AIR QUALITY IMPACT ASSESSMENT

AT: Penistone Road – Fenay Bridge

CLIENT: Newett Homes

DATE: Septemebr 2022

STROMA PROJECT REF: PRO-078170

Please find below the link to the online feedback form:

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1 INTRODUCTION

1.1 Scope

Stroma Built Environment Ltd has been commissioned to undertake an air quality impact assessment based on the potential impacts of existing and future traffic levels on the proposed residential unit. The pollutants modelled as part of this assessment are nitrogen oxides (NOx) and particulate matter (PM_{10}).

The impacts of vehicle emissions have been assessed using the techniques detailed within Volume 11, Section 3 of the Design Manual for Roads and Bridges (DMRB)[1] and the Local Air Quality Management Technical Guidance (LAQM.TG16)[2]. The impact of road traffic emissions will be assessed using the ADMS-Roads air dispersion model. This model has been devised by Cambridge Environmental Research Consultants (CERC) and is described as a "*comprehensive tool for investigating air pollution problems due to small networks of roads*".

It should be noted that the short-term impacts of NO_2 and PM_{10} emissions have not been modelled as dispersion models are inevitably poor at predicting short-term peaks in pollutant concentrations, which are highly variable from year to year, and from site to site. Notwithstanding this, general assumptions have been made about short term concentrations based on the modelled annual mean concentrations.

An assessment on the potential impact on local air quality from demolition and construction activities at the site has been undertaken. Some of the information required for the construction assessment was unavailable at the time of reporting, so a reasonable worst case scenario has been assumed.

1.2 Site Description

The proposed development site is located to the east of Penistone Road, Kirklees. A location plan can be found in Figure 1.

Figure 1 – Site Location Plan

1 Design Manual for Roads and Bridges, Vol 11, Section 3, Part 1 – HA207/07, Highways Agency, May 2007
2 Part IV of the Environment Act 1995, Local Air Quality Management Technical Guidance (TG16), Defra, February 2018

2 POLLUTANTS & LEGISLATION

2.1 Pollutant Overview

In most urban areas of the UK, traffic generated pollutants have become the most common pollutants. These are nitrogen dioxide (NO_2), fine particulates (PM_{10}), carbon monoxide (CO), 1,3-butadiene and benzene, as well as carbon dioxide (CO_2). This air quality assessment focuses on NO_2 and PM_{10}, as these pollutants are least likely to meet their Air Quality Strategy objectives near roads. Table 1 provides an overview of NO_2 and PM_{10}.

Table 1 – Overview of NO_2 and PM_{10}

Pollutant	Properties	Anthropogenic Sources	Natural Sources	Potential Effects
Particles (PM_{10})	Tiny particulates of solid or liquid nature suspended in the air	Road transport; Power generation plants; Production processes e.g. windblown dust	Soil erosion; Volcanoes; Forest fires; Sea salt crystals	Asthma; Lung cancer; Cardiovascular problems
Nitrogen Dioxide (NO_2)	Reddish-brown coloured gas with a distinct odour	Road transport; Power generation plants; Fossil fuels – extraction & distribution; Petroleum refining	No natural sources, although nitric oxide (NO) can form in soils	Pulmonary edema; Various environmental impacts e.g. acid rain

2.2 Air Quality Strategy

The UK Government and the devolved administrations published the latest Air Quality Strategy for England, Scotland, Wales and Northern Ireland on 17 July 2007[3]. The Strategy provides an over-arching strategic framework for air quality management in the UK.

With regards to this assessment, the Air Quality Strategy contains national air quality standards and objectives established by the Government to protect human health. The objectives for nitrogen dioxide and particulates (PM_{10} and $PM_{2.5}$) have been set, along with seven other pollutants (benzene, 1,3-butadiene, carbon monoxide, lead, PAHs, sulphur dioxide and ozone). Those which are limit values required by EU Daughter Directives on Air Quality have been transposed into UK law through the Air Quality Standards Regulations 2010 which came into force on 11th June 2010 and amended in The Air Quality Standards (Amendment) Regulations 2016. Table 2 provides the UK Air Quality Objectives for NO_2 and PM_{10}.

[3] The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, Department for Environment, Food and Rural Affairs in partnership with the Scottish Executive, Welsh Assembly Government and Department of the Environment Northern Ireland, July 2007

Table 2 – UK Air Quality Objectives for Nitrogen Dioxide and Particulate Matter

Pollutant	Objective	Concentration measured as
Nitrogen Dioxide (NO_2)	200µg/m^3 not to be exceeded more than 18 times a year	1 hour mean
	40µg/m^3	Annual mean
Particles (PM_{10})	50µg/m^3 not to be exceeded more than 35 times a year	24 hour mean
	40µg/m^3	Annual mean
Particles ($PM_{2.5}$)	25µg/m^3 (except Scotland)	Annual Mean

Objectives for $PM_{2.5}$ were also introduced by the UK Government and the Devolved Administrations in 2010. However, these are not included in Regulations as the Air Quality Strategy has adopted an "exposure reduction" approach for $PM_{2.5}$ in order to seek a more efficient way of achieving further reductions in the health effects of air pollution by providing a driver to improve air quality everywhere in the UK rather than just in a small number of localised hotspot areas.

As defined in Table 4, background $PM_{2.5}$ concentrations are well below the limit value of 25 µg/m^3. As such, no further consideration has been given to $PM_{2.5}$ within this assessment.

2.3 Local Air Quality Management (LAQM)

At the core of LAQM delivery are three pollutant objectives; these are: nitrogen dioxide (NO_2), particulate matter (PM_{10}) and sulphur dioxide (SO_2). All current Air Quality Management Areas (AQMAs) across the UK are declared for one or more of these pollutants, with NO_2 accounting for the majority. It is a statutory requirement for local authorities to regularly review and assess air quality in their area and take action to improve air quality when objectives set out in regulation cannot be met.

2.3.1 Kirklees Metropolitan Council

Kirklees Metropolitan Council has declared ten Air Quality Management Areas (AQMAs). The proposed development is adjacent to the nearest AQMA.

