H-Pack Packaging UK Ltd.

Land Adjacent to H-pack, Davy Way, Llay

Air Quality Assessment

September 2022

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Document Control Sheet

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Executive Summary

Bureau Veritas UK Ltd has been commissioned by H-Pack Packaging UK Ltd. to undertake an air quality assessment (AQA) for the proposed development. The application is for Erection of 1no B8 Storage and Distribution building and associated access and external works at Land adjacent to H-Pack, Davy Way, Llay.

The assessment has included assessment of potential air quality effects during the construction and operation phases of the development. The assessment of dust and PM_{10} effects from the construction phase of the development was subject to a qualitative assessment. Effective mitigation measures for fugitive dusts would be implemented under site management controls by the development company within a site-specific Construction Environmental Management Plan (CEMP) inclusive of a Dust Management Plan (DMP).

With such mitigation in place, the assessment carried out has shown that any off-site impacts from dust emissions during the construction phase would be **not significant**.

Once operational, traffic data provided by the appointed transport consultants estimate that there is to be an increase of 610 Annual Average Daily Traffic (AADT) movements resulting from the Site, 268 of which would be HGV movements. In line with EPUK/IAQM Guidance, as the AADT estimated to be generated from the development exceeds 100 AADT, a detailed dispersion modelling assessment has been carried out to evaluate potential air quality impacts.

Dispersion modelling software was used to model the emissions from the additional traffic generated by the development and evaluate the impact on receptors along affected roads. The assessment has predicted a negligible impact at all assessed receptors modelled for NO_2, PM_{10} and $PM_{2.5}$ with no new exceedances being created as a result of the development. Therefore, the development's impact on local air quality during the operational phase is considered to be **not significant**.

1 Introduction

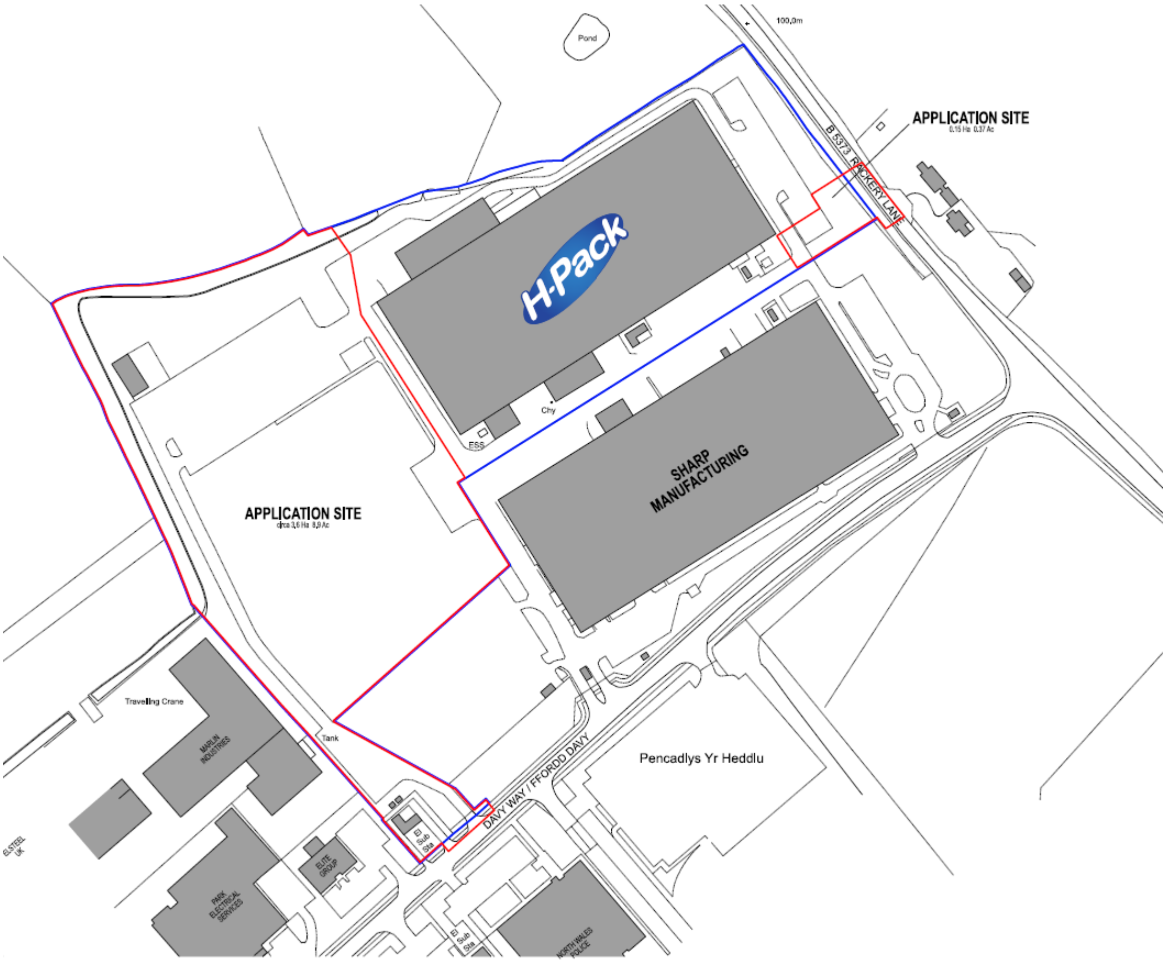
Bureau Veritas UK Ltd has been commissioned by H-Pack Packaging UK Ltd. on behalf of their client H-Pack Packaging UK to undertake an air quality assessment (AQA) for the proposed development. The application is for the erection of 1no B8 storage and distribution building and associated access and external works at land adjacent to H-Pack, Davy Way, Llay.

H-Pack Packaging UK, an international manufacturer of food packaging, are planning to develop a new warehouse facility adjacent to their existing warehouse and manufacturing building located within Llay Industrial Park. The development site ("the Site") covers 3.54 Ha, and the proposed warehouse has a footprint of 160,000 sq ft.

The Site is located approximately 6.4 km to the north of Wrexham, and approximately 1.3 km to the west of the village of Llay. To the north, the Site is bounded by open grassland and to the east, the Site is bounded by the existing H-Pack warehouse and the Sharp Manufacturing warehouse. Surrounding the Site to the south is North Wales Police Station, whilst industrial properties boarder the Site to the west.

The Site is not located within, or close to, an Air Quality Management Area (AQMA), with the nearest AQMA being approximately 12.5 km north-east of the site ('Chester City Centre AQMA'). The purpose of this report is to determine the likely air quality impacts of the proposed development on nearby sensitive receptors. The Site location is illustrated in Figure 1-1 and a layout plan of the Site is provided in Appendix 2.

Figure 1-1 – Site Location



1.1 Scope of Assessment

The following are the main objectives of the assessment:

- Obtain and review the Council's latest statutory air quality review and assessment reports and place them and any local monitoring results within the context of the development site.
- Assess, qualitatively, the short-term impacts of the construction phase and review any mitigation measures available to reduce these impacts to an acceptable level.
- Assess, both qualitatively and quantitatively, the air quality impacts of the proposed development, during the operational phase, including the potential traffic generated from the site and the existing air quality conditions.

The purpose of the air quality assessment (AQA) is to characterise existing air quality conditions in the area and to quantify the effect (if any) the development may have on these conditions and its impact upon existing receptor locations near to the site. Additionally, it is important to quantity the pollutant exposure levels to ensure that no new receptors are being introduced into an area of poor air quality and is therefore suitable for the proposed usage of the development.

The approach adopted in this assessment to assess the impact of dust and particulates during the construction phase was based on Institute of Air Quality Management (IAQM) Guidance for Construction Sites[1], and the approach adopted in this assessment to assess the impact of road traffic on air quality was based on the EPUK/IAQM Guidance for Land-Use Planning and Development[2].

The assessment covers both the impact on air quality during the construction phase of the development through the emissions of dust and Particulate Matter (PM_{10}), as well as the operational phase whereby the development may lead to changes in the existing traffic flow and consequently changes in nitrogen oxides (NO_x) as nitrogen dioxide (NO_2) and PM (PM_{10} and $PM_{2.5}$) emissions to the local area. It is understood that there is no intention to provide on-site energy generation, so this has therefore not been considered as part of the assessment. Further general information in relation to these pollutants and urban pollution is provided in Appendix 1.

In order to provide consistency with the Council's own work on air quality, the guiding principles for air quality assessments as set out in the latest guidance and tools provided by Defra (Local Air Quality Management (LAQM) TG(22)[3]) have been used where relevant.

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[1] Institute of Air Quality Management (IAQM) (2014) Guidance on the Assessment of Dust from Demolition and Construction (v1.1).

[2] Environmental Protection UK (EPUK) and Institute of Air Quality Management (IAQM) (2017). Land-Use Planning & Development Control: Planning for Air Quality (v1.2).

[3] LAQM Technical Guidance LAQM TG(22) – August 2022. Published by Defra in partnership with the Scottish Government, Welsh Assembly Government and Department of the Environment Northern Ireland.

2 Air Quality – Legislative Context

2.1 Air Quality Strategy

The importance of existing and future pollutant concentrations can be assessed in relation to the national air quality standards and objectives established by Government. The Air Quality Strategy (AQS)[4] provides the over-arching strategic framework for air quality management in the UK and contains national air quality standards and objectives established by the UK Government and Devolved Administrations to protect human health. The air quality objectives incorporated in the AQS, and the UK Legislation are derived from Limit Values prescribed in the EU Directives transposed into national legislation by Member States.

The CAFE (Clean Air for Europe) programme was initiated in the late 1990s to draw together previous directives into a single EU Directive on air quality. The CAFE Directive[5] has been adopted and replaces all previous air quality Directives, except the 4th Daughter Directive[6]. The Directive introduces new obligatory standards for $PM_{2.5}$ for National Government but places no statutory duty on Local Governments to work towards achievement of these standards.

The Air Quality Standards (England) Regulations 2010[7] came into force on the 11th June 2010 in order to align and bring together in one statutory instrument the Government's obligations to fulfil the requirements of the new CAFE Directive. Domestic objectives have been set under the Air Quality (England) Regulations 2000[8] and subsequent updates in 2002[9] and upon the UK's departure from the EU[10].

The objectives for ten pollutants – benzene (C_6H_6), 1,3-butadiene (C_4H_6), carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), particulate matter - PM_{10} and $PM_{2.5}$, ozone (O_3) and Polycyclic Aromatic Hydrocarbons (PAHs), have been prescribed within the AQS[4].

The objective limit values are considered to apply everywhere with the exception of the carriageway and central reservation of roads and any location where the public do not have access (e.g., industrial sites).

