FIDDLERS FERRY POWER STATION (FFPS) REDEVELOPMENT

Development Framework Technical Note: Air Quality Modelling

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Abbreviations and Glossary

Abbreviation	Definition
AADT	Annual Average Daily Traffic
Applicant	Peel NRE
AQAL	Air Quality Assessment Level
AQLV	Air Quality Limit Value
AQMA	Air Quality Management Area
AQS	Air Quality Strategy
Baseline	The conditions against which potential effects arising from the FF Allocation Site are identified and evaluated.
CEMP	Construction Environment Management Plan
Development Framework	A Development Framework is currently being prepared, which will set out a comprehensive approach to the redevelopment of the FF Allocation Site over the next 10-15 years.
ES	Environmental Statement
EU	European Union
FFPS	Fiddlers Ferry Power Station
FF Allocation Site	The whole of the proposed Fiddlers Ferry Allocation (as defined by emerging local plan Policy MD3), which comprises the mixed-use redevelopment of the entirety of the former power station site (brownfield land) and land to be removed from the Green Belt for residential development (greenfield land to north of the railway line), which will be developed in multiple phases. The FF Allocation Site also includes land to the south of the railway which is expected to remain within the Green Belt.
FF Development Site	The land within the FF Allocation Site to the north of the railway, comprising both the FF Employment Land and FF Residential Land.
FF Employment Land	The employment component of the Fiddlers Ferry Allocation, which comprises brownfield land comprising the former power station
FF Residential Land	The residential component of the Fiddlers Ferry Allocation, which comprises land north of the railway land which is proposed to be removed from the Green Belt through the emerging Local Plan.
HDV	Heavy Duty Vehicle
IAQM	Institute of Air Quality Management
impact	A change at or to a receptor brought about by the proposed development.

Abbreviation	Definition
LAQM	Local Air Quality Management
mitigation	Measures including any process, activity, or design to avoid, reduce, remedy or compensate for negative environmental impact or effects of the proposed development.
NO_2	Nitrogen Dioxide
NO_X	Nitrogen Oxides
NPPF	National Planning Policy Framework
OS	Ordnance Survey
PM_{10}	Particulate Matter where particles are less than 10 micrometres in diameter
$PM_{2.5}$	Particulate Matter where particles are less than 2.5 micrometres in diameter
proposed development boundary	The Red Line Boundary for the whole of the FFPS Development Framework The boundary within which planning permission for the proposed development will be sought, as defined by the submitted Site Location Plan.
receptor	Any defined feature that is sensitive to or has the potential to be subject to an impact.
Trackout	The vehicle-borne transfer of mud and debris onto the highway

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Tables

1 Introduction

1.1.1 This technical note provides information to inform the preparation of the Development Framework for the FF Allocation Site, with respect to Air Quality.

1.1.2 The technical note is not a detailed assessment but instead an appraisal of the FF Allocation Site, to inform the preparation of the Development Framework, using currently available baseline and construction data, as well as interim traffic data. It primarily focusses on introduced residential receptors on the FF Allocation Site and does not take into account impacts on existing receptors across the wider traffic network.

1.1.3 Impacts on the employment areas of the FF Allocation Site have not been considered in detail at this stage. In accordance with Defra Local Air Quality Management (LAQM) Technical Guidance (TG) (LAQM.TG (22)) (Ref 1), Air Quality Strategy (AQS) objectives are not relevant at places of work. It is therefore considered that places of work are not deemed as sensitive receptors with respect to air quality. Nonetheless, design principles and mitigation measures for air quality across the FF Allocation Site have been incorporated into the Development Framework as part of its preparation, as set out later in this technical note.

1.1.4 Detailed assessments pursuant to each individual phase of development at Fiddlers Ferry will be prepared and submitted as part of the respective individual planning applications.

1.1.5 The following is covered within the technical note. Baseline conditions and potential constraints are set out. A summary of the methodology used to model air quality impacts on existing and future receptors is outlined, followed by the modelling results, residual effects, design and mitigation followed by a conclusion.

