQ/01 (00)

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RSK GENERAL NOTES

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This work has been undertaken in accordance with the quality management system of RSK Group Limited.

Abbreviations

AQMA	Air Quality Management Area
AQOs	Air Quality Objectives
AQSs	Air Quality Standards
BMBC	Barnsley Metropolitan Borough Council
CO	Carbon Monoxide
COCP	Code of Construction Practice
DEFRA	Department of Environment, Food and Rural Affairs
EC	European Commission
EU	European Union
LDV	Light Duty Vehicle
HDV	Heavy Duty Vehicle
IAQM	Institute of Air Quality Management
LAQM	Local Air Quality Management
NAQS	National Air Quality Strategy
NPPF	National Planning Policy Framework
NO_2	Nitrogen Dioxide
NO_x	Oxides of Nitrogen
NRMM	Non Road Mobile Machinery
RSK	RSK Environment Limited
$PM_{2.5}$	Particulate matter of size fraction approximating to <2.5mm diameter
PM_{10}	Particulate matter of size fraction approximating to <10mm diameter

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APPENDICES

1 INTRODUCTION

RSK Environment Ltd (RSK) was commissioned to undertake an assessment of the potential air quality impacts associated with the proposed residential development (circa 82 units) at the former William Freeman site, Wakefield Road, Mapplewell. The proposed development falls within the jurisdiction of Barnsley Metropolitan Borough Council (BMBC).

Figures 1.1 and 1.2 show the location of the former William Freeman site. A proposed Lidl supermarket would be located in the southern section the site within the redline boundary, whilst the residential area would take up the remaining area of the site.

This report presents the findings of an assessment of existing/baseline air quality conditions and the impact of ambient air quality on the surrounding area. The report also reviews the impact of ambient air quality on future site users, and recommends mitigation measures as appropriate.

Figure 1.1: Proposed Development Site Location

Note: Base mapping from Google Satellite Imagery, 2018.

Figure 1.2: Proposed Development Site Location; Residential area and separate Lidl store

2 LEGISLATION, PLANNING POLICY AND GUIDANCE

2.1 Air Quality Strategy

UK air quality policy is published under the umbrella of the Environment Act 1995, Part IV and specifically Section 80, the National Air Quality Strategy. The latest *Air Quality Strategy for England, Scotland, Wales and Northern Ireland – Working Together for Clean Air*, published in July 2007 sets air quality standards and objectives for ten key air pollutants to be achieved between 2003 and 2020.

The EU (European Union) Air Quality Framework Directive (1996) established a framework under which the EU could set limit or target values for specified pollutants. The directive identified pollutants for which limit or target values have been, or will be set in subsequent 'daughter directives'. The framework and daughter directives were consolidated by Directive 2008/50/EC on Ambient Air Quality and Cleaner Air for Europe, which retains the existing air quality standards and introduces new objectives for fine particulates ($PM_{2.5}$).

2.1.1 Air Quality Objectives and Standards

The air quality standards in the United Kingdom are derived from European Commission (EC) directives and are adopted into English law via the Air Quality (England) Regulations 2000 and Air Quality (England) Amendment Regulations 2002. The Air Quality Limit Values Regulations 2003 and subsequent amendments implement the EU Air Quality Framework Directive into English Law. Directive 2008/50/EC was translated into UK law in 2010 via the Air Quality Standards Regulations 2010.

The relevant[1] air quality objectives and air quality standards (AQSs) for England and Wales to protect human health are summarised in Table 2.1. The standard for $PM_{2.5}$ is a target value and is not legally binding.

Table 2.1: Air Quality Objectives and standards relevant to the development

Substance	Averaging period	Exceedances allowed per year	Ground level concentration limit ($\mu g/m^3$)
Nitrogen dioxide (NO_2)	1 calendar year	-	40
	1 hour	18	200
Particles (PM_{10})	1 calendar year	-	40
	24 hours	35	50
$PM_{2.5}$	1 year	N/A	25

[1] Relevance, in this case, is defined by the scope of the assessment.

2.1.2 The Environment Act

The set objectives are to be used in the review and assessment of air quality by local authorities under Section 82 of the Environment Act (1995). If exceedances are measured or predicted through the review and assessment process, the local authority must declare an air quality management area (AQMA) under Section 83 of the Act, and produce an air quality action plan to outline how air quality is to be improved.

2.2 Planning Policy and Guidance

The land use planning process is a key means of improving air quality, particularly in the long term, through the strategic location and design of new developments. Any air quality concern that relates to land use and its development can be a material consideration in the determination of planning applications.

2.2.1 National Planning Policy Framework

In March 2012 The National Planning Policy Framework (NPPF) was published, superseding the bulk of previous Planning Policy Statements with immediate effect. The National Planning Policy Framework was intended to simplify the planning system and includes a presumption in favour of sustainable development.

Section 11 of the NPPF deals with Conserving and Enhancing the Natural Environment, and states that the intention is that the planning system should prevent '*development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, air, water or noise pollution or land instability*' and goes on to state that '*new development* [should be] *appropriate for its location' and 'the effects (including cumulative effects) of pollution on health, the natural environment or general amenity, and the potential sensitivity of the area or proposed development to adverse effects from pollution, should be taken into account*.'

With specific regard to air quality, the NPPF states that:

> *'Planning policies should sustain compliance with and contribute towards EU limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and the cumulative impacts on air quality from individual sites in local areas. Planning decisions should ensure that any new development in Air Quality Management Areas is consistent with the local air quality action plan'.*

2.2.2 Guidance Document – Assessment of Dust from Demolition and Construction (Institute of Air Quality Management (IAQM), 2014) ('the IAQM 2014 guidance')

The Institute of Air Quality Management (IAQM) 2014 guidance establishes a method for the assessment of dust and emissions generated during the construction phase of a development, each for demolition, earthworks, construction and trackout. The assessment is used to define the appropriate level of mitigation required and the measures to reduce the identified potential impact. The method used in this guidance is summarised in Appendix A of this report.

2.2.3 Guidance Document – Land-Use Planning & Development Control: Planning for Air Quality ('the EPUK-IAQM guidance')

Environmental Protection UK (EPUK) and the Institute of Air Quality Management (IAQM) jointly published a guidance note 'Land-Use Planning & Development Control: Planning for Air Quality' in 2017. It provides a framework for air quality considerations within local development control processes, promoting a consistent approach to the treatment of air quality. The approach for assessing the significance of air quality impacts associated with a development is employed in this assessment, and is outlined in Appendix B.

2.2.4 Local Planning Policy

BMBC adopted its Core Strategy in 2011, a spatial strategy for the future development of Barnsley up to the year 2026.

Policy CSP 41 (Development in Air Quality Management Areas) is most relevant to this assessment and states:

"Development in air quality management areas will be expected to demonstrate that it will not have a harmful effect on the health or living conditions of any future users of the development in terms of air quality (including residents, employees, visitors and customers), or that any such harmful effects can be mitigated against.

We will only allow residential development in air quality management areas, where the developer provides an assessment that shows living conditions will be acceptable for future residents.

We will only allow development in air quality management areas which could cause more air pollution, where the developer provides an assessment that shows there will not be a significantly harmful effect on air quality."

2.2.5 Local Planning Guidance – the BMBC Good Practice Guidance

BMBC published their *'Air Quality and Emissions: Good Practice Guidance'* ('the BMBC guidance') in September 2014. The guidance provides a template for integrating air quality considerations into land-use planning and development management policies that can influence the reduction of road transport emissions.

The Guidance recommends that the air quality assessments follow a three stage process:

1. Determining the classification of the development proposal;
2. Assessing and quantifying the impact on local air quality;
3. Determining the level of a mitigation required by the proposal to meet Local Development Plan requirements.

3 ASSESSMENT SCOPE AND METHOD

3.1 Overall Approach

The approach taken for assessing the potential air quality impacts of the proposed development may be summarised as follows:

- consultation with the local authority;
- characterisation of baseline characterisation of local air quality;
- advanced dispersion modelling assessment of air quality impacts of the proposed developments under the following scenarios:
  - **Scenario 1 (S1):** Base case (2016);
  - **Scenario 2 (S2):** Cumulative baseline scenario - traffic during the proposed development opening year (2023) with the consented developments (described in section 5.2) and the Lidl development in place, but without the proposed residential development in place, using 'base case' (2016) emissions factors;
  - **Scenario 3 (S3):** Cumulative with-development scenario - traffic during the proposed development opening year (2023) with the consented developments (described in section 5.2), the Lidl development and the proposed residential development in place, using 'base case' (2016) emissions factors;
  - **Scenario 2a (S2a):** Cumulative Baseline scenario - traffic during the proposed development opening year (2023) with the consented developments (described in section 5.2) and the Lidl development in place, but without the proposed residential development in place, using opening year ('2023') emissions factors; and,
  - **Scenario 3a (S3a):** 'Cumulative With-Development' scenario - traffic during the proposed development opening year (2023) with the consented developments (described in section 5.2), the Lidl development and the proposed residential development in place, using opening year ('2023') emissions factors;
- recommendation of mitigation measures, where appropriate, for any adverse effects on air quality; and,
- assessment of residual impacts resulting from the proposed development.

3.2 Baseline Characterisation

Existing or baseline air quality refers to the concentrations of relevant substances that are already present in ambient air. These substances are emitted by various sources, including road traffic, industrial, domestic, agricultural and natural sources.

A desk based study has been undertaken using data obtained from continuous and diffusion tube monitoring stations maintained by BMBC and from the LAQM (Local Air Quality Management) Support/ United Kingdom Atmospheric Information Resource (UK-AIR) website maintained by the Department for Environment, Food and Rural Affairs (Defra).

3.3 Construction Phase

Construction of the proposed development may have the potential to lead to the release of fugitive dust and PM_{10}. There are human receptors within 350m of the boundary of the site and within 50m of the trackout route; therefore, a full qualitative construction impact assessment has been undertaken.

Appendix A explains how the magnitude of impacts associated with demolition, earthworks, construction and trackout, is compared with the sensitivity of ecological receptors, and human receptors to particulate matter and dust nuisance, to determine the overall dust risk.

3.4 Operation Phase Impact Assessment

The development can be classified as 'medium' as per the BMBC guidance, and therefore dispersion modelling was undertaken to determine the impact of ambient air quality on receptors at and around the proposed development site. The method utilised to determine the significance of impacts associated with the proposed development was the EPUK-IAQM guidance (see Appendix B).

Section 6 identifies the methodology adopted to undertake the operational phase assessment.

4 BASELINE AIR QUALITY CHARACTERISATION

Existing or baseline air quality refers to the concentrations of relevant substances that are already present in ambient air. These substances are emitted by various sources, including road traffic, industrial, domestic, agricultural and natural sources.

For this assessment, the following public sources of information have been used to characterise the background air quality:

- Published results of local authority review and assessment studies of air quality, including local monitoring and modelling studies; and
- Estimated background concentrations in the UK-AIR/ LAQM Support website operated by Defra.

Baseline air quality has been assessed in the forthcoming subsections of this section.

4.1 Air Quality Management Areas

The local authority, Barnsley Metropolitan Borough Council (BMBC), has designated six Air Quality Management Areas (AQMAs) due to elevated concentrations of nitrogen dioxide (NO_2) attributable to road traffic emissions.

The proposed residential development site is not located within or close to any of the six designated AQMAs.

4.2 Local Urban Background Monitoring

Monitors at urban background locations measure concentrations away from the local influence of emission sources and are therefore broadly representative of residential areas within large conurbations. Monitoring at local urban background locations is considered an appropriate source of data for the purposes of describing baseline air quality for the proposed development site.

There is one local monitoring station where urban background concentrations of NO_2 are measured using continuous automatic instruments: Barnsley Gawber (CM3). The most recently measured annual mean NO_2 concentrations are presented in Table 4.1. There are no urban background monitoring stations which measure PM_{10} in the vicinity of the site.