3 PLANNING POLICY & GUIDANCE

3.1 National Planning Policy & Guidance

3.1.1 National Planning Policy Framework

On a national level, air quality can be a material consideration in planning decisions. The National Planning Policy Framework (NPPF)[4] for England, revised and released on 20th July 2021, is considered a key part of the Governments reforms to make the planning system less complex and more accessible, to protect the environment and to promote sustainable growth. The NPPF replaces the Planning Policy Statement 23 (PPS23) Planning and Pollution Control[5].

Paragraph 174 within the NPPF states that "planning policies and decisions should contribute to and enhance the natural and local environment" and that developments "should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans"

It goes on to state in paragraph 186 that "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 development in Air Quality Management Areas and Clean Air Zones is consistent with the local air quality action plan".

3.1.2 Land-Use Planning & Development Control

In January 2017, Environmental Protection UK (EPUK) and the Institute of Air Quality Management (IAQM) produced guidance to ensure that air quality is adequately considered in the land-use planning and development control processes[6].

The guidance document is particularly applicable to assessing the effect of changes in exposure of members of the public resulting from residential and mixed-use developments, especially those within urban areas where air quality is poorer. It is also relevant to other forms of development where a proposal could affect local air quality and for which no other guidance exists.

3.1.3 Local Air Quality plan

The site is located in an area covered by the WYLES guidance. This covers classification of developments and potential mitigation to offset emissions. These can range from physical mitigation measures such as bike hiring schemes and local sourcing of staff to damage costs.

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[4] National Planning Policy Framework, Secretary of State for Ministry of Housing, Communities and Local Government, February 2019

[5] Planning Policy Statement 23: Planning and Pollution Control, Office of the Deputy Prime Minister (ODPM), November 2004

[6] Land-Use Planning & Development Control: Planning for Air Quality. Guidance from Environmental Protection UK and the Institute of Air Quality Management for the consideration of air quality within the land-use planning and development control processes. EPUK & IAQM. January 2017

4 ASSESSMENT METHODOLOGY

4.1 Construction Phase

The Institute of Air Quality Management (IAQM) has published guidance on the assessment of dust from construction and demolition[7]. Based on this guidance, the main air quality impacts that may arise during construction activities are:

- Dust deposition, resulting in the soiling of surfaces;
- Visible dust plumes, which are evidence of dust emissions;
- Elevated PM_{10} concentrations, as a result of dust generating activities on site; and
- An increase in concentrations or airborne particles and nitrogen dioxide due to exhaust emissions from diesel powered vehicles and equipment on site.

In relation to the most likely impacts, the guidance states the following:

"*The most common impacts are dust soiling and increased ambient PM_{10} concentrations due to dust arising from activities on the site. Dust soiling will arise from the deposition of particulate matter in all size fractions.*

Experience of assessing the exhaust emissions from on-site plant (also known as non-road mobile machinery or NRMM) and site traffic suggests that they are unlikely to make a significant impact on local air quality, and in the vast majority of cases they will not need to be quantitatively assessed".

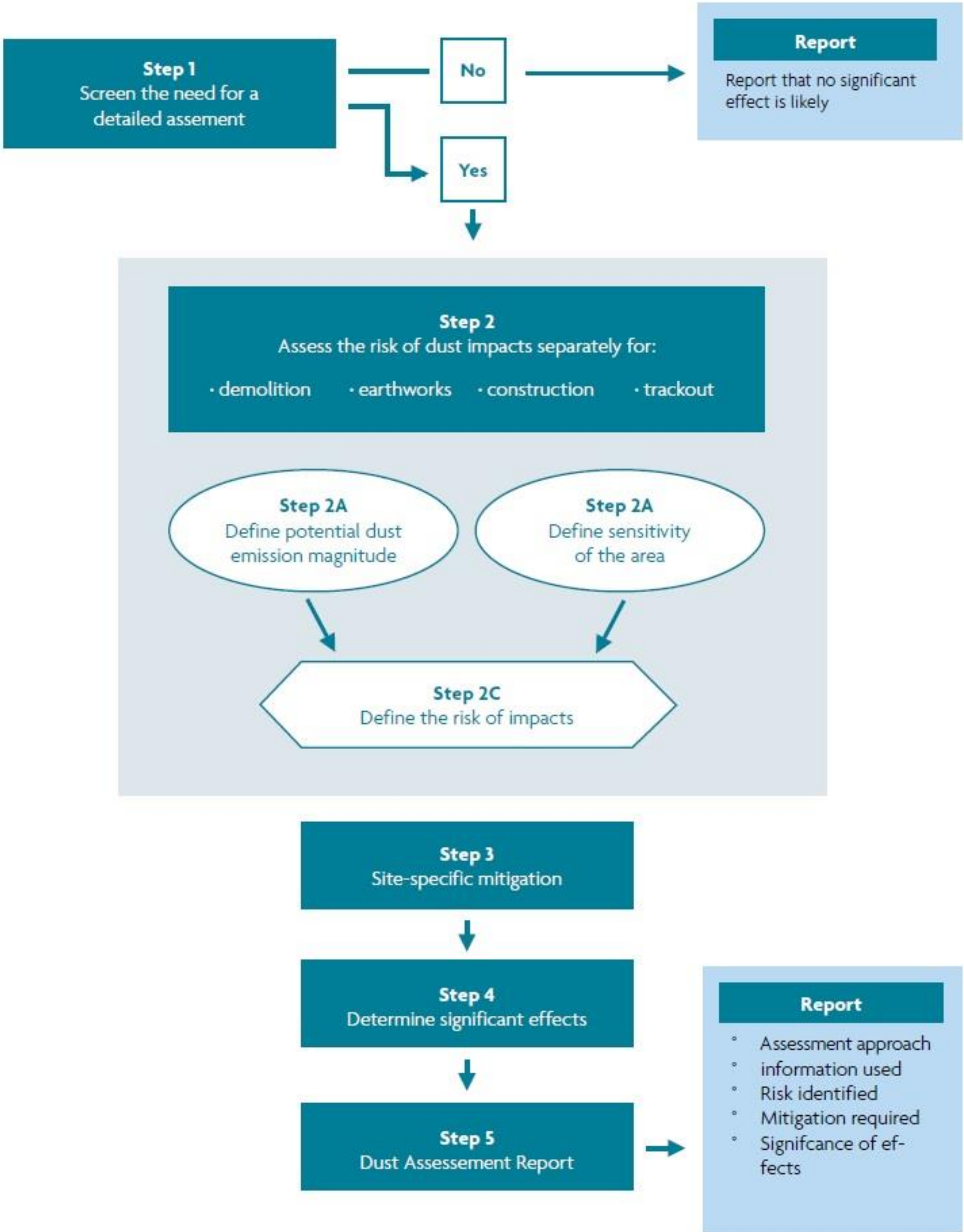
The guidance continues by providing an assessment procedure. This includes sub-dividing construction activities into four types to reflect their different potential impacts. These are as follows:

- Demolition;
- Earthworks;
- Construction; and
- Track out.