1.2 Site Location

1.2.1 The FF Allocation Site comprises the mixed-use redevelopment of the entirety of the former power station site (brownfield land) and the land to be removed from the Green Belt for residential development (greenfield land to north of the railway land). The FF Allocation Site is situated within a broader industrial estate along River Mersey at the eastern edge of Warrington Borough’s administrative area. The FF Allocation Site abuts the A562 Widnes Road to its north, which serves as the main point of vehicular access.

1.2.2 The surrounding area comprises industrial premises which occupy a strip of land straddling St Helens Canal and the A562 Widnes Road and a mix of rural housing and agricultural development and private recreation sites to the north of the A562 Widnes Road. Figure 1 below shows the FF Allocation Site.

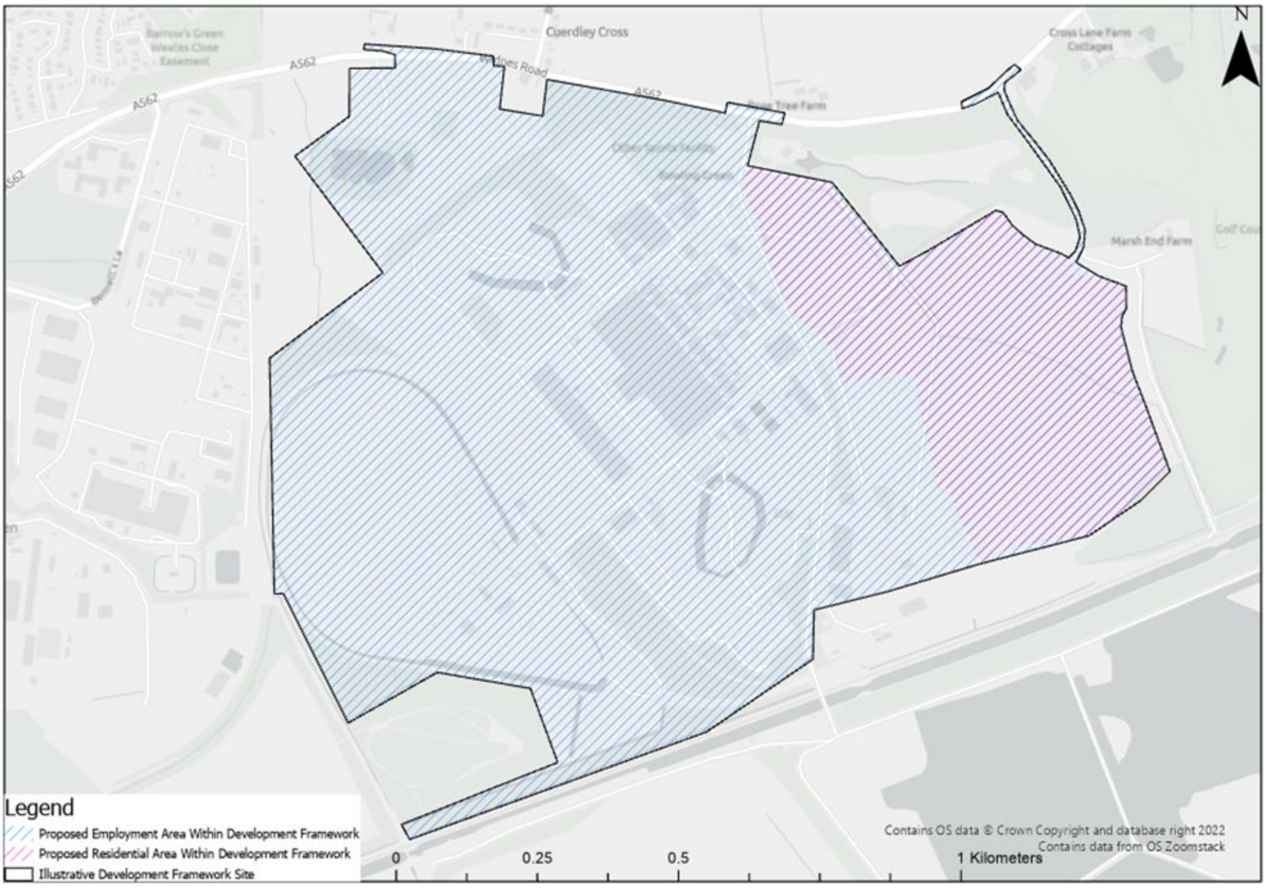

Figure 1 – FF Allocation Site

2 Methodology

2.1 Legislation, Policy and Guidance

2.1.1 This assessment has been undertaken in accordance with current national legislation, and national, regional and local plans and policies relating to Air Quality in the context of the FF Allocation Site. A summary of the relevant legislation, policies and guidance is provided below.

Legislation

2.1.2 Part IV of the Environment Act 1995 (amended 2021) (Ref 2) requires the UK government to produce a national Air Quality Strategy (AQS) which contains standards, objectives and measures for improving ambient air quality. The most recent AQS was published in July 2007 (Ref 3). The AQS sets out AQS objectives that are maximum ambient pollutant concentrations not to be exceeded either without exception or with a permitted number of exceedances over a specified timescale.

2.1.3 The regulations referred to in the AQS have been supplemented by the Air Quality Regulations (2010), which came into force on 11th June 2010 and transpose the European Union (EU) Air Quality Directive (2008/50/EC) into UK law. Since the UK has left the EU, the Air Quality Regulations have been amended through The Air Quality (Amendment of Domestic Regulations) (EU Exit) Regulations (Ref 4). Air Quality Limit Values (AQLVs) were published in these regulations for seven pollutants, in addition to Target Values for an additional five pollutants. These are generally in line with the AQS objectives, although the requirements for the determination of compliance vary.