Table 4.1: Automatically Monitored Urban Background Annual-Mean NO_2 Concentrations

Monitor Name (Code)	Approx distance from proposed devt. (km)	Concentration (µg/m^3)				
		2012	2013	2014	2015	2016
Barnsley Gawber (CM3)	2.8	21.0	22.0	19.0	19.0	19.0

In addition, BMBC manually monitors NO_2 concentrations at a number of urban background locations using passive diffusion tubes. Table 4.2 presents the concentrations monitored at DT10, which is the closest urban background monitoring location to the site,

Table 4.2: Passively Monitored Urban Background Annual-Mean NO_2 Concentrations

Monitor Name (Code)	Approx distance from proposed devt. (km)	Concentration (µg/m^3)				
		2012	2013	2014	2015	2016
Lansdowne Crescent, Darton (DT10)	3.2	31.6	28.8	30.3	29.6	29.1

4.3 DEFRA Estimated Background Concentrations

In addition to local monitoring data, estimated background air quality data are available from the LAQM Support website operated by Defra. The website provides estimated annual average background concentrations of nitrogen oxides (NO_x), NO_2, PM_{10} and $PM_{2.5}$ on a 1km^2 grid basis. Table 4.3 reproduces estimated annual average background NO_2, PM_{10} and $PM_{2.5}$ concentrations for the 1km^2 grid square containing the proposed development site for the years 2015 through to 2018.

No exceedances of the annual mean AQSs for these pollutants is anticipated at background locations within the square during any of the years presented below. As concentrations are predicted to fall with time, exceedances in years following on would also not be expected to exceed the relevant AQSs.

Table 4.3: Estimated Background Annual Average NO_2, PM_{10} and $PM_{2.5}$ Concentrations at Proposed Development Site

Assessment Year	Estimated Annual Average Pollutant Concentrations Derived from the LAQM Support Website		
	Annual Average NO_2 (µg/m^3)	Annual Average PM_{10} (µg/m^3)	Annual Average $PM_{2.5}$ (µg/m^3)
2015	13.9	11.8	7.9
2016	13.4	11.7	7.8
2017	13.0	11.6	7.7
2018	12.4	11.5	7.6
Air Quality Standard	**40**	**40**	**25**

Notes: Presented concentrations for 1 km^2 grid centered on 434500,409500; approximate centre of the proposed site is located at 434024, 409922.

5 OPERATIONAL PHASE ASSESSMENT METHODOLOGY

The following subsections provide further information regarding input to the dispersion model including traffic emissions sources, meteorological data and receptors included, and the outcomes of the assessment.

5.1 Modelling Software

ADMS-Roads Extra (Version 4.1) was used for assessing the air quality impacts of road traffic emissions sources during the operational phase of the proposed development.

5.2 Modelling Scenarios and Traffic Data

The transport consultants for the scheme, Bryan G Hall, provided the annual average daily traffic (AADT) flows for a 2017 base case, 2023 base case (including the committed and consented developments referenced), and a 2023 with development scenario. They also provided a Tempro factor which was used by RSK to convert 2017 AADTs to 2016 AADTs for use in the base case scenario.

Byran G Hall did not provide data for modelled road links 19 and 20. These data were instead derived from traffic counts available on the Department for Transport (DFT) website for the year 2016 under their advice. These were then factored to 2023 by RSK using Tempro growth factors provided by Byran G Hall. As development-generated traffic data were not available for these links, development traffic was not added on these two links.

Bryan G Hall included four developments scheduled to be opened prior to 2018 in S2 – S5:

- The consented Wakefield Road development of 250 residences (ref. 2014/0249) – due to open during 2017;
- The consented Lee Lane development of 200 residences (ref. 2013/0932);
- The consented North Gawber residential development of 325 residences (ref. 2014/0452); and,
- The proposed Lidl site adjacent to this proposed residential site.

The traffic data (including % heavy duty vehicle / HDV movements) used in the modelling is presented in Appendix D. The road network included in the dispersion model is presented in Figure 5.1. Speed data for all road links are based on speed limits, with speeds slowed at junctions using professional judgment and with reference to LAQM TG.16.

5.3 Emission Factors

Nitrogen oxides (NOx), PM_{10} and $PM_{2.5}$ emission factors were obtained using the Defra emissions factor toolkit (EFT) (v8.0), to estimate the grams of pollutant emitted per vehicle kilometre travelled per second, based on the average anticipated vehicle fleet for the year and part of the UK modelled.

However, there is still currently some uncertainty over how representative future predictions are, with greater uncertainty the further into the future predictions are made; emissions are predicted to fall with time but at a slower rate than is considered likely within the EFT. Consequently ‘base case’ (2016) emissions factors were used for all modelled scenarios except S2a and S3a, for a conservative assessment.

In order to assess the sensitivity of the model to emissions factors for different years, a sensitivity test using 2023 NOx emissions factors was also undertaken.

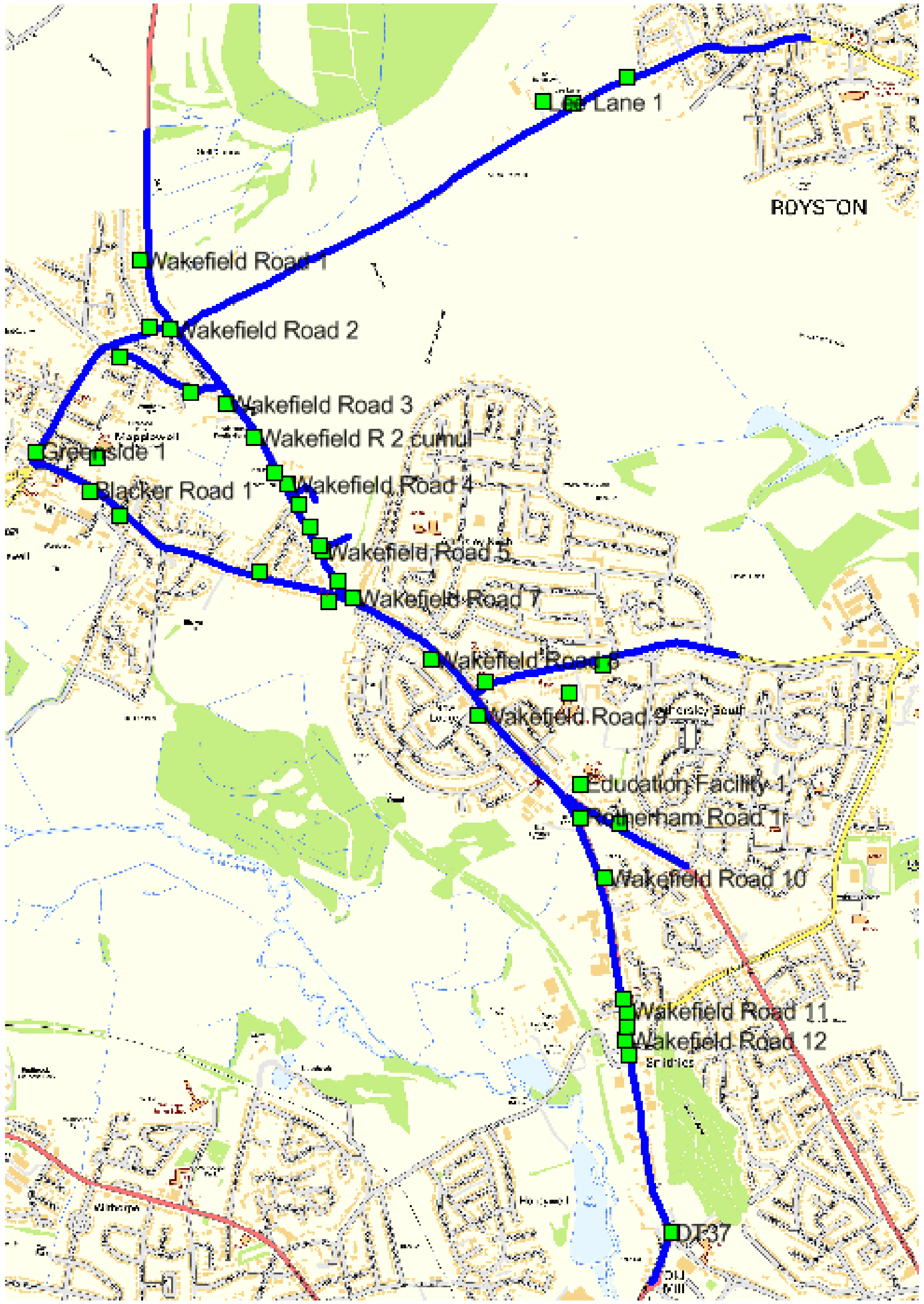
5.4 Receptor Locations

Pollutant concentrations were predicted at a number of receptors in and around the development site. Details of all specific receptors included in the modelling study (and hence the air quality impacts assessed) are summarised in Appendix E. The locations of all assessed receptors are shown in Figure 5.1.

5.5 Time-Varying Profile

Vehicle movements and emissions from the proposed plant may vary with time. The national diurnal traffic profile for 2016 obtained from the DfT website was used for this assessment. The applied road emissions profiles are displayed in Figure D1 in Appendix D.

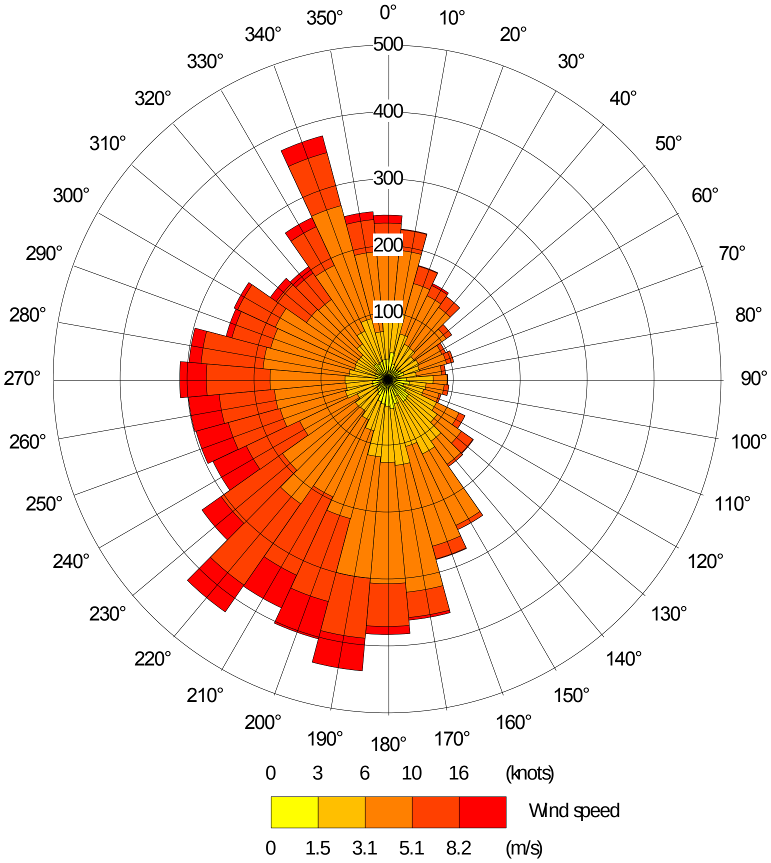
Figure 5.1: Roads and receptors in and around the development site included in the dispersion modelling assessment



5.6 Meteorological Data

Hourly sequential meteorological data were employed in the dispersion model. Data for 2016 from the Doncaster Robin Hood Airport meteorological monitoring station was utilised. The windrose derived from the meteorological data is presented in Figure 5.2, below.

Figure 5.2: Windrose from the Doncaster Robin Hood Airport meteorological station in 2016



5.7 Background Air Quality Data Used in the Modelling

The CM3 urban background monitor is located in the northwest of Barnsley, located 2.3km from the proposed development site, in a more densely populated area with a larger number of minor roads.

Urban background diffusion tube DT10 is located in close proximity to the M1 and therefore may be influenced by this road source.

Therefore, in the absence of urban background monitoring data considered likely to be representative of the 'background' conditions within the modelled domain, the estimated background annual mean NO_2, PM_{10} and $PM_{2.5}$ concentrations obtained from UK-AIR website were used.

