Land at Blackmoorfoot Road, Huddersfield

Air Quality Assessment: Condition 29

Miller Homes Ltd, Vistry Group & Countryside Properties

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Basis of Report

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1.0 Introduction

SLR Consulting Ltd (SLR) has been commissioned by Miller Homes Ltd, Vistry Group & Countryside Properties to undertake an Air Quality Assessment (AQA) to support the application for reserved matters approval and discharge of a pre-commencement condition for an outline consented development on Land off Blackmoorfoot Road and Felks Stile Road, Huddersfield (the 'Site'). The Site is on land of the former Black Cat Fireworks.

The Site currently comprises brownfield land associated with the Former Black Cat Fireworks factory, as well as vacant agricultural land. The Site is located at the approximate National Grid Reference (NGR): x411300, y414600. The surrounding area comprises:

- Open green space immediately to the north, beyond which are existing residential dwellings associated with the settlement of Cowlersley at approximately 200m;
- To the immediate east are existing dwellings associated with the settlement of Crosland Hill. Lowndons Motorhomes and Caravans is also adjacent to the eastern Site boundary, at the southern extent of the Site;
- Blackmoorfoot Road runs adjacent to the southern Site boundary, beyond which is agricultural land, Waterholes Quarry, Johnstones Quarry and a small airfield and associated runway; and
- Felks Street runs adjacent to the western Site boundary, beyond which is the Crosland Heath Golf Course.

1.1 Background

Empire Knight Group Ltd submitted an outline application for the Site to Kirklees Council (KC) which was granted consent on 25th March 2022 (KC application reference: 2020/60/92546/W). The description of development for the outline consent is as follows:

> *"Outline application (with details of points of access only) for the development of up to 770 residential dwellings (Use Class C3), including up to 70 care apartments (Use Classes C2/C3) with doctors surgery of up to 350 sq m (Use Class D1); up to 500 sq m of Use Class A1/A2/A3/A4/A5/D1 floorspace (dual use), vehicular and pedestrian access points off Blackmoorfoot Road and Felks Stile Road and associated works."*

The above description is hereafter referred to as "the Development".

The Development was granted outline consent subject to a number of planning conditions, including the following of relevance to this document:

> *"29. Before construction work commences on each phase of development, a revised Air Quality Impact Assessment shall be submitted to and approved in writing by the Local Planning Authority. The assessment shall:*
>
> *a) Determine the impact that the development will have on air quality (taking into consideration any cumulative impact from other local developments)*
>
> *b) Include a calculation of the monetary damages from the development; and*
>
> *c) Include a fully costed mitigation plan detailing the proposed low emission mitigation measures.*
>
> *The monetary value of the damages should be reflected in money spent on the low emission mitigation measures.*

> *The approved low emission mitigation measures for each phase shall be implemented before the occupation of 50% of the residential dwellings within that phase and shall be retained thereafter.*
>
> *Reason: For promoting sustainable development and transport and conserving the natural environment."*

In the interim, Miller Homes Ltd, Vistry Group & Countryside Properties have acquired the Site and is seeking to progress with the application for Reserved Matters approval and associated condition discharge for the residential portion, only.

1.2 Scope of Assessment

The following scope of works has been undertaken in accordance with the above planning Condition 29, the West Yorkshire Low Emissions Group: *Air Quality & Emissions, Technical Planning Guidance*[1]*,* and industry best practice:

- Baseline Evaluation – Assessment of existing air quality in the local area;
- Operational Phase – Identification and updated assessment of potential air quality impacts associated with the operational phase of the Development;
- A calculation of monetary damages from the development; and
- Mitigation Measures – Identification of operational phase air quality specific mitigation measures proposed and cost itemisation of each measure

[1] West Yorkshire Low Emissions Group – Air Quality & Emissions, Technical Planning Guidance, Part of the West Yorkshire Low Emissions Strategy (WYLES).

2.0 Background Context

2.1 Legislation

A dual set of regulations, applicable to National and Local Government separately are currently operable within the UK.

2.1.1 National Obligations

The Air Quality Standards Regulations 2010[2] (AQSR) transpose both the EU Ambient Air Quality Directive (2008/50/EC), and the Fourth Daughter Directive (2004/107/EC) within UK legislation, in order to align and mirror European obligations. The AQSR includes Limit Values which are legally binding ambient concentration thresholds, however, must be assessed at specific locations (micro and macroscale sampling points). Carriageways or central reservations of roads and any location where the public do not have access (e.g. industrial sites) are exempt. If the sampling point does not comply with the siting locations (Schedule 1: AQSR), then strict comparison cannot be made.

Following the UK's withdrawal from the EU, the Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020[3] was introduced to mirror revisions to supporting EU legislation. The fine particulate matter ($PM_{2.5}$) Limit Value is 20µg/m^3 (to be met by 2020).

The responsibility of achieving the AQSR (and European equivalent Directives) is a national obligation for Central Government and Devolved Administrations who undertake assessments on an annual basis. Local Authorities have no responsibility to achieve the AQSR or the European equivalent Directives, unless otherwise instructed to assist Central Government under Ministerial Direction.

In response to persistent exceedances, the Government published its 2017 plan[4] for reducing roadside nitrogen dioxide (NO_2) concentrations in order to achieve compliance in the shortest time possible. This has resulted in the introduction of Clean Air Zones across England. However, KC was not identified as required to conduct a feasibility study to achieve compliance.

2.1.1.1 Environment Targets (Fine Particulate Matter) Regulations

The Environmental Targets (Fine Particulate Matter) (England) Regulations 2023[5] introduced an annual mean concentration target of 10µg/m^3 to be met across England by 2040. Central Government and Devolved Administrations is responsible for meeting this target, however not until 2040. Local Authorities have no responsibility to achieve this target.

2.1.2 Local Obligations

Part IV of the Environment Act 1995 (as amended) requires the Secretary of State to publish a national Air Quality Strategy (AQS) every five years and established the system of Local Air Quality Management (LAQM) for Local Authorities to regularly review and assess air quality within its area.

[2] The Air Quality Standards Regulations (England) 2010, Statutory Instrument No 1001, The Stationary Office Limited.

[3] The Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020, Statutory Instrument No. 1313, The Stationary Office Limited.

[4] UK Plan for Tackling Roadside Nitrogen Dioxide Concentrations, 2017.

[5] The Environmental Targets (Fine Particulate Matter) (England) Regulations 2023. UK Statutory Instruments 2023 No. 96.

The Air Quality (England) Regulations 2000 (as amended) ('the Regulations') provide the statutory basis for the Air Quality Objectives Local Authorities must adhere to under LAQM in England. $PM_{2.5}$ is not currently cited within the Regulations; Local Authorities are however required to work towards reducing $PM_{2.5}$.

The Air Quality Objectives apply at locations where members of the public are regularly present and might reasonably be expected to be exposed to pollutant concentrations over the relevant averaging period (relevant exposure). Table B provides an indication of those locations. Where any of the prescribed Air Quality Objectives are not likely to be achieved, the authority must designate an Air Quality Management Area (AQMA). For each AQMA, the local authority is required to prepare an Air Quality Action Plan (AQAP), which details measures the authority intends to introduce to deliver improvements in local air quality in pursuit of the objective.

The latest AQS for England was published in 2023[6]. The AQS provides the delivery framework for air quality management across England for local authorities and summarises the air quality standards and objectives operable within England for the protection of public health and the environment.

The ambient air quality standards of relevance this assessment (collectively termed Air Quality Assessment Levels (AQALs) throughout this report) are provided in Table A. These are primarily based upon the Air Quality Objectives Local Authorities are responsible for achieving – reflective of the Local Planning Authority's duties. The $PM_{2.5}$ AQSR AQAL has also been included for completeness, to provide an indicative assessment (as the sampling point may not comply with the siting locations prescribed under Schedule 1: AQSR).

Table A: Relevant Ambient AQALs

Pollutant	AQAL (µg/m³)	Averaging Period
NO_2	40	Annual mean
	200	1-hour mean (not to be exceeded on more than 18 occasions per annum)
Particles (as PM_{10})	40	Annual mean
	50	24-hour mean (not to be exceeded on more than 35 occasions per annum)
Particles (as $PM_{2.5}$)	20	Annual mean
Table Notes: The $PM_{2.5}$ AQAL is not prescribed within the Air Quality (England) Regulations 2000 / 2002 and there is no requirement for local authorities to meet it. Exceedances are only valid at specific siting locations (Schedule 1: AQSR).		

Table B: Human Health Relevant Exposure

AQAL Averaging Period	AQALs should apply at	AQALs should not apply at
Annual Mean	Building facades of residential properties, schools, hospitals etc.	Facades of offices Hotels Gardens of residences Kerbside sites

[6] Air Quality Strategy: Framework for Local Authority Delivery, Department for Environment Food and Rural Affairs, April 2023.

AQAL Averaging Period	AQALs should apply at	AQALs should not apply at
24-hour mean	As above together with hotels and gardens of residential properties	Kerbside sites where public exposure is expected to be short term
1-hour mean	As above together with kerbside sites of regular access, car parks, bus stations etc.	Kerbside sites where public would not be expected to have regular access

2.1.3 Clean Air Strategy

The 2019 Clean Air Strategy[7] sets out the Government's proposals aimed at delivering cleaner air in England and indicates how devolved administrations intend to make emissions reductions. It sets out the comprehensive action that is required from across all parts of government and society to deliver clean air.

2.1.4 Environment Improvement Plan 2023

The 2023 Environment Improvement Plan[8] is the first revision of the UK Government's 25 Year Environment Plan (25YEP) – planned on a five-year rolling cycle. This document sets out the 5-year delivery plan to improve the natural environment. The 2023 Environment Improvement Plan builds on the 2019 Clean Air Strategy by setting environmental targets and commitments to reduce air pollution.

2.2 Policy

2.2.1 National Policy

2.2.1.1 National Planning Policy Framework

The December 2023 update to the National Planning Policy Framework[9] (NPPF) sets out planning policy for England. The NPPF states that the planning system should contribute to and enhance the natural and local environment, by preventing new development from contributing to or being adversely affected by unacceptable concentrations of air pollution and development should, wherever possible, help to improve local environmental conditions such as air quality.

In specific relation to air quality policy, the document states:

> ***"Chapter 15 - Conserving and Enhancing the Natural Environment***
>
> *Para 192: Planning policies and decisions should sustain and contribute towards compliance with relevant limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and Clean Air Zones, and the cumulative impacts from individual sites in local areas. Opportunities to improve air quality or mitigate impacts should be identified, such as through traffic and travel management, and green infrastructure provision and enhancement. So far as possible these opportunities should be considered at the plan-making stage, to ensure a strategic approach and limit the need for issues to be reconsidered when determining individual applications. Planning decisions should ensure that any new*

[7] The Clean Air Strategy, Defra. January 2019.

[8] Environmental Improvement Plan 2023, Defra. 2023.

[9] National Planning Policy Framework, Ministry of Housing, Communities & Local Government. 2023.