The AQS objectives apply at locations outside buildings or other natural or man-made structures above or below ground, where members of the public are regularly present and might reasonably be expected to be exposed to pollutant concentrations over the relevant averaging period. Typically, these include residential properties and schools/care homes for long-term (i.e., annual mean) pollutant objectives and high streets for short-term (i.e., 1-hour) pollutant objectives. Table 2-1, taken from LAQM TG(22)[3], provides an indication of those locations that may or may not be relevant for each averaging period.

This assessment focuses on NO_2, PM_{10} and $PM_{2.5}$ as these are the pollutants of most concern within the Council's administrative area. Moreover, as a result of traffic pollution the UK has failed to meet the EU Limit Values for NO_2 by the 2010 target date. As a result, the Government has had to submit time extension applications for compliance with the EU Limit Values. Continued failure to achieve

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[4] The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (2007), Published by Defra in partnership with the Scottish Executive, Welsh Assembly Government and Department of the Environment Northern Ireland.

[5] Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe.

[6] Directive 2004/107/EC of the European Parliament and of the Council of 15 December 2004 relating to arsenic, cadmium, mercury, nickel and polycyclic hydrocarbons in ambient air.

[7] Air Quality Standards (England) Regulations 2010, available: https://www.legislation.gov.uk/uksi/2010/1001/contents/made

[8] Air Quality (England) Regulations 2000, available: https://www.legislation.gov.uk/uksi/2000/928/contents/made

[9] Air Quality (Amendment) (England) Regulations 2002, available: https://www.legislation.gov.uk/uksi/2002/3043/contents/made

[10] Air Quality Standards (Amendment) (EU Exit) Regulations 2019, available: https://www.legislation.gov.uk/uksi/2019/74/contents/made

these limits may lead to further fines. The AQS objectives for these pollutants are presented in Table 2-2.

Table 2-1– Examples of where the AQS Objectives should apply

Averaging Period	Objectives should apply at:	Objectives should generally not apply at:
Annual mean	All locations where members of the public might be regularly exposed. Building facades of residential properties, schools, hospitals, care homes etc.	Building facades of offices or other places of work where members of the public do not have regular access. Hotels, unless people live there as their permanent residence. Gardens of residential properties. Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term
24-hour mean, and 8-hour mean	All locations where the annual mean objectives would apply, together with hotels. Gardens or residential properties[1].	Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.
1-hour mean	All locations where the annual mean and 24 and 8-hour mean objectives would apply. Kerbside sites (e.g., pavements of busy shopping streets). Those parts of car parks, bus stations and railway stations etc. which are not fully enclosed, where the public might reasonably be expected to spend one hour or more. Any outdoor locations at which the public may be expected to spend one hour or longer.	Kerbside sites where the public would not be expected to have regular access.
15-minute mean	All locations where members of the public might reasonably be expected to spend a period of 15 minutes or longer.	

Notes:
[1] For gardens and playgrounds, such locations should represent parts of the garden where relevant public exposure is likely, for example where there is seating or play areas. It is unlikely that relevant public exposure would occur at the extremities of the garden boundary, or in front gardens, although local judgement should always be applied.

Table 2-2 – Relevant AQS Objectives for the Assessed Pollutants in the UK

Pollutant	AQS Objective	Concentration Measured as:	Date for Achievement
Nitrogen Dioxide (NO_2)	200 µg/m³ not to be exceeded more than 18 times per year	1-hour mean	31 December 2005
	40 µg/m³	Annual mean	31 December 2005
Particulate Matter (PM_{10})	50 µg/m³ not to be exceeded more than 35 times per year	24-hour mean	1 January 2005
	40 µg/m³	Annual mean	1 January 2005
Particulate Matter ($PM_{2.5}$)	20 µg/m³	Annual Mean	2010

2.2 National Planning Policy

Planning Policy Wales[11], published in February 2021, sets out that that the planning system should contribute to and enhance the natural, built, and historic environment, by preventing new development from contributing or being adversely affected by unacceptable concentrations of air pollution and development should, wherever possible, help to improve local environmental

[11] https://gov.wales/sites/default/files/publications/2021-02/planning-policy-wales-edition-11_0.pdf

conditions such as air and water quality. In specific relation to the air quality policy, the document states:

Clean air and an appropriate soundscape, contribute to a positive experience of place as well as being necessary for public health, amenity and well-being. They are indicators of local environmental quality and integral qualities of place which should be protected through preventative or proactive action through the planning system. Conversely, air, noise and light pollution can have negative effects on people, biodiversity and the resilience of ecosystems and should be reduced as far as possible.

2.3 Local Planning Policy

Policy 15 ('Natural Environment') of the Council's Local Development Plan (2013 – 2028)[12] states that:

"Developments will only be supported where it protects, conserves, and enhances the natural environment including… the quality of natural services including water, air, and soils".

*Policy DM1 ('*Development Management Considerations') indicates that all developments must:

"Safeguard the environment from the effects of pollution on water, land, light or air arising from the development".

2.4 Local Air Quality Management

Part IV of the Environment Act 1995 (as amended 2021) requires that Local Authorities periodically review air quality within their individual areas. This Act has now been amended and supplemented by the Environment Act 2021 Schedule 11. Defra have said: "Responsibility for tackling local air pollution will now be shared with designated relevant public authorities, all tiers of local government and neighbouring authorities."

This process of Local Air Quality Management (LAQM) is an integral part of delivering the Government's AQOs.

To carry out an air quality Review and Assessment under the LAQM process, the Government recommends a three-stage approach. This phased review process uses initial simple screening methods and progresses through to more detailed assessment methods of modelling and monitoring in areas identified to be at potential risk of exceeding the objectives in the Regulations.

Review and assessments of local air quality aim to identify areas where national policies to reduce vehicle and industrial emissions are unlikely to result in air quality meeting the Government's AQOs by the required dates.

For the purposes of determining the focus of Review and Assessment, Local Authorities should have regard to those locations where members of the public are likely to be regularly present and are likely to be exposed over the averaging period of the objective.

Where the assessment indicates that some or all of the objectives may be potentially exceeded, the Local Authority has a duty to declare an AQMA. The declaration of an AQMA requires the Local Authority to implement an Air Quality Action Plan (AQAP), to reduce air pollution concentrations so that the required AQOs are met.

2.5 Air Quality Guidance for Construction Sites

There are a number of regulatory and legislative constraints in place to control pollution from construction and demolition activities. The Building Act 1984 and subsequent Building Regulations

12 Wrexham County Borough Council, Local Development Plan (2013 – 2018).

2000 are in place to ensure the safety of people in and around the building during work. Part III of the Environmental Protection Act (EPA) 1990 identifies the emission of dust from construction sites as having the potential to be a statutory nuisance and requires its control under Section 80.

In December 2011, the IAQM published a guidance document to assess the impact of construction on air quality. The guidance was reviewed in January 2012 and updated in February 2014 to incorporate new evidence. The approach adopted in this assessment is based on adopting the methodology published in the 2014 version of the IAQM guidance.

The significance of the impact of the construction phase on air quality was determined through application of the criteria outlined in IAQM construction guidance.

2.6 Land-Use Planning & Development Control: Planning for Air Quality

Although no formal procedure exists for classifying the magnitude and significance of air quality effects from a new development, guidance issued by the EPUK and IAQM suggests ways to address the issue. The EPUK/IAQM Guidance provides a decision-making process which assists with the understanding of air quality impacts and implications as a result of development proposals.

The guidance includes a method for screening the requirement for an air quality assessment, the undertaking of an air quality assessment, the determination of the air quality impact associated with a development proposal and whether this impact is significant. Details of this methodology are presented within Section 4.2.

3 Review and Assessment of Air Quality Undertaken by the Council

3.1 Local Air Quality Management

The Council has, under its obligations in Part IV of the Environment Act 1995 (as amended 2021), maintained a thorough annual review and assessment of air quality through their statutory reporting. These are publicly available up to 2021 on their website, with the 2022 report currently not completed for this assessment. Wrexham County Borough Council submit a combined Annual Progress Report (APR) with the five other local authorities in the North Wales Region.

Pollutant monitoring has found that levels of NO_2 have not exceeded the annual mean objective of 40 µg/m^3 in any of the boroughs over the last five years. The Council have therefore not declared any AQMAs.

3.2 Review of Air Quality Monitoring

Local Air Quality Monitoring

The most recent LAQM report that is available from the Council is the 2021 Annual Progress Report for North Wales, which presents the 2020 monitoring data. However, owing to the impacts of COVID-19, the 2020 data is unlikely to be representative for use as a baseline year. Therefore, 2019 data has instead been used for the purpose of informing this assessment.

In 2019, the Council undertook both automatic continuous monitoring and passive NO_2 monitoring in Wrexham. The nearby passive monitoring locations (within approximately 5km of the site) are presented in Table 3-1, and the locations are presented in Figure 3-1. It is important to note that four of the nearby diffusion tube sites lie within the adjacent local authority boundary of Flintshire County Council. The reported concentration are considered to be representative of the baseline air quality conditions near to the Site and along roads which will likely be impacted by any generated traffic by the proposed development.

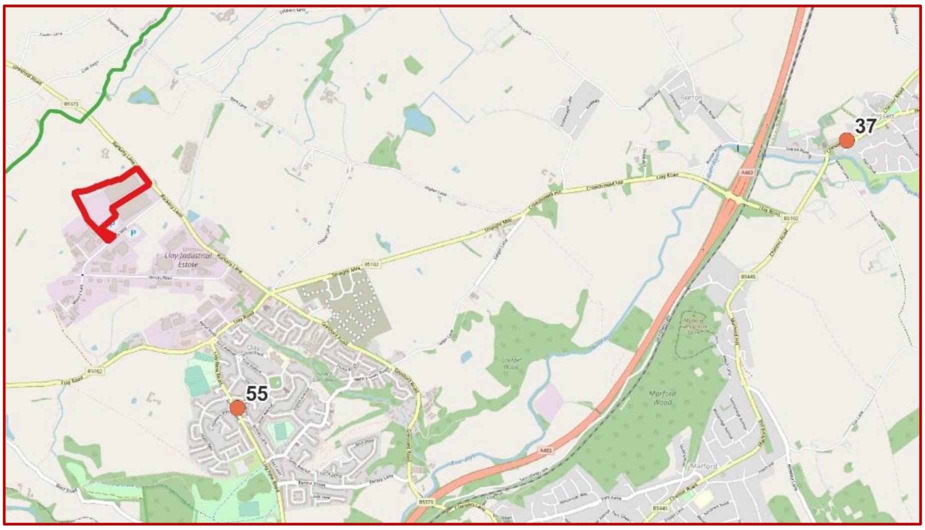
The nearby passive monitoring within the area shows that NO_2 concentrations are compliant against the AQS objective of 40 µg/m^3 in 2019.