Estimated concentrations for the year 2016 from the 2015 base year maps were used in this assessment for all modelling scenarios, with the exception of S2a and S3a, for which 2023 background data (from the 2015 base year maps) were used. Each discrete receptor was modelled using the background applicable for the 1km^2 site in which it is located. Table 5.1 summarises the background concentrations applied.

Table 5.1: Background Concentrations used within the Assessment

Scenario (including emission years modelled)	1km^2 grid square	Estimated Annual Average Pollutant Concentrations Derived from the LAQM Support Website		
		Annual Average NO_2 (µg/m^3)	Annual Average PM_{10} (µg/m^3)	Annual Average $PM_{2.5}$ (µg/m^3)
S1, S2, S3, (2016)	433500,409500	13.42	11.69	7.77
	433500,410500	12.07	11.97	7.81
	435500,407500	17.90	Not modelled – background at model verification points only	
	435500,408500	14.74	11.86	7.91
	435500,411500	11.58	11.54	7.61
	434500,408500	13.03	12.06	7.88
	434500,409500	13.42	11.69	7.77
	434500,411500	10.34	12.12	7.83
S2a, S3a (2023)	433500,409500	8.88	Not modelled –sensitivity test for NO_2 emissions factors only	
	433500,410500	9.07		
	435500,407500	13.67		
	435500,408500	11.10		
	435500,411500	8.73		
	434500,408500	9.75		
	434500,409500	9.96		
	434500,411500	7.82		
AQS		**40**	**40**	**25**

5.8 Other Model Input Parameters

The modelling input parameters for the dispersion modelling assessment are presented in Table 5.2.

Table 5.2: Summary of remaining inputs to the Dispersion Model

Parameter	Brief Description	Input into model
Road elevation	Elevation of road above ground level	No terrain file used
Road width	Width of road (m)	Road widths determined based on approximate measurement of roads (internet).
Canyon heights	Height of canyons effects turbulent flow patterns; these are greater with larger canyon heights	No canyons included.

Parameter	Brief Description	Input into model
Road type	Selection of different types of road to be assessed, inputted into the emission factor toolkit calculations	Urban (not London) settings used
Road speeds	Speed of the road effects the vehicle emissions to air	Based on speed limits on roads modelled. Reduced speeds have been used at junctions.
Meteorology	Representative hourly sequential meteorological data	Doncaster Robin Hood 2016
Latitude	Allows the location of the model area to be determined	53.5°
Surface roughness	This defines the surface roughness of the model area	0.4m (for the modelled domain and area in which meteorological station is located
Monin-Obukhov length	A boundary layer parameter required to precisely describe the atmospheric stability conditions and to predict dispersion of pollutants released from road traffic	30m for the modelled domain and 10m for the area in which meteorological station is located

5.9 Interpretation of modelled NOx, PM_{10} and $PM_{2.5}$ concentrations

The following method was used to estimate total annual mean concentrations:

- Modelled road NOx, PM_{10} or $PM_{2.5}$ concentrations were verified using the method set out in Appendix E of this report and as per LAQM TG.16;
- For NOx only, the road source NO_2 at each receptor was estimated from the modelled NOx concentration using version 6.1 of the NOx to NO_2 calculator (Barnsley);
- These results were added to background concentrations.

Annual mean PM_{10} and $PM_{2.5}$ concentrations represent the summation of background and road source impacts.

5.10 Assessment and comparison with air quality standards

The magnitude of changes in annual mean NO_2, PM_{10} and $PM_{2.5}$ concentrations (for S2 and S3, or S2a and S3a) associated with the proposed development were assessed in accordance with the EPUK-IAQM 2017 guidance, at the existing sensitive receptor locations representative of exposure to which the annual mean AQSs apply. The EPUK-IAQM method used is summarised in Appendix B of this report.

Significance of effects was determined using professional judgement, based on the impact magnitudes assigned. Any exceedance of the daily mean PM_{10} AQS or potential exceedance of the hourly mean NO_2 AQS at any of the receptor locations, or an exceedance of any of the AQSs at proposed development receptors, would also be considered to generate a significant effect.

The results of the dispersion modelling are presented in section 6.2 and Appendix E.

5.11 Additional Uncertainties and Assumptions

- No on-site background monitoring was undertaken and therefore it is assumed that background data used are likely to reasonably represent conditions at site. Similarly, model verification has been undertaken using nearby roadside monitoring locations in a similarly built up urban area, but local conditions may mean that the model has been verified at locations which may not accurately represent conditions at site. It is assumed that the same model adjustment factor is applicable to the results generated at all modelled locations;
- Emissions from the average vehicle fleet using the local road network cannot be known, and therefore it is assumed those generated by the EFT provide an accurate representation of emissions generated by vehicles which currently and will use the modelled roads;
- There will be uncertainties introduced because the modelling has simplified real-world processes into a series of algorithms. For example, it has been assumed that wind conditions measured at Doncaster Robin Hood Airport in 2016 are representative of wind conditions at the site. Furthermore, it has been assumed that the subsequent dispersion of emitted pollutants will conform to a Gaussian distribution over flat terrain in order to simplify the real-world dilution and dispersion conditions;
- The national diurnal profiles have been assumed to be applicable for the roads assessed;
- There is an element of uncertainty in all measured and modelled data. All values presented in this chapter are best possible estimates.

6 IMPACT ASSESSMENT

6.1 Construction Phase Impact Assessment

Atmospheric emissions from construction activities will depend on a combination of the potential for emissions (the type of activity and prevailing conditions) and the effectiveness of control measures. In general terms, there are two sources of emissions that will need to be controlled to minimise the potential for adverse environmental effects:

- exhaust emissions from site plant, equipment and vehicles; and
- fugitive dust emissions from site activities.

6.1.1 Exhaust Emissions from Plant and Vehicles

The main air quality effects associated with plant and vehicles are likely to comprise the emissions of carbon monoxide (CO), PM_{10}, $PM_{2.5}$ and NOx from non-road mobile machinery (NRMM) (i.e. plant which are likely to be used whilst the site is redeveloped) and vehicles used to transport goods and employees to and from the site. The quantities emitted depend on factors such as engine type, service history, pattern of usage and fuel composition.

Due to the transient nature of such emissions, it is considered that emissions generated by vehicles and plant moving to and from the site is unlikely to have a significant effect on local air quality. Any emissions generated by plant and equipment can be reduced by implementing the mitigation measures (such as the use of NRMM compliant with relevant emissions standards); this is discussed further in section 7.1 of this report. The implementation of appropriate mitigation measures such as those listed here would also likely reduce any cumulative effects on air quality associated with this site and the nearby proposed or consented sites.

6.1.2 Fugitive Dust Emissions

Fugitive dust emissions arising from construction activities are likely to be variable in nature and will depend upon the type and extent of the activity, soil type and moisture, road surface conditions and weather conditions. Periods of dry weather combined with higher than average wind speeds have the potential to generate more dust.

Construction activities that are considered to be the most significant potential sources of fugitive dust emissions include:

- Earthworks – removal of any remaining surface hard standing and subsurface features, piling works, haulage and stockpiling;
- Construction – use of materials including concrete with potential to generate dust in the construction of the buildings; and,
- Trackout – defined in the IAQM 2014 guidance as *"The transport of dust and dirt from the construction/demolition site onto the public road network, where it may be deposited and then re-suspended by vehicles using the network. This arises*

when heavy duty vehicles (HDVs) leave the construction/demolition site with dusty materials, which may then spill onto the road, and/or when HDVs transfer dust and dirt onto the road having travelled over muddy ground on site."

Fugitive dust arising from construction phase activities is mainly of a particle size greater than the PM_{10} fraction (that which can potentially impact upon human health), however it is noted that construction related activities may contribute to local PM_{10} concentrations. Appropriate dust control measures can be highly effective for controlling emissions from potentially dust generating activities identified above, and adverse effects can be greatly reduced or eliminated.

See Appendix A for further explanation of the tendency of dust to remain airborne.

The potential for fugitive dust and PM_{10} to be generated by on-site construction-related activities has been assessed in the forthcoming subsections with reference to the method within the IAQM 2014 guidance (replicated in Appendix A of this report). The risk of dust and emissions impacting on sensitive receptors has been assessed (in section 6.1.5) with reference to the potential dust emissions magnitude (6.1.3) from all construction-related activities and the number and sensitivity of receptors (6.1.4). It should be noted that the following assumptions have been made:

- The North Gawber and Lee Lane developments are considered to be too far from the site to be considered within the construction phase assessment. However, both the Lidl site and Wakefield Road site are anticipated to be operational before the end of 2018, and therefore receptors at these sites have been considered where appropriate;
- As RSK's air quality assessment for the Lidl site (reference: 442852/AQ/01 (00)) outlined a suite of mitigation measures to minimise fugitive dust and emissions during the construction phase, significant cumulative impacts from dust and emissions from both sites are considered unlikely and therefore have not been considered further within this assessment;
- The consented Wakefield Road development of 250 residences (ref. 2014/0249) – due to open during 2017, as well as the adjacent proposed Lidl supermarket (due to open in 2018 if consented) have been considered as sensitive receptors within this assessment;
- It is assumed earthworks activities may take place anywhere within the site (except the area excluded for the separate Lidl development), whilst construction activities are limited to the areas upon which new buildings will be located; and,
- It is assumed that trackout may occur on any arterial roads within 500 metres of the site exit, i.e. along Wakefield Road in both directions from the site exit. It is assumed that the site exit will be located in the same place as the site exit shown in the proposed development masterplan and that traffic will not use the exit associated with the Lidl development for this proposed development.

6.1.2.1 *Construction Phase Dust Impact Risk*

The IAQM 2014 guidance establishes a method for assessing the risk of dust and emissions affecting sensitive receptors in the area around the proposed development site, based on the 'area sensitivity' and the magnitude of emissions from each of the following four types of construction activity:

- demolition;
- earthworks;
- construction; and
- trackout.

In this case, demolition works are not to be undertaken and therefore demolition activities have not been included in this assessment.

For each activity, the risk of site-derived dust and emissions affecting local sensitive receptors is determined as either negligible, low, medium or high risk. The risk category may be different for each of the activities and depends on the potential emissions magnitude and the sensitivity of the area. Three different types of impact are considered:

- disamenity due to dust soiling;
- the risk of health effects due to an increase in exposure to PM_{10}; and
- harm to ecological receptors.

Appendix A sets out the construction dust assessment methodology in further detail.

6.1.2.2 *Potential Dust Emission Magnitude*

With reference to the IAQM 2014 guidance criteria reproduced in Appendix A, the dust emissions magnitudes for earthworks, construction and trackout activities are summarised in Table 6.1 to Table 6.3. Demolition works are not proposed and therefore this has not been considered within this assessment.

Table 6.1: Summary of Dust Emissions Magnitude of Earthworks Activities (Before mitigation)

Earthworks Criteria	Dust Emissions Class	Basis of Classification
Total site area	Medium	2,500 to 10,000m^2
Soil type of site	Small	Siltstone seams within carboniferous beds
Earth moving vehicles at any one time	Small	Assumed 5-10
Height of stockpiles	Small	< 4 m
Total material moved	Small	Assumed <20,000 Tonnes
Times of year during which earthworks will take place	Medium to large	Assumed that earthworks may take place at any time during the year
Overall Rating	**Medium**	Conservative rating

Table 6.2: Summary of Dust Emissions Magnitude of Construction Activities (Before mitigation)

Construction Criteria	Dust Emissions Class	Evaluation
Total building volume	Large	Assumed >100,000m^3
On-site concrete batching proposed	Small	None proposed
On-site sandblasting proposed	Small	None proposed
Potentially dusty construction activities undertaken	Medium to large	Assumed potentially dusty materials (such as concrete) may be used.
Overall Rating	**Medium**	Conservative rating

Table 6.3: Summary of Dust Emissions Magnitude of Trackout Activities (Before mitigation)

Trackout Criteria	Dust Emissions Class	Basis of Classification
Number of HDV>3.5t per day	Medium	Assumed 10–50
Site surface type	Medium	Siltstone. Assumed that site may be underlain by made ground, with the potential to contain clay-based materials which are easily entrained.
Length of unpaved road	Large	>100m
Overall Rating	**Medium**	Conservative rating

On the basis of the above, the emissions magnitudes associated with earthworks, construction and trackout are likely to be medium.