> *development in Air Quality Management Areas and Clean Air Zones is consistent with the local air quality action plan."*

The NPPF is accompanied by web based supporting Planning Practice Guidance (PPG)[10] which includes guiding principles on how planning can take account of the impacts of new development on air quality. In regard to air quality, the PPG states:

> *"The Department for Environment, Food and Rural Affairs carries out an annual national assessment of air quality using modelling and monitoring to determine compliance with relevant limit values. It is important that the potential impact of new development on air quality is taken into account where the national assessment indicates that relevant limits have been exceeded or are near the limit, or where the need for emissions reductions has been identified."*

> *"Whether air quality is relevant to a planning decision will depend on the proposed development and its location. Concerns could arise if the development is likely to have an adverse effect on air quality in areas where it is already known to be poor, particularly if it could affect the implementation of air quality strategies and action plans and/or breach legal obligations (including those relating to the conservation of habitats and species)."*

The PPG sets out the information that may be required within the context of a supporting air quality assessment, stating that "*Assessments need to be proportionate to the nature and scale of development proposed and the potential impacts (taking into account existing air quality conditions), and because of this are likely to be locationally specific. […] Mitigation options will need to be locationally specific, will depend on the proposed development and need to be proportionate to the likely impact*".

2.2.2 Local Policy

2.2.2.1 Local Plan

The Kirklees Local Plan[11] was adopted on 27th February 2019 and is the statutory development plan for Kirklees which supersedes the Kirklees Unitary Development Plan.

The Local Plan comprises the strategy and policies document, allocations and designations document and associated policies map showing the allocations and designations. The Local Plan sets out the policies necessary to achieve the strategy, how much new development there should be in the district and where, and it covers the period up to 2031.

A review of the Kirklees Local Plan indicated the following policies relating to air quality:

> *"**Policy LP20: Sustainable travel***
>
> *New development will be located in accordance with the spatial development strategy to ensure the need to travel is reduced and that essential travel needs can be met by forms of sustainable transport other than the private car. The council will support development proposals that can be served by alternative modes of transport such as public transport, cycling and walking and in the case of new residential development is located close to local facilities or incorporates opportunities for day to day activities on site and will accept that variations in opportunity for this will vary between larger and smaller settlements in the area.*

[10] Planning Practice Guidance: Air Quality. Department for Levelling Up, Housing and Communities and Ministry of Housing, Communities & Local Government. November 2019.

[11] https://www.kirklees.gov.uk/beta/planning-policy/local-plan.aspx.

The council will support demand management measures which discourage single occupancy car travel within new development and encourage the use of low emission vehicles to improve areas with low levels of air quality. Proposals should include measures to encourage the use of sustainable travel options, including public transport, the promotion of personal journey planning, walking, cycling, car sharing, electronic communication and home working.

Travel plans will normally be required for all major planning applications in accordance with current guidance and should set targets and monitoring arrangements to ensure sustainable travel patterns are maintained. Travel plans should include agreed and defined outcomes related to a package of specified measures to be implemented including an approach to lower carbon emissions where applicable.

The requirement of a travel plan will also be considered on case by case basis where the proposed development falls below the major application category where it has the potential to generate significant transport movements and/or has insufficient off-street parking within the vicinity of a stressed part of the highway network

Proposals for new development shall be designed to encourage sustainable modes of travel and demonstrate how links have been utilised to encourage connectivity. Proposals will be required to facilitate the needs of the following user hierarchy:

a. pedestrians

b. cyclists

c. public transport

d. private vehicles"

*"**Policy LP21: Highways and access***

Proposals shall demonstrate that they can accommodate sustainable modes of transport and be accessed effectively and safely by all users.

New development will normally be permitted where safe and suitable access to the site can be achieved for all people and where the residual cumulative impacts of development are not severe.

Proposals shall demonstrate adequate information and mitigation measures to avoid a detrimental impact on highway safety and the local highway network. Proposals shall also consider any impacts on the Strategic Road Network.

All proposals shall:

c. be accompanied by a supporting Transport Assessment or Transport Statement where the development would generate significant trip generation, providing detail as to the impact on highway safety, air quality, noise and light restrictions;"

*"**Policy LP47: Healthy, active and safe lifestyles***

The council will, with its partners, create an environment which supports healthy, active and safe communities and reduces inequality.

Healthy, active and safe lifestyles will be enabled by:

g. ensuring that the current air quality in the district is monitored and maintained and, where required, appropriate mitigation measures included as part of new development proposals;"

*"**Policy LP51: Protection and improvement of local air quality***

1. Development will be expected to demonstrate that it is not likely to result, directly or indirectly, in an increase in air pollution which would have an unacceptable impact on the natural and built environment or to people.

2. Proposals that have the potential to increase local air pollution either individually or cumulatively must be accompanied by evidence to show that the impact of the development has been assessed in accordance with the relevant guidance. Development which has the potential to cause levels of local air pollution to increase must incorporate sustainable mitigation measures that reduce the level of this impact. If sustainable measures cannot be introduced the development will not be permitted.

3. Where the development introduces new receptors into Air Quality Management Areas or Areas of Concern or near other areas of relatively poor air quality, for example near roads or junctions, the development must incorporate sustainable mitigation measures that protect the new receptors from unacceptable levels of air pollution. Where sustainable mitigation measures cannot be introduced which prevent receptors from being exposed to unsafe levels of air pollution, development will not be permitted."

The above policies stated within the Kirklees Local Plan in relation to air quality are considered within this AQA.

2.3 Assessment Guidance

This assessment has been carried out in accordance with the following principles contained within the guidance documents below.

- West Yorkshire Low Emissions Group: Air Quality & Emissions, Technical Planning Guidance, Part of the West Yorkshire Low Emissions Strategy Group (WYLES)[1], herein referred to as the 'WYLES guidance';
- Department for Environment Food and Rural Affairs (Defra): Local Air Quality Management Technical Guidance (LAQM.TG(22))[12];
- Defra: COVID-19: Supplementary Guidance. Local Air Quality Management Reporting in 2021[13];
- Design Manual for Roads and Bridges LA 105[14];
- Environmental Policy Implementation Community (EPIC) (previously Environmental Protection UK (EPUK)) and the Institute of Air Quality Management (IAQM): Land-Use Planning and Development Control: Planning for Air Quality[15] (hereafter referred to as the 'EPIC & IAQM guidance'); and
- IAQM: Use of 2020 and 2021 Monitoring Datasets[16].

[12] Local Air Quality Management Technical Guidance (22), Published by Defra in partnership with the Scottish Government, Welsh Assembly Government and Department of the Environment Northern Ireland. August 2022.

[13] Defra and the Greater London Authority, COVID-19: Supplementary Guidance. Local Air Quality Management Reporting in 2021. April 2021.

[14] DMRB, LA 105-Air Quality, Highways England, 2019.

[15] EPIC and IAQM, Land-Use Planning and Development Control: Planning for Air Quality, v1.2 2017.

[16] IAQM, Use of 2020 and 2021 Monitoring Datasets, v1.1, December 2023.

3.0 Assessment Methodology

3.1 Operational Phase – Human Receptors

In order to appropriately reassess road traffic emission impacts associated with the operation of the Development, detailed dispersion modelling has been undertaken using the Cambridge Environmental Research Consultants (CERC) ADMS-Roads v5 dispersion model, focussing on concentrations of NO_2, PM_{10} and $PM_{2.5}$ for the following scenarios:

- 2022 Base Case (2022 BC) – Base flows for the year (2022);
- 2034 Do Minimum (2034 DM) – Without development flows for the assumed year of opening, inclusive of any relevant committed development flows; and
- 2034 Do Something (2034 DS) – 'Do Minimum' flows, plus all trips associated with the Development for the proposed year of opening.

For the above 2022 base case scenario, concurrent emission factors and background pollutant concentrations have been used.

For the above 2034 future year scenarios, 2030 emission factors and background pollutant concentrations have been utilised. The supporting tools and datasets used in air quality assessment (i.e. Defra mapped background concentrations and associated tools) are currently not projected beyond 2030. As such, whilst the traffic data used in the assessment utilises the development flows predicted for the fully operational scheme (2034), emission factors and background pollutant concentrations for the year 2030 have been used. This is considered to be a precautionary approach given that emission factors and predicted background concentrations are both forecast to decrease year on year with the introduction of less polluting vehicles and policy advancements and, therefore, in the completed year will be lower. This allows for a precautionary assessment of impacts on air quality (i.e. concertation change) and absolute concentrations (i.e. assessment against the applied AQALs) associated with the Development.

Details of model inputs are discussed in turn, below. Advanced inputs are discussed in Appendix A.

3.1.1 Traffic Inputs

Traffic data was provided by Andrew Moseley Associates (AMA) – the appointed transport consultant to the Applicant.

Traffic speeds were modelled at the relevant speed limit for each road or the average speed of the links as surveyed from a period of localised automatic traffic counter (ATC) locations. However, where appropriate, the speeds have been reduced to simulate queues at junctions, traffic lights and other locations where queues or slower traffic are known to be an issue, in accordance with LAQM.TG(22). Traffic speeds have been assumed to be consistent across all the modelled scenarios.

The Emissions Factors Toolkit (EFT) version 12.1 developed by Defra[17] has been used to determine vehicle emission factors for input into the ADMS-Roads dispersion model.

To inform the spatial extent of the model, changes in traffic volumes on the local road network were compared to the 'indicative criteria for assessment' provided by EPIC & IAQM

[17] Defra, EFT v12. 1 (2024). https://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html.

guidance – limited to the extent of the traffic data network as provided by AMA. These are as follows:

- Outside of an AQMA:
  - A change of Light-Duty Vehicle (LDV) flows of more than 500 24-hour Annual Average Daily Traffic flow (AADT); and/or
  - A change of Heavy-Duty Vehicle (HDV) flows of more than 100 24-hour AADT.
- Within an AQMA:
  - A change of LDV flows of more than 100 24-hour AADT; and/or
  - A change of HDV flows of more than 25 24-hour AADT.

Where available, neighbouring road links (i.e. links within 200m of a modelled receptor) were also included within the dispersion model to facilitate a robust assessment, rather than rely on their individual contributions being represented within the appropriate background datasets. For those links where distributed operational phase Development trips fall below the EPIC & IAQM indicative criteria for assessment, it can be concluded that at adjacent receptor locations trips will result in an 'insignificant' effect on air quality.

All details of the traffic flows used in this assessment are provided in Appendix A, whilst the modelled roads in relation to the Site are presented in Figure 2.

3.1.2 Meteorological Data

To calculate pollutant concentrations at identified sensitive receptor locations the dispersion model uses sequential hourly meteorological data, including wind direction, wind speed, temperature, cloud cover and stability, which exert significant influence over atmospheric dispersion.

The dispersion modelling has been undertaken using 2022 data from the Bingley meteorological station, located approximately 21km to the north of the Site – the nearest meteorological station with the most comparable elevation relative to the Site, and with sufficient data capture.

LAQM.TG(22) recommends that meteorological data should have a percentage of usable hours greater than 85%. 2022 meteorological data from Bingley meteorological station includes 8,760 lines of usable hourly data for the year, i.e. 100% usable data. This is therefore suitable for the dispersion modelling exercise.

A surface roughness value of 0.5m was used to represent the Site locale (corresponding to 'parkland and open suburbia'). Whereas a surface roughness value of 0.2m was used to represent the meteorological station setting (corresponding to 'agricultural areas (min)').

A wind rose for the Bingley meteorological station is presented in Figure 1.