Table 3-1 – Annual Average NO_2 Monitoring Locations within 5km of the Site

Site ID	Site Name	Site Type	Coordinates		Distance from site (km)	NO_2 Annual Mean Concentration (µg/m^3)				
			X	Y		2016	2017	2018	2019	2020
55	Llay	S	333078	355649	1.5	-	-	-	11.8	9.4
37	Rossett	R	336635	357211	4.4	22.3	20.8	20.3	16.9	12.1

Notes:
R – Roadside
K – Kerbside
S – Suburban

Figure 3-1 – Monitoring Locations Near to the Site



3.3 Background Concentrations used in the Assessment

Defra maintain a nationwide model of existing and future background air quality concentrations at a 1 km x 1 km grid square resolution[13]. The data sets include annual average concentration estimates for NO_x, NO_2, PM_{10} and $PM_{2.5}$, using a reference year of 2018. The model used is semi-empirical in nature; it uses the national atmospheric emissions inventory (NAEI) emissions to model-predict the concentrations of pollutants at the centroid of each 1 km x 1 km grid square, but then calibrates these concentrations in relation to actual monitoring data.

The estimated background concentrations for the baseline year (2019) and the proposed opening year (2024) are outlined in Table 3-2. Background values remain considerably lower than the annual mean AQS objectives for all pollutants for the years 2019 to 2024. There is a marginal decrease PM_{10} and $PM_{2.5}$ concentrations, with a larger decrease seen in NO_2 concentrations, likely as a result of a decrease in the emissions from the national vehicle fleet.

Table 3-2 – 2019 to 2024 Background Pollutant Concentrations

Source	Background Concentration (µg/m^3) *(Background concentrations taken from grid square; 332500, 355500)*					
	NO_2		PM_{10}		$PM_{2.5}$	
	2019	2024	2019	2024	2019	2024
Defra Background Maps	7.2	6.0	10.4	9.8	6.8	6.3
AQS Objective (annual mean)	***40***		***40***		***20***	

The background-mapped values provide an indication of air quality of a 1 km grid square (which is inclusive of the location of the development). However, this is averaged over the entire area of the grid square, so whilst high concentrations along main roads will contribute to the overall background concentration, the monitoring data is more useful at determining the levels of exceedance along key transport routes.

[13] UK AIR Background Mapping Tool. Available at: https://uk-air.defra.gov.uk/data/laqm-background-home

4 Assessment Methodology

The approach applied to this assessment has been based on the following:

- Qualitative assessment of impacts from the proposed development's construction phase on air quality through emission of dust and particulates;
- Qualitative and quantitative assessment of ambient NO_2, PM_{10} and $PM_{2.5}$ concentrations to which existing and new receptors may be exposed to upon completion of the development, based on a review of current pollutant concentrations and the expected traffic generated from the development, and comparison with the relevant guidance.

4.1 Construction Effects

The assessment of potential dust/PM_{10}/$PM_{2.5}$ effects in relation to the development's construction phase has been undertaken qualitatively in accordance with IAQM Guidance. The guidance proposes a method to assess the significance of construction dust impacts by considering the annoyance due to dust soiling, as well as harm to ecological receptors and the risk of health effects due to significant increases to dust/PM_{10}/$PM_{2.5}$ concentrations.

Construction site activities are divided into four types to reflect their different potential impacts. These activities are:

- Demolition – an activity involved with the removal of an existing structure or structures;
- Earthworks – the processes of soil-stripping, ground-levelling, excavation, and landscaping;
- Construction – an activity involved in the provision of a new structure; and
- Trackout – the transport of dust and dirt from the site onto the public road network. This arises when lorries leave site with dusty materials or transfer dust and dirt onto the road having travelled over muddy ground on-site.

A detailed assessment is required where a sensitive human receptor is located within 350 m from the site boundary and/or within 50 m of the routes used by vehicles on the public highway, up to 500 m from the site entrances. There are a number of sensitive receptors adjacent to the proposed site boundary, such as North Wales Police Station, and numerous industrial/commercial properties to the south of the site boundary.

A detailed assessment is also required where ecologically sensitive receptors are located within 50m of the site boundary and/or 50 m of the routes used by vehicles on the public highway, up to 500m from the site entrances. In accordance with IAQM methodology these are defined as legislatively protected areas such as Sites of Special Scientific Interest (SSSI) and Special Conservation Areas (SCA).

The first step of the detailed assessment is to assess the risk of dust impacts. This is undertaken separately for each of the four activities (demolition, earthworks, construction and trackout) and takes account of:

- The scale and nature of the works, which determines the potential dust emission magnitude.
- The sensitivity of the area.

These factors are combined to give an estimate of the risk of dust impacts occurring. Risks are described in terms of there being a low, medium, or high risk of dust impact for each of the four separate potential activities. Where there are low, medium, or high risks of an impact, then site specific mitigation will be required, proportionate to the level of risk.

Based on the threshold criteria and professional judgment, one or more of the groups of activities may be assigned a 'negligible' risk. Such cases could arise, for example, because the scale is very small and there are no receptors near to the activity.

Site-specific mitigation for each of the four potential activities is then determined based on the risk of dust impacts identified. Where a local authority has issued guidance on measures to be adopted at demolition/construction sites, these should also be taken into account. Professional judgment is then employed to examine the residual dust effects assuming mitigation to determine whether or not they are significant.

Given the short-term nature of the construction phase and the comparatively low volume of vehicle movements that will likely arise, there is not considered to be any potential for significant air quality effects from development related road traffic NO_2 emissions during the construction phase. Such potential impacts have therefore been scoped out from requiring detailed assessment on the basis of their negligible impact.

4.2 Operational Effects – Road Traffic Emissions

With regards to changes in air quality or exposure to air pollution, the guidance indicates that each local authority will likely have their own view on the significance of this; these are to be described in relation to whether an air quality objective is predicted to be met, or at risk of not being met. Exceedances of these objectives are considered as significant if not mitigated.

Where an assessment is deemed to be required, this may take the form of a simple qualitative assessment or a more detailed dispersion modelling assessment. The level of air quality assessment required is determined by the criteria in Table 4-1.

Table 4-1 – Indicative Criteria for Requiring an Air Quality Assessment

The Development Will	Indicative Criteria to Proceed to an Air Quality Assessment
1. Cause a significant change in Light Duty Vehicle (LDV) traffic slows on local roads with relevant receptors	A change of LDV flows of: - more than 100 Annual Average Daily Traffic (AADT) within or adjacent to an AQMA - more than 500 AADT elsewhere
2. Cause a significant change in Heavy Duty Vehicle (HDV) flows on local roads with relevant receptors.	A change of HDV flows of: - more than 25 AADT within or adjacent to an AQMA - more than 100 AADT elsewhere
3. Realign roads, i.e., changing the proximity of receptors to traffic lanes.	Where the change is 5 m or more and the road is within an AQMA
4. Introduce a new junction or remove an existing junction near to relevant receptors.	Applies to junctions that cause traffic to significantly change vehicle accelerate/decelerate, e.g., traffic lights, or roundabouts.
5. Introduce or change a bus station.	Where bus flows will change by: - more than 25 AADT within or adjacent to an AQMA - more than 100 AADT elsewhere.
6. Have an underground car park with extraction system.	The ventilation extract for the car park will be within 20 m of a relevant receptor. Coupled with the car park having more than 100 movements per day (total in and out).
7. Have one or more substantial combustion processes.	Where the combustion unit is: - any centralised plant using biofuel - any combustion plant with single or combined thermal input >300 kWh

	- a standby emergency generator associated with a centralised energy centre (if likely to be tested/used >18 hours a year).
8. Have a combustion process of any size.	Where the pollutants are exhausted from a vent or stack in a location and at a height that may give rise to impacts at receptors through insufficient dispersion. This criterion is intended to address those situations where a new development may be close to other buildings that could be residential and/or which could adversely affect the plume's dispersion by way or their size and/or height.

4.3 Detailed Assessment

A detailed assessment of road traffic emissions involves air dispersion modelling. In order to appropriately consider the impacts of the development, the following scenarios have been assessed:

- 2019 Base Case (BC) – Without development base traffic flows for the base year (2019), used to enable model verification;
- 2024 Do Minimum (2024 DM) – Without the proposed development flows but including future committed development flows for the proposed year of opening (2024); and
- 2024 Do Something (2024 DS) – As above but including the proposed development flows for the proposed year of opening (2024).

4.3.1 Model Inputs

4.3.1.1 Road Traffic Emissions

Assessing the air quality effects of a proposed development that affects local traffic flows is typically carried out by using an atmospheric dispersion model to calculate pollutant concentrations at sensitive receptors, based on the calculated vehicle exhaust emissions, having due regard to their spatial distribution. The predicted annual mean modelled road contributions are added to the relevant annual mean background concentration in order to predict the total pollutant concentration at each receptor location.

Where possible, the performance of the dispersion model is evaluated by comparison against measured pollutant concentrations from the monitoring sites within the study area, through a process known as model verification. Future concentrations then can be predicted with and without the proposed development and compared with the relevant air quality standards and significance criteria. The monitoring locations used for model verification are presented in Appendix 3 – ADMS Model Verification.

The ADMS-Roads assessment incorporates numbers of road traffic vehicles, vehicle speeds on the local roads and the composition of the traffic fleet.

The traffic data used by Bureau Veritas in this assessment consisted of Annual Average Daily Traffic (AADT) flows with the proportion of Heavy Duty Vehicles (HDVs). Cameron Rose Associates are undertaking the Transport Assessment for the developer and therefore have provided the traffic data for 2019 (baseline conditions) as well as the changes in traffic flow with the development in the Do Minimum and Do Something 2024 Scenarios. One additional road (A483) has been modelled for which traffic data was sourced from the Department for Transport Road Traffic Statistics[14]. Data was not available for future years for this road and so it has been assumed to be the same across the three assessment scenarios.

[14] https://roadtraffic.dft.gov.uk/#6/55.254/-6.053/basemap-regions-countpoints

The difference in traffic data between the DM and DS scenarios is due to the additional traffic generated as a result of the proposed development.

Traffic speeds were modelled at the relevant speed limit for each road. Where appropriate, vehicle 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 Defra's TG(22)[3].

The Emissions Factors Toolkit (EFT) version 11.0, developed by Bureau Veritas on behalf of Defra, has been used to determine vehicle emission factors for input into the ADMS-Roads model. The emission factors are based upon the traffic data inputs. Details of the traffic flows used in this assessment are provided in Table 4-2, whilst the modelled roads in relation to the site are presented in Figure 4.1.