6.1.2.3 Sensitivity of the Area (Pathway and Receptor)

There are no statutory standards for 'disamenity dust' in the UK, and BMBC does not monitor particulate matter (PM_{10}). On this basis, estimated background concentrations of PM_{10}, published by the Department of Environment, Food and Rural Affairs (Defra), have been reviewed. The findings of this review are shown in Table 6.4 below.

Table 6.4: Estimated Defra Background Annual-Mean PM_{10} Concentration at Application Site

Year	Concentration (µg/m^3)
2015	11.8
2016	11.7
2017	11.6
2018	11.5

The Defra Background annual-mean PM_{10} concentrations at the Application Site are all below 24 µg/m^3.

6.1.2.4 *Sensitivity of Area for Earthworks and Construction*

All earthworks and construction activities are assumed to occur within the site boundary. The sensitivity of the area has been classified and the results are provided in Table 6.5 below.

Table 6.5: Sensitivity of the Surrounding Area for Earthworks and Construction

Potential Impact	Sensitivity of the Surrounding Area	Reason for Sensitivity / Classification
Dust Soiling	**Medium**	Between 1 and 10 high sensitivity receptors located within 20 m of the site boundary (i.e. residences to north and west, including the Wakefield Road development site, excluding those seemingly screened by vegetation).
Human Health	**Low**	Between 1 and 10 high sensitivity receptors located within 20 m of the site boundary (i.e. residences to north and west, including the Wakefield Road development site, excluding those seemingly screened by vegetation). Background PM_{10} concentrations below 24 µg/m^3
Ecological	**Negligible**	No ecological receptors within the relevant screening distance

6.1.2.5 *Sensitivity of Area for Trackout*

The dust emission magnitude for trackout is classified as medium (Table 6.3). The IAQM 2014 guidance notes that for a medium dust emissions magnitude, trackout may occur within 50m of roads used by heavy duty vehicles within 200m of the site exit. The sensitivity of the area has been classified and the results are provided in Table 6.6.

Table 6.6: Sensitivity of the Surrounding Area for Trackout

Potential Impact	Sensitivity of the Surrounding Area	Reason for Sensitivity / Classification
Dust Soiling	**High**	Between 10 and 100 high sensitivity receptors located within 20 m of Wakefield Road (i.e. residences to north and west, including the Wakefield Road development site, excluding those seemingly screened by vegetation).
Human Health	**Low**	Between 10 and 100 high sensitivity receptors located within 20 m of Wakefield Road (i.e. residences to north and west, including the Wakefield Road development site, excluding those seemingly screened by

Potential Impact	Sensitivity of the Surrounding Area	Reason for Sensitivity / Classification
		vegetation). Background PM_{10} concentrations below 24 µg/m^3
Ecological	**Negligible**	No ecological receptors within the relevant screening distance

6.1.2.6 *Risk of Impacts*

The dust emission magnitude is combined with the sensitivity of the area to determine the risk of impacts of construction activities before mitigation; based on the matrices presented in Tables A5 to A7 in Appendix A. The risk of dust impacts from the construction activities are identified in Table 6.7.

Mitigation measures to reduce potential impacts, based on this assessment, are defined in Section 7.

Table 6.7: Summary of the Dust Risk from Construction Phase Activities

Potential Impact	Dust Risk Impact			
	Demolition	Earthworks	Construction	Trackout
Dust soiling	-	Medium Risk	Medium Risk	Medium Risk
Human health	-	Low Risk	Low Risk	Low Risk
Ecological	-	Negligible Risk		

It can be seen that the risk of dust impacts has been assessed as a maximum of 'Medium risk' at the proposed development.

6.2 Operational Phase Air Quality Assessment

6.2.1 Impacts of the Development on Local Air Quality

Annual mean Nitrogen Dioxide (NO_2)

Table 6.8 presents the predicted annual mean NO_2 concentrations under the S2 and S3 scenarios. As per the EPUK-IAQM guidance, the impact of the development on local air quality was assessed as 'negligible' at 33 of the 35 modelled existing receptor locations, and 'slight' and 'moderate' adverse at one receptor location each. However, the development did not expose any new receptors to annual mean NO_2 concentrations exceeding the annual mean NO_2 AQS where they were not predicted to exceed without the development in place.

Table 6.8: Comparison of Predicted annual mean NO_2 Concentrations between S2 and S3

Receptor ID	Without Development	With Development	% Change NO_2	Predicted Impact

	$\mu g/m^3$	% of AQAL	$\mu g/m^3$	% of AQAL		
Wakefield Road 1	16.87	42	16.90	42	0	Negligible
Wakefield Road 2	30.77	77	30.84	77	0	Negligible
Wakefield Road 3	18.92	47	18.99	47	0	Negligible
Wakefield Road 4	36.18	90	36.45	91	1	Negligible
Wakefield Road 5	37.41	94	37.70	94	1	Negligible
Wakefield Road 6	37.56	94	37.84	95	1	Slight adverse
Wakefield Road 7	**47.26**	**118**	**47.47**	**119**	1	Moderate adverse
Wakefield Road 8	23.86	60	23.94	60	0	Negligible
Wakefield Road 9	28.84	72	28.94	72	0	Negligible
Wakefield Road 10	24.99	62	25.07	63	0	Negligible
Rotherham Road 1	31.04	78	31.12	78	0	Negligible
Rotherham Road 2	23.42	59	23.46	59	0	Negligible
Education Facility 1	21.30	53	21.30	53	0	Negligible
Education Facility 2	16.86	42	16.88	42	0	Negligible
Laithes Lane 1	32.09	80	32.16	80	0	Negligible
Laithes Lane 2	20.87	52	20.88	52	0	Negligible
Bar Lane 1	25.41	64	25.49	64	0	Negligible
Bar Lane 2	23.54	59	23.60	59	0	Negligible
Paddock Road 1	17.42	44	17.48	44	0	Negligible
Paddock Road 2	18.83	47	18.88	47	0	Negligible
Shaw Lane 1	23.63	59	23.65	59	0	Negligible
Proposed Resi 1	31.00	78	31.23	78	1	Negligible
Proposed Resi 2	28.88	72	29.02	73	0	Negligible
Proposed Lidl 1	34.40	86	34.59	86	0	Negligible
Lee Lane 1	12.99	32	13.00	33	0	Negligible
Lee Lane 2 cumul	20.82	52	20.83	52	0	Negligible
Lee Lane 3 cumul	21.83	55	21.84	55	0	Negligible
Wakefield R. 1 cumul	25.63	64	25.78	64	0	Negligible
Wakefield R 2 cumul	23.59	59	23.70	59	0	Negligible
Blacker Road 1	25.74	64	25.81	65	0	Negligible
Blacker Road 2	24.85	62	24.92	62	0	Negligible
Education Facility 3	15.23	38	15.24	38	0	Negligible
Greenside 1	25.33	63	25.34	63	0	Negligible
Wakefield Road 11	37.33	93	37.41	94	0	Negligible
Wakefield Road 12	**49.21**	**123**	**49.22**	**123**	0	Negligible

Note: AQAL – Air Quality Action Level, i.e. annual mean NO_2 AQS.

As indicated in section 5.3 above, 'base case' 2016 emissions factors were applied throughout the assessment; however some reduction in emission factors is expected with time. For these reasons, a sensitivity test was undertaken for S2 and S3, in which all modelled parameters remained the same, with the exception that the emissions factor toolkit, estimated background concentrations and NOx to NO_2 calculator used the year 2023 (the anticipated development opening year) as opposed to 2016. The results of these 'optimistic' scenarios (presented as S2a and S3a), shown in Table 6.9 below, show that none of the receptors are predicted to exceed the annual mean NO_2 AQS. Moreover, the predicted impact was assessed as 'negligible' at all 35 receptor locations, in accordance with the EPUK-IAQM guidance.

Table 6.9: Comparison of Predicted annual mean NO_2 Concentrations between S2a and S3a

Receptor ID	S2a Without Development		S3a With Development		% Change NO_2 concentration relative to AQAL	Predicted Impact
	$\mu g/m^3$	% of AQAL	$\mu g/m^3$	% of AQAL		
Wakefield Road 1	11.85	30	11.87	30	0	Negligible
Wakefield Road 2	20.33	51	20.39	51	0	Negligible
Wakefield Road 3	13.10	33	13.15	33	0	Negligible
Wakefield Road 4	23.42	59	23.61	59	0	Negligible
Wakefield Road 5	23.23	58	23.44	59	1	Negligible
Wakefield Road 6	24.22	61	24.42	61	1	Negligible
Wakefield Road 7	30.25	76	30.41	76	0	Negligible
Wakefield Road 8	15.97	40	16.02	40	0	Negligible
Wakefield Road 9	18.77	47	19.00	48	1	Negligible
Wakefield Road 10	16.52	41	16.57	41	0	Negligible
Rotherham Road 1	20.12	50	20.17	50	0	Negligible
Rotherham Road 2	16.26	41	16.29	41	0	Negligible
Education Facility 1	14.41	36	14.42	36	0	Negligible
Education Facility 2	11.84	30	11.85	30	0	Negligible
Laithes Lane 1	20.20	51	20.28	51	0	Negligible
Laithes Lane 2	13.97	35	13.98	35	0	Negligible
Bar Lane 1	16.70	42	16.76	42	0	Negligible
Bar Lane 2	15.61	39	15.65	39	0	Negligible
Paddock Road 1	12.26	31	12.30	31	0	Negligible
Paddock Road 2	13.13	33	13.15	33	0	Negligible
Shaw Lane 1	15.96	40	15.97	40	0	Negligible
Proposed Resi 1	20.15	50	20.31	51	0	Negligible
Proposed Resi 2	19.05	48	19.15	48	0	Negligible
Proposed Lidl 1	22.25	56	22.39	56	0	Negligible
Lee Lane 1	9.40	24	9.40	24	0	Negligible
Lee Lane 2 cumul	14.20	36	14.21	36	0	Negligible
Lee Lane 3 cumul	14.99	37	15.00	38	0	Negligible
Wakefield R. 1 cumul	17.14	43	17.24	43	0	Negligible
Wakefield R 2 cumul	15.93	40	16.00	40	0	Negligible
Blacker Road 1	16.76	42	16.81	42	0	Negligible
Blacker Road 2	16.14	40	16.18	40	0	Negligible
Education Facility 3	10.84	27	10.85	27	0	Negligible
Greenside 1	16.94	42	16.94	42	0	Negligible
Wakefield Road 11	23.63	59	23.68	59	0	Negligible

Receptor ID	S2a Without Development		S3a With Development		% Change NO_2 concentration relative to AQAL	Predicted Impact
	$\mu g/m^3$	% of AQAL	$\mu g/m^3$	% of AQAL		
Wakefield Road 12	30.57	76	30.58	76	0	Negligible

Annual mean Particulate Matter (PM_{10})

Table 6.10 presents the predicted annual mean PM_{10} concentrations under the S2 and S3 scenarios. As per the EPUK-IAQM guidance, the impact of the development on local air quality was assessed as 'negligible' at all of the modelled existing receptor locations and no exceedances of the AQS were predicted at any receptor locations.