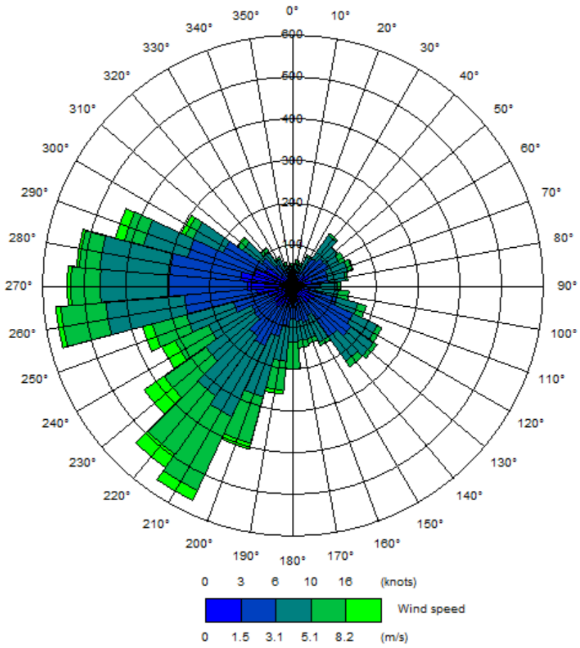

Figure 1: Wind Rose for Bingley Meteorological Station (2022)

3.1.3 Background Concentrations

In the absence of available locally representative background monitoring sites, annual mean background concentrations used for the purposes of the assessment have been obtained from the Defra supplied background maps (2018 reference year)[18], based on the 1km grid squares which cover the modelled area. Further detail on these datasets can be found in Section 4.0.

3.1.4 Sensitive Receptors

3.1.4.1 Human Receptors

Human receptors considered in the assessment of emissions from road traffic are shown Table C, whilst their locations are illustrated in Figure 2.

Receptors R1 – R8 are representative of worst-case exposure locations at existing receptors within the Site locale, relative to the affected road network discussed. Receptors O_R7 – O_R12 are representative of receptor locations which were modelled within the AQA submitted in support of the outline consent[19] and where the modelling domains between that assessment and this assessment overlap.

All receptors were considered in relation to exposure at breathing height relative to the adjacent modelled road. In the majority this is at ground level, i.e. 1.5m height, otherwise where stated to reflect relevant exposure at 1st floor level above ground-floor uses which are not 'relevant exposure' to the AQALs as defined in Table B. Receptor locations represent relevant exposure to the annual mean AQAL – in accordance with LAQM.TG(22) presented in Table B.

[18] Defra Background Maps (2018-Reference) http://uk-air.defra.gov.uk/data/laqm-background-home.

[19] Redmore Environmental, Air Quality Assessment: Land off Blackmoorfoot Road and Felks Stile Road, Huddersfield, 31st July 2020.

Table C: Receptor Locations Considered

Receptor	Receptor Description	NGR X (m)	NGR Y (m)	Height (m)
O_R7	Residential - Manchester Road, 1	413213	415960	1.5
O_R8	Residential - Manchester Road, 2	413727	416202	1.5
O_R9	Residential - Manchester Road, 3	414073	416178	1.5
O_R10	Residential - Manchester Road, 4	414323	416186	4.5
O_R11	Kirklees College	414256	416175	1.5
O_R12	Residential - Lockwood Road	414128	415866	1.5
R1	Residential - Manchester Road, 5	414242	416198	1.5
R2	Residential - Outcote Bank	414193	416210	1.5
R3	Residential - Manchester Road, 6	413894	416203	1.5
R4	Residential - St Thomas' Road, 1	413901	415977	1.5
R5	Residential - Manchester Road, 7	413276	415964	1.5
R6	Residential - Blackmoorfoot Road, 1	413066	415858	1.5
R7	Residential - Blackmoorfoot Road, 2	413023	415856	1.5
R8	Residential - Manchester Road, 8	412860	415922	1.5

3.1.5 Model Outputs

The background pollutant values discussed in Section 4.3 have been used in conjunction with the concentrations predicted by the ADMS-Roads model to calculate predicted total annual mean concentrations of NO_2, PM_{10} and $PM_{2.5}$ for each respective scenario.

For the prediction of annual mean NO_2 concentrations for all modelled scenarios at receptor locations, the road NOx contributions (adjusted as per Appendix A) have been converted to total NO_2 following the methodology in LAQM.TG(22) using the latest version of Defra's NOx to NO_2 conversion tool (v8.1)[20]. The traffic mix within the calculator was set to "*All Other Urban UK traffic*" and "*Kirklees District*" was selected as the local authority. The modelled NO_2 road contribution was then added to the appropriate NO_2 background concentration value to obtain an overall total annual mean NO_2 concentration.

For the prediction of short-term NO_2 impacts, LAQM.TG(22) advises that it is valid to assume that exceedences of the 1-hour mean AQAL for NO_2 are unlikely to occur where the annual mean NO_2 concentration is <60µg/m^3. This approach has thus been adopted for the purposes of this assessment, at relevant receptor locations with an applicable exposure period.

For the prediction of short-term PM_{10}, LAQM.TG(22) provides an empirical relationship between the annual mean and the number of exceedences of the 24-hour mean AQAL for PM_{10} that can be calculated as follows:

$$\textit{No. 24-hour mean exceedances} = -18.5 + 0.00145 \times \textit{annual mean}^3 + (206/\textit{annual mean})$$

[20] Defra NOx to NO2 Calculator v8.1 (2020), available at https://laqm.defra.gov.uk/air-quality/air-quality-assessment/no2-adjustment-for-nox-sector-removal-tool/.

This relationship has thus been adopted to determine whether exceedences of the short-term PM_{10} AQAL are likely in this assessment.

Verification of the ADMS-Roads assessment has been undertaken as per Appendix A.1.1. All results presented in the assessment are calculated following the process of model verification.

3.1.6 Assessing Significance

Guidance for determining operational phase effects associated with air quality is provided by EPIC & IAQM.

When describing the developmental impact at a specific existing receptor, the resultant total concentration as well as the magnitude of change in relation to respective AQALs are both considered – using the approach detailed in Table D.

Table D: Impact Descriptor Matrix for Receptors

Long Term Average Concentration at Receptor in Assessment Year	Change in Concentration relative to AQAL			
	1% [(A)]	2-5%	6-10%	>10%
75% or less of AQAL	Negligible	Negligible	Slight	Moderate
76-94% 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:
(A) Changes < 0.5% will be described as Negligible.

Following derivation of impacts at all receptor locations assessed, the overall significance of the developmental 'effect' is determined based upon consideration, as necessary, of the following factors:

- The existing and future air quality in the absence of the Development;
- The extent of current and future population exposure to the impacts;
- The worst-case assumptions adopted when undertaking the prediction of impacts; and
- The extent to which the Development has adopted best practice to eliminate and minimise emissions.

3.1.7 Uncertainty

Dispersion modelling is inherently uncertain and is principally reliant on the accuracy and representativity of its inputs. In acknowledgement of this, the ADMS-Roads dispersion model has been verified with the latest representative publicly available local monitoring data, as collected by KC.

In addition, there is a widely acknowledged disparity between emission factors and ambient monitoring data[21]. To help minimise any associated uncertainty when forming conclusions

[21] Carslaw, et al. (2011). Trends in NOx and NO_2 emissions and ambient measurements in the UK.

from the results, this assessment has utilised the latest EFT version 12.1 utilising COPERT 5.6 emission factors, and associated tools/datasets published by Defra.

The IAQM published a Position Statement on ‘Dealing with Uncertainty in Vehicle NOx Emissions Within Air Quality Assessments’ in July 2018[22] within which it was suggested to include a sensitivity test to account for predicted large reductions in NOx emissions that were not borne out in measured roadside concentrations. However, the latest iterations of the EFT (from version 9 onwards), reflect the real-world NOx emissions more accurately. As such, the IAQM has withdrawn its position statement saying as such and including:

> *“It is judged that an exclusively vehicle emissions-based sensitivity test is no longer necessary.*
>
> *On this basis, the EFT may be used for future year modelling with greater confidence when considering the per vehicle emission, provided that the assessment is verified against measurements made in the year 2016 or later.”*

Furthermore, the dispersion modelling assessment for the Development 2034 future year scenarios has utilised 2030 emission factors and background concentrations in conjunction with fully operational (2034) predicted development flows. By utilising 2030 supporting datasets with the fully operational development flows, a conservative outcome is anticipated based on the accepted forecast that both vehicle emission factors and background pollutant concentrations will decrease year on year, generating a potentially greater resultant concentration relative to what may occur in reality.

Given the above, use of further sensitivity modelling is not considered relevant or appropriate (i.e. too pessimistic).

[22] IAQM, Dealing with Uncertainty in Vehicle NOx Emissions Within Air Quality Assessments, July 2018.

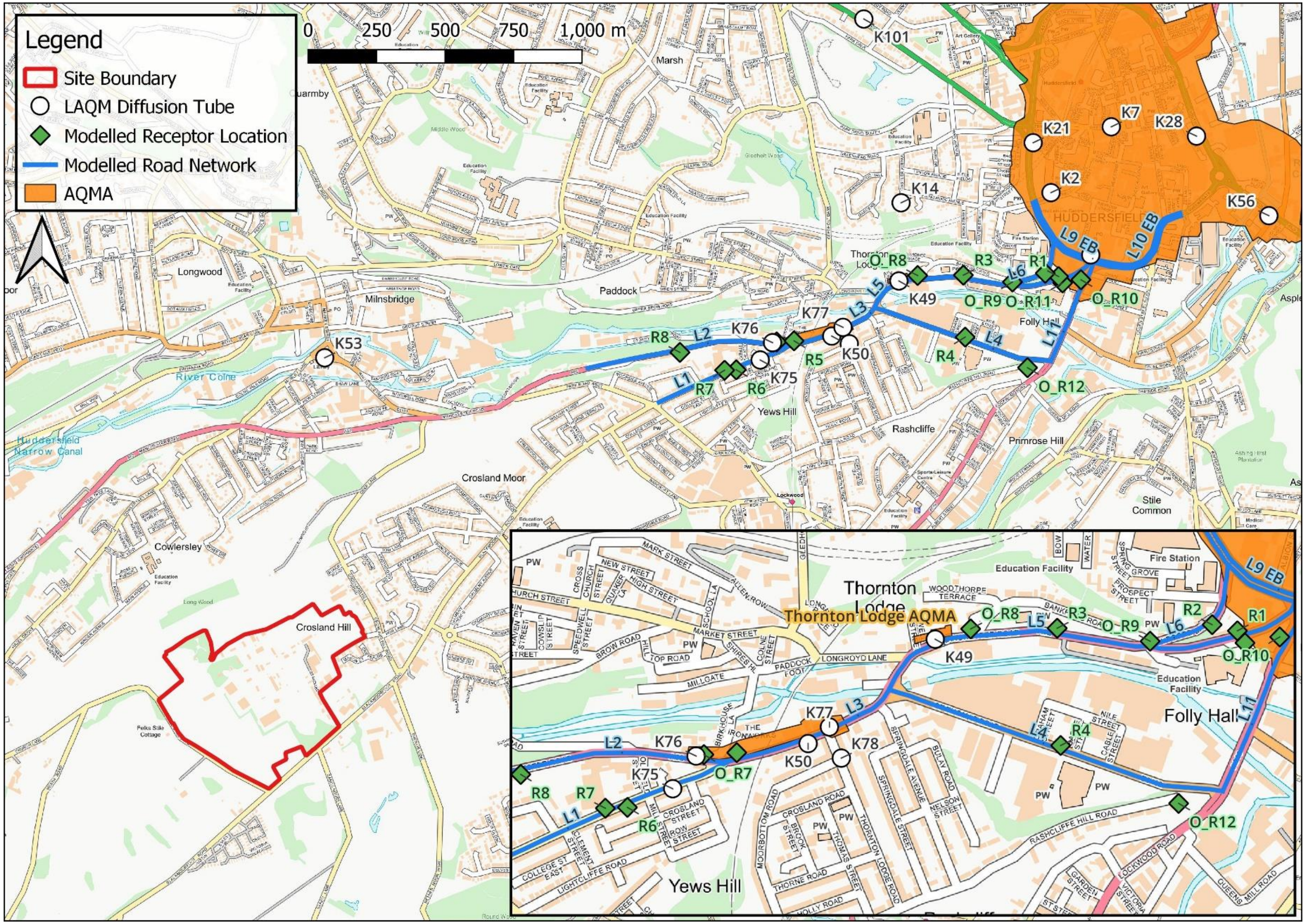

Figure 2: Site Setting, Monitoring & Operational Phase Road Traffic Emissions Inputs

4.0 Baseline Environment

4.1 LAQM Review and Assessment

KC, in fulfilment of statutory requirements, has conducted an on-going exercise to review and assess air quality within their administrative area. The latest publicly available LAQM report for KC at the time of writing is the 2023 Annual Status Report[23] (ASR).