Figure 4-1 – Modelled Receptor Locations and Roads (Emissions Sources)

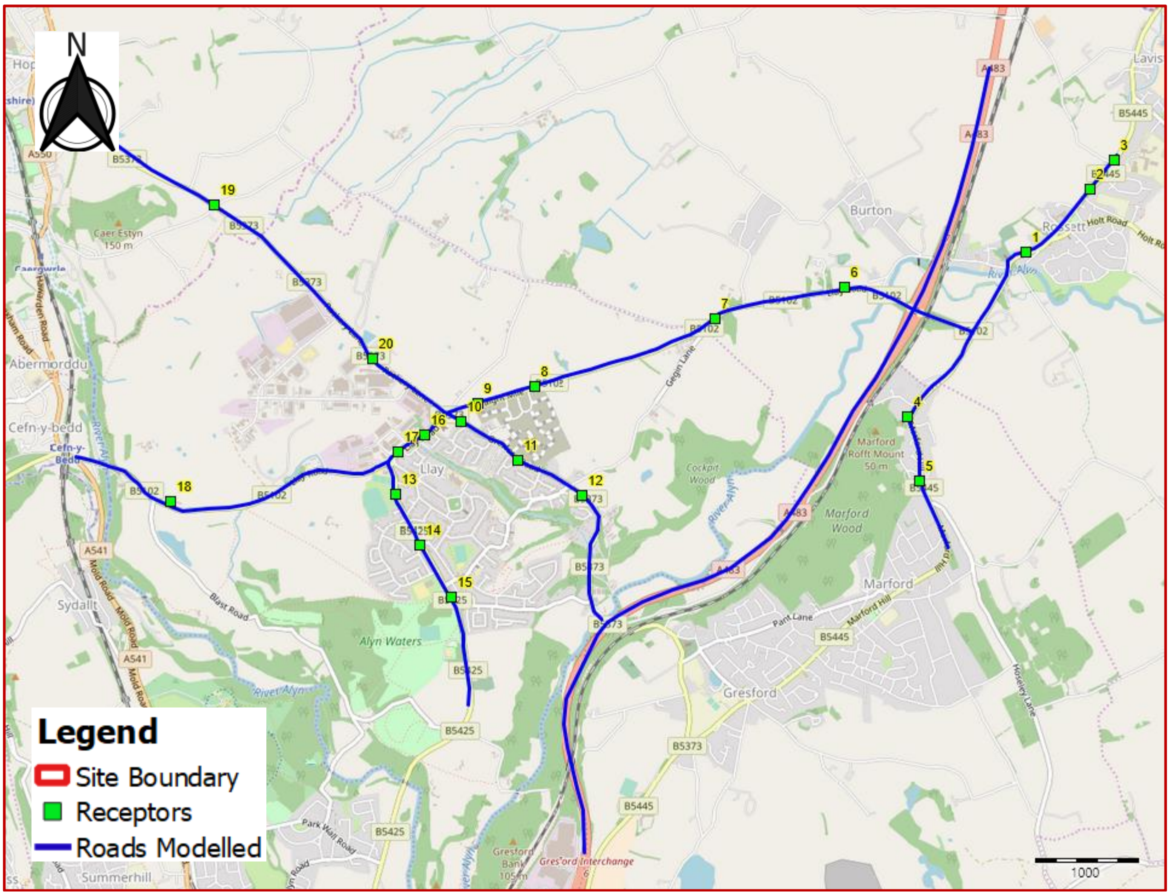


Table 4-2 – Traffic Data

Ref	Link Name	2019 BC		2024 DM		2024 DS		Baseline Source [b]
		AADT	% HDV [a]	AADT	% HDV [a]	AADT	% HDV [a]	
1	B5373 (W)	11732	5.6	13086	5.3	13696	7.0	CRA
2	B3573 (W) SD	11732	5.6	13086	5.3	13696	7.0	CRA
3	Llay Road (N)	9771	3.1	11213	2.9	11557	4.3	CRA
4	Llay Road (N) Junc SD	9771	3.1	11213	2.9	11557	4.3	CRA
5	Llay Road (N) Rnd SD	9771	3.1	11213	2.9	11557	4.3	CRA
6	Llay Road (S)	9771	3.1	11213	2.9	11557	4.3	CRA
7	Llay Road(S) SD	9771	3.1	11213	2.9	11557	4.3	CRA
8	Llay New Road SD	8949	3.4	9388	3.4	9492	4.3	CRA
9	Llay New Road	8949	3.4	9388	3.4	9492	4.3	CRA
10	Gresford Road	4642	2.5	5659	2.2	5689	2.3	CRA
11	Gresford Road SD	4642	2.5	5659	2.2	5689	2.3	CRA
12	B5102	5898	8.1	6614	7.5	6850	8.4	CRA
13	B5102 Junc SD	5898	8.1	6614	7.5	6850	8.4	CRA
14	B5102 (E) SD	5898	8.1	6614	7.5	6850	8.4	CRA
15	B5102 (W) SD	5898	8.1	6614	7.5	6850	8.4	CRA
16	B5102 Small	5898	8.1	6614	7.5	6850	8.4	CRA
17	B5102 Small SD	5898	8.1	6614	7.5	6850	8.4	CRA
18	Chester Road(N)	1616	1.8	1695	1.8	1700	1.8	CRA
19	Chester Road (N) SD	1616	1.8	1695	1.8	1700	1.8	CRA
20	Marford Hill	1616	1.8	1695	1.8	1700	1.8	CRA
21	Marford Hill SD	1616	1.8	1695	1.8	1700	1.8	CRA
22	A483	49234	8.0	49234	8.00	49234	8.0	DfT

Notes:
[a] HDV denotes Heavy Goods Vehicles (HGVs) and Buses/Coaches with a total unladen weight ≥3.5 tonnes.
[b] CRA denotes Cameron Rose Associates (CRA) Traffic Flow data

4.3.1.2 Sensitive Receptors

The receptors considered in the assessment of emissions from road traffic are detailed in Table 4-3 and their locations are presented in Figure 4.1.

These receptors are sited at locations of worst-case exposure in order to predict the maximum pollutant concentrations representative of exposure. Receptors were considered in relation to exposure at typical breathing zone height i.e., 1.5 m.

In alignment with DMRB Guidance[15] and IAQM Guidance[16], any ecologically designated sites within 200 m of roads affected by the development must be considered. There were no ecologically designated sites within the development area, as per the Defra Magic Map resource[17].

[15] Standards for Highways DMRB LA105 Guidance available online at https://www.standardsforhighways.co.uk/dmrb/search/10191621-07df-44a3-892e-c1d5c7a28d90

[16] A guide to the assessment of air quality impacts on designated nature conservation sites available online at https://iaqm.co.uk/text/guidance/air-quality-impacts-on-nature-sites-2019.pdf

[17] Magic Maps available online at http://www.natureonthemap.naturalengland.org.uk/

Table 4-3 – Receptor Locations

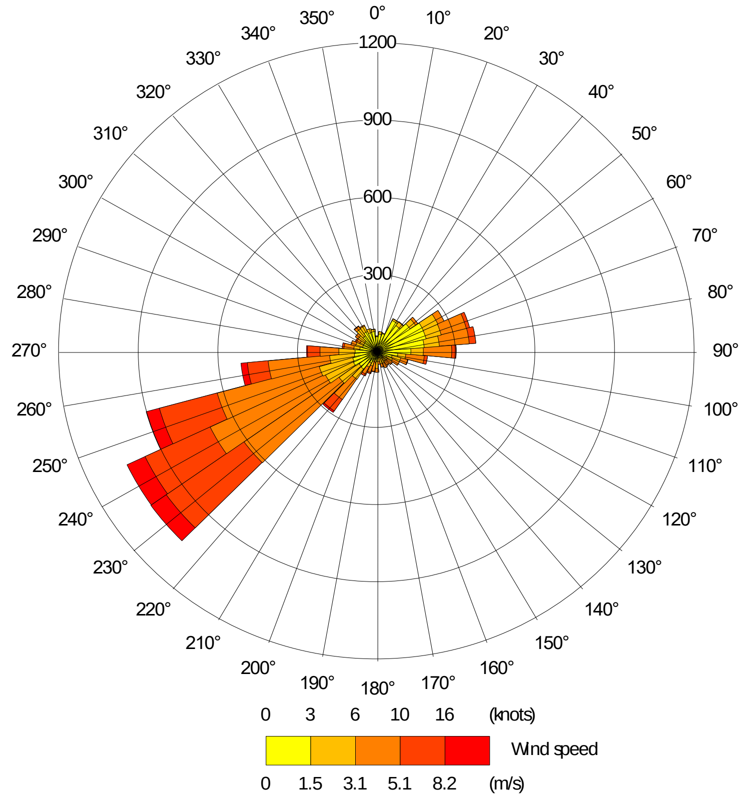
Receptor ID	Coordinates		Height (m)	Type of Receptor
	X	Y		
1	336612	357203	1.5	Residential – Chester Road (1)
2	337038	357584	1.5	Residential – Chester Road (2)
3	337169	357753	1.5	Educational – Darland High School
4	335936	356254	1.5	Residential – Manford Hill (1)
5	336092	355650	1.5	Residential – Manford Hill (2)
6	335552	357005	1.5	Educational – Rossett House Nursery
7	334839	356854	1.5	Residential – Croeshowell Hill
8	333733	356451	1.5	Residential – Straight Mile (1)
9	333523	356391	1.5	Residential – Straight Mile (2)
10	333345	356272	1.5	Residential – Cresford Road (1)
11	333506	356166	1.5	Residential – Cresford Road (2)
12	333768	355997	1.5	Residential – Cresford Road (3)
13	332962	355945	1.5	Residential – Llay New Road (1)
14	333039	355717	1.5	Residential – Llay New Road (2)
15	333274	355263	1.5	Residential – Llay New Road (3)
16	333166	356202	1.5	Residential – Llay Road (1)
17	333000	356097	1.5	Residential – Llay Road (2)
18	331668	355809	1.5	Residential – Llay Road (3)
19	331950	357528	1.5	Residential – B5373 (1)
20	332947	356562	1.5	Residential – B5373 (2)

4.3.1.3 Other Model Inputs

A site surface roughness value of 0.5 m was entered into the ADMS-Roads model, consistent with the nature of the suburban/open area surrounding the Site, whilst a surface roughness value of 0.5 m was also used to represent the open nature surrounding the meteorological measurement site.

One year of hourly sequential meteorological data from a representative synoptic observing station is required by the dispersion model. 2019 meteorological data for Bala has been provided by ADML (Atmospheric Dispersion Modelling Ltd). The meteorological station is approximately 30 miles to the south-west of the site. A wind rose for this site for the year 2019 is shown in Figure 4-2.

Figure 4-2 – Wind Rose for Bala's Meteorological Data (2019)



4.3.2 Model Outputs

The background pollutant values presented in Table 4-4 have been used in the ADMS-Roads model to calculate predicted total annual mean concentrations of NO_2, PM_{10} and $PM_{2.5}$.