2.1.4 Table 2-1 summarises the AQS Objectives applicable to the FF Allocation Site. This air quality assessment has considered the air quality impacts in relation to the annual, daily and hourly mean AQS objectives in Table 2-1.

Table 2-1 – Annual Mean AQS Objectives

Pollutant	Air Quality Strategy Objective	
	Concentration (µg/m^3)	Averaging Period
NO_2 (Nitrogen Dioxide)	40	Annual mean
	200	1-hour mean; not to be exceeded more than 18 times a year
PM_{10} (Particulate Matter less than 10 microns in diameter)	40	Annual mean
	50	24-hour mean; not to be exceeded more than 35 times a year
$PM_{2.5}$ (Particulate Matter less than 2.5 microns in diameter)	25	Annual mean

Policy

2.1.5 The planning policy relevant to Air Quality and how this policy has been taken into account is provided in Table 2-2.

Table 2-2 – National Policy

Policy Document	Policy/Reference	Description in Relation to Air Quality	Project Response
National Planning Policy Framework 2021 (Ref 5)	Paragraph 186	"*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*".	The assessment has determined the air quality effects in relation to Air Quality Limit Values and national objectives and has taken into account impacts within AQMAs. The traffic data includes traffic growth associated with future developments and as such the assessment has accounted for cumulative impacts.
Warrington Draft Local Plan 2021 (Ref 6), as modified	Policy ENV8	The Council will seek to ensure that proposals for new development will not have an unacceptable negative impact on air quality and will not further exacerbate negative air quality impacts in the Council's AQMAs; or will contribute to air pollution in areas which may result in further areas being designated. An air quality assessment will be required where a development may place new sensitive receptors in areas of poor air quality; and/or that may lead to a deterioration in local air quality resulting in unacceptable effects on human health and or/the environment.	The assessment has been undertaken in accordance with Institute of Air Quality Management (IAQM) guidance to determine significance and propose any mitigation if required, in order to ensure the development does not negatively impact air quality or further exacerbate negative air quality impacts in the AQMAs.

Guidance

2.1.6 Table 2-3 summarises the advice provided in Defra (LAQM.TG (22)) (Ref 1) on where the AQS objectives for pollutants considered within this report apply.