KC presently has ten AQMAs declared within their administrative area. The closest of which is the Kirklees AQMA No. 10 Thornton Lodge (hereafter referred to as the 'Thornton Lodge AQMA') at a distance of approximately 1.8km to the north-east of the Site (see Figure 2). The Thornton Lodge AQMA was declared in 2019 for exceedences of the annual mean NO_2 AQAL at locations of relevant public exposure. Within the KC 2023 ASR, the Thornton Lodge AQMA is described as *"The designated area incorporates Manchester Road"*. It is worth noting that the Thornton Lodge AQMA does not appear on the UK Air Information Resource (AIR) interactive AQMA map[24], nor the shapefile available for download.

Furthermore, the Kirklees AQMA No. 9 Huddersfield Town Centre (hereafter referred to as the 'Huddersfield AQMA') is located at a distance of approximately 2.9km to the north-east of the Site (see Figure 2). The Huddersfield AQMA was declared in 2017 for exceedences of the annual mean NO_2 AQAL at locations of relevant public exposure. Within the KC 2023 ASR, the Huddersfield AQMA is described as *"The designated area incorporates roads bordering and within the Huddersfield Ring Road"*.

Given the proximity of the Thornton Lodge AQMA and the Huddersfield AQMA to the Site, consideration of potential operational phase road traffic emission impacts at receptor locations within both AQMAs has been considered within this assessment

4.2 Review of Air Quality Monitoring

4.2.1 Automatic Air Quality Monitoring

KC undertook automatic monitoring at three locations within their administrative area during 2022. However, the closest of these to the Site (i.e. automatic monitor ID: CM3) is located approximately 4km to the north of the Site. Given the separation distance between the Site and the KC automatic monitors, comparable pollutant concentrations are not anticipated. As such, no further consideration has been given to the KC automatic monitoring network within this assessment.

The nearest Automatic Urban and Rural Network (AURN) automatic monitor is situated approximately 14.2km to the north-east of the Site (AURN ID: UKA00654). Given the separation distance between this monitor and the Site and the differences in site characteristics, comparable pollutant concentrations are not anticipated.

4.2.2 Passive Diffusion Tube Monitoring

Passive NO_2 diffusion tube monitoring is currently undertaken by KC within the Site locale, at numerous locations.

The details and results of the monitoring locations of relevance to the Site (i.e. within 2km) are presented in Table E and Table F, respectively, whilst their locations are shown in Figure 2. All monitoring data presented has been ratified by KC.

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[23] Kirklees Council, Air Quality Annual Status Report 2023, June 2023.

[24] https://uk-air.defra.gov.uk/aqma/maps/

Table E: Local NO_2 Diffusion Tube Monitoring Sites: Details

Site ID	Site Type	NGR (m)		Height (m)	Within AQMA	Distance and Direction to Site (km)
		X	Y			
K53	Roadside (A)	411564	415902	2.0	No	0.9, N
K75	Roadside (A)	413153	415894	2.0	No	1.75, NE
K76	Roadside (A)	413153	415894	2.0	Yes, AQMA No. 10	1.82, NE
K50	Roadside (A)	413414	415981	2.0	Yes, AQMA No. 10	2.02, NE (B)
K78	Roadside (A)	413478	415953	2.0	No	2.06, NE (B)
K77	Roadside (A)	413455	416013	2.0	Yes, AQMA No. 10	2.07, NE (B)
K49	Roadside (A)	413659	416182	2.0	Yes, AQMA No. 10	2.33, NE (B)
K11	Roadside (A)	414359	416277	2.0	Yes, AQMA No. 9	2.99, NE (B)

Table notes:

(A) Roadside site defined by LAQM.TG(22) as: "*a site sampling typically within one to five metres of the kerb of a busy road*".

(B) Although located at a distance >2km from the Site, these monitoring locations have been utilised for model verification (see Appendix A).

Table F: Local NO_2 Diffusion Tube Monitoring Sites: Results

Site ID	2022 Data Capture %	Annual Mean NO_2 Concentration ($\mu g/m^3$)				
		2018	2019	2020 (A)	2021 (A)	2022
K53	100	29.4	53.7	24.6	30.6	28.0
K75	100	37.8	-	25.5	28.9	27.1
K76	100	35.0	28.5	25.4	28.9	27.1
K50	100	45.3	38.2	33.1	39.8	40.6
K78	100	28.0	24.1	18.4	21.3	21.1
K77	100	46.9	38.9	33.2	42.6	41.9
K49	100	38.1	33.1	33.1	36.4	33.6
K11	100	39.6	35.0	27.7	31.3	32.0

Table Notes:

(A) As per guidance published by Defra[13] and the IAQM's Position Statement[16], monitoring results obtained in 2020 and 2021 are likely to be atypical due to the impacts of the COVID-19 pandemic. The IAQM's Position Statement[16] further states "*the 2022 (or later year) monitoring data is likely to represent a post-pandemic baseline*".

As shown in Table F, two of the considered monitoring locations exceeded the annual mean NO_2 AQAL (i.e. $40\mu g/m^3$) during 2022: K50 and K77. All other considered monitoring locations remained <90% below the AQAL.

Monitoring locations K50 and K77 are both situated within the Thornton Lodge AQMA, where elevated concentrations are anticipated. Both are situated adjacent to the A62 Manchester

Road, which had a 2022 baseline traffic flow of 18,817 AADT (of which 683 AADT were as HDVs) (see Appendix A, Table S). This relatively high baseline traffic flow (for a single lane A road) is coupled with a section of road which has an average gradient of approximately 5% and buildings lining each side of the street, creating a street canyon effect and limiting dispersion. These factors combine to produce a high emission contribution from the road traffic where dispersion of pollutants is limited, thus resulting in elevated annual mean NO_2 concentrations.

Overall, there has been a downward trend in annual mean NO_2 concentrations at all considered monitoring locations. Each monitored a lower concentration in 2022 than in 2018, despite some year-on-year fluctuations.

The empirical relationship given in LAQM.TG(22) states that exceedences of the 1-hour mean NO_2 AQAL is unlikely to occur where annual mean concentrations are <60µg/m^3. This indicates that an exceedence of the 1-hour mean AQAL was unlikely to have occurred at the above locations in between 2018-2022.

4.3 Defra Mapped Background Concentrations

Defra maintains a nationwide model of existing and future background air quality concentrations at a 1km grid square resolution which is routinely used to support LAQM requirements and air quality assessments. The data sets include annual average concentration estimates for NO_2, PM_{10} and $PM_{2.5}$ using a base year of 2018 (the year in which comparisons between modelled and monitoring are made).

The Defra mapped background concentrations for the base year (2022) are presented in Table G. The earliest predicted opening year of the Development is anticipated to be 2034. However, as the emission factors used within this assessment are currently not projected beyond 2030, the corresponding 2030 mapped background concentrations are also presented in Table G.

All of the mapped background concentrations presented are well below the respective annual mean AQALs.

Table G: Defra Mapped Background Concentrations

Grid Square (X, Y) (m)	Year	Annual Mean Concentration (µg/m^3)			
		NOx	NO_2	PM_{10}	$PM_{2.5}$
414500, 416500	2022	27.9	19.3	11.9	8.0
	2030	23.0	16.3	11.5	7.7
413500, 416500	2022	17.6	13.0	11.0	7.6
	2030	14.7	11.0	10.7	7.4
413500, 415500	2022	19.3	14.0	11.9	8.3
	2030	16.3	12.1	11.5	8.0
414500, 415500	2022	16.7	12.4	11.0	7.6
	2030	14.0	10.5	10.6	7.3
412500, 415500	2022	14.3	10.8	11.4	7.9
	2030	11.8	9.0	11.0	7.6
AQAL		***-***	***40***	***40***	***20***

5.0 Operational Phase Assessment

This section presents the potential air quality impacts and effects associated with the operational phase of the Development.

5.1 NO_2 Modelling Results

Table H presents the annual mean NO_2 concentrations predicted at all assessed receptor locations for the 2022 BC, 2034 DM and 2034 DS scenarios.

Table H: Predicted Annual Mean NO_2 Concentrations –2034 Development Opening Year

Receptor	Predicted Annual Mean NO_2 Concentration (µg/m^3)			% Change of AQAL	% of 2034 DS Relative to AQAL	EPIC & IAQM Impact Descriptor
	2022 BC	2034 DM	2034 DS			
O_R7	37.5	21.4	21.9	+1.40	54.9	Negligible
O_R8	30.3	17.8	18.7	+2.25	46.8	Negligible
O_R9	42.7	25.6	26.8	+3.18	67.1	Negligible
O_R10	33.4	21.7	22.0	+0.60	55.0	Negligible
O_R11	29.5	20.0	20.4	+1.00	51.1	Negligible
O_R12	16.9	12.3	12.4	+0.20	30.9	Negligible
R1	34.5	22.1	22.8	+1.72	57.1	Negligible
R2	36.1	22.7	23.5	+2.13	58.8	Negligible
R3	35.0	20.0	21.2	+2.90	52.9	Negligible
R4	33.7	20.1	20.4	+0.82	51.0	Negligible
R5	41.4	22.9	24.2	+3.30	60.6	Negligible
R6	26.2	16.9	18.2	+3.10	45.4	Negligible
R7	29.6	18.3	19.9	+4.05	49.9	Negligible
R8	23.0	14.0	14.0	+0.23	35.1	Negligible

The maximum predicted annual mean NO_2 concentration at all existing receptors during the 2022 BC scenario was at Receptor O_R9 with a predicted concentration of 42.7µg/m^3; this represents 106.8% of the AQAL. Receptor O_R9 is located adjacent to a traffic light-controlled junction where the A62 Manchester Road (Link 5) splits into two one-way streets (Links 6 and 7). The high volume of traffic at this junction (16,285 AADT, of which 315 AADT are as HDVs) is reduced to slow speeds and is subject to high levels of congestion as a result of the traffic light-controlled junction, resulting in a higher emission contribution from the vehicles on these links. In addition, Link 6 has an average uphill gradient of approximately 6%, resulting in a greater emission contribution from the traffic accelerating away from the junction and up the hill. Receptor O_R9's proximity to this (i.e. 3.5m from the kerbside) explains the high predicted annual mean NO_2 concentration in this location.