Table 4-4 – Background Pollutant Concentrations

Year	Grid Square (E,N)	Annual Mean Concentration (µg/m^3)*			
		NO_2	NO_x	PM_{10}	$PM_{2.5}$
2019	336500, 357500	10.0	13.0	11.9	7.3
2024		7.9	10.1	11.2	6.7
2019	337500, 357500	7.5	9.6	10.7	6.8
2024		6.2	7.9	10.1	6.3

Year	Grid Square (E,N)	Annual Mean Concentration (µg/m^3)*			
		NO_2	NO_x	PM_{10}	$PM_{2.5}$
2019	335500, 356500	10.2	13.3	12.5	7.3
2024		8.0	10.3	11.8	6.8
2019	336500, 355500	7.2	9.2	10.9	6.8
2024		5.9	7.5	10.3	6.3
2019	335500, 357500	7.3	9.3	10.8	6.7
2024		6.0	7.6	10.2	6.2
2019	334500, 356500	7.2	9.2	11.2	6.9
2024		6.0	7.5	10.5	6.3
2019	333500, 356500	7.3	9.4	10.8	6.9
2024		6.2	7.8	10.1	6.3
2019	333500, 355500	7.6	9.8	10.6	7.1
2024		6.4	8.1	9.9	6.6
2019	332500, 355500	7.2	9.1	10.4	6.8
2024		6.0	7.6	9.8	6.3
2019	331500, 355500	7.8	10.0	10.1	6.7
2024		6.5	8.2	9.4	6.1
2019	331500, 357500	6.6	8.4	9.9	6.5
2024		5.5	7.0	9.3	6.0
2019	332500, 356500	10.1	13.4	10.7	7.0
2024		8.8	11.5	9.9	6.4

For the prediction of annual mean NO_2 concentrations for the modelled scenarios, the output of the ADMS-Roads modelled for road-NO_x has been converted to total NO_2 following the methodology in LAQM.TG(22)[3] and using the NO_x to NO_2 conversion tool developed by Bureau Veritas on behalf of Defra. This tool also utilises the total background NO_x and NO_2 concentrations. This assessment has utilised version 8.1 (August 2020) of the NO_x to NO_2 conversion tool[18]. The road contribution is then added to the appropriate NO_2 background concentration value to obtain an overall total NO_2 concentration.

For the prediction of short term NO_2 impacts, LAQM.TG(22)[3] advises that it is valid to assume that exceedances of the 1-hour mean AQS objective for NO_2 are only likely to occur where the annual mean NO_2 concentration is 60 µg/m^3 or greater. This approach has thus been adopted for the purposes of this assessment.

Annual mean PM_{10} road and car park contributions were also output from the model and processed in a similar manner i.e., combined with the relevant background annual mean PM_{10} concentrations to obtain an overall total PM_{10} concentration.

For the prediction of short term PM_{10}, LAQM.TG(22)[3] provides an empirical relationship between the annual mean and the number of exceedances of the 24-hour mean AQS objective for PM_{10} that can be calculated as follows:

[18] Defra NO_x to NO_2 Calculator v8.1 (2020). http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html#NOxNO2calc

$$Number\ of\ 24\ hour\ Mean\ Exceedences = -18.5 + 0.00145 * annual\ mean^3 + \frac{206}{annual\ mean}$$

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

Verification of the ADMS-Roads assessment has been undertaken using a number of local authority diffusion tube monitoring locations. All results presented in the assessment are those calculated following the process of model verification, using an adjustment factor of 2.015 for NO_2, PM_{10} and $PM_{2.5}$.

The verification process is a comparison of modelled results with local monitoring data at relevant locations. The process attempts to minimise modelling uncertainty and systematic error by correcting modelled results by an adjustment factor to gain greater confidence in the final results.

The predicted results from a dispersion model may differ from measured concentrations for a large number of reasons, including uncertainties associated with:

- Background concentration estimates;
- Source activity data such as traffic flows and emissions factors;
- Monitoring data, including locations; and
- Overall model limitations.

Model verification is the process by which these and other uncertainties are investigated and, where possible, minimised. In reality, the differences between modelled and monitored results are likely to be a combination of all of these aspects.

Model setup parameters and input data were checked prior to running the model in order to reduce these uncertainties. The following were checked to the extent possible to ensure accuracy:

- Traffic data;
- Distance between sources and monitoring as represented in the model;
- Speed estimates on roads;
- Background monitoring and background estimates; and
- Monitoring data.

Following these checks, the model was still under-predicting and over-predicting at all verification locations and no further improvement of the modelled results could be obtained, therefore an adjustment factor of 2.015 was utilised. Further detail on how this factor was derived is included in Appendix 3.

4.3.3 Uncertainty

Due to the number of inputs that are associated with the modelling of the study area there is a level of uncertainty that has to be taken into account when drawing conclusions from the predicted concentrations of NO_2, PM_{10}, and $PM_{2.5}$. The predicted concentrations are based upon the inputs of traffic data, background concentrations, emission factors, meteorological data, modelling terrain limitations and the availability of monitoring data from the assessment area.

Analysis of historical monitoring data within the UK has shown a disparity between measured concentration data and the projected decline in concentrations associated with emission forecasts for future years[19]. The report identifies that trends in ambient concentrations of NO_x and NO_2 in many urban areas of the UK have generally shown two characteristics; a decrease in concentration from about 1996 to 2002-2004, followed by a period of more stable concentrations from 2002-2004 up until 2009. This trend of more stable recent years is expected to continue in future years. Trends in more rural, less densely trafficked areas, tend to show downward trend in either NO_x or NO_2, which are more in line with those expected.

The reason for this disparity is related to the actual on-road performance of vehicles; in particular, diesel cars and vans, when compared with calculations based on the Euro emission standards. Preliminary studies suggest the following:

- NO_x emissions from petrol vehicles appear to be in line with current projections and have decreased by 96% since the introduction of 3-way catalysts in 1993;
- NO_x emissions from diesel cars, under urban driving conditions, do not appear to have declined substantially, up to and including Euro 5. There is limited evidence that the same pattern may occur for motorway driving conditions; and
- NO_x emissions from HDVs equipped with Selective Catalytic Reduction (SCR) are much higher than expected when driving at low speeds.

This disparity in the historical national data highlights the uncertainty of future year projections of both NO_x and NO_2.

Defra and the Devolved Administrations have investigated these issues and have since published an updated version of the Emissions Factors Toolkit (EFT Version 11.0) utilising COPERT 5.3 emission factors, along with 2018 background map projections and associated tools, which may go some way to addressing this disparity, but it is considered possible that a gap still remains.

This assessment has utilised the latest EFT version 11.0[20] and associated tools including the latest 2018-reference year background maps[21] published by Defra, to help minimise any associated uncertainty when forming conclusions from this assessment.

All modelling assumptions that have been made are based on predictions that were correct prior to the Covid-19 pandemic. As a conservative approach, a 2019 baseline year has been used but any future year effects do not take into account any changes which may result from a greater tendency to work from home and slower uptake of newer vehicles as a result.

[19] Carslaw, D, Beevers, S, Westmoreland, E, Williams, M, Tate, J, Murrells, T, Steadman, J, Li, Y, Grice, S, Kent, A and Tsagatakis, I. 2011. Trends in NO_x and NO_2 emissions and ambient measurements in the UK. Prepared for Defra, 18th July 2011.

[20] Emissions Factor Toolkit Version 11.0 published by Defra. Available at: https://laqm.defra.gov.uk/air-quality/air-quality-assessment/emissions-factors-toolkit/

[21] UK AIR Background Maps, published by Defra. Available at https://uk-air.defra.gov.uk/data/laqm-background-home

5 Results

5.1 Construction Phase – Dust / PM_{10} Emissions

This assessment of dust/PM_{10}/$PM_{2.5}$ presents the effects which are likely to be relevant both prior to and following the use of the appropriate mitigation measures on-site, which would be outlined by the site contractor and detailed within a Construction Environmental Management Plan (CEMP) inclusive of a Dust Management Plan (DMP). As per the IAQM guidance, the risk associated with the site to potentially generate dust/PM_{10}/$PM_{2.5}$ is identified. Potential unmitigated effects at receptor locations are determined, and site-specific recommendations are then made to ensure residual dust/PM_{10}/$PM_{2.5}$ effects associated with the construction phase are not significant.

The assessment of construction dust will focus on dust arising from the three relevant dust producing construction activities outlined in the IAQM guidance (earthworks, construction and trackout).

Demolition

No demolition works are proposed to take place as part of this development, therefore impacts associated with demolition have not been considered.

Earthworks

Potential sources of impacts associated with earthworks/ground preparation activities include fugitive dust/PM_{10}/$PM_{2.5}$ emissions resulting from disturbance of dusty materials by construction plant, the construction materials used, vehicle movements and wind action. Owing to the size of the site, the dust emission magnitude for earthworks is therefore considered to be **Large**.

Construction

Potential sources of impacts associated with construction activities include fugitive dust/PM_{10}/$PM_{2.5}$ emissions resulting from disturbance of dusty materials by construction plant, the construction materials used, vehicle movements and wind action. The total building volume has therefore been assumed to be between > 100,000 m^3. The dust emission magnitude for construction is therefore considered to be **Large**.

Trackout

Dust emissions during trackout from the site may occur from the transport of dust and dirt from the construction site onto the public road network, where it may be deposited and then re-suspended by vehicles using the network. The number of predicted outward HDV (i.e., >3.5 tonne) movements in any one day is likely to be less than 10, the approximate unpaved on-site road length is expected to be >100m. This estimation is based on the fact that there is no demolition works planned to take place, meaning that the only likely outwards HDV movements will be largely from the deliveries. The dust emission magnitude for trackout is therefore considered to be **Medium**.

Summary

A summary of the dust emission magnitude for the relevant activities is detailed in Table 5-1.

Table 5-1 – Construction Dust Emission Magnitude

Source	Dust Emission Magnitude
Demolition	N/A
Earthworks	Large
Construction	Large
Trackout	Medium

Sensitivity of the Area

There are approximately 0 residential receptors located within 20 m of the development site. The sensitivity of the area with respect to dust soiling effects on people and property resulting from earthworks, construction and trackout is therefore **Low.**

The existing maximum background PM_{10} concentration is 10.4 µg/m^3 which is below the AQS annual mean objective of 40 µg/m^3. Given the above information regarding the number of receptors within 20 m of the site boundary, the sensitivity of the area with respect to human health impacts in relation to earthworks, construction and trackout is therefore **low**.

A summary of the sensitivity of the surrounding area is detailed Table 5-2 below. According to the Defra Magic Map natural environment mapping tool[22], there are no ecologically sensitive receptors within 1 km from the development site. Therefore, the sensitivity of ecological receptors has been classified as '**Not Applicable**' due to there being no nearby sensitive ecological receptors within 50 m of the Site.