Table 6.10: Comparison of Predicted annual mean PM_{10} Concentrations between the 'S2 without Development' and S3 'With Development' Scenarios

Receptor ID	Without Development		With Development		% Change NO_2 concentration relative to AQAL	Predicted Impact
	$\mu g/m^3$	% of AQAL	$\mu g/m^3$	% of AQAL		
Wakefield Road 1	12.80	32	12.80	32	0	Negligible
Wakefield Road 2	15.05	38	15.06	38	0	Negligible
Wakefield Road 3	13.16	33	13.17	33	0	Negligible
Wakefield Road 4	15.44	39	15.49	39	0	Negligible
Wakefield Road 5	15.11	38	15.16	38	0	Negligible
Wakefield Road 6	15.12	38	15.17	38	0	Negligible
Wakefield Road 7	16.57	41	16.62	42	0	Negligible
Wakefield Road 8	13.42	34	13.43	34	0	Negligible
Wakefield Road 9	13.95	35	13.96	35	0	Negligible
Wakefield Road 10	14.05	35	14.07	35	0	Negligible
Rotherham Road 1	14.82	37	14.84	37	0	Negligible
Rotherham Road 2	13.31	33	13.32	33	0	Negligible
Education Facility 1	12.78	32	12.78	32	0	Negligible
Education Facility 2	12.21	31	12.21	31	0	Negligible
Laithes Lane 1	14.14	35	14.15	35	0	Negligible
Laithes Lane 2	12.88	32	12.88	32	0	Negligible
Bar Lane 1	13.29	33	13.30	33	0	Negligible
Bar Lane 2	13.70	34	13.71	34	0	Negligible
Paddock Road 1	12.82	32	12.82	32	0	Negligible
Paddock Road 2	13.01	33	13.01	33	0	Negligible
Shaw Lane 1	13.68	34	13.69	34	0	Negligible
Proposed Resi 1	14.50	36	14.53	36	0	Negligible
Proposed Resi 2	14.67	37	14.69	37	0	Negligible
Proposed Lidl 1	14.91	37	14.94	37	0	Negligible
Lee Lane 1	12.54	31	12.54	31	0	Negligible
Lee Lane 2 cumul	13.86	35	13.86	35	0	Negligible
Lee Lane 3 cumul	13.33	33	13.33	33	0	Negligible
Wakefield R. 1	14.35	36	14.38	36	0	Negligible

Receptor ID	Without Development		With Development		% Change NO_2 concentration relative to AQAL	Predicted Impact
	µg/m³	% of AQAL	µg/m³	% of AQAL		
cumul						
Wakefield R 2 cumul	14.06	35	14.09	35	0	Negligible
Blacker Road 1	13.75	34	13.76	34	0	Negligible
Blacker Road 2	13.40	33	13.41	34	0	Negligible
Education Facility 3	12.41	31	12.42	31	0	Negligible
Greenside 1	13.80	34	13.80	34	0	Negligible
Wakefield Road 11	14.83	37	14.84	37	0	Negligible
Wakefield Road 12	16.47	41	16.47	41	0	Negligible

Note: AQAL – Air Quality Action Level (i.e. the annual mean AQS).

Annual mean Particulate Matter ($PM_{2.5}$)

Table 6.11 presents the predicted annual mean $PM_{2.5}$ concentrations under the S2 and S3 scenarios. As per the EPUK-IAQM guidance, the impact of the development on local air quality was assessed as 'negligible' at all of the modelled existing receptor locations and no exceedances of the AQS were predicted at any receptor locations.

Table 6.11: Comparison of Predicted annual mean PM2.5 Concentrations between the 'S2 without Development' and S3 'With Development' Scenarios

Receptor ID	Without Development		With Development		% Change NO_2 concentration relative to AQAL	Predicted Impact
	µg/m³	% of AQAL	µg/m³	% of AQAL		
Wakefield Road 1	8.30	33	8.31	33	0	Negligible
Wakefield Road 2	9.66	39	9.67	39	0	Negligible
Wakefield Road 3	8.52	34	8.53	34	0	Negligible
Wakefield Road 4	9.93	40	9.96	40	0	Negligible
Wakefield Road 5	9.86	39	9.89	40	0	Negligible
Wakefield Road 6	9.86	39	9.90	40	0	Negligible
Wakefield Road 7	10.77	43	10.79	43	0	Negligible
Wakefield Road 8	8.79	35	8.80	35	0	Negligible
Wakefield Road 9	9.13	37	9.14	37	0	Negligible
Wakefield Road 10	9.06	36	9.07	36	0	Negligible
Rotherham Road 1	9.54	38	9.55	38	0	Negligible
Rotherham Road 2	8.76	35	8.77	35	0	Negligible
Education Facility 1	8.43	34	8.43	34	0	Negligible
Education Facility 2	8.08	32	8.08	32	0	Negligible
Laithes Lane 1	9.27	37	9.28	37	0	Negligible
Laithes Lane 2	8.47	34	8.48	34	0	Negligible
Bar Lane 1	8.74	35	8.75	35	0	Negligible
Bar Lane 2	8.87	35	8.88	36	0	Negligible

Receptor ID	Without Development		With Development		% Change NO_2 concentration relative to AQAL	Predicted Impact
	$\mu g/m^3$	% of AQAL	$\mu g/m^3$	% of AQAL		
Paddock Road 1	8.32	33	8.33	33	0	Negligible
Paddock Road 2	8.44	34	8.44	34	0	Negligible
Shaw Lane 1	8.85	35	8.85	35	0	Negligible
Proposed Resi 1	9.38	38	9.40	38	0	Negligible
Proposed Resi 2	9.44	38	9.46	38	0	Negligible
Proposed Lidl 1	9.64	39	9.66	39	0	Negligible
Lee Lane 1	8.08	32	8.08	32	0	Negligible
Lee Lane 2 cumul	8.87	35	8.88	36	0	Negligible
Lee Lane 3 cumul	8.67	35	8.67	35	0	Negligible
Wakefield R. 1 cumul	9.22	37	9.24	37	0	Negligible
Wakefield R 2 cumul	9.05	36	9.06	36	0	Negligible
Blacker Road 1	8.92	36	8.93	36	0	Negligible
Blacker Road 2	8.73	35	8.73	35	0	Negligible
Education Facility 3	8.08	32	8.09	32	0	Negligible
Greenside 1	8.93	36	8.93	36	0	Negligible
Wakefield Road 11	9.73	39	9.74	39	0	Negligible
Wakefield Road 12	10.76	43	10.76	43	0	Negligible

Note: AQAL – Air Quality Action Level (i.e. the annual mean AQS).

<u>Hourly mean nitrogen dioxide, and particulate matter</u>

The number of exceedances of the daily mean PM_{10} AQS was less than the permissible 35 at all of the modelled existing receptor locations.

In addition, the development is not predicted to expose any of the modelled discrete receptors to concentrations of the annual mean NO_2 AQS exceeding $60\mu g/m^3$. As per LAQM TG.16, it is consequently unlikely that the development would cause new receptors to be exposed to concentrations of NO_2 exceeding the hourly mean NO_2 AQS on more than the permissible number of occasions each year.

6.2.2 Impact of Future Air Quality on the Proposed Sensitive Receptors

As shown in Table E5 of Appendix E, the proposed development is not predicted to expose future residents to annual mean NO_2, PM_{10} or $PM_{2.5}$ concentrations or daily mean PM_{10} concentrations, exceeding the applicable AQSs. The development is not predicted to expose future residents to concentrations of the annual mean NO_2 AQS exceeding $60\mu g/m^3$, therefore as per LAQM TG.16, it is unlikely that the development would cause new receptors to be exposed to concentrations of NO_2 exceeding the hourly mean NO_2 AQS on more than the permissible number of occasions each year.

As a result, future ambient air quality at the proposed development site is likely to be acceptable.

6.3 Significance of Effects

In terms of the impacts of the development on local air quality, the development is not anticipated to have a perceptible impact on annual mean PM_{10} or $PM_{2.5}$ concentrations, daily mean PM_{10} concentrations, or hourly mean NO_2 concentrations, at any of the modelled existing sensitive receptor locations. Moreover, the impact of the development on local air quality was generally assessed as 'negligible' with regard to annual mean NO_2, PM_{10} and $PM_{2.5}$ concentrations, although a slight and moderate adverse effect was predicted at two receptors in S2 and S3.

In practice, additional traffic associated with the development was estimated to contribute less than 1% to the total annual mean NO_2 concentration, and the retention of base case emissions factors and background annual mean NO_2 concentrations is considered conservative.

On the basis of the 2023 background concentrations and emissions factors, the impacts were assessed as 'negligible' at each receptor location, although it is acknowledged that the pollutant concentrations predicted in S2a and S3a may be optimistic.

On balance, it is considered unlikely that the development would have a significant effect on local air quality.

The impact of ambient air quality on receptors proposed at the development site is also considered insignificant.

7 MITIGATION MEASURES

7.1 Construction Phase

The dust emitting activities outlined in section 6.1 can be effectively controlled by appropriate dust control measures and any adverse affects can be greatly reduced or eliminated.

Prior to commencement of construction activities, it is recommended that agreement of a dust management plan (DMP) for the construction phase be reached with the local authority to ensure that any potential for adverse environmental effects on local receptors is minimised. The DMP, which could be prepared as part of a Construction Environmental Management Plan (CEMP), should include *inter alia*, measures for controlling dust and general pollution from site construction operations, and include details of any monitoring scheme, if appropriate. Controls should be applied throughout the construction period to ensure that emissions are mitigated. This statement should also include measures designed to reduce impacts in emergency circumstances.

The dust risk categories identified were used to define appropriate, site-specific mitigation, presented in Appendix C.

It is also best practice to reduce emissions from construction phase activities by developing and implementing a construction phase travel and logistics plan, to reduce the likelihood of goods and workers arriving in single-occupancy vehicles where this is practicable.

With the proposed construction activities mitigation measures as described above and in Appendix C in place, the likely residual impact of works undertaken during the construction phase on local air quality can be considered as ‘not significant’.

7.2 Operational Phase

As indicated in section 6.3, the development is considered unlikely to have a significant adverse effect on local air quality. However, residual impacts will be minimised (for a ‘medium’ development as per the BMBC guidance) by use of an appropriate selection of measures such as the following:

- Selection of ‘ultra low’ NOx boilers, wherever used throughout the development. Boilers installed in domestic buildings should achieve a NOx rating of 40mg NOx/kWh;
- Provision of on-site ‘rapid charge’ electric vehicle charging points, which should be maintained in good condition. As a guide, the EPUK-IAQM guidance recommends that one is installed per 10 residential dwellings, or where on-site parking is available, one could be made available for each parking space; and,

- Implementation of measures facilitating ‘modal shift’, discouraging the use of driving and encouraging waking, cycling, public transport, car sharing, and/or the uptake of low emissions fuels and technologies. These could be facilitated through the preparation of a travel plan. Such measures may include the promotion of car share schemes and provision of up-to-date public transport information (i.e. timetables, bus maps and routes, etc.) to residents; the development of a designated car sharing scheme and/or a cycle bank scheme; subsidised cycling proficiency testing; subsidised cycling equipment; the provision of on-site cycle parking; improved access to the local cycle network; improved bus stop infrastructure; subsidies for residents to encourage the use of public transport in the area; and a site layout designed to encourage walking.

8 CONCLUSIONS

An air quality assessment for the proposed residential development at the former William Freeman site, Mapplewell, has been prepared with reference to existing air quality in the area and relevant air quality legislation, policy and guidance.

Construction phase impacts of the proposed development on local air quality may have the potential to occur, due to dust and PM emissions during the period of construction. The potential risk of dust impacts was predicted to be a maximum of ‘medium risk’ during the construction phase. Site specific mitigation measures have been recommended to reduce these risks. Additional measures have also been recommended to reduce temporary increases in NO_2, PM_{10} and $PM_{2.5}$ concentrations associated with the use of vehicles and plant attributable to construction related activities. If appropriate mitigation, such as those measures recommended in this report are implemented, the residual impact of construction phase air quality impacts is likely to be ‘not significant’.

Regarding operational phase air quality impacts, an assessment of the impact of existing sources of relevant air pollutants in the local area on receptors to be introduced at the proposed development site, and of the impacts of the proposed development on local air quality, has been undertaken based on detailed dispersion modelling using ADMS Roads.

In order to quantify potential air quality impacts at receptor locations during the operational phase of the development, the following five scenarios were modelled:

- **S1:** Base case (2016);
- **S2:** Cumulative baseline scenario - traffic during the proposed development opening year (2023) with the consented developments (described in section 5.2) and the Lidl development in place, but without the proposed residential development in place, using ‘base case’ (2016) emissions factors;
- **S3:** Cumulative with-development scenario - traffic during the proposed development opening year (2023) with the consented developments (described in section 5.2), the Lidl development and the proposed residential development in place, using ‘base case’ (2016) emissions factors;
- **S2a:** Cumulative baseline scenario - traffic during the proposed development opening year (2023) with the consented developments (described in section 5.2) and the Lidl development in place, but without the proposed residential development in place, using opening year (‘2023’) emissions factors; and,
- **S3a:** Cumulative with-development scenario - traffic during the proposed development opening year (2023) with the consented developments (described in section 5.2), the Lidl development and the proposed residential development in place, using opening year (‘2023’) emissions factors.