Similarly, the predicted 2022 annual mean NO_2 concentration at Receptor R5 is in exceedance of the AQAL, with a predicted concentration of 41.4µg/m^3; representing 103.5% of the AQAL. Receptor R5 is located within the Thornton Lodge AQMA, where, as discussed in Section 4.2.2, elevated concentrations are anticipated. Receptor R5 is situated adjacent to the A62 Manchester Road, which had a 2022 baseline traffic flow of 18,817 AADT (of which 683 AADT were as HDVs) (see Appendix A, Table S). This is the highest traffic flow within the modelling domain and is coupled with a section of road which has an average gradient of approximately 5%. Furthermore, Receptor R5 is situated in close proximity to a traffic light-controlled junction, where slow moving or congested traffic is expected to occur, resulting in a greater emission contribution. Receptor R5 has a greater separation distance from the kerbside than that of Receptor O_R9, which is considered partially responsible for the lower predicted annual mean NO_2 concentration.

The maximum predicted annual mean NO_2 concentration at existing receptors with the Development in place (2034 DS) was at Receptor O_R9 with a predicted concentration of 26.8µg/m^3; this represents 67.1% of the AQAL (i.e. 'well-below'). The change in the annual mean NO_2 concentrations at this location, due to the Development (2034 DS vs. 2034 DM) relative to the AQAL was +3.18% (i.e. 1.27µg/m^3).

The maximum observed increase in annual mean NO_2 concentrations at all existing receptors as a result of the Development (2034 DS vs. 2034 DM) was +4.05% (i.e. 1.62µg/m^3) at Receptor R7. The resultant concentration predicted at Receptor R7 with the Development in place (2034 DS) is 19.9µg/m^3, representing 49.9% of the AQAL. Receptor R7 is located on the façade of a residential property adjacent to Link 7, which is predicted to witness the greatest change in traffic flows as a result of the Development (i.e. an increase of 3,019 AADT, of which 39 AADT are as HDVs). Although Receptor R6 and Receptor R5 are also adjacent to links which are predicted to witness the same increase in traffic flows, Receptor R7 is considered to experience a greater increase in annual mean NO_2 concentrations because it is closer to the kerbside than Receptor R5 and is more frequently downwind of emissions from Link 1 than Receptor R6 (see **Error! Reference source not found.**).

In accordance with EPIC & IAQM guidance, the impact of the Development on annual mean NO_2 concentrations at all assessed existing receptors (of relevant exposure) is considered to be 'negligible'. Given the marginal increase in annual mean NO_2 concentrations associated with the Development, and that there are no predicted exceedences of the annual mean NO_2 AQAL, unmitigated effects associated with annual mean NO_2 concentrations at all existing assessed receptor locations are therefore considered to be 'not significant'.

It is unlikely that an exceedence of the 1-hour mean NO_2 AQAL objective will occur in reference to the empirical relationship given in LAQM.TG(22) and predicted maximum absolute annual mean NO_2 concentration. Effects associated with likely 1-hour mean NO_2 concentrations at all assessed receptor locations are therefore considered to be 'not significant'.

5.2 PM_{10} Modelling Results

Table I presents the annual mean PM_{10} concentrations predicted at all assessed receptor locations for the 2022 BC, 2034 DM and 2034 DS scenarios.

Table I: Predicted Annual Mean PM_{10} Concentrations – 2034 Development Opening Year

Receptor	Predicted Annual Mean PM_{10} Concentration (µg/m^3)			% Change of AQAL	% of 2034 DS Relative to AQAL	EPIC & IAQM Impact Descriptor
	2022 BC	2034 DM	2034 DS			
O_R7	17.7	17.3	17.6	+0.92	44.0	Negligible
O_R8	15.9	15.5	16.2	+1.64	40.5	Negligible
O_R9	19.0	18.7	19.6	+2.35	49.1	Negligible
O_R10	15.9	15.6	15.8	+0.43	39.4	Negligible

Receptor	Predicted Annual Mean PM_{10} Concentration (µg/m^3)			% Change of AQAL	% of 2034 DS Relative to AQAL	EPIC & IAQM Impact Descriptor
	2022 BC	2034 DM	2034 DS			
O_R11	15.1	14.8	15.1	+0.72	37.6	Negligible
O_R12	12.2	11.8	11.8	+0.13	29.6	Negligible
R1	16.7	16.3	16.8	+1.28	42.1	Negligible
R2	17.2	16.9	17.5	+1.62	43.8	Negligible
R3	17.5	17.1	18.0	+2.17	45.0	Negligible
R4	17.8	17.5	17.7	+0.63	44.4	Negligible
R5	18.4	17.9	18.8	+2.14	47.0	Negligible
R6	15.4	15.1	16.0	+2.25	40.0	Negligible
R7	16.5	16.1	17.3	+2.97	43.2	Negligible
R8	14.8	14.5	14.5	+0.15	36.4	Negligible

The maximum predicted annual mean PM_{10} concentration at all existing receptors during the 2022 BC scenario was at Receptor O_R9 with a predicted concentration of 19.0µg/m^3; this represents 47.5% of the AQAL (i.e. 'well-below').

The maximum predicted annual mean PM_{10} concentration at existing receptors with the Development in place (2034 DS) was at Receptor O_R9 with a predicted concentration of 19.6µg/m^3; this represents 49.1% of the AQAL. The change in annual mean PM_{10} concentrations at this location, due to the Development (2034 DS vs. 2034 DM) relative to the AQAL was +2.35% (i.e. 0.94µg/m^3).

The maximum observed increase in annual mean PM_{10} concentrations at all existing receptors as a result of the Development (2034 DS vs. 2034 DM) was +2.97% (i.e. 1.19µg/m^3) at Receptor R7. The resultant concentration predicted at Receptor R7 with the Development in place (2034 DS) is 17.3µg/m^3, representing 43.2% of the AQAL.

In accordance with EPIC & IAQM guidance, the impact of the Development on annual mean PM_{10} concentrations at all assessed existing receptors (of relevant exposure) is considered to be 'negligible'. Given the marginal increase in annual mean PM_{10} concentrations associated with the Development, and that there are no predicted exceedences of the annual mean PM_{10} AQAL, unmitigated effects associated with annual mean PM_{10} concentrations at all existing assessed receptor locations are therefore considered to be 'not significant'.

Based upon the maximum predicted annual mean PM_{10} concentration of 19.6µg/m^3 (predicted at Receptor O_R9 2034 DS), this equates to three days where 24-hour mean PM_{10} concentrations are predicted to be greater than 50µg/m^3. This is below the 35 permitted 24-hour mean concentrations in excess of 50µg/m^3 prescribed within the 24-hour mean AQAL. Effects associated with likely 24-hour mean PM_{10} concentrations at all assessed receptor locations are therefore considered to be 'not significant'.

5.3 $PM_{2.5}$ Modelling Results

Table J presents the annual mean $PM_{2.5}$ concentrations predicted at all assessed receptor locations for the 2022 BC, 2034 DM and 2034 DS scenarios.

Table J: Predicted Annual Mean $PM_{2.5}$ Concentrations – 2034 Development Opening Year

Receptor	Predicted Annual Mean $PM_{2.5}$ Concentration (µg/m^3)			% Change of AQAL	% of 2034 DS Relative to AQAL	EPIC & IAQM Impact Descriptor
	2022 BC	2034 DM	2034 DS			
O_R7	11.4	11.0	11.2	+0.95	55.9	Negligible
O_R8	10.2	9.89	10.2	+1.71	51.2	Negligible
O_R9	11.8	11.4	11.9	+2.45	59.6	Negligible
O_R10	10.2	9.81	9.90	+0.44	49.5	Negligible
O_R11	9.73	9.39	9.54	+0.75	47.7	Negligible
O_R12	8.22	7.92	7.94	+0.14	39.7	Negligible
R1	10.6	10.2	10.5	+1.33	52.3	Negligible
R2	10.8	10.5	10.8	+1.68	54.0	Negligible
R3	11.1	10.7	11.2	+2.28	55.9	Negligible
R4	11.4	11.1	11.3	+0.66	56.3	Negligible
R5	11.8	11.4	11.8	+2.20	59.0	Negligible
R6	10.2	9.88	10.3	+2.34	51.7	Negligible
R7	10.7	10.4	11.0	+3.09	55.1	Negligible
R8	9.76	9.45	9.48	+0.15	47.4	Negligible

The maximum predicted annual mean $PM_{2.5}$ concentration at existing receptors during the 2022 BC scenario was at Receptors O_R9 with a predicted concentration of 11.8µg/m^3; this represents 59.0% of the AQAL (i.e. 'well-below'). It is worth noting that the values in Table J are rounded; Receptor O_R9 is predicted to witness a 2022 annual mean $PM_{2.5}$ concentration of 11.82µg/m^3, verses 11.80µg/m^3 at Receptor R5.

The maximum predicted annual mean $PM_{2.5}$ concentration at existing receptors with the Development in place (2034 DS) was at Receptor O_R9 with a predicted concentration of 11.9µg/m^3; this represents 59.6% of the AQAL. The change in the annual mean $PM_{2.5}$ concentrations at this location, due to the Development (2034 DS vs. 2034 DM) relative to the AQAL was +2.45% (i.e. 0.49µg/m^3).

The maximum observed increase in annual mean $PM_{2.5}$ concentrations at all existing receptors as a result of the Development (2034 DS vs. 2034 DM) was +3.09% (i.e. 0.62µg/m^3) at Receptor R7. The resultant concentration predicted at Receptor R7 with the Development in place (2034 DS) is 11.0µg/m^3, representing 55.1% of the AQAL.

In accordance with EPIC & IAQM guidance, the impact of the Development on annual mean $PM_{2.5}$ concentrations at all assessed existing receptors is considered to be 'negligible'. Given the marginal increase in annual mean $PM_{2.5}$ concentrations associated with the Development, and that there are no predicted exceedences of the annual mean $PM_{2.5}$ AQAL, unmitigated effects associated with annual mean $PM_{2.5}$ concentrations at all existing assessed receptor locations are therefore considered to be 'not significant'.

6.0 Emissions Damage Cost Calculation

An estimation of the likely emission impact of the Development's operational phase trips associated emission contributions has been undertaken, in accordance with the methodology outlined within Defra's Interdepartmental Group on Costs and Benefits (IGCB) 'damage cost approach' method[25]. It is noted that the applied methodology is referenced within the EPIC & IAQM guidance[26] and the WYLES Guidance[1]*.* The calculation is termed the 'damage cost calculation' herein.