Table 5-2 – Sensitivity of Surrounding Area

Potential Impact	Sensitivity Of The Surrounding Area			
	Demolition	Earthworks	Construction	Trackout
Dust Soiling	N/A	Low	Low	Low
Human Health	N/A	Low	Low	Low
Ecological	N/A	N/A	N/A	N/A

Risk of Dust Impacts

The risk of dust impacts is defined using Tables 6, 7, 8 and 9 in the IAQM guidance for earthworks, construction and trackout respectively. The dust emission magnitude classes in Table 5-1 combined with the sensitivity of surrounding area classes in Table 5-2, result in the site risk categories as shown in Table 5-3.

Table 5-3 – Summary of Dust Risk

Potential Impact	Risk			
	Demolition	Earthworks	Construction	Trackout
Dust Soiling	N/A	Low Risk	Low Risk	Low Risk
Human Health	N/A	Low Risk	Low Risk	Low Risk
Ecological	N/A	N/A	N/A	N/A

Following the construction dust assessment, the development Site is found to be **low risk** in relation to dust soiling effects and **low risk** for human health impacts, as summarised in Table 5-3.

[22] DEFRA Magic Map Tool. Available at: https://magic.defra.gov.uk/

Providing effective mitigation measures are implemented, such as those outlined in Section 6.1, construction dust impacts are considered to be **not significant**.

5.2 Operational Phase – Road Traffic Emissions

The appointed transport consultants on this project, have provided an Annual Average Daily Traffic (AADT) value of 610 additional AADt, 268 of which will be HDVs.

Table 5-4 reproduces the guidance published by EPUK/IAQM, the criteria of which are used to determine when a further air quality assessment is likely to be required and evaluates the proposed development in relation to each criterion.

Table 5-4 – Evaluation of the Proposed Operational Phase Impacts with Reference to EPUK/IAQM Criteria

Indicative Criteria to Proceed to an Air Quality Assessment	Evaluation of the Potential Operational Impacts of Proposed Development Site
A change of LDV* flows of: - more than 100 AADT within or adjacent to an AQMA - more than 500 AADT elsewhere.	AADT of vehicles is estimated to increase by 610, above the 500 threshold.
A Change of HDV** flows of: - more than 25 AADT within or adjacent to an AQMA - more than 100 AADT elsewhere.	The development is expected to result in an additional 268 HDVs trips, above the 100 threshold.
Road realignment, where the change is 5m or more and the road is within an AQMA.	No change of road realignment expected.
Introduction of a new junction or the removal of an existing junction near to relevant receptors. This applies to junctions that cause traffic to significantly change vehicle accelerate/ decelerate, e.g., traffic lights, or roundabouts.	A small access junction already presents at the site. Not expected to be changed significantly.
Introduction or change of a bus station, where bus flows will change by: - more than 25 AADT within or adjacent to an AQMA - more than 100 AADT elsewhere.	The introduction or changes to a bus station are not proposed.
Have an underground car park with extraction system, where the ventilation extract for the car park will be within 20m of a relevant receptor. Coupled with the car park having more than 100 movements per day (total in and out).	No underground car park proposed.
Having one or more substantial combustion process, where the combustion unit is: - any centralised plant using bio fuel - any combustion plant with single or combined thermal input >300kWh - a standby emergency generator associated with a centralised energy centre (if likely to be tested/used >18 hours a year).	No plant proposed.
Have a combustion process of any size, where the pollutants are exhausted from a vent or stack in a location and at a height that may give rise to impacts at receptors through insufficient dispersion. This criterion is intended to address those situations where a new development may be close to other buildings that could be residential and/or which could adversely affect the plume's dispersion by way or their size and/or height.	No such plant proposed.
**LDV – Light Duty Vehicle* ***HDV – Heavy Duty Vehicle*	

The number of expected additional road transport vehicles generated by the proposed development is expected to exceed the EPUK/IAQM indicative criterion of 500 AADT. As a result, a detailed dispersion modelling assessment is required.

This assessment considers emissions of NO_x/NO_2, PM_{10} and $PM_{2.5}$ from road traffic at receptor locations local to the Site. The results of the dispersion modelling are summarised in the following sections, for those receptor locations detailed in Table 4-3 and illustrated in

Figure 4-1.

5.2.1 Assessment of Nitrogen Dioxide (NO_2)

Table 5-5 presents the annual mean NO_2 concentrations predicted at receptors in consideration of the proposed development for all scenarios, and a comparison against the 40 µg/m^3 annual mean AQS objective.

The maximum predicted annual mean NO_2 concentration at any modelled receptor in 2019 BC was 24.1 µg/m^3, located at Receptor 19 – representing 60.2% of the annual mean AQS objective. Receptor 21 is a residential property on the B5373.

The maximum predicted annual mean NO_2 concentration at any modelled receptor in 2024 DM was 17.1 µg/m^3, located at Receptor 19 – representing 42.8% of the annual mean AQS objective.

The maximum predicted annual mean NO_2 concentration at any modelled receptor in 2024 DS was 17.7 **µg/m^3**, located at Receptor 19 – representing 44**.2 %** of the annual mean AQS objective. All results for scenario 2024 DS reported annual mean NO_2 concentrations below the AQS objective limit.

The maximum percentage change at any modelled receptor from 2024 DM to 2024 DS, relative to the AQS, was 1.6**%** at Receptor 19.

The empirical relationship given in LAQM.TG(22)[3] states that exceedances of the 1-hour mean objective for NO_2 are only likely to occur where annual mean concentrations are 60 µg/m^3 or above. Annual mean NO_2 concentrations at all receptor locations are well below this limit. Therefore, it is unlikely that an exceedance of the 1-hour mean objective will occur as a result of the Site development.

NO_2 annual mean concentrations predicted at all receptors associated with the proposed development in both the 2024 DM and 20254DS scenarios are below the annual mean AQS objective. Furthermore, in the determination of overall significance, in line with EPUK/IAQM guidance, the impact, or the percentage change from 2024 DM to 2024 DS have been assessed as **negligible**. On this basis, it is considered that the proposed development site is considered suitable for the proposed use, and will not lead to the creation of any new exceedances within, or outside, the existing AQMA.

Table 5-5 – Predicted Annual Mean Concentrations of NO_2

Receptors	Annual Mean						
	AQS (µg m^{-3})	2019 BC (µg m-3)	2024 DM (µg m-3)	2024 DS (µg m-3)	% Change relative to AQS	% DC OF AQS	Effect
1	40	12.8	9.6	9.6	<0.1%	23.9%	Negligible (A)
2	40	13.0	9.6	9.7	<0.1%	24.2%	Negligible (A)
3	40	10.1	7.8	7.8	<0.1%	19.5%	Negligible (A)
4	40	13.0	9.6	9.6	<0.1%	24.1%	Negligible (A)
5	40	9.2	7.1	7.1	<0.1%	17.9%	Negligible (A)
6	40	12.0	9.0	9.1	0.3%	22.6%	Negligible (A)
7	40	13.9	10.2	10.3	0.4%	25.8%	Negligible (A)
8	40	22.2	15.8	16.2	1.0%	40.4%	Negligible (A)
9	40	16.2	11.8	12.1	0.6%	30.1%	Negligible (A)
10	40	12.4	9.6	9.7	0.1%	24.2%	Negligible (A)
11	40	12.1	9.6	9.6	<0.1%	24.0%	Negligible (A)
12	40	11.0	8.7	8.7	<0.1%	21.7%	Negligible (A)
13	40	15.4	11.2	11.3	0.2%	28.2%	Negligible (A)
14	40	12.5	9.4	9.5	0.1%	23.6%	Negligible (A)
15	40	13.9	10.3	10.3	0.2%	25.9%	Negligible (A)

Receptors	Annual Mean						
	AQS (µg m-3)	2019 BC (µg m-3)	2024 DM (µg m-3)	2024 DS (µg m-3)	% Change relative to AQS	% DC OF AQS	Effect
16	40	17.1	12.8	13.0	0.6%	32.6%	Negligible (A)
17	40	17.8	13.3	13.6	0.7%	34.0%	Negligible (A)
18	40	10.2	8.1	8.1	0.1%	20.3%	Negligible (A)
19	40	24.1	17.1	17.7	1.6%	44.2%	Negligible (A)
20	40	18.9	14.5	14.8	0.7%	36.9%	Negligible (A)

5.2.2 Assessment of Particulate Matter (PM_{10})

Table 5-6 presents the annual mean PM_{10} concentrations predicted at all receptors linked with the proposed development for all scenarios, and a comparison against the 40 µg/m³ annual mean AQS objective.

The maximum predicted annual mean PM_{10} concentration at any receptor in scenario 2019 BC was **12.6 µg/m³**, located at Receptor 19. The maximum predicted annual mean PM_{10} concentration at receptors in scenario 2024 DM was **12.0 µg/m³**. The maximum predicted annual mean PM_{10} concentration at receptors in scenario 2024 DS was **12.3 µg/m³** at Receptor 20.

The maximum percentage change from 2025 DM to 2025 DS, relative to the AQS, at any modelled receptor was an **0.6%** at Receptor 19.

PM_{10} annual mean concentrations predicted at all receptors associated with the proposed development in all scenarios are well below the annual mean AQS objective. Furthermore, in the determination of overall significance, in line with EPUK/IAQM guidance, the **impact at all receptors** has been assessed as being **negligible**. On this basis, it is considered that the proposed development site is considered suitable for the proposed use, and will not lead to any new exceedances.

Table 5-6 – Predicted Annual Mean PM_{10} Concentrations

Receptors	Annual Mean						
	AQS (µg m-3)	2019 BC (µg m-3)	2024 DM (µg m-3)	2024 DS (µg m-3)	% Change relative to AQS	% DC OF AQS	Effect
1	40	12.2	11.5	11.5	<0.1%	28.8%	Negligible (A)
2	40	11.3	10.7	10.7	<0.1%	26.7%	Negligible (A)
3	40	11.0	10.3	10.3	<0.1%	25.9%	Negligible (A)
4	40	12.8	12.1	12.1	<0.1%	30.1%	Negligible (A)
5	40	11.1	10.5	10.5	<0.1%	26.2%	Negligible (A)
6	40	11.5	10.9	10.9	<0.1%	27.2%	Negligible (A)
7	40	12.2	11.5	11.6	0.1%	29.0%	Negligible (A)
8	40	13.1	12.5	12.6	0.3%	31.6%	Negligible (A)
9	40	12.1	11.5	11.5	0.2%	28.9%	Negligible (A)
10	40	11.3	10.7	10.7	<0.1%	26.8%	Negligible (A)
11	40	11.4	10.8	10.8	<0.1%	27.1%	Negligible (A)
12	40	11.0	10.4	10.4	<0.1%	25.9%	Negligible (A)
13	40	11.5	10.8	10.9	<0.1%	27.1%	Negligible (A)
14	40	11.2	10.5	10.5	<0.1%	26.3%	Negligible (A)
15	40	11.4	10.7	10.7	<0.1%	26.8%	Negligible (A)

Receptors	Annual Mean						
	AQS ($\mu g\ m^{-3}$)	2019 BC (µg m-3)	2024 DM (µg m-3)	2024 DS (µg m-3)	% Change relative to AQS	% DC OF AQS	Effect
16	40	12.2	11.6	11.7	0.2%	29.2%	Negligible (A)
17	40	12.2	11.7	11.8	0.3%	29.4%	Negligible (A)
18	40	10.4	9.7	9.8	<0.1%	24.4%	Negligible (A)
19	40	12.6	12.0	12.3	0.6%	30.7%	Negligible (A)
20	40	12.0	11.3	11.4	0.3%	28.4%	Negligible (A)

At all receptors considered within this assessment, the maximum number of predicted exceedances of the 24-hour PM_{10} 50 µg/m^3 AQS objective out of all scenarios was 0 days at all receptors.