In terms of the impacts of the development on local air quality, the development is not anticipated to have a perceptible impact on annual mean PM_{10} or $PM_{2.5}$ concentrations, daily mean PM_{10} concentrations, or hourly mean NO_2 concentrations, at any of the modelled existing sensitive receptor locations. Moreover, the impact of the development on local air quality was generally assessed as 'negligible' with regard to annual mean NO_2, PM_{10} and $PM_{2.5}$ concentrations, although either slight or moderate adverse impacts were predicted at two receptors in S2 and S3, as per the EPUK-IAQM guidance.

In practice, additional traffic associated with the development was estimated to contribute less than 1% to the total annual mean NO_2 concentration, and the retention of base case emissions factors and background annual mean NO_2 concentrations is considered conservative. When the 2023 background concentrations and emissions factors were presented, the impacts were assessed as negligible at each receptor location, although it is acknowledged that the pollutant concentrations predicted in S2a and S3a may be optimistic.

On balance, it is considered unlikely that the development would have a significant effect on local air quality.

The impact of ambient air quality on receptors proposed at the development site is also considered insignificant as no exceedances of any of the assessed pollutants of the assessed AQSs were predicted.

Although the development is considered unlikely to have a significant adverse effect on local air quality, mitigation measures have been recommended as good practice to minimise emissions.

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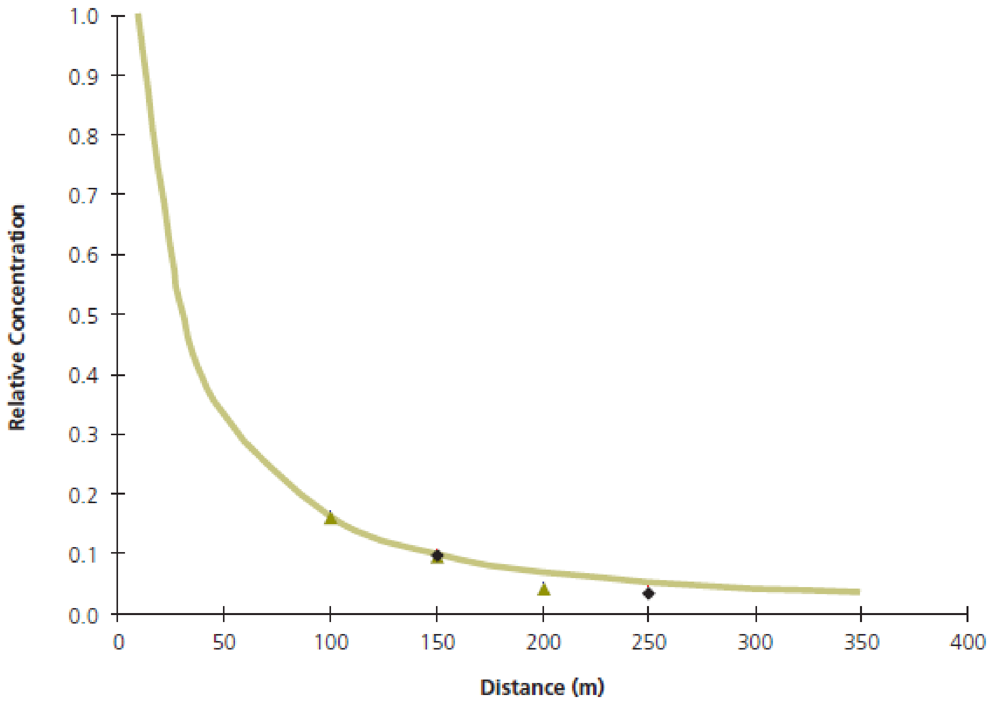
APPENDIX A
CONSTRUCTION DUST ASSESSMENT METHODOLOGY

This appendix contains the construction dust assessment methodology used in the assessment. To assess the potential impacts, construction activities are divided into demolition, earthworks, construction and trackout. The descriptors included in this section are based upon the IAQM 2014 guidance. The assessment follows the steps recommended in the guidance.

Step 1 and Step 2 methods from the IAQM 2014 guidance are described in this Appendix to assign dust risk categories for each of the construction activities.

The tendency of dust to remain airborne is determined by the particle size and weather conditions. Eventually, particles will drop from suspension as a deposit. The previous Local Air Quality Management Technical Guidance document (LAQM.TG(03))[2] identifies that PM_{10} concentrations fall-off rapidly with distance from source. Figure A1 shows the fall-off in PM_{10} concentration from source for a typical wind speed of 6m/s. At 100m from source, the PM_{10} concentration is predicted to be less than 20% of that at the point of generation.

Figure A1: Typical Fall-off in PM_{10} Concentration with Distance from Source



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[2] LAQM TG (03). The Local Air Quality Management Technical Guidance Note published by the Department for Food and Rural Affairs in 2003. This guidance note is revised in 2009 and is available as LAQM TG(09).

Step 1: Screen the requirement for assessment

The first step is to screen out the requirement for a construction dust assessment; this is usually a somewhat conservative level of screening. An assessment is usually required where there is:

- a ‘human receptor’ within:
  - 350m of the boundary of the site; or
  - 50m of the route used by construction vehicles onto the public highway, up to 500m from the site entrance(s).
- an ‘ecological receptor’:
  - 50m of the boundary of the site; or
  - 50m of the route(s) used by construction vehicles on the public highway, up to 500m from the site entrance(s).

Step 2A: Defining the Potential Dust Emission Magnitude

Demolition

The dust emission magnitude category for demolition is varied for each site in terms of timing, building type, duration and scale. Examples of the potential dust emission classes are provided in the guidance as follows:

- **Large**: Total building volume >50,000m^3, potentially dusty construction material, on-site crushing and screening, demolition activities >20m above ground level;
- **Medium**: Total building volume 20,000m^3 – 50,000m^3, potentially dusty construction material, demolition activities 10m – 20m above ground level; and,
- **Small**: Total building volume <20,000m^3, construction material with low potential for dust release, demolition activities <10m above ground, demolition during wetter months.

Earthworks

The dust emission magnitude category for earthworks is varied for each site in terms of timing, geology, topography and duration. Examples of the potential dust emission classes are provided in the guidance as follows:

- **Large**: Total site area >10,000m^2, potentially dusty soil type (e.g. clay), >10 heavy earth moving vehicles active at any one time, formation of bunds >8m in height, total material moved >100,000 tonnes;
- **Medium**: Total site area 2,500 – 10,000m^2, moderately dusty soil type (e.g. silt), 5 – 10 heavy earth moving vehicles active at any one time, formation of bunds 4 – 8m in height, total material moved 20,000 – 100,000 tonnes; and,
- **Small**: Total site area < 2,500m^2, soil type with large grain size (e.g. sand), <5 heavy earth moving vehicles active at any one time, formation of bunds <4m in height, total material moved <10,000 tonnes, earthworks during wetter months.

Construction

The dust emission magnitude category for construction is varied for each site in terms of timing, building type, duration, and scale. Examples of the potential dust emissions classes are provided in the guidance as follows:

- **Large**: Total building volume >100,000m^3, piling, on site concrete batching;

- **Medium**: Total building volume 25,000 – 100,000m^3, potentially dusty construction material (e.g. concrete), piling, on site concrete batching; and,
- **Small**: Total building volume <25,000m^3, construction material with low potential for dust release (e.g. metal cladding or timber).

Trackout

Factors which determine the dust emission magnitude class of trackout activities are vehicle size, vehicle speed, vehicle number, geology and duration. Examples of the potential dust emissions classes are provided in the guidance as follows:

- **Large**: >100 HDV (3.5t) trips in any one day, potentially dusty surface material (e.g. high clay content), unpaved road length >100m;
- **Medium**: 25 – 100 HDV (>3.5t) trips in any one day, moderately dusty surface material (e.g. high clay content), unpaved road length 50 – 100m; and,
- **Small**: <25 HDV (<3.5t) trips in any one day, surface material with low potential for dust release, unpaved road length <50m.

<u>Step 2B</u>: Defining the Sensitivity of the Area

The sensitivity of the area is defined for dust soiling, human health and ecosystems. The sensitivity of the area takes into account the following factors:

- The specific sensitivities of receptors in the area;
- The proximity and number of those receptors;
- In the case of PM_{10}, the local background concentration; and,
- Site-specific factors, such as whether here are natural shelters such as trees, to reduce the risk of wind-blown dust.

Table A1 has been used to define the sensitivity of different types of receptors to dust soiling, health effects and ecological effects.

Table A1: Sensitivity of Individual receptors in the area surrounding the Site

Sensitivity of Area	Dust Soiling	Human Receptors	Ecological Receptors
High	• Users can reasonably expect an enjoyment of a high level of amenity. • The appearance, aesthetics or value of their property would be diminished by soiling, and • The people or property would reasonably be expected to be present continuously, or at least regularly for extended periods, as part of the normal pattern of use of the land. • Examples include dwellings, museums and other culturally important collections, medium and long term car parks and car showrooms.	• Locations where members of the public are exposed over a time period relevant to the air quality objective for PM_{10} (in the case of the 24-hour objectives, a relevant location would be one where individuals may be exposed for eight hours or more in a day) • Examples include residential properties, hospitals, schools and residential care homes should also be considered as having equal sensitivity to residential areas for the purposes of this assessment.	• Locations with an international or national designation *and* the designated features may be affected by dust soiling. • Locations where there is a community of a particularly dust sensitive species such as vascular species included in the Red Data List for Great Britain. • Examples include a Special Area of Conservation (SAC) designated for acid heathlands or a local site designated for lichens adjacent to the demolition of a large site containing concrete (alkali) buildings.
Medium	• Users would expect to enjoy a reasonable level of amenity, but would not reasonably expect to enjoy the same level of amenity as in their home. • The appearance, aesthetics or value of their property could be diminished by soiling. • The people or property wouldn't reasonably be expected to be present here continuously or regularly for extended periods as part of the normal pattern of use of the land. • Examples include parks and places of work.	• Locations where the people exposed are workers and exposure is over a time period relevant to the air quality objective for PM_{10} (in the case of the 24-hour objectives, a relevant location would be one where individuals may be exposed for eight hours or more in a day). • Examples include office and shop workers, but will generally not include workers occupationally exposed to PM_{10}, as protection is covered by Health and Safety at Work legislation.	• Locations where there is a particularly important plant species, where its dust sensitivity is uncertain or unknown. • Locations with a national designation where the features may be affected by dust deposition. • Example is a Site of Special Scientific Interest (SSSI) with dust sensitive features.
Low	• The enjoyment of amenity would not reasonably be expected. • Property would not reasonably be expected to be diminished in appearance, aesthetics or value by soiling. • There is transient exposure, where the people or property would reasonably be expected to be present only for limited periods of time as part of the normal pattern of use of the land. • Examples include playing fields, farmland (unless commercially-sensitive horticultural), footpaths, short term car parks and roads.	• Locations where human exposure is transient. • Indicative examples include public footpaths, playing fields, parks and shopping streets.	• Locations with a local designation where the features may be affected by dust deposition. • Example is a local Nature Reserve with dust sensitive features.

Based on the sensitivities assigned of the different types of receptors surrounding the site and numbers of receptors within certain distances of the site, a sensitivity classification for the area can be defined for each. Tables A2 to A4 indicate the method used to determine the sensitivity of the area for dust soiling, human health and ecological impacts, respectively.

For trackout, as per the guidance, it is only considered necessary to consider trackout impacts up to 50m from the edge of the road.