The damage cost calculation has utilised the most up to date version of the emissions factors toolkit at the time of assessment (presently EFT v12.1), as produced by Defra, to calculate emissions of nitrogen oxide (NOx) (as NO_2) and PM_{10}, with inputs derived from the National Travel Survey (NTS)[27] in accordance with the Defra 'damage cost approach' and the WYLES Guidance*.*

Given that the Development is a joint venture between Miller Homes Ltd, Vistry Group & Countryside Properties, the damage costs have been calculated based upon each respective share. Miller Homes Ltd are to deliver 231 dwellings, whilst Vistry Group & Countryside Properties are to deliver 469 dwellings. The total trip generation from the Site as a whole (i.e. 3,019 AADT) was first split according to the portion each party is to be responsible for (i.e. 1,007 AADT as a result of Miller Homes Ltd share and 2,013 AADT as a result of Vistry Group & Countryside Properties share). The expected build out rates have been obtained from Miller Homes Ltd and Vistry Group / Countryside Properties, allowing for the corresponding number of trips per number of dwellings per year to been calculated for input into the damage cost calculation. It is noted that Vistry Group & Countryside Properties advised their build-out would occur over a 7-year period (2026 – 2032). However, as a precautionary approach and to align with the requirements of the damage cost calculation method, the build rates anticipated to occur in 2031 and 2032 have been included within 2030.

The following traffic inputs are used within the damage cost calculation:

Table K: Calculation of Traffic Inputs for Damage Costs – Miller Homes Ltd

Year	Number of Dwellings	Percentage of Dwellings as Portion of Miller Homes Ltd share (%) (A)	Adjusted Number of Trips (AADT) (B)
2026	90	39.0	392
2027	140	60.6	610
2028	180	77.9	785
2029	231	100.0	1,007
2030	231	100.0	1,007

Note:
(A) Based upon a total number of dwellings of 231.
(B) Based upon the Miller Homes Ltd trip generation of 1,007 AADT.

[25] Air Quality Appraisal – Damage Cost Methodology, January 2019, DEFRA.

[26] Environmental Protection UK and Institute of Air Quality Management, *'Land-Use Planning and Development Control: Planning for Air Quality*, v1.2 2017.

[27] National Travel Survey: England 2019, Department for Transport, August 2020.

Table L: Calculation of Traffic Inputs for Damage Costs – Vistry Group & Countryside Properties

Year	Number of Dwellings	Percentage of Dwellings as Portion of Vistry Group / Countryside Properties share (%) (A)	Adjusted Number of Trips (AADT) (B)
2026	115	24.5	494
2027	166	35.4	712
2028	217	46.3	931
2029	268	57.1	1,150
2030	469	100.0	2,013

Note:

(A) Based upon a total number of dwellings of 469.

(B) Based upon the Vistry Group & Countryside Properties trip generation of 2,013.

The following sections present the inputs and outputs to the damage cost calculation for the Development, by share of Miller Homes Ltd and Vistry Group / Countryside Properties. The input trip generation has accounted for the predicted HDV generation of 1% of total vehicles. For the purpose of the damage cost calculation, 100% of the trips have been calculated using a total speed related emission based on an average surrounding road network speed of 48kph (30mph).

The damage cost calculation applies an average trip length of 10km as stated within the WYLES Guidance. No site-specific trip lengths were available at the time of the calculation.

Miller Homes Ltd

The inputs and outputs to the damage cost calculations for Miller Homes Ltd are presented in Table M and Table N, respectively.

Table M: Damage Cost Calculation – Inputs (Miller Homes Ltd)

Input Parameter	Former Black Cat Fireworks – Miller Homes Ltd				
	2026	2027	2028	2029	2030
Number of dwellings	90	140	180	231	231
Total trips (AADT) associated with number of trips (A)	392	610	785	1,007	1,007
Average trip length (km) (B)	10				
Speed	30mph / 48kph				
2022 Base Damage cost NOx (£ per tonne) (C) (D)	£11,682				
2022 Base Damage cost $PM_{2.5}$ (£ per tonne) (C) (D)	£84,548				

Notes:

(A) Provided by AMA, the appointed transport consultant to the Applicants.

Input Parameter	Former Black Cat Fireworks – Miller Homes Ltd				
	2026	2027	2028	2029	2030
(B) Average trip length from the National Travel Survey: England 2013, as referenced within WYLES Guidance. (C) 'Damage Cost' is based upon 'Road Transport'. (D) An uplift of 2% per year (from the 2022 base-year value) has been applied to calculate the corresponding damage cost over the 5-year period.					

Table N: Damage Cost Calculation – Outputs (Miller Homes Ltd)

Output Parameter	Year					5 – Year Total
	2026	2027	2028	2029	2030	
Annual NOx Emissions (tonnes/year)	0.23	0.31	0.35	0.39	0.33	1.62
Annual PM_{10} Emissions (tonnes/year)	0.05	0.08	0.10	0.13	0.13	0.48
Annual $PM_{2.5}$ Emissions (tonnes/year) (A)	0.03	0.05	0.06	0.08	0.08	0.30
NOx contribution (£) (rounded up)	2,914	4,063	4,640	5,234	4,576	21,426
$PM_{2.5}$ contribution (£) (rounded up)	2,872	4,518	5,883	7,642	7,742	28,656
Total contribution (£) (rounded up)	5,786	8,580	10,523	12,876	12,317	50,082
Note: (A) Converted utilising 'Road Transport' PM_{10} to $PM_{2.5}$ factor of 0.622.						

Vistry Group / Countryside Properties

The inputs and outputs to the damage cost calculations for Vistry Group & Countryside Properties are presented in Table M and Table N, respectively.

Table O: Damage Cost Calculation – Inputs (Vistry Group & Countryside Properties)

Input Parameter	Former Black Cat Fireworks – Vistry Group & Countryside Properties				
	2026	2027	2028	2029	2030
Number of dwellings	115	166	217	268	469
Total trips (AADT) associated with number of trips (A)	494	712	931	1,150	2,013
Average trip length (km) (B)	10				
Speed	30mph / 48kph				
2022 Base Damage cost NOx (£ per tonne) (C) (D)	£11,682				
2022 Base Damage cost $PM_{2.5}$ (£ per tonne) (C) (D)	£84,548				
Notes: (E) Provided by AMA, the appointed transport consultant to the Applicants. (F) Average trip length from the National Travel Survey: England 2013, as referenced within WYLES Guidance.					

Input Parameter	Former Black Cat Fireworks – Vistry Group & Countryside Properties				
	2026	2027	2028	2029	2030
(G) 'Damage Cost' is based upon 'Road Transport'. (H) An uplift of 2% per year (from the 2022 base-year value) has been applied to calculate the corresponding damage cost over the 5-year period.					

Table P: Damage Cost Calculation – Outputs (Vistry Group & Countryside Properties)

Output Parameter	Year					5 – Year Total
	2026	2027	2028	2029	2030	
Annual NOx Emissions (tonnes/year)	0.29	0.37	0.42	0.45	0.67	2.19
Annual PM_{10} Emissions (tonnes/year)	0.06	0.09	0.12	0.14	0.25	0.67
Annual $PM_{2.5}$ Emissions (tonnes/year) (A)	0.04	0.06	0.07	0.09	0.16	0.42
NOx contribution (£) (rounded up)	3,672	4,742	5,503	5,977	9,147	29,041
$PM_{2.5}$ contribution (£) (rounded up)	3,619	5,273	6,977	8,727	15,475	40,072
Total contribution (£) (rounded up)	7,291	10,015	12,480	14,704	24,622	69,113
Note: (B) Converted utilising 'Road Transport' PM_{10} to $PM_{2.5}$ factor of 0.622.						

Damage Cost Calculation Summary

In summary, over a 5-year period the calculated damage costs for the Development, for each of Miller Homes Ltd and Vistry Group / Countryside Properties, are as follows:

- Miller Homes Ltd - £50,082;
- Vistry Group & Countryside Properties - £69,113; and
- **Combined[28]: £119,165.**

The above damage costs provide an indicator of the financial commitment required to offset emissions. The amount (value) determined is not a direct indication of the monetary contribution required to off-set impacts upon air quality. Rather, the scale of damage cost will determine the level of appropriate mitigation required for specific proposals. The Interdepartmental Group on Costs and Benefits (IGCB) department of Defra, who produced the 'Damage Cost' guidance, has stated that[29]:

> *"The damage costs methodology was designed for economic appraisal of government policies that lead to air quality changes and wider cost-benefit analysis. While our guidance can be used to estimate the damage to society caused per tonne of emissions, we don't provide any recommendations for the right level of compensation required to offset the impacts of air pollution."*

[28] i.e. the sum of the calculated damage costs associated with both Miller Homes Ltd and Vistry Group / Countryside Properties.

[29] E-mail communication between Interdepartmental Group on Costs and Benefits department of Defra, and SLR Consulting Ltd, dated 28th January 2016.

7.0 Mitigation Measures

This section presents any mitigation measures required during the operational phase of the Development in order to be commensurate with the damage cost calculation.

7.1 Mitigation Hierarchy

An IAQM position statement[30] recommends basic hierarchy principles for determining appropriate mitigation measures for a development scheme. These are as follows:

1. Preventing and Avoiding – the initial step should be to, if possible, prevent or avoid exposure to the pollutant by isolating or removing potential sources. The design process should take air quality into account.
2. Reduction and Minimisation – all options for avoiding exposure and preventing exposure should be implemented. Preference should be given to measures which are close to the potential source, then those which act on the pathway and finally measures close to the point of exposure.
3. Off-setting – compensating for impacts associated with the new development by contributing to air quality improvements elsewhere.

These hierarchy principles have been taken into account when suggesting appropriate measures for the development.

7.2 WYLES Guidance – Mitigation Requirements

In line with the WYLES Guidance, 'major' developments should include Type 1, Type 2 and Type 3 mitigation measures. Table Q displays the mitigation measures which are relevant to the Development.

Table Q: Type 1, 2 and 3 Mitigation Measures

Mitigation Measure	
Residential Use	
Type 1	1 charging point per unit (dwelling with dedicated parking), or 1 charging point per 10 spaces (unallocated parking).
Type 2	Monitored Travel Plan, including mechanisms for discouraging high emission vehicle use and encouraging modal shift (i.e. public transport, cycling and walking) as well as the uptake of low emission fuels and technologies.
	Improved pedestrian links to public transport stops.
	Provision of new bus stops infrastructure including shelters, raised kerbing, information displays.
	Provision of subsidised or free ticketing (Corporate and residential MetroCards, Student Metrocards).
	Site layout to include improved pedestrian pathways to encourage walking.
	Improved convenient and segregated cycle paths to link to local cycle network.
Type 3	**Support measures to reduce the need to travel:**

[30] Institute of Air Quality Management, Position Statement - Mitigation of Development Air Quality Impacts, 2015.