5.2.3 Assessment of Particulate Matter ($PM_{2.5}$)

Table 5-7 presents the annual mean $PM_{2.5}$ concentrations predicted at all receptors linked with the proposed development for all scenarios, and a comparison against the 20 µg/m^3 annual mean AQS objective.

The maximum predicted annual mean $PM_{2.5}$ concentration at receptors in scenario 2019 BC was 8.2 µg/m^3, located at Receptor 19. The maximum predicted annual mean $PM_{2.5}$ concentration at receptors in scenario 2024 DM was 7.6 µg/m^3, located once again at Receptor 19. The maximum predicted annual mean $PM_{2.5}$ concentration at receptors in scenario 2025 DS was 7.8 µg/m^3 at Receptor 19.

The maximum percentage change from 2024 DM to 2025 D4, relative to the AQS, at all modelled receptors was an increase of **0.6%** at Receptor 19, this is very low and indicates that the development will not lead to a deterioration in air quality with regards to $PM_{2.5}$.

$PM_{2.5}$ annual mean concentrations predicted at all receptors associated with the proposed development in all scenarios are well below the annual mean AQS objective. Furthermore, in the determination of overall significance, in line with EPUK/IAQM guidance, the **impact at all receptors** has been assessed as being **negligible**. On this basis it is considered that the proposed development site is considered suitable for the proposed use, and will not lead to any new exceedances.

Table 5-7 – Predicted Annual Mean $PM_{2.5}$ Concentrations

Receptors	Annual Mean						
	AQS ($\mu g\ m^{-3}$)	2019 BC (µg m-3)	2024 DM (µg m-3)	2024 DS (µg m-3)	% Change relative to AQS	% DC OF AQS	Effect
1	25	7.5	6.9	6.9	<0.1%	27.7%	Negligible (A)
2	25	7.2	6.6	6.6	<0.1%	26.6%	Negligible (A)
3	25	7.0	6.4	6.4	<0.1%	25.8%	Negligible (A)
4	25	7.5	7.0	7.0	<0.1%	27.9%	Negligible (A)
5	25	6.9	6.4	6.4	<0.1%	25.6%	Negligible (A)
6	25	7.1	6.6	6.6	<0.1%	26.4%	Negligible (A)
7	25	7.5	6.9	7.0	0.1%	27.8%	Negligible (A)
8	25	8.3	7.7	7.8	0.3%	31.1%	Negligible (A)
9	25	7.7	7.1	7.1	0.2%	28.6%	Negligible (A)
10	25	7.2	6.7	6.7	<0.1%	26.7%	Negligible (A)
11	25	7.2	6.7	6.7	<0.1%	26.9%	Negligible (A)

Receptors	Annual Mean						
	AQS (µg m^{-3})	2019 BC (µg m-3)	2024 DM (µg m-3)	2024 DS (µg m-3)	% Change relative to AQS	% DC OF AQS	Effect
12	25	7.4	6.9	6.9	<0.1%	27.4%	Negligible (A)
13	25	7.5	6.9	6.9	<0.1%	27.7%	Negligible (A)
14	25	7.5	6.9	7.0	<0.1%	27.8%	Negligible (A)
15	25	7.6	7.1	7.1	<0.1%	28.3%	Negligible (A)
16	25	7.7	7.2	7.2	0.2%	28.9%	Negligible (A)
17	25	7.7	7.2	7.3	0.2%	29.1%	Negligible (A)
18	25	6.9	6.3	6.3	<0.1%	25.4%	Negligible (A)
19	25	8.2	7.6	7.8	0.6%	31.1%	Negligible (A)
20	25	7.8	7.2	7.3	0.3%	29.1%	Negligible (A)

6 Recommended Mitigation Measures

6.1 Short-term Impacts during Construction – Dust / PM_{10} Emissions

As discussed in Section 5.1, construction impacts associated with the proposed development would result in the generation of dust and PM_{10}. However, it is considered that employment of construction best practice should ensure that no problematic dust or PM_{10} concentrations occur during the construction process.

The IAQM guidance outlines a number of site-specific mitigation measures based on the assessed site risk. The measures are grouped into those which are highly recommended and those which are desirable.

As the site is classed as **low risk** the following mitigation measures are **highly recommended**:

With respect to communications:

- Display the name and contact details of person(s) 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.

With respect to site management:

- 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 offsite, and the action taken to resolve the situation in the log book.

With respect to monitoring:

- Carry out regular site inspections to monitor compliance with the DMP, 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.

With respect to 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.

With respect to operating vehicle/machinery and sustainable travel:

- Ensure all on-road vehicles comply with the requirements of the London Low Emission Zone and the London NRMM standards, where applicable.
- 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.
- Implement a Travel Plan that supports and encourages sustainable travel (public transport, cycling, walking, and car-sharing).

With respect to 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.

With respect to waste management

- Avoid bonfires and burning of waste materials.

As the site is classed as low risk the following mitigation measures are desirable:

With respect to communications:

- Develop and implement a Dust Management Plan (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 in this document. The desirable measures should be included as appropriate for the site. In London additional measures may be required to ensure compliance with the Mayor of London's guidance. The DMP may include monitoring of dust deposition, dust flux, real time PM10 continuous monitoring and/or visual inspections.

With respect to monitoring:

- 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 when 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.

With respect to preparing and maintaining the site:

- Fully enclose site or specific operations where there is a high potential for dust production and the site is actives for an extensive period.
- 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.

With respect to operating vehicle/machinery and sustainable travel:

- Impose and signpost a maximum-speed-limit of 15 mph on surfaced and 10 mph on unsurfaced haul roads and work areas (if long haul routes are required these speeds may be increased with suitable additional control measures provided, subject to the approval of the nominated undertaker and with the agreement of the local authority, where appropriate).

With respect to operations:

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

7 Conclusions

Bureau Veritas UK Ltd has been commissioned by H-Pack Packaging UK Ltd. to undertake an air quality assessment to support a planning application for the Erection of 1no B8 Storage and Distribution building and associated access and external works at Land adjacent to H-Pack, Davy Way, Llay. The following section provides the conclusions of this assessment.

7.1 Construction Effects – Dust / PM_{10} Emissions

The assessment of dust and PM_{10} effects from the construction phase of the development was subject to a qualitative assessment following IAQM guidance. Effective mitigation measures for fugitive dusts would be implemented under site management controls by the development company within a site-specific CEMP inclusive of a DMP.

With such mitigation in place, the assessment carried out has shown that any off-site impacts from dust emissions during the construction phase would be **not significant**.

7.2 Operational Effects – Road Traffic Emissions

The assessment of air quality effects in relation to the development's operational phase has been initially undertaken qualitatively in accordance with EPUK/IAQM Guidance.

Relevant pollutant monitoring completed close to the Site, coupled with additional supporting data from the Defra background mapping tool suggests that pollutant levels in the vicinity of the site are generally below the relevant annual mean AQS objectives. Predicted NO_2 annual mean concentrations modelled at future receptors which will be introduced as part of the development are well below the AQS objective, except Receptor 20 predicting exceedances in 2019 BC, 2025 DN and DS, this receptor is located within Newcastle City Centre's AQMA. Diffusion tube monitoring located north of this receptor reports exceedances of the NO_2 AQS objective. Therefore, it is unlikely that any new sensitive receptors will be introduced into an area of poor air quality from the proposed development.

The maximum percentage change in NO_2 concentrations relative to the AQS at any modelled receptor from 2024 DM to 2024 DS was 1.6**%**. With regards to NO_2, the impact is classed as **negligible** in line with EPUK/IAQM guidance.

In line with EPUK and IAQM guidance, the impact of the proposed development's operational phase on local air quality is considered **not significant,** as all pollutants modelled have shown to have **negligible** impact on local receptors from the change in traffic flows.

Appendices

Appendix 1 – Background to Air Quality

Emissions from road traffic contribute significantly to ambient pollutant concentrations in urban areas. The main constituents of vehicle exhaust emissions produced by fuel combustion are carbon dioxide (CO_2) and water vapour (H_2O). However, combustion engines are not 100% efficient and partial combustion of fuel results in emissions of a number of other pollutants, including carbon monoxide (CO), particulate matter (PM), Volatile Organic Compounds (VOCs) and hydrocarbons (HC). For HC, the pollutants of most concern are 1,3 - butadiene (C_4H_6) and benzene (C_6H_6). In addition, some of the nitrogen (N) in the air is oxidised under the high temperature and pressure during combustion; resulting in emissions of oxides of nitrogen (NO_x). NO_x emissions from vehicles predominately consist of nitrogen oxide (NO), but also contain nitrogen dioxide (NO_2). Once emitted, NO can be oxidised in the atmosphere to produce further NO_2.

The quantities of each pollutant emitted depend upon a number of parameters; including the type and quantity of fuel used, the engine size, the vehicle speed, and the type of emissions abatement equipment fitted. Once emitted, these pollutants disperse in the air. Where there is no additional source of emission, pollutant concentrations generally decrease with distance from roads, until concentrations reach those of the background.

This air quality assessment focuses on NO_2 and PM_{10} (PM of aerodynamic diameter less than 10µm) as these pollutants are least likely to meet their respective Air Quality Strategy (AQS) objectives near roads. This has been confirmed over recent years by the outcome of the Local Air Quality Management (LAQM) regime. The most recent statistics[23] regarding Air Quality Management Areas (AQMAs) show that approximately 650 AQMAs are declared in the UK. The majority of existing AQMAs have been declared in relation to road traffic emissions.

In line with these results, the reports produced by the Council under the LAQM regime have confirmed that road traffic within their administrative area is the main issue in relation to air quality.

An overview of these two pollutants, briefly describing the sources and processes influencing the ambient concentrations, is presented below.