With regards to the proposed development the potential for dust emissions is assessed for each activity that is likely to take place. The assessment procedure assumes no mitigation measures are applied. The conditions with no mitigation thus form the baseline or "do-nothing" situation for a construction site. The assessment procedure uses the steps provided in the guidance and summarised in Figure 2.

[7] Holman et al (2016). IAQM Guidance on the assessment of dust from demolition and construction, Institute of Air Quality Management, London. www.iaqm.co.uk/text/guidance/construction-dust-2014.pdf

Figure 2 – Dust Assessment Procedure



4.2 Operational Phase

4.2.1 Modelled Scenarios

A modelled baseline year of 2019 has been used as this corresponds with the latest year of monitoring undertaken by the Council. The future year has also been chosen (2025) representing the first full year with the proposed development in place. Three scenarios have been adopted as part of the assessment. These are as follows:

- **Scenario 1 –** existing levels of air quality / model verification (2019); and

- **Scenario 2 –** future impact of traffic emissions on the proposed development i.e. introduction of new exposure (2025).

- **Scenario 3 –** 2025 Future Baseline + Proposed Development

Predicted concentrations will be compared to the Air Quality Strategy objectives. Background pollutant concentrations and vehicle emission rates for all modelled years are based on the latest data issued by Defra. These background concentrations and emission factors are discussed further in the following sections.

4.2.2 ADMS-Roads

Modelling the impact of traffic emissions on the proposed development will be undertaken using the latest version of the ADMS-Roads model[8]. ADMS-Roads is significantly more advanced than that of most other air dispersion models in that it incorporates the latest understanding of the boundary layer structure, and goes beyond the simplistic Pasquill-Gifford stability categories method with explicit calculation of important parameters. The model uses advanced algorithms for the height-dependence of wind speed, turbulence and stability to produce improved predictions.

4.2.3 Emission Factors

Defra and the Devolved Administrations have provided an updated Emission Factors Toolkit (Version 11.0) which incorporates updated NOx emissions factors and vehicle fleet information[9]. These emission factors have been integrated into the latest ADMS-Roads modelling software. However, in order to undertake a worst-case assessment emission factors for 2019 have been used for all modelled years.

4.2.4 Traffic Data

Traffic flow data has been provided by the DfT website and the Transport Assessment provided by the client and is summarised in Table 3. From this traffic data, roads which are changing by greater than 500AADT have been identified to obtain the 'Affected Road Network'. Whilst none of the roads meet the criteria, they have been modelled.

Roads around the verification locations will be modelled for the purposes of model verification. Baseline flows for these links have been downloaded from the Department for Transport (DFT). Baseline data has been projected to the model scenario years with the projection of traffic data undertaken using growth factors specific to Kirklees, obtained from TEMPro11.

For the modelled speeds, the figures provided in Table 3 have been used. However, where a link approaches a junction a speed of between of 20 kmph has been modelled in order to represent queuing traffic at a junction. This is the approach recommended by the Local Air

8 Model Version: 5.0.01. Interface Version 5.0.0.5313 (16/03/2020)
9 https://laqm.defra.gov.uk/documents/EFT2010_v11.0.xlsb

Quality Management Technical Guidance (LAQM.TG16) for modelling queuing traffic at junctions by way of reducing the modelled vehicle speeds.

Table 3 – Annual Average Daily Traffic Flows, Percentage HDV and Speeds for Modelled Roads

Modelled Year/ Scenario	Link	Future Baseline Flows			Future Baseline + Development Flows		
		24-Hr AADT	% HGV	Average Speed (kmph)	24-Hr AADT	% HGV	Average Speed (kmph)
First year of completion (2025)	Penistone Road N	19,425	9.1	64	22,378	8.4	64
	Penistone Road S	19,265	9.1	64	21,714	8.3	64

4.3 Background Concentrations

Background NOx, NO_2 and PM_{10} concentrations have been obtained from Defra[10]. These 1 km x 1 km grid resolution maps are derived from a base year of 2018 (for NOx, NO_2, PM_{10} and $PM_{2.5}$ only), which are then projected to future years up to 2030. Background concentrations of NO_2, PM_{10} and $PM_{2.5}$ derived from Defra are provided in Table 4.

Table 4 – Background NOx, NO_2, PM_{10} and $PM_{2.5}$ Concentrations

Location	Pollutant	X	Y	2019
Proposed Development	NO_2	418500	414500	9.7
	NOx			12.6
	PM_{10}			10.0
	$PM_{2.5}$			6.6

In order to undertake a worst-case assessment, 2019 background concentrations have been assumed for all modelled scenarios.