Mitigation Measure	
	• Alternative working practices – flexitime, teleworking, homeworking, videoconferencing, compressed work periods. • Local sourcing of staff, products and raw materials. • Development and use of hub distribution centres employing low emission deliveries. • Provision of discounted on-site shopping, eating, child-care, banking facilities. **Support measures to reduce polluting motorised vehicle use:** • Development of car clubs and car sharing with financial incentive and promotion. • Use of pooled low emission vehicles – car, vans, taxis, bicycles. • Support smart driving training schemes. • Provision of dedicated low emission shuttle bus including managed pick-up and drop-off. • Contribution to the emerging low emission vehicle refuelling infrastructure. • Contribution to site low emission waste collection services. • Incentives for the take-up of low emission vehicle technologies and fuels. **Measures to support improved public transport:** • Provision of new or enhance public transport services to the site. • Shuttle services to public transport interchange, rail station or park and ride facilities. • Support improving information systems for public transport. • Supporting city free bus expansion schemes. • Promoting low emission bus service provision. • Support air quality monitoring programmes. **Further measures to promote walking and cycling:** • Improvements to district walking and cycling networks including lighting, shelters, and information points and timetables. • Support cycling training and awareness schemes. • Bike/e-bike hiring schemes. • Guaranteed ride home in emergencies. • Support secure and safe cycling parking facilities. **Measures to promote sustainable travel plans:** • Support local travel to school and school travel plans initiatives. • Marketing aimed at persuading a switch to sustainable modes with incentives. • Promotion of subsidised/sponsored travel plan measures through social and other media. • Supporting community / local organisation groups to promote sustainable travel.

7.3 Proposed Mitigation to be Implemented

7.3.1 Type 1

In line with the WYLES Guidance, EV charging will be provided for the Development, with a 100% provision rate for all dwellings, based upon a 3.7kW nominal rated output. The specific detail for such will come forward post-planning as a building control requirement as required by Approved Document S: Infrastructure for Charging Electric Vehicles of the Building Regulations[31].

7.3.2 Type 2

A number of Type 2 mitigation measures have also proposed to be implemented as part of the Development, including:

- Existing public transport will be extended to include coverage within and adjacent to the Site, by means of extension of the existing bus route. The Section 106 (S.106) agreement[32] includes requirements for a 'Bus Stop Contribution' as a financial provision for two new bus shelters within the vicinity of the Site with real time information displays and two new bus stop poles within the Site. The S.106 agreement outlines the Bus Stop Contribution as £47,000. The layout[33] for the Site to be submitted for Reserved Matters approval indicates these two bus stop poles are included on the new Site road connecting Blackmoorfoot Road and Felks Style Road;
- The layout[33] for the Site to be submitted for Reserved Matters approval further indicates pedestrian and cycle links are included through Site which includes connectivity to existing Public Right of Way (PRoW) paths to the north. The Development also proposes a continuous safe connection for cyclists travelling through the site, with the provision of dedicated cycling infrastructure such as cycle lanes, a parallel crossing and a raised table crossing. Cycling connections are provided via both the southeastern and southwestern access points, as well as a connection to Quarry Road in the north; and
- A Travel Plan.

An Interim Travel Plan[34] has been prepared in support of the application for Reserved Matters approval. The Interim Travel Plan includes the following measures relative to the residential use of the Site, that will also help to improve air quality:

- Appoint a Travel Plan Co-ordinator (TPC) to oversee, implement and manage the Travel Plan;
- Following the occupation of the development and completion of full baseline surveys, a Full Travel Plan will be prepared. The Full Travel Plan will be informed by updated baseline surveys (to be completed within 6-months of Site occupation or 25% occupancy, whichever occurs first) to help inform targets and travel patterns. A follow up survey will be undertaken one year after the initial survey and targets will be revisited as appropriate. Further surveys will be undertaken annually over the five-year Travel Plan monitoring period;
- Pedestrian and cycle infrastructure and linkages, as described above. Secure cycle parking will be provided across the site. Where garages are proposed with (or within) a property this will accommodate the provision, those without garages will have secure cycle storage provided within the curtilage of the property.

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[31] https://www.gov.uk/government/publications/infrastructure-for-charging-electric-vehicles-approved-document-s.

[32] Agreement pursuant to Section 106 of the Town and Country Planning Act 1990 relating to land off Blackmoorfoot Road and Felks Street, Crosland moor, Huddersfield, HD4 7A. Planning reference: 2020/92546, dated 25th March 2022.

[33] Blackmoorfoot Road, Huddersfield. Technical Planning Layout. Drawing reference: n2114 008.

[34] Blackmoorfoot Road, Huddersfield. Interim Travel Plan, July 2024, Andrew Moseley Associates.

- A Travel Information Pack will be provided to all residents at the site upon occupation. The pack will include details of walking/cycling/public transport routes and timetable information as well as potential car sharing arrangements; and
- The TPC will encourage car sharing amongst residents and will facilitate matches. The Lift Share Car Share scheme will be promoted by the TPC.

Whilst it is noted the TPC will be appointed by the appointed Transport Consultant on behalf of the Applicants, the S.106 agreement[32] includes requirements for a 'Travel Plan Monitoring Sum' as a financial provision to KC to monitor compliance with the Travel Plan. The S.106 agreement outlines the Travel Plan Monitoring Sum as £15,000.

7.3.3 Type 3

A number of Type 3 mitigation measures have also proposed to be implemented as part of the Development, including:

- The S.106 agreement[32] includes requirements for a 'Sustainable Transport Contribution', as a sum of £397,000. The 'Sustainable Transport Contribution' is defined as: "*[…] to be applied by the Council towards the encouragement of the use of sustainable modes of transport by owners, occupiers, residents and users of, and visitors to, the Development and the implementation of measures identified in the Travel Plan*". The definition of the 'Sustainable Transport Contribution' is directly linked and proportionate to the WYLES Guidance 'Type 3' mitigation measure requirements outlined within Table Q ; and
- The S.106 agreement[32] futter includes requirements for a 'Highway Improvement Contribution' as a sum of £552,980. The 'Highway Improvement Contribution' is defined as: "*[…] to be applied by the Council towards the Longroyd Bridge junction improvement scheme*".

7.3.4 Mitigation Costings

A summary of all the proposed mitigation measures which are able to be item costed are outlined in Table R.

Table R: Costed Mitigation Measures

Mitigation Measures	Mitigation Measure Type	Cost (£)
EV charging – by-dwelling basis	Type 1	£400 each / £280,000 total
Cycle Parking – by-dwelling basis	Type 2	-
Cycle / footpath infrastructure provision	Type 2	-
Bus Stop Contribution: as required by S.106 agreement	Type 2	£47,000
Monitored Travel Plan	Type 2	-
Travel Plan Monitoring Sum: as required by S.106 agreement	Type 2	£15,000
Sustainable Transport Contribution: as required by S.106 agreement	Type 3	£397,000

Mitigation Measures	Mitigation Measure Type	Cost (£)
Highway Improvement Contribution: as required by S.106 agreement	Type 3	£552,980
Total (not including those elements detailed above which are not costed)		£325,984

As indicated in Table R. mitigation to the value of £1,291,980 (not including those elements detailed which are not costed) is proposed to be included as part of commensurate mitigation for the Development.

The 'damage cost calculation' undertaken, as presented in Section 6.0, has determined a 5-year total NOx and PM_{10} cost of £119,165.

The WYLES references the purpose of the 'damage cost calculation' as:

> *"B. The pollutant emissions costs calculation will identify the environmental damage costs associated with the proposal and determine the amount (value) of mitigation that is expected to be spent on measures to mitigate the impacts […]"*

On the basis that the total cost of mitigation proposed is over and above the calculated damage costs, the emissions associated with the Development are considered to be fully mitigated through those measures proposed. Therefore, no additional 'further mitigation' contribution is considered to be required. It is noted the Sustainable Transport Contribution as required within the S.106 is individually in excess of the calculated damage costs.

8.0 Conclusions

SLR Consulting Ltd has been commissioned by Miller Homes Ltd, Vistry Group & Countryside Properties to undertake an AQA to support the application for reserved matters approval, and associated discharge of Condition 29, for 700 residential dwellings, on Land off Blackmoorfoot Road and Felks Stile Road, Huddersfield.

8.1 Operational Phase

The assessment of operational phase effects considered impacts on all relevant receptors from road traffic emissions associated with the Development.

The ADMS-Roads dispersion model was used to determine the likely NO_2, PM_{10}, and $PM_{2.5}$ concentrations at all assessed receptor locations for a series of scenarios, in accordance with technical guidance published in LAQM.TG(22). Predicted pollutant concentration changes at relevant receptor locations are a result of the Development were assessed using the EPIC & IAQM significance criteria.

In accordance with EPIC & IAQM guidance, the impacts of the Development on NO_2, PM_{10} and $PM_{2.5}$ concentrations at all existing assessed receptor locations are considered to be ‘negligible’. Unmitigated effects associated with NO_2, PM_{10} and $PM_{2.5}$ concentrations at all assessed receptor locations are therefore considered to be ‘not significant’.

Nonetheless, and in accordance with Condition 29 of the outline consent, a ‘damage cost calculation’ following the WYLES Guidance has been undertaken to scale the level of required mitigation compensation to negate the predicted impact. A damage cost calculation was completed for the Development to reflect the build-rate schedules and associated commencement / completion dates. The damage cost calculation has been separately calculated for Miller Homes Ltd and Vistry Group / Countryside Properties, based upon their share of the Development. The 5-year calculated damage costs are £50,082 for Miller Homes Ltd and £69,113 for Vistry Group / Countryside Properties (combined sum of £119,165).

Commensurate Type 1, Type 2 and Type 3 mitigation measures as defined within the WYLES Guidance will be implemented across the Development as detailed in Section 7.0. The total value of the above mitigation proposed is over and above the calculated pollutant damage cost, and no further mitigation is considered to be required.

Appendix A Model Inputs and Verification

Land at Blackmoorfoot Road, Huddersfield

Air Quality Assessment: Condition 29

Miller Homes Ltd, Vistry Group & Countryside Properties

SLR Project No.: 410.065276.00001

2 October 2024

A.1 Traffic Data

Table S details the traffic data used within the assessment.

Table S:Traffic Data Used Within the Assessment

Link		2022 BC		2034 DM		2034 DS		Average Speed (kph) [(A)]
		AADT	% HDV	AADT	% HDV	AADT	% HDV	
1	Blackmoorfoot Road	9,727	1%	10,668	1%	13,687	1%	46
2	A62 Manchester Road	12,070	2%	13,217	2%	13,217	2%	47
3	A62 Manchester Road	18,817	4%	20,605	4%	23,624	3%	49
4	St Thomas' Road	11,283	1%	12,373	1%	12,831	1%	45
5	A62 Manchester Road	16,285	2%	17,833	2%	20,395	2%	47
6	Outcote Bank	8,208	3%	8,988	3%	10,286	3%	44
7	A62 Manchester Road	8,967	2%	9,819	2%	11,083	2%	45
8	A62 Castlegate	35,853	2%	39,263	2%	39,997	2%	48
9	A62 Castlegate	32,863	2%	35,988	2%	37,276	2%	48
10	Queensgate	29,873	2%	32,713	2%	34,541	2%	48
11	Chapel Hill	21,116	4%	23,123	4%	23,123	4%	48

Note:
(A) Speeds are based upon ATC data. Traffic speeds have been adjusted to take into account queues and congestion in accordance with LAQM.TG(22).

A.1.1 Model Verification

The ADMS-Roads dispersion model has been widely validated for this type of assessment and is specifically listed in the Defra's LAQM.TG(22) guidance as an accepted dispersion model.

Model validation undertaken by the software developer (CERC) will not have included validation in the vicinity of the Site. It is therefore necessary to perform a comparison of modelled results with local monitoring data at relevant locations. This process of verification attempts to minimise modelling uncertainty and systematic error by correcting modelled results by an adjustment factor to gain greater confidence in the final results.