Particulate Matter (PM_{10} and $PM_{2.5}$)

Particulate matter is a mixture of solid and liquid particles suspended in the air. There are a number of ways in which airborne PM may be categorised. The most widely used categorisation is based on the size of particles such as $PM_{2.5}$, particles of aerodynamic diameter less than 2.5 µm (micrometre = 10^{-6} metre), and PM_{10}, particles of aerodynamic diameter less than 10 µm. Generically, particulate residing in low altitude air is referred to as Total Suspended Particulate (TSP) and comprises coarse and fine material including dust.

Particulate matter comprises a wide range of materials arising from a variety of sources. Examples of anthropogenic sources are carbon (C) particles from incomplete combustion, bonfire ash, recondensed metallic vapours, and secondary particles (or aerosols) formed by chemical reactions in the atmosphere. As well as being emitted directly from combustion sources, man-made particles can arise from mining, quarrying, demolition, and construction operations, from brake and tyre wear in motor vehicles and from road dust resuspension from moving traffic or strong winds. Natural sources of PM include wind-blown sand and dust, forest fires, sea salt and biological particles such as pollen and fungal spores.

The health impacts from PM depend upon size and chemical composition of the particles. For the purposes of the AQS objectives, PM_{10} or $PM_{2.5}$ is solely defined on size rather than chemical composition. This enables a uniform method of measurement and comparison. The short and long-term exposure to PM has been associated with increased risk of lung and heart diseases.PM may also carry surface-absorbed carcinogenic compounds. Smaller PM have a greater likelihood of

[23] Statistics from the UK AIR website available at https://uk-air.defra.gov.uk/aqma/summary – Figures as of November 2019

penetrating the respiratory tract and reaching the lung to blood interface and causing the above adverse health effects.

In the UK, emissions of PM_{10} have declined significantly since 1980, and were estimated to be 114kt (kilotonne) in 2010[24]. Residential / public electricity and heat production and road transport are the largest sources of PM_{10} emissions. The road transport sector contributed 22% (25 kt) of PM_{10} emissions in 2010. The main source within road transport is brake and tyre wear.

It is important to note that these estimates only refer to primary emissions, that is, the emissions directly resulting from sources and processes and do not include secondary particles. These secondary particles, which result from the interaction of various gaseous components in the air such as ammonia (NH_3), sulphur dioxide (SO_2) and NO_x, can come from further afield and impact on the air quality in the UK and vice versa.

Similarly, to PM_{10}, emissions of $PM_{2.5}$ have declined since 1970, and were estimated to be 67 kt in 2010, which makes over 58% of PM_{10} emissions. In 2010, the road transport sector emitted 28% (18 kt) of the total $PM_{2.5}$ emissions in the UK.

Nitrogen Oxides (NO_x)

NO and NO_2, collectively known as NO_x, are produced during the high temperature combustion processes involving the oxidation of N. Initially, NO_x is mainly emitted as NO, which then undergoes further oxidation in the atmosphere, particularly with ozone (O_3), to produce secondary NO_2. Production of secondary NO_2 could also be favoured due to a class of compounds, VOCs, typically present in urban environments, and under certain meteorological conditions, such as hot sunny days and stagnant anti-cyclonic winter conditions.

Of NO_x, it is NO_2 that is associated with health impacts. Exposure to NO_2 can bring about reversible effects on lung function and airway responsiveness. It may also increase reactivity to natural allergens, and exposure to NO_2 puts children at increased risk of respiratory infection and may lead to poorer lung function in later life.

In the UK, emissions of NO_x have decreased by 62% between 1990 and 2010. For 2010, NO_x (as NO_2) emissions were estimated to be 1,106kt. The transport sector remained the largest source of NO_x emissions with road transport contribution 34% to NO_x emissions in 2010.

[24] National Atmospheric Emissions Inventory (NAEI) Summary Emission Estimate Datasets 2010. March 2012

Appendix 2 – Proposed Site Layout

Appendix 3 – ADMS 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)[3] guidance as an accepted dispersion model.

Model validation undertaken by the software developer (CERC) will not have included validation in the vicinity of the proposed development 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.

The predicted results from a dispersion model may differ from measured concentrations for a large number of reasons, including uncertainties associated with:

- Background concentration estimates;
- Source activity data such as traffic flows and emissions factors;
- Monitoring data, including locations; and
- Overall model limitations.

Model verification is the process by which these and other uncertainties are investigated and where possible minimised. In reality, the differences between modelled and monitored results are likely to be a combination of all of these aspects.

Model setup parameters and input data were checked prior to running the models in order to reduce these uncertainties. The following were checked to the extent possible to ensure accuracy:

- Traffic data;
- Distance between sources and monitoring as represented in the model;
- Speed estimates on roads;
- Background monitoring and background estimates; and
- Monitoring data.

As outlined in Section 4.3.1.1, Cameron Rose have provided the changes in traffic with the development in the Do Minimum and Do Something 2024 Scenario's for this assessment. Baseline traffic data has been provided in combination of DfT count point data and transport consultant data,

For model verification, 2019 passive monitoring data collected by the Council, as presented in Table A-1 and Figure 3-1, has been used.

PM_{10} and $PM_{2.5}$ results have been verified by applying the adjustment factor which was determined for NO_x/NO_2. This is considered valid as LAQM.TG(22) states the following:

> *'It may be appropriate to apply the road-NO_x adjustment to the modelled road-PM_{10}. If this identifies exceedances of the objective, then it would be appropriate to monitor PM_{10} to confirm the findings.'*

Table A-1 – Local Monitoring Data Available for Model Verification

Site ID	OS Grid Reference		Height	2019 Annual Mean NO_2 (µg/m³)
	X	Y		
33	333078	355649	1	11.8
57	336635	357211	1.5	16.9

NO_2 Verification Calculations

The verification of the modelling output was performed in accordance with the guidance provided in Chapter 7 of LAQM.TG(22)[2]. For the verification and adjustment of NO_x/NO_2, the 2019 data from 4 of the available Council NO_2 diffusion tube monitoring locations, as presented in Table A-1 was used. The remainder of the Council's monitoring network was located outside of the modelled road network.

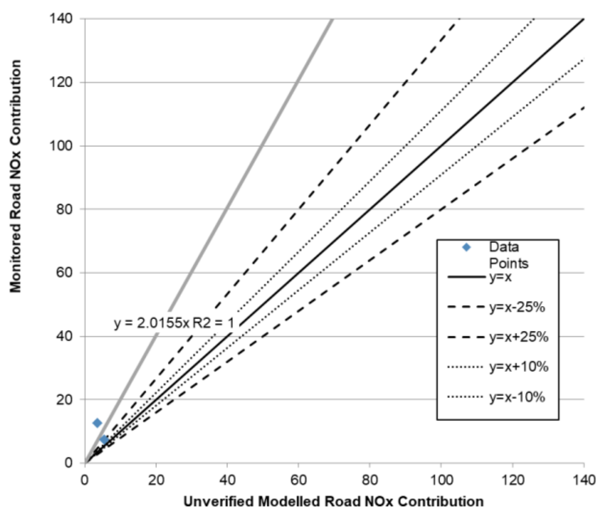
Table A-2 below shows an initial comparison of the monitored and unverified modelled NO_2 results for the year 2019, in order to determine if verification and adjustment was required.

Table A-2 – Comparison of Unverified Modelled and Monitored NO2 Concentrations

Site ID	Monitored total NO_2 (µg/m³)	Modelled total NO_2 (µg/m³)	% Difference (modelled vs. monitored)
55	11.8	10.7	-9.4
37	16.9	11.2	-34.0

As the unverified model is outside the 25% difference acceptable as per LAQM TG(22), further model verification has been undertaken.

Figure A-1 – Unverified Modelled Road NO_x Contribution



Model adjustment needs to be undertaken for road NO_x rather than NO_2. For the monitoring results used in the calculation of the model adjustment, NO_x was derived from NO_2; these calculations were undertaken using the NO_x to NO_2 Calculator (version 8.1) spreadsheet tool available from the LAQM website.

The results for the final verification factor are presented in Table A-3. All diffusion tube locations are within the ±25% acceptance level. Alongside this, the RMSE for this verification is 3.0µg/m^3 indicating that this finalised verification is performing accurately. The verification factor used for the receptors in this AQA is 2.015.

Table A-3 – Final Verification

Site ID	Ratio of monitored road contribution NO_x / modelled road contribution NO_x	Adjustment factor for modelled road contribution NO_x	Adjusted modelled road contribution NO_x (µg/m^3)	Adjusted modelled total NO_x (including background NO_x) (µg/m^3)	Modelled total NO_2 (based upon empirical NO_x / NO_2 relationship) (µg/m^3)	Monitored total NO_2 (µg/m^3)	% Difference (adjusted modelled NO_2 vs. monitored NO_2)
55	1.37	2.015	11.1	20.8	13.7	11.8	16.4
37	3.55		7.2	16.4	13.1	16.9	-22.2

Figure A-2 – Verified Modelled Road NO_x Contribution

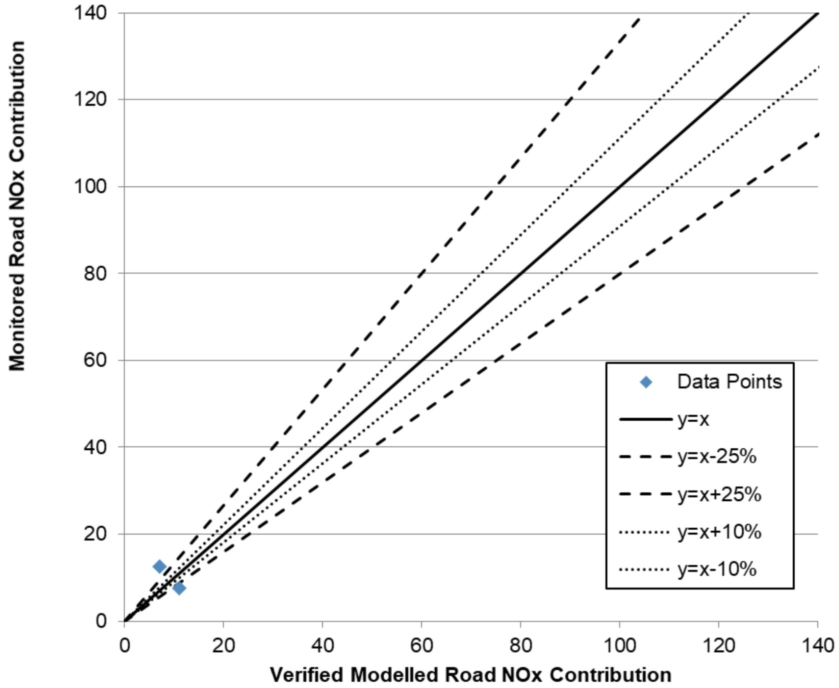


Figure A-3 – Verified Modelled Total NO_2