Table A2: Sensitivity of the area to dust soiling effects on people and property

Receptor Sensitivity	Number of Receptors	Distances from the Source (m)			
		<20	<50	<100	<350
High	>100	High	High	Medium	Low
	10-100	High	Medium	Low	Low
	1-10	Medium	Low	Low	Low
Medium	>1	Medium	Low	Low	Low
Low	>1	Low	Low	Low	Low

Table A3: Sensitivity of the area to Human Health Impacts (from the IAQM 2014 guidance)

Receptor Sensitivity	Annual Mean PM_{10} Conc.	Number of Receptors	Distances from the Source (m)				
			<20	<50	<100	<200	<350
High	>32$\mu g/m^3$	>100	High	High	High	Medium	Low
		10-100	High	High	Medium	Low	Low
		1-10	High	Medium	Low	Low	Low
	28-32$\mu g/m^3$	>100	High	High	Medium	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	High	Medium	Low	Low	Low
	24-28$\mu g/m^3$	>100	High	Medium	Low	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
	<24 $\mu g/m^3$	>100	Medium	Low	Low	Low	Low
		10-100	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
Medium	>32$\mu g/m^3$	>10	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
	28-32$\mu g/m^3$	>10	Medium	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
	24-28$\mu g/m^3$	>10	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
	<24 $\mu g/m^3$	>10	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low

Receptor Sensitivity	Annual Mean	Number of Receptors	Distances from the Source (m)				
Low	-	>1	Low	Low	Low	Low	Low

Table A4: Sensitivity of the area to Ecological Impacts

Receptor Sensitivity	Distances from the Source (m)	
	<20	<50
High	High	Medium
Medium	Medium	Low
Low	Low	Low

<u>Step 2C</u>: Defining the Risk of Impacts

The final step is to use both the dust emission magnitude classification with the sensitivity of the area, to determine a potential risk of impacts for each construction activity, before the application of mitigation. Tables A5 to A7 indicate the method used to assign the level of risk for each construction activity.

Table A5: Risk of Dust Impacts from Demolition

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small
High	High Risk	Medium Risk	Medium Risk
Medium	High Risk	Medium Risk	Low Risk
Low	Medium Risk	Low Risk	Negligible

Table A6: Risk of Dust Impacts from Earthworks/Construction

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small
High	High Risk	Medium Risk	Medium Risk
Medium	Medium Risk	Medium Risk	Low Risk
Low	Low Risk	Low Risk	Negligible

Table A7: Risk of Dust Impacts from Trackout

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small
High	High Risk	Medium Risk	Medium Risk
Medium	Medium Risk	Low Risk	Negligible
Low	Low Risk	Low Risk	Negligible

APPENDIX B
OPERATION IMPACT ASSESSMENT METHODOLOGY

This appendix contains the methodology used in the assessment for the operational impact assessment to include reference to EPUK-IAQM guidance.

The impacts of a development are usually assessed at selected 'receptors'. The magnitude of impacts is derived by the percentage of change in pollutant concentration relative to an Air Quality Assessment Level (AQAL) and long term average pollutant concentration at receptor, as presented in Table B1. The significance of effects is then determined using professional judgement.

Table B1: Impact Descriptors for Individual Receptors

Long term average concentration at receptor in assessment year	% Change in concentration relative to Air Quality Assessment Level (AQAL)			
	1	2-5	6-10	>10
75% or less of AQAL	Negligible	Negligible	Slight	Moderate
79 – 94% of AQAL	Negligible	Slight	Moderate	Moderate
95 – 102% of AQAL	Slight	Moderate	Moderate	Substantial
103 – 109% of AQAL	Moderate	Moderate	Substantial	Substantial
110% or more of AQAL	Moderate	Substantial	Substantial	Substantial

Note: AQAL – air quality assessment level, such as the annual mean NO_2, PM_{10} or $PM_{2.5}$ AQS.

The EPUK/IAQM guidance notes that the criteria in Table B1 should be used to describe impacts at individual receptors and should only be considered as a starting point to make a judgement on significance of effects, as other influences may need to be accounted for. The EPUK/IAQM guidance states that the assessment of overall significance should be based on professional judgement, taking into account several factors, including:

- The existing and future air quality in the absence of the development;
- The extent of current and future population exposure to the impacts; and
- The influence and validity of any assumptions adopted when undertaking the prediction of impacts.

The EPUK/IAQM guidance states that for most road transport related emissions, long-term average concentrations are the most useful for evaluating the severity of impacts.

APPENDIX C
CONSTRUCTION PHASE MITIGATION MEASURES

Site-specific mitigation measures are divided into general measures, applicable to all sites and measures specific to earthworks, construction and trackout. Depending on the level of risk assigned to each site, different mitigation is assigned. The method of assigning mitigation measures as detailed in the IAQM guidance has been used.

For those mitigation measures that are general, the highest risk category assigned to the construction activity has been applied. In this case, the 'medium risk' site mitigation measures have been applied, as determined by the dust risk assessment in Section 6, due to the medium risk of impact associated with the earthworks. There are two categories of mitigation measure – 'highly recommended' and 'desirable', which are indicated according to the dust risk level identified in Table 6.7. Desirable measures are presented in *italics*.

<u>Communications</u>

- Develop and implement a stakeholder communications plan that includes community engagement before work commences on site.
- Display the name and contact details of people accountable for air quality and dust issues on the site boundary. This may be the environment manager/engineer or the site manager.
- Display the head or regional office contact information.

<u>Dust Management</u>

- Develop and implement a DMP, which may include measures to control other emissions, approved by the Local authority. The level of detail will depend on the risk, and should include as a minimum the highly recommended measures. The desirable measures should be included as appropriate for the site. The DMP may include monitoring of dust deposition, dust flux, real-time continuous PM_{10} monitoring and/or visual inspections.

<u>Site Management</u>

- Record all dust and air quality complaints, identify cause(s), take appropriate measures to reduce emissions in a timely manner, and record the measures taken.
- Make the complaints log available to the local authority when asked.
- Record any exceptional incidents that cause dust and/or air emissions, either on- or off-site or the action taken to resolve the situation in the log book.

<u>Monitoring</u>

- *Undertake daily on-site and off-site inspection, where receptors (including roads) are nearby, to monitor dust, record inspection results, and make the log available to the local* *authority if asked. This should include regular dust soiling checks of surfaces such as street furniture, cars and window sills within 100m of site boundary, with cleaning to be provided if necessary.*

- Carry out regular site inspections to monitor compliance with any dust management plan, record inspection results, and make an inspection log available to the local authority when asked.
- Increase the frequency of site inspections by the person accountable for air quality and dust issues on site when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions.

Preparing and maintaining the site

- Plan site layout so that machinery and dust causing activities are located away from receptors, as far as is possible.
- Erect solid screens or barriers around dusty activities or the site boundary that are at least as high as any stockpiles on site.
- Fully enclose site or specific operations where there is a high potential for dust production and the site is active for an extensive period.
- Avoid site runoff of water or mud.
- Keep site fencing, barriers and scaffolding clean using wet methods.
- Remove materials that have a potential to produce dust from site as soon as possible, unless being re-used on site. If they are being re-used on-site cover as described below.
- Cover, seed or fence stockpiles to prevent wind whipping.

Operating Vehicles/Machinery and Sustainable Travel

- Ensure all vehicles switch off engines when stationary - no idling vehicles.
- Avoid the use of diesel or petrol powered generators and use mains electricity or battery powered equipment where practicable.
- *Impose and signpost a maximum-speed-limit of 15mph on surfaced and 10mph on unsurfaced haul roads and work areas, where applicable.*
- Produce a construction logistics plan to manage the sustainable delivery of goods and materials.
- *Implement a Travel Plan that supports and encourages sustainable travel (public transport, cycling, walking, and car-sharing).*

Operations

- Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g. suitable local exhaust ventilation systems.
- Ensure an adequate water supply on the site for effective dust/particulate matter suppression/mitigation, using non-potable water where possible and appropriate.
- Use enclosed chutes and conveyors and covered skips.
- Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate.

- Ensure equipment is readily available on site to clean and dry spillages, and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods.

Waste Management

- Avoid bonfires or burning of waste materials.

Specific to Earthworks

- *Re-vegetate earthworks and exposed areas/soil stockpiles to stabilise surfaces as soon as practicable.*
- *Use Hessian, mulches or trackifiers where it is not possible to re-vegetate to cover with topsoil, as soon as practicable.*
- *Only remove the cover in small areas during work and not all at once.*

Specific to Construction

- *Avoid scabbling (roughening of concrete surfaces) if possible.*
- Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place.
- *Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery.*
- *For smaller supplies of fine power materials ensure bags are sealed after use and stored appropriately to prevent dust.*

Specific to Trackout

- Use water-assisted dust sweeper(s) on the access and local roads, to remove, as necessary, any material tracked out of the site. This may require the sweeper being continuously in use.
- Avoid any dry sweeping of large areas.
- Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport.
- Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable.
- Record all inspections of haul routes and any subsequent action in a site log book.
- Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable).
- Ensure there is an adequate area of hard surfaced road between the wheel wash facility and the site exit, wherever site size and layout permits.
- Access gates to be located at least 10 m from receptors where possible.

APPENDIX D
TRAFFIC DATA

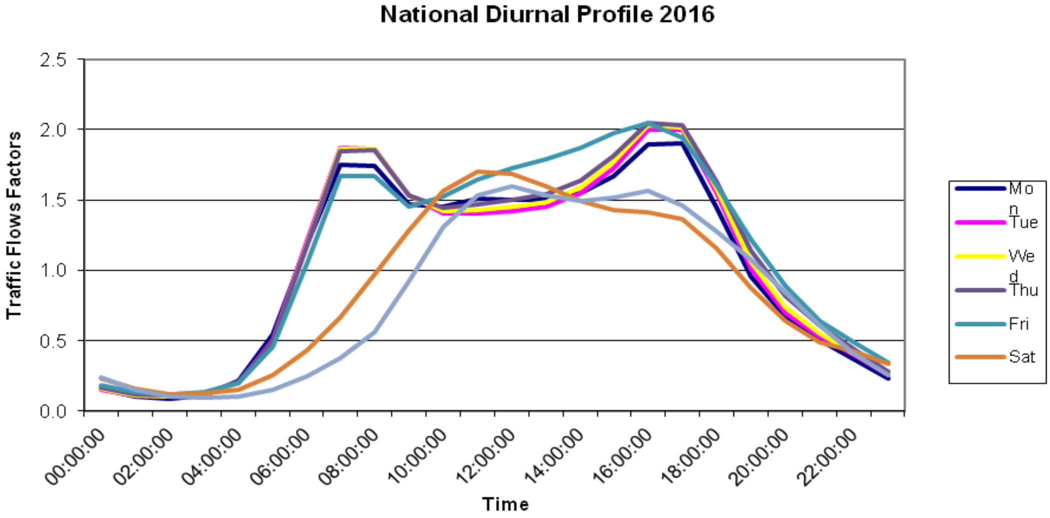
This appendix contains the traffic data used in the dispersion modelling assessment. Included are traffic flow data in AADT, percentage Heavy Duty Vehicle (HDV) and the speed for each road link.