Prior to undertaking model verification, model setup parameters and input data were reviewed to maximise the performance of the dispersion model in relation to the real-world conditions.

A.1.2 NOx / NO_2 Verification

NOx / NO_2 verification relates to the comparison and adjustment of modelled road-NOx (as output from the ADMS-Roads dispersion model), relative to monitored road-NOx.

For NOx / NO_2 model verification, 2022 LAQM KC monitoring data has been used for those roadside locations situated adjacent to a modelled link i.e. where traffic data exists. Table T presents all local monitoring data available for model verification.

Table T: Local Monitoring Data Available for Model Verification

Site ID	NGR X (m)	NGR Y (m)	2022 Monitored Annual Mean NO_2 (µg/m^3)	2022 Data Capture (%)
K11	414359	416279	32.0	100
K49	413659	416182	33.6	100
K77	413454	416015	41.9	100
K50	413413	415984	40.6	100
K76	413198	415955	27.1	100
K75	413153	415895	27.1	100

NOx was back calculated using the latest version of Defra's NOx to NO_2 Calculator (v8.1) for all monitors – given the absence of data. The NOx to NO_2 Calculator was also used to facilitate the conversion of modelled road-NOx (as output from the ADMS-Roads dispersion model) into road-NO_2.

Verification was completed using the 2022 Defra background mapped concentrations (2018 base year) for the relevant 1km x 1km grid squares (i.e. those within which the model verification locations are located), as discussed in Section 4.3.

Comparison of the modelled vs. monitored road NO_x contribution at the verification locations detailed in Table T is provided in Table U. An adjustment factor of 2.950 has been derived, based on a linear regression forced through zero as shown in Figure 3.

Table U: NOx / NO_2 Model Verification (2.950) – Initial Stage

Site ID	Monitored Road NOx (µg/m^3)	Modelled Road NOx (µg/m^3)	Ratio (Monitored vs. Modelled Road NOx)	Adjustment Factor	Adjusted Modelled Total NO_2 (µg/m^3)	Monitored Total NO_2 (µg/m^3)	% Difference (Adjusted Modelled NO_2 vs Monitored NO_2)
K11	29.5	18.01	1.64	2.950	42.7	32.0	+33.3%
K49	41.6	11.35	3.66		29.8	33.6	-11.2%
K77	60.4	12.37	4.88		31.3	41.9	-25.4%
K50	55.4	10.62	5.22		29.7	40.6	-26.9%
K76	26.1	14.77	1.76		35.4	27.1	+30.4%
K75	26.1	6.79	3.84		24.1	27.1	-11.0%

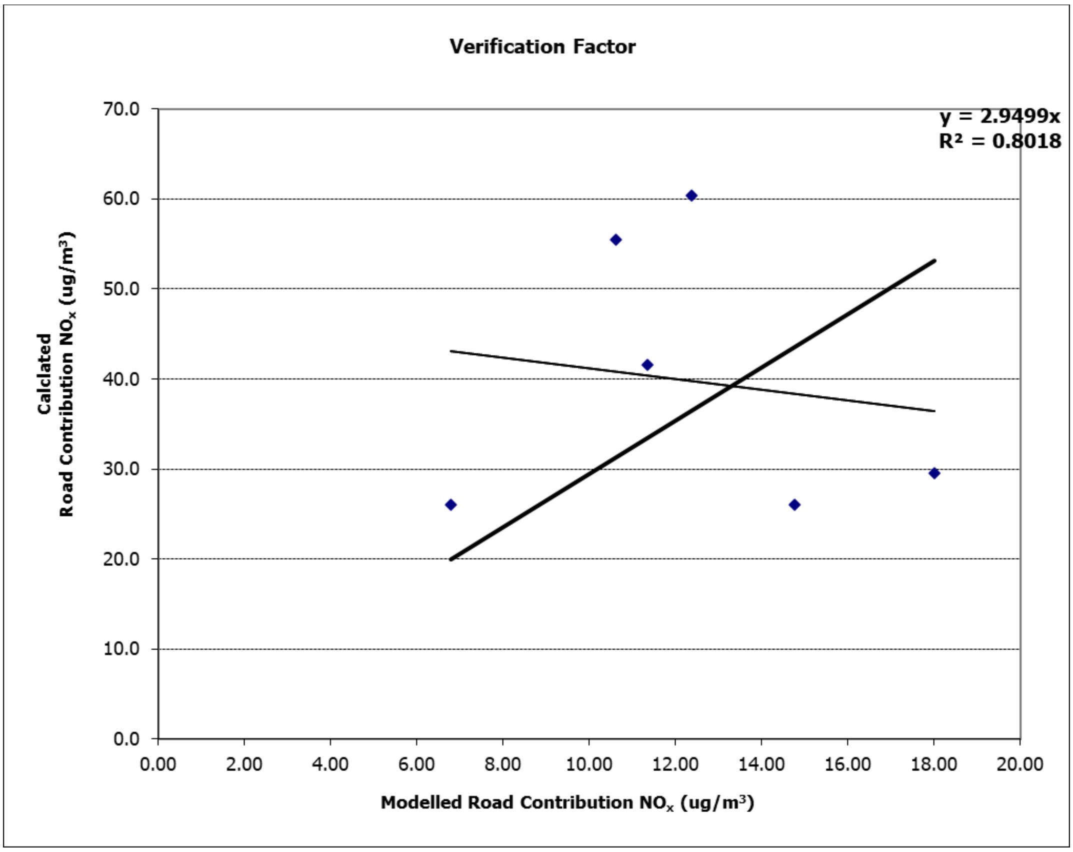

Figure 3: Comparison of Modelled vs. Monitored Road NO_x Contribution (2.950) – Initial Stage

LAQM.TG(22) states that:

> *"In order to provide more confidence in the model predictions and the decisions based on these, the majority of results should be within 25% of the monitored concentrations as a minimum, preferably within 10%".*

As noted in Table U, the difference between the adjusted modelled NO_2 and monitored NO_2 is outside of the LAQM.TG(22) minimum tolerances of 25% at diffusion tubes K11, K77, K50 and K76. With reference to Table U, the model was over-predicting at diffusion tubes K11 and K76, whereas it was underpredicting at the remaining monitoring locations. The model is therefore not showing consistency between these monitoring sites and as a result is distorting the resultant verification factor. Although the model was performing relatively well at diffusion tubes K11 and K76, the applied verification factor resulted in a large over prediction.

To provide greater confidence in the results, it was decided to remove monitoring locations K11 and K76 from the verification process. This is considered to be a conservative approach, as the removal of K11 and K76 results in a greater verification factor and ultimately greater predicted concentrations at modelled receptors.

Comparison of the modelled vs. monitored road NOx contributions for those remaining verification locations is provided in Table V. An adjustment factor of 4.501 has been derived, based on a linear regression forced through zero, as shown in Table V.

Table V: NOx / NO_2 Model Verification: Final Stage (4.501)

Site ID	Monitored Road NOx (µg/m³)	Modelled Road NOx (µg/m³)	Ratio (Monitored vs. Modelled Road NOx)	Adjustment Factor	Adjusted Modelled Total NO_2 (µg/m³)	Monitored Total NO_2 (µg/m³)	% Difference (Adjusted Modelled NO_2 vs Monitored NO_2)
K49	41.6	11.4	3.7	4.501	37.9	33.6	+12.8%
K77	60.4	12.4	4.9		39.9	41.9	-4.8%
K50	55.4	10.6	5.2		37.3	40.6	-8.2%
K75	26.1	6.8	3.8		29.3	27.1	+8.0%

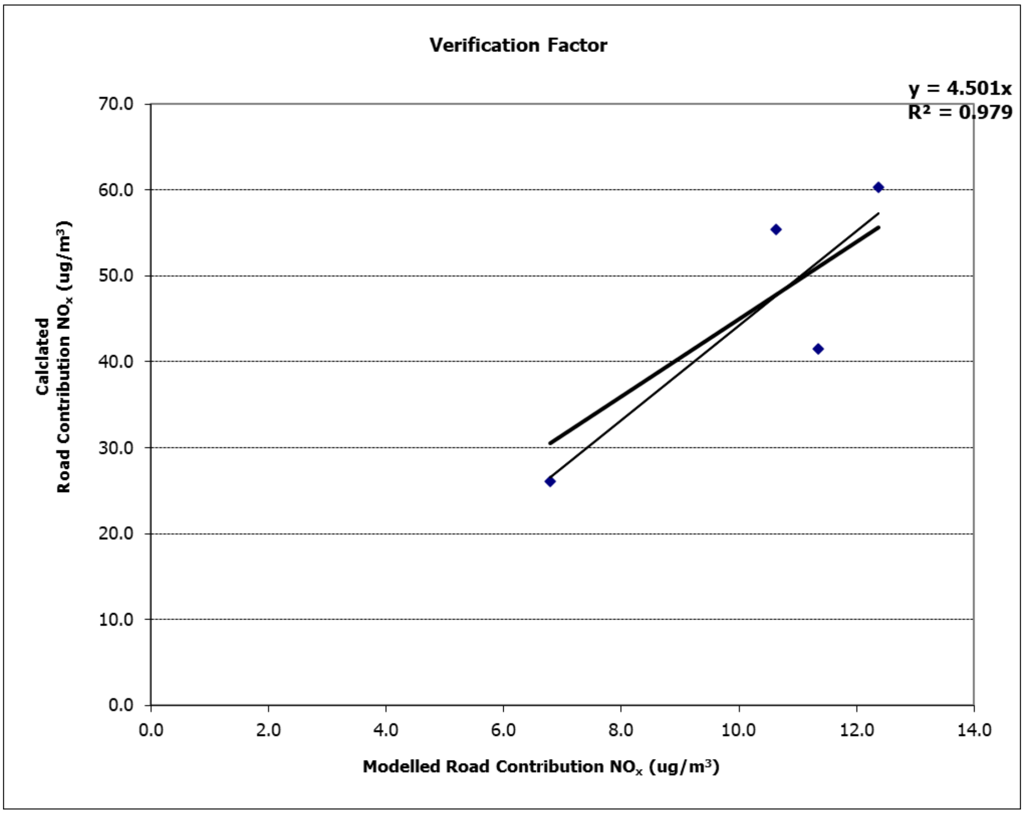

Figure 4: Comparison of Modelled vs. Monitored Road NO_x Contribution (4.501): Final Stage

Table V illustrates that the difference between modelled and monitored NO_2 concentrations are within 10% at three of the four remaining locations (i.e. within the LAQM.TG(22) *ideal* prescribed limits). The difference between modelled and monitored NO_2 concentrations is within 25% at monitoring location K49. In addition, a verification factor of 4.501 reduces the RMSE to 3.09µg/m³ – i.e. within the LAQM.TG(22) prescribed ideal limit (4µg/m³). On this basis, the derived verification factor (4.501) was considered acceptable and was subsequently applied to all road-NOx concentrations (as output of the ADMS Roads dispersion model).

A.1.3 PM_{10} / $PM_{2.5}$ Verification

The adjustment factor of 4.501 was also applied to road-PM_{10} and $PM_{2.5}$ concentrations (as output of the ADMS Roads dispersion model), following the recommendations of LAQM.TG(22), in the absence of local particulate monitoring.

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