4.4 Surface Roughness

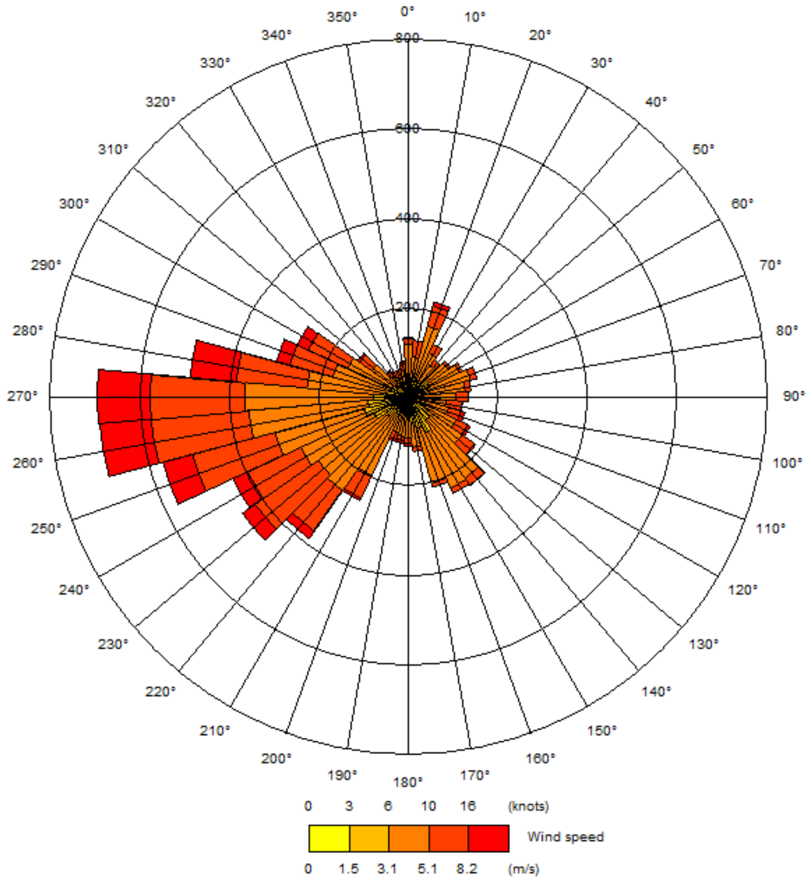
A surface roughness of 1.5 metre has been used in the model. This value is provided by ADMS-Roads as a typical roughness length for large urban areas. This value has been used across the modelled domain.

4.5 Meteorological Data

Hourly sequential meteorological data from the Leeds-Bradford Airport meteorological station has been used. Wind speed and direction data from the Leeds-Bradford Airport meteorological station has been plotted as a wind rose in Figure 3.

10 https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2018

Figure 3 – Wind Speed and Direction Data, Leeds-Bradford Airport (2019)



4.6 Model Output

4.6.1 NOx/NO_2 Relationship

Following recent evidence that shows the proportion of primary NO_2 in vehicle exhaust has increased[11]. As such, a new NOx to NO_2 calculator has been devised[12]. This new calculator has been used to determine NO_2 concentrations for this assessment, based on predicted NOx concentrations using ADMS-Roads. Converted NO_2 concentrations are initially compared to local monitoring data in order to verify the model output. If the model performance is considered unacceptable then the NOx concentrations are adjusted before conversion to NO_2.

4.6.2 Predicted Short Term Concentrations

As discussed in the introduction, it has not been possible to model the short-term impacts of NO_2 and PM_{10}. Research undertaken in 2003[13] has indicated that the hourly NO_2 objective is unlikely to be exceeded at a roadside location where the annual mean NO_2 concentration is less than 60 µg/m^3.

[11] Trends in Primary Nitrogen Dioxide in the UK, Air Quality Expert Group, 2007
[12] https://laqm.defra.gov.uk/documents/NOx_to_NO2_Calculator_v8.1.xlsm
[13] Analysis of Relationship between 1-Hour and Annual Mean Nitrogen Dioxide at UK Roadside and Kerbside Monitoring Sites, Laxen and Marner, 2003

For PM_{10}, a relationship between the annual mean and the number of 24-hour mean exceedances has been devised and is as follows:

- No. 24-hour mean exceedances = -18.5 + 0.00145 x annual mean^3 + (206/annual mean)

This relationship has been applied to the modelled annual mean concentrations in order to estimate the number of 24-hourly exceedances.

4.6.3 Model Verification

The monitoring sites listed in Table 5 have been used for the purposes of model verification. These are the closest monitoring sites to the proposed development.

Table 5 – Modelled Verification Locations

Site ID	Location	X	Y	Height (m)
K52	Penistone Road Waterloo	417627	416472	2.0
K56	Wakefield Road Huddersfield	415009	416420	2.0
K86	Kings Mill Lane	415164	416323	2.0

4.6.4 Receptor Locations

In order to assess the potential impact of the proposed development, receptor locations at the proposed development and receptors located on roads which are changing in traffic as result of the proposed development has been modelled. The location of these model points, together with their height above ground level is provided in Table 6 and represented in Figures 5 and 6.

Table 6 – Modelled Receptor Locations

Air Quality Assessment ID	X	Y	Height (m)
Proposed Development			
1	418554.6	414965.3	1.5
2	418547.8	414922.6	1.5
3	418557.6	414893.7	1.5
4	418569.4	414852.9	1.5
5	418580.3	414831.3	1.5
6	418586.1	414811.8	1.5
7	418592.2	414798.0	1.5
8	418600.1	414778.7	1.5
9	418605.4	414757.9	1.5
10	418610.0	414739.3	1.5
11	418603.7	414721.7	1.5
12	418608.1	414689.7	1.5
Existing Receptors			
1	418624.8	414637.1	1.5
2	418639.2	414579.3	1.5
3	418680.3	414313.0	1.5
4	418697.6	414254.4	1.5
5	418725.3	414216.2	1.5

6	418732.1	414186.0	1.5
7	418750.1	414091.3	1.5
8	418731.4	414026.3	1.5

Figure 4 – Proposed Development modelled receptor locations

4.7 Significance Criteria

4.7.1 Construction Phase

The risk of dust arising in sufficient quantities to cause annoyance and/or health and/or ecological impacts should be determined using four risk categories: negligible, low, medium and high risk. A development is allocated to a risk category based on two factors:

- the scale and nature of the works, which determines the potential dust emission magnitude as small, medium or large (see Table 7); and
- the sensitivity of the area to dust impacts, which is defined as low, medium or high sensitivity.

These two factors are combined to determine the risk of dust impacts with no mitigation applied (see Table 8). The risk category assigned to the development can be different for each of the four potential activities (demolition, earthworks, construction and trackout).