Table D1	AADT Traffic Flows and heavy duty vehicle composition for Model Scenarios used in the dispersion modelling assessment
Figure D1	National diurnal profile for roads modelled

Table D1: AADT Traffic Flows for Model Scenarios used in the dispersion modelling assessment

Ref	Road Link	Source of Data	S1 – without development		S2 – with development		S3 –with development	
			AADT	%HGV	AADT	%HGV	AADT	%HGV
1	Wakefield Road - North of Lee Lane / Shaw Lane	Bryan G Hall	7791	3.36	9913	2.92	10009	2.92
2	Shaw Lane / Greenside	Bryan G Hall	9191	1.50	10622	1.44	10622	1.44
3	Lee Lane	Bryan G Hall	8374	1.32	10412	1.19	10427	1.19
4	Wakefield Road - North of Paddock Road	Bryan G Hall	9002	3.03	11977	2.51	12088	2.51
5	Paddock Road	Bryan G Hall	3314	0.83	3952	0.80	4015	0.80
6	Wakefield Road - North of Proposed Residential Development Site Access	Bryan G Hall	11261	2.63	14762	2.22	14936	2.22
7	Proposed Residential Development Site Access	Bryan G Hall	0	0.00	0	0.00	479	0.00
8	Wakefield Road - North of Proposed Lidl Site Access	Bryan G Hall	11261	2.63	14472	2.27	14598	2.27
9	Proposed Lidl Site Access	Bryan G Hall	0	0.00	1276	0.08	1276	0.08
10	Wakefield Road - North of Bar Lane / Blacker Road	Bryan G Hall	11257	2.57	14445	2.19	14750	2.19
11	Bar Lane / Blacker Road	Bryan G Hall	9336	3.55	11317	3.24	11391	3.24
12	Wakefield Road - North of Newstead Road	Bryan G Hall	19786	3.00	24563	2.66	24794	2.66
13	Wakefield Road - North of Laithes Lane	Bryan G Hall	19859	3.14	24644	2.79	24875	2.79
14	Laithes Lane	Bryan G Hall	9136	5.40	10222	5.36	10247	5.36
15	Wakefield Road - South of Laithes Lane	Bryan G Hall	16738	2.42	21107	2.85	21314	2.85
16	Wakefield Road - South of New Lodge Crescent	Bryan G Hall	17545	3.03	21546	2.72	21752	2.72
17	Rotherham Road	Bryan G Hall	8495	1.34	9612	1.32	9675	1.32
18	Wakefield Road - South of Rotherham Road fork	Bryan G Hall	11726	3.06	14911	3.60	15053	3.60
19 and 20	Wakefield Road - South of Carlton Road	DFT	16203	3.06	18406	4.82	18406	4.82
RA	Roundabout connecting road links 16, 17 and 18	DFT	12588	2.66	15493	2.71	15493	2.71

Figure D1: Diurnal Profile for Road Sources Included in the Dispersion Modelling Assessment



APPENDIX E
MODELLING OF OPERATIONAL PHASE – VERIFICATION METHODOLOGY AND MODEL RESULTS

The dispersion model results were verified following the relevant guidance in the Local Air Quality Management Technical Guidance (2016) (LAQM.TG(16)). Predicted results from a dispersion model may differ from measured concentrations for a variety of reasons; these are identified in TG(16) to include:

- Estimates of background concentrations;
- Meteorological data uncertainties;
- Uncertainties in source data for example, traffic flow data, stack emissions and emission factors;
- Model input parameters such as roughness length, minimum Monin-Obukhov and overall model limitations; and,
- Uncertainties associated with monitoring data, including locations.

Annual mean NO_2 data collected at DT34, DT35, DT36 and DT37 during 2016 were used to verify the dispersion model, as detailed in Section 5.

A comparison of modelled versus monitored NO_2 concentrations at these sites is presented in Table E1. They show that the model underpredicted road traffic concentrations by more than 25%. Therefore, model verification has been undertaken as per the procedure in LAQM TG.16.

Table E1: Modelled versus Monitored NO_2 Concentrations

Site	Background NO_2	Monitored total NO_2	Modelled total NO_2	% Difference [(modelled – monitored)/monitored]x100
DT37	17.90	29.10	22.09	-24.1
DT34	14.74	29.30	17.98	-38.6
DT35	14.74	40.70	20.57	-49.5
DT36	14.74	34.80	20.30	-41.7

Modelled versus measured road NOx data at the diffusion tube sites are shown in Table E2. The model as a whole underpredicted road NOx concentrations by a factor of 4.14; this factor has been applied to model results.

Table E2: Modelled versus Monitored NO_x/NO_2

Site	Background NO_2	Monitored NO_2	Monitored Road Contribution NO_2	Monitored Road Contribution NOx	Modelled road contribution NOx	Ratio of Modelled and Measured Road NOx
DT37	17.90	29.10	11.20	22.36	8.08	2.77
DT34	14.74	29.30	14.56	29.12	6.14	4.74
DT35	14.74	40.7	25.96	55.09	11.18	4.93
DT36	14.74	34.8	20.06	41.26	10.66	3.87

The verified annual average modelled road contribution NO_x concentrations were used to estimate the annual average road NO_2 by using the DEFRA NO_x to NO_2 spreadsheet; a comparison of monitored and model adjusted total NO_2 is presented in Table E3 for the four diffusion tube results used for verification.

Table E3: Modelled versus Monitored NO_2 Concentrations

Site	Background NO_2	Monitored NO_2	Modelled total NO_2 after adjustment	% Difference [(modelled – monitored)/monitored]x100
DT37	17.9	29.1	34.24	17.7
DT34	14.7	29.3	27.58	-5.9
DT35	14.7	40.7	37.00	-9.1
DT36	14.7	34.8	36.06	3.6

In the absence of local monitoring locations measuring data for PM_{10} or $PM_{2.5}$ within the vicinity of the site, verification for PM_{10} and $PM_{2.5}$ has been undertaken using the NOx adjustment factor.

A list of the receptor locations included in the dispersion model is displayed in Table E4.

Table E4: Receptors Included in the Dispersion Modelling Assessment

Receptor ID	X	Y	Height (m)
Wakefield Road 1	433388	410771	1.50
Wakefield Road 2	433489	410538	1.50
Wakefield Road 3	433673	410287	1.50
Wakefield Road 4	433879	410015	1.50
Wakefield Road 5	433999	409791	1.50
Wakefield Road 6	434051	409694	1.50
Wakefield Road 7	434104	409635	1.50
Wakefield Road 8	434367	409426	1.50
Wakefield Road 9	434523	409238	1.50
Wakefield Road 10	434950	408691	1.50
Rotherham Road 1	434870	408896	1.50
Rotherham Road 2	435000	408877	1.50

Receptor ID	X	Y	Height (m)
Education Facility 1	434870	409010	1.50
Education Facility 2	434827	409315	1.50
Laithes Lane 1	434545	409353	1.50
Laithes Lane 2	434941	409410	1.50
Bar Lane 1	434022	409624	1.50
Bar Lane 2	433789	409721	1.50
Paddock Road 1	433554	410328	1.50
Paddock Road 2	433319	410446	1.50
Shaw Lane 1	433414	410545	1.50
Proposed Resi 1	433916	409951	1.50
Proposed Resi 2	433956	409873	1.50
Proposed Lidl 1	433989	409813	1.50
Lee Lane 1	434741	411302	1.50
Lee Lane 2 cumul	434842	411300	1.50
Lee Lane 3 cumul	435022	411386	1.50
Cumulative residential 1	433838	410054	1.50
Cumulative residential 2	433770	410172	1.50
Blacker Road 1	433218	409995	1.50
Blacker Road 2	433316	409915	1.50
Education Facility 3	433241	410107	1.50
Greenside 1	433033	410126	1.50
Wakefield Road 11	435024	408244	1.50
Wakefield Road 12	435020	408145	1.50
DT37	435173	407501	2.80
DT34	435010	408283	3.50
DT35	435026	408190	2.80
DT36	435028	408100	2.70

Model results for long-term and short-term PM_{10}, and long-term NO_2 and $PM_{2.5}$, concentrations at receptors are presented in Table E5, for S1, S2 and S3.

Table E5: Predicted Pollutant Concentrations at Modelled Receptor Locations

Receptor ID	Long-term NO$_2$ Annual Average Concentrations (µg/m^3)			Short-term No. days PM$_{10}$ 24-Hour Average Concentrations (µg/m^3)			Long-term PM$_{10}$ Annual Average Concentrations (µg/m^3)			Long-term PM$_{2.5}$ Annual Average Concentrations (µg/m^3)		
	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
Cumulative residential 1	22.9	25.6	25.8	0	0	0	13.82	14.35	14.38	8.91	9.22	9.24
Cumulative residential 2	21.2	23.6	23.7	0	0	0	13.60	14.06	14.09	8.77	9.05	9.06
Wakefield Road 1	16.0	16.9	16.9	1	1	1	12.63	12.80	12.80	8.21	8.30	8.31
Wakefield Road 2	27.7	30.8	30.8	0	0	0	14.47	15.05	15.06	9.31	9.66	9.67
Wakefield Road 3	17.5	18.9	19.0	1	0	0	12.90	13.16	13.17	8.37	8.52	8.53
Wakefield Road 4	31.6	36.2	36.5	0	0	0	14.67	15.44	15.49	9.47	9.93	9.96
Wakefield Road 5	32.6	37.4	37.7	0	0	0	14.31	15.11	15.16	9.37	9.86	9.89
Wakefield Road 6	33.4	37.6	37.8	0	0	0	14.43	15.12	15.17	9.45	9.86	9.90
Wakefield Road 7	**42.2**	**47.3**	**47.5**	0	1	1	15.67	16.57	16.62	10.22	10.77	10.79
Wakefield Road 8	22.0	23.9	23.9	0	0	0	13.09	13.42	13.43	8.60	8.79	8.80
Wakefield Road 9	25.7	28.8	28.9	0	0	0	13.48	13.95	13.96	8.85	9.13	9.14
Wakefield Road 10	22.4	25.0	25.1	0	0	0	13.61	14.05	14.07	8.80	9.06	9.07
Rotherham Road 1	27.6	31.0	31.1	0	0	0	14.26	14.82	14.84	9.20	9.54	9.55
Rotherham Road 2	22.2	23.4	23.5	0	0	0	13.11	13.31	13.32	8.64	8.76	8.77
Education Facility 1	19.9	21.3	21.3	1	1	1	12.58	12.78	12.78	8.31	8.43	8.43
Education Facility 2	16.3	16.9	16.9	1	1	1	12.13	12.21	12.21	8.03	8.08	8.08
Laithes Lane 1	29.6	32.1	32.2	0	0	0	13.77	14.14	14.15	9.05	9.27	9.28
Laithes Lane 2	20.0	20.9	20.9	1	1	1	12.74	12.88	12.88	8.39	8.47	8.48
Bar Lane 1	23.4	25.4	25.5	1	0	0	13.00	13.29	13.30	8.57	8.74	8.75
Bar Lane 2	21.7	23.5	23.6	0	0	0	13.36	13.70	13.71	8.67	8.87	8.88
Paddock Road 1	16.5	17.4	17.5	1	1	1	12.66	12.82	12.82	8.23	8.32	8.33
Paddock Road 2	17.8	18.8	18.9	1	1	1	12.85	13.01	13.01	8.34	8.44	8.44

Receptor ID	Long-term NO_2 Annual Average Concentrations (µg/m^3)			Short-term No. days PM_{10} 24-Hour Average Concentrations (µg/m^3)			Long-term PM_{10} Annual Average Concentrations (µg/m^3)			Long-term $PM_{2.5}$ Annual Average Concentrations (µg/m^3)		
	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
Shaw Lane 1	22.0	23.6	23.7	0	0	0	13.42	13.68	13.69	8.69	8.85	8.85
Proposed Resi 1	27.4	31.0	31.2	0	0	0	13.91	14.50	14.53	9.03	9.38	9.40
Proposed Resi 2	25.6	28.9	29.0	0	0	0	14.04	14.67	14.69	9.08	9.44	9.46
Proposed Lidl 1	29.8	34.4	34.6	0	0	0	14.16	14.91	14.94	9.19	9.64	9.66
Lee Lane 1	12.5	13.0	13.0	1	1	1	12.46	12.54	12.54	8.04	8.08	8.08
Lee Lane 2 cumul	18.9	20.8	20.8	0	0	0	13.52	13.86	13.86	8.67	8.87	8.88
Lee Lane 3 cumul	20.0	21.8	21.8	1	0	0	12.99	13.33	13.33	8.47	8.67	8.67
Blacker Road 1	23.6	25.7	25.8	0	0	0	13.41	13.75	13.76	8.72	8.92	8.93
Blacker Road 2	22.9	24.9	24.9	0	0	0	13.12	13.40	13.41	8.56	8.73	8.73
Education Facility 3	14.7	15.2	15.2	1	1	1	12.34	12.41	12.42	8.04	8.08	8.09
Greenside 1	23.6	25.3	25.3	0	0	0	13.54	13.80	13.80	8.77	8.93	8.93
Wakefield Road 11	32.5	37.3	37.4	0	0	0	14.22	14.83	14.84	9.35	9.73	9.74
Wakefield Road 12	**42.6**	**49.2**	**49.2**	0	0	0	15.69	16.47	16.47	10.26	10.76	10.76