Table 7 – Dust Emission Magnitude

Activity	Dust Emission Class		
	Large	Medium	Small
Demolition	Total building volume >50,000 m^3, potentially dusty construction material (e.g. concrete), on-site crushing and screening, demolition activities >20 m above ground level	Total building volume 20,000 – 50 000m^3, potentially dusty construction material, demolition activities 10-20m above ground level	Total building volume <20,000 m^3, construction material with low potential for dust release (e.g. metal cladding or timber), demolition activities <10m above ground, demolition during wetter months
Earthworks	Total site area >10,000 m^2, potentially dusty soil type (e.g. clay, which will be prone to suspension when dry due to small particle size), >10 heavy earth moving vehicles active at any one time, formation of bunds >8 m in height, total material moved >100,000 tonnes	Total site area 2,500 – 10,000 m^2, moderately dusty soil type (e.g. silt), 5-10 heavy earth moving vehicles active at any one time, formation of bunds 4 m - 8 m in height, total material moved 20,000 tonnes – 100,000 tonnes	Total site area <2,500 m^2, soil type with large grain size (e.g. sand), <5 heavy earth moving vehicles active at any one time, formation of bunds <4 m in height, total material moved <10,000 tonnes, earthworks during wetter months
Construction	Total building volume >100,000 m^3, piling, on site concrete batching; sandblasting	Total building volume 25,000 m^3 – 100,000 m^3, potentially dusty construction material (e.g. concrete), piling, on site concrete batching	Total building volume <25,000 m^3, construction material with low potential for dust release (e.g. metal cladding or timber)
Track out	>50 HDV (>3.5t) trips in any one day, potentially dusty surface material (e.g. high clay content), unpaved road length >100 m	10 – 50 HDV (>3.5t) trips in any one day, moderately dusty surface material (e.g. high clay content), unpaved road length 50m – 100 m;	<10 HDV (>3.5t) trips in any one day, surface material with low potential for dust release, unpaved road length <50 m.

Table 8 – Risk of Dust Impacts

Construction Activity	Sensitivity of Area	Dust Emission Magnitude		
		Large	Medium	Small
Demolition	High	High Risk	Medium Risk	Medium Risk
	Medium	High Risk	Medium Risk	Low Risk
	Low	Medium Risk	Low Risk	Negligible
Earthworks	High	High Risk	Medium Risk	Low Risk
	Medium	Medium Risk	Medium Risk	Low Risk
	Low	Low Risk	Low Risk	Negligible
Construction	High	High Risk	Medium Risk	Low Risk
	Medium	Medium Risk	Medium Risk	Low Risk
	Low	Low Risk	Low Risk	Negligible
Track out	High	High Risk	Low Risk	Low Risk
	Medium	Medium Risk	Low Risk	Negligible
	Low	Low Risk	Low Risk	Negligible

4.7.2 Operational Phase

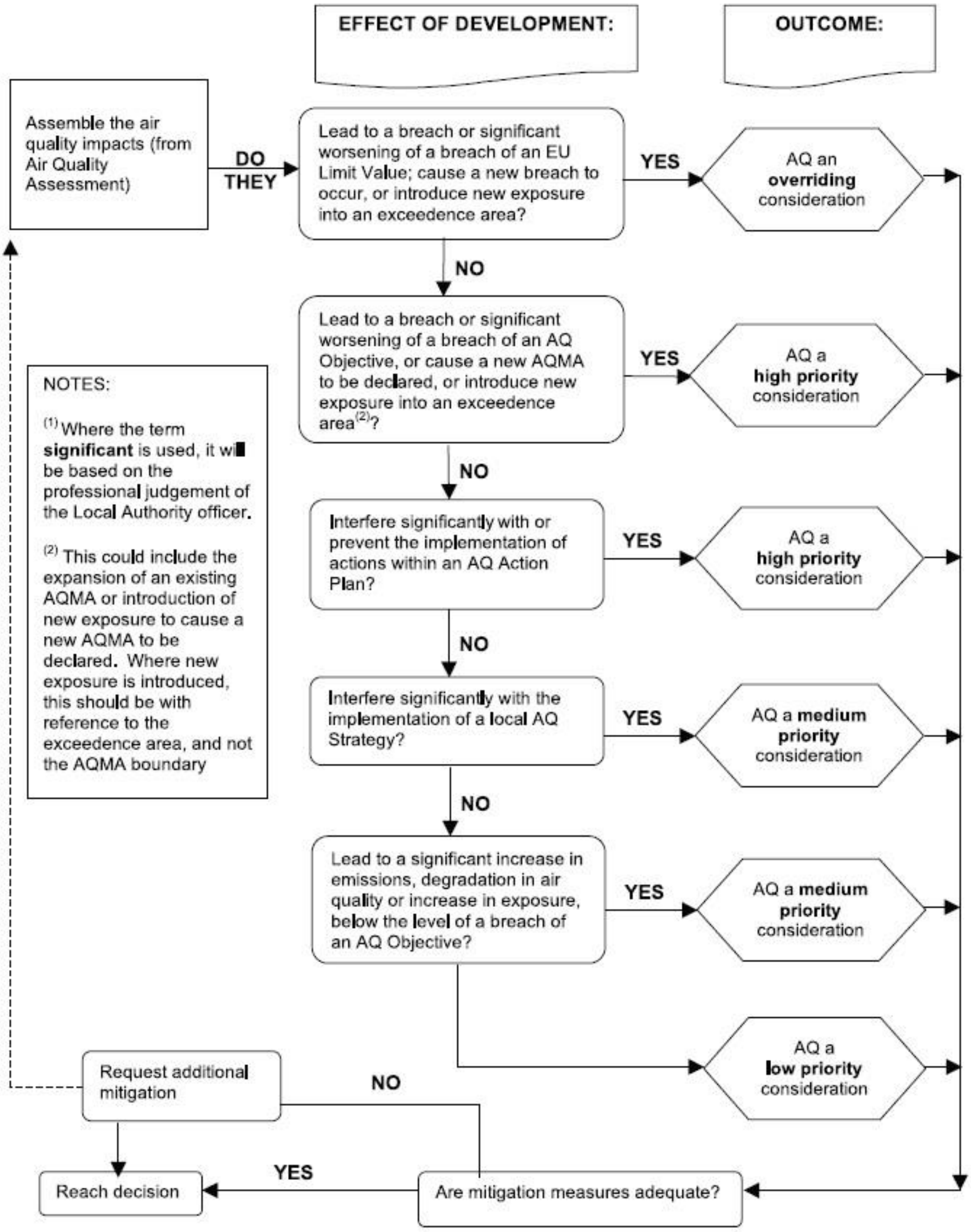
The guidance released by Environmental Protection UK (EPUK) provides steps for a Local Authority to follow in order to assess the significance of air quality impacts of a development proposal. This procedure, shown in Figure 5, will be applied to the modelled results.

The joint guidance released by EPUK and the IAQM provides impact descriptors for individual receptors. These descriptors are provided in Table 9.

Table 9 – Impact Descriptors for Individual Receptors

Long term average concentration at receptor in assessment year	% Change in concentration relative to AQ objective			
	1%	2-5%	6-10%	>10%
75% or less of AQ objective	Negligible	Negligible	Slight	Moderate
76-94% of AQ objective	Negligible	Slight	Moderate	Moderate
95-102% of AQ objective	Slight	Moderate	Moderate	Substantial
103-109% of AQ objective	Moderate	Moderate	Substantial	Substantial
110% or more of AQ objective	Moderate	Substantial	Substantial	Substantial

Figure 5 – Assessing the Significance of Air Quality Impacts of a Development Proposal



5 AIR QUALITY ASSESSMENT

5.1 Impact from Construction Activities

The assessment of construction activities has focused on demolition, earthworks, construction and track out activities at the site. Using the criteria provided in Table 7 the dust emission magnitude for each activity is as follows:

- Demolition = N/A;
- Earthworks = Large;
- Construction = Large; and
- Track out = Medium.

Based on the IAQM guidance the sensitivity of the surrounding area is summarised in Table 10.

Table 10 – Sensitivity of the Surrounding Area

Potential Impact	Sensitivity of the Surrounding Area			
	Demolition	Earthworks	Construction	Trackout
Dust Soiling	Medium	Medium	Medium	Medium
Human Health	Low	Low	Low	Low

The dust emission magnitudes and sensitivity of the surrounding area are combined to determine the risk of dust impacts with no mitigation applied. These are summarised in Table 11.

Table 11 – Summary of Dust Risk

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

It should also be noted that the likelihood of an adverse impact occurring is correlated to wind speed and wind direction. As such, unfavourable wind speeds and wind directions must occur at the same time as a dust generating activity in order to generate an adverse impact. The overall impacts also assume that the dust generating activities are occurring over the entirety of the site meaning that as an activity moves further away from a potential receptor the magnitude and significance of the impact will be further reduced.

5.2 Impact of Vehicle Emissions

5.2.1 Model Verification

Using the guidance provided within the Local Air Quality Management Technical Guidance TG(16), the modelled output has been verified against the monitoring data obtained from the site listed in Table 12. The following tables provide a summary of the model verification process for NOx/NO_2 and PM_{10} concentrations.

Table 12 – Comparison of Modelled and Monitored NO_2 Concentrations (µg/m^3)

Verification Location	Modelled Concentration	Monitored Concentration	Difference [(modelled - monitored)/ monitored] x100
K52	19.4	30.7	-36.9%
K56	26.2	34.9	-24.9%
K86	25.3	29.1	-13.1%

As described in the Technical Guidance (LAQM.TG16), in order to provide more confidence in the model predictions and the decisions based on these, the majority of results should be within ±25% (ideally ±10%) of the monitored concentrations. In order to improve the confidence in modelled concentrations across the modelled domain the model output has been adjusted. This is described further in the next section.

5.2.2 Model Adjustment

In order to undertake model adjustment, it is first necessary to derive the monitored and modelled road contributions of NOx (excluding background). The modelled road contribution NOx is taken directly from the ADMS-Roads output before it has been converted to NO_2 using the NOx to NO_2 calculator described in Section 4.6.1. The NOx to NO_2 calculator can also be used to derive monitored road contributions of NOx from NO_2 diffusion tube results. A summary of these calculations is provided in Table 13.

Table 13 – Monitored NOx and NO_2 concentrations

Verification Location	Monitored Total NO_2	Defra Background NO_2	Monitored road contribution NO_2 (total – background)	Monitored road contribution NOx (total – background)	Modelled road contribution NOx (excludes background)	Ratio of monitored road contribution NOx / modelled road contribution NOx
K52	30.7	13.4	17.2	34.0	11.1	3.06
K56	34.9	18.6	16.3	32.7	14.6	2.24
K86	29.1	18.6	10.5	20.5	12.8	1.60

Once the monitored and modelled road contributions of NOx (excluding background) have been derived the contributions of NOx are compared and a ratio derived. In this case it is 2.232 and is used to adjust the modelled road contribution of NOx. This is shown in Table 14.

Figure 6 – Linear Regression of Modelled and Monitored NO_2

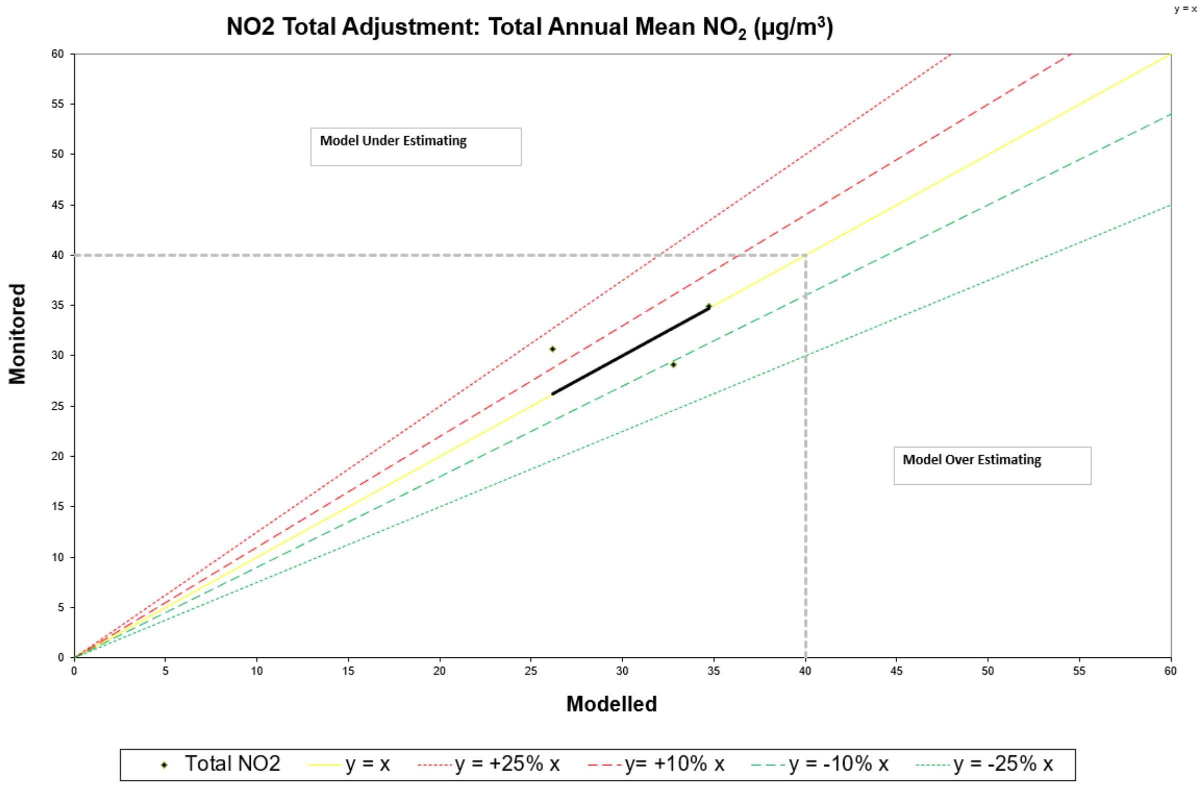


Table 14 – Adjustment of Modelled NOx Contributions

Verification Location	Adjustment factor for modelled road contribution	Adjusted modelled road contribution NOx	Modelled total NO_2 (based on empirical NOx/NO_2 relationship)	Monitored total NO_2	% Difference [(modelled – monitored) / monitored] x 100
K52	**2.232**	24.8	26.3	30.7	-14.4%
K56	**2.232**	32.7	34.9	34.9	-0.1%
K86	**2.232**	28.5	32.9	29.1	13.3%

Following adjustment of the modelled NOx concentrations by a factor of 2.232 the total NO_2 concentration at the model verification location has been calculated using the method described in Section 4.6.1. The revised NO_2 concentration, shown in Table 14, indicates a more acceptable model performance when compared against the monitored NO_2 concentrations. As such, an adjustment factor of 2.232 has been applied to all modelled NOx concentrations across the model domain before conversion to NO_2.

5.2.3 Nitrogen Dioxide

Predicted annual mean concentrations for NO_2 at the proposed development in 2019 and 2025 are provided in Table 15. As mentioned in Section 4.6.1, NO_2 concentrations have been calculated from the predicted NOx concentrations using the latest NOx-NO_2 conversion spreadsheet available from the Air Quality Archive.

Table 15 – Comparison of Predicted Annual Mean NO_2 Concentrations (µg/m^3)

Receptor ID	Baseline (2019)	Future Baseline (2025)	Future Baseline + Development Flows (2025)	% of AQ Objective	Above/ Below AQO
Proposed Development Receptors					
1	16.2	17.0	17.1	42.7	Below
2	23.1	24.6	24.6	61.5	Below
3	23.0	24.4	24.4	61.0	Below
4	24.1	25.4	25.4	63.4	Below
5	21.5	22.5	22.5	56.3	Below
6	21.1	22.0	22.0	55.1	Below
7	19.8	20.6	20.6	51.6	Below
8	18.6	19.4	19.4	48.4	Below
9	18.4	19.2	19.2	48.0	Below
10	18.4	19.1	19.1	47.8	Below
11	23.2	24.2	24.2	60.6	Below
12	25.8	27.0	27.0	67.6	Below
Existing Receptors					
Receptor ID	**Baseline (2019)**	**Future Baseline (2025)**	**Future Baseline + Development Flows (2025)**	**Change**	**Impact Descriptor**
1	22.1	23.3	23.3	0.0	Negligible
2	21.6	22.7	22.7	0.0	Negligible
3	18.4	19.2	19.2	0.0	Negligible
4	19.5	20.4	20.4	0.0	Negligible
5	29.0	30.8	30.8	0.0	Negligible
6	30.4	32.3	32.3	0.0	Negligible
7	25.0	26.4	26.4	0.0	Negligible
8	20.1	21.1	21.1	0.0	Negligible

The ADMS predictions for annual mean NO_2 concentrations in 2019 and 2025 indicate that the annual mean objective (40 µg/m^3) would be achieved at the modelled receptor locations.

Nitrogen dioxide also has an hourly objective of 200 µg/m^3 not to be exceeded more than 18 times in one year. However, the hourly mean concentration has not been calculated directly by ADMS Roads. This is as a result of an evaluation of continuous monitoring data from across the UK that revealed that the relationship between the annual mean and hourly mean NO_2 concentrations was very weak. Nonetheless, research undertaken in 2003[14] has indicated that the hourly NO_2 objective is unlikely to be exceeded at a roadside location where the annual mean NO_2 concentration is less than 60 µg/m^3. Given that predicted NO_2 concentration in 2019 and 2025 are well below 60 µg/m^3 at the modelled receptor the likelihood of the short-term objective for NO_2 being exceeded is considered low.

[14] Analysis of Relationship between 1-Hour and Annual Mean Nitrogen Dioxide at UK Roadside and Kerbside Monitoring Sites, Laxen and Marner, 2003

5.2.4 Particulate Matter

Predicted annual mean concentrations for PM_{10} in 2019 and 2025 are provided in Table 16.

Table 16 – Predicted PM_{10} Concentrations, Annual Mean (µg/m^3)

Receptor ID	Baseline (2019)	Future Baseline (2025)	Future Baseline + Development Flows (2025)	% of AQ Objective	Above/ Below AQO
Proposed Development Receptors					
1	11.2	11.5	11.5	28.8	Below
2	12.7	13.2	13.2	33.1	Below
3	12.6	13.2	13.2	33.0	Below
4	12.9	13.4	13.4	33.6	Below
5	12.3	12.8	12.8	31.9	Below
6	12.2	12.7	12.7	31.6	Below
7	12.0	12.3	12.3	30.8	Below
8	11.7	12.0	12.0	30.1	Below
9	11.7	12.0	12.0	30.0	Below
10	11.7	12.0	12.0	30.0	Below
11	12.7	13.2	13.2	32.9	Below
12	13.3	13.8	13.8	34.6	Below
Existing Receptors					
Receptor ID	**Baseline (2019)**	**Future Baseline (2025)**	**Future Baseline + Development Flows (2025)**	**Change**	**Impact Descriptor**
1	12.7	13.0	13.0	0.0	Negligible
2	12.6	12.8	12.8	0.0	Negligible
3	11.8	12.0	12.0	0.0	Negligible
4	12.1	12.3	12.3	0.0	Negligible
5	14.3	14.8	14.8	0.0	Negligible
6	14.7	15.1	15.1	0.0	Negligible
7	13.4	13.7	13.7	0.0	Negligible
8	12.2	12.5	12.5	0.0	Negligible

The ADMS predictions for annual mean PM_{10} concentrations in 2019 and 2025 indicate that the annual mean objective (40 µg/m^3) would be achieved at all the modelled receptor locations. In addition, the maximum number of days when PM_{10} concentrations are more than 50 µg/m^3 is 1, less than the 35 exceedances allowed in the regulations.

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Impact from Construction Activities

A qualitative assessment of dust levels associated with the proposed development has been carried out. Mitigation measures have been listed in Table 17 and are applicable for a low to medium risk site. Implementation of these Best Practice Measures will help reduce the impact of the construction activities.

With these mitigation measures enforced, the likelihood of nuisance dust episodes occurring at those receptors adjacent to the development are considered low to negligible. Notwithstanding this, the developer should take into account the potential impact of air quality and dust on occupational exposure standards (in order to minimise worker exposure) and breaches of air quality objectives that may occur outside the site boundary. Keeping an accurate and up to date complaints log will isolate particular site activities to a nuisance dust episode and help prevent it from reoccurring in the future.

Table 17 – Mitigation of Construction Activities

Construction Activity	Mitigation Measures
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.
	Develop and implement a stakeholder communications plan that includes community engagement before work commences on site
	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. The DMP may include monitoring of dust deposition, dust flux, realtime PM_{10} continuous monitoring and/or visual inspections.
	Display the head or regional office contact information.
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 a complaints log available to the local authority when asked.
	Record any exceptional incidents that cause dust and air quality pollutant emissions, either on or off the site, and the action taken to resolve the situation is recorded in the log book.
Monitoring	Carry out regular site inspections to monitor compliance with air quality and dust control procedures, record inspection results, and make an inspection log available to the local authority when asked.
	Increase the frequency of site inspections by those accountable for dust and air quality pollutant emissions issues when activities with a high potential to produce dust and emissions and dust are being carried out, and during prolonged dry or windy conditions.
	Agree dust deposition, dust flux, or real-time PM_{10} continuous monitoring locations with the Local Authority. Where possible commence baseline monitoring at least three months before work commences on site or, if it a large site, before work on a phase commences. Further guidance is provided by IAQM on monitoring during demolition, earthworks and construction.
Preparing and maintaining the site	Plan site layout: machinery and dust causing activities should be located away from receptors.
	Erect solid screens or barriers around dust activities or the site boundary that are, at least, as high as any stockpiles on site.
	Fully enclose site or specific operations where there is a high potential for dust production and the site is actives for an extensive period
	Avoid site runoff of water or mud.
	Keep site fencing, barriers and scaffolding clean using wet methods
	Remove materials that have a potential to produce dust from site as soon as possible, unless being re-used on site. If they are being re-used on-site cover as described below.
	Cover, seed or fence stockpiles to prevent wind whipping
Operating Vehicle/Machinery and Sustainable Travel	Ensure all non-road mobile machinery (NRMM) comply with the standards set within this guidance.
	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 possible.
	Implement a Travel Plan that supports and encourages sustainable travel (public transport, cycling, walking, and car-sharing).

	Produce a Construction Logistics Plan to manage the sustainable delivery of goods and materials
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 mitigation (using recycled water where possible).
	Use enclosed chutes, conveyors and covered skips.
	Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate
	Ensure equipment is readily available on site to clean any dry spillages, and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods.
Waste Management	Avoid bonfires and burning of waste materials.
Demolition	N/A
Earthworks	Re-vegetate earthworks and exposed areas/soil stockpiles to stabilise surfaces
	Use Hessian, mulches or trackifiers where it is not possible to re-vegetate or cover with topsoil
	Only remove secure covers in small areas during work and not all at once
Construction	Avoid scabbling (roughening of concrete surfaces) if possible
	Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place
	Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery
	For smaller supplies of fine powder materials ensure bags are sealed after use and stored appropriately to prevent dust
Trackout	Regularly use a water-assisted dust sweeper on the access and local roads, as necessary, to remove any material tracked out of the site
	Avoid dry sweeping of large areas
	Ensure vehicles entering and leaving sites are securely covered to prevent escape of material during transport
	Record all inspections of haul routes and any subsequent action in a site log book
	Install hard surfaced haul routes, which are regularly damped down with fixed or mobile sprinkler systems and regularly cleaned
	Inspect haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable
	Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable)
	Ensure there is an adequate area of hard surfaced road between the wheel wash facility and the site exit, wherever site size and layout permits
	Access gates to be located at least 10m from receptors where possible
	Apply dust suppressants to locations where a large volume of vehicles enter and exit the construction site

6.2 Impact of Vehicle Emissions

In terms of introducing new exposure, predicted NO_2 and PM_{10} concentrations across the proposed development are below the relevant air quality objectives. Using the flow chart presented in Figure 5, air quality is a low priority consideration with regards to the impact of the proposed development.

All additional modelled receptors are having a negligible impact in the future year.

A travel plan has been provided for the development which outlines suggestions in which residents can be encouraged to increase the use of sustainable transport. A reduced use of cars will result in a better environment within the site and improved health and fitness if walking and cycling is taken up. This is in addition to the reduced pollution and environmental impacts of fewer vehicle movements which will further contribute to a healthier lifestyle.