Table 2-3 – Examples of Where the AQS Objectives Apply

Averaging Period	Objectives Should Apply At	Objectives Should Not Apply At
Annual Mean	All locations where members of the public might be regularly exposed. Building façades of residential properties, schools, hospitals, care homes etc.	Building façades 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	All locations where the annual mean objective would apply, together with hotels and 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.
1-Hour Mean	All locations where the annual mean and 24-hour mean objectives apply. Kerbside sites (for example, pavements of busy shopping streets). Those parts of car parks, bus stations and railway stations etc. which are not fully enclosed, where the public may reasonably be expected to spend one hour or more. Any outdoor locations where members of the public might reasonably be expected to spend one hour or longer.	Kerbside sites where the public would not be expected to have regular access.

2.1.7 The construction dust assessment has been undertaken in accordance with the IAQM Assessment of Dust from Demolition and Construction 2014 Guidance (Ref 7).

2.1.8 The operational phase assessment has been undertaken in accordance with the IAQM Guidance on Land-Use Planning and Development Control: Planning for Air Quality 2017 (Ref 8).

2.2 Dispersion Modelling

2.2.1 Dispersion modelling has been undertaken using provisional traffic data to predict concentrations of NO_2, PM_{10} and $PM_{2.5}$ at future receptor locations associated with the FF Residential Land and at existing receptors along the A562.

2.2.2 In summary, dispersion modelling of emissions from the A562, site access and on-site roads was undertaken using ADMS-Roads, for the following scenarios:

- Existing base year (for model verification) (2019);
- Opening Year without development (2026); and
- Opening Year with development (2026)

2.2.3 The 2026 opening year assumes that the whole Development Framework is operational in 2026, including both the FF Employment and Residential areas.

2.2.4 The model requires input data that details the following parameters, details of which are presented in Appendix C:

- Traffic data;
- Vehicle emission factors;
- Road widths;
- Meteorological data;
- Roughness length; and
- Monin-Obukhov length.

2.3 Emission Factors

2.3.1 Emission factors were utilised from Defra's Emission Factor Toolkit (v11) based on vehicle fleet composition, traffic speeds and road type. The emissions rates were calculated using emissions projections for the 2019 base year and 2026 in the 'with' and 'without' development scenarios.

2.4 NO_X to NO_2 Conversion

2.4.1 Predicted annual mean NO_x concentrations from the dispersion model were converted to NO_2 concentrations using the Defra NO_x to NO_2 Calculator (v8.1) (Ref 9), following the method detailed within Defra LAQM.TG (22) (Ref 1).

2.5 Backgrounds

2.5.1 Background concentrations for NO_x, PM_{10} and $PM_{2.5}$ from the Defra background maps (Ref 10) have been used for background levels and have been added to the road traffic outputs from the dispersion model to account for background pollutant levels.

2.6 Verification

2.6.1 The predicted results from a dispersion model may differ from measured concentrations for a number of reasons, including:

- Uncertainties in source activity data such as traffic flows and emissions factors;
- Variations in meteorological conditions;
- Overall model limitations; and,
- Uncertainties associated with monitoring data.

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

2.6.3 Model verification was undertaken using meteorological data and monitoring data for the year 2019 and traffic data for year 2022, as this was confirmed by the Curtins (environment consultant) traffic team as being representative of the year 2019. Details of the model verification procedure are outlined in Appendix D.

2.7 Traffic Data

2.7.1 Traffic data was provided by Curtins for use in the assessment. Traffic data used for air quality modelling purposes included modelled AADT flows, HDV % and speeds (kph) for each scenario. Further information on the traffic data is provided in Appendix C.

2.8 Receptors

2.8.1 Worst-case sensitive receptors were identified along the A562 Widnes Road and indicative receptor points were placed within the FF Residential area, adjacent to the main roads to represent future residential receptors. It should be noted that no residential receptors are proposed within 200m of the A562 Widnes Road. Details of the receptors are shown below in Table 2-4 and Figure 2.

Table 2-4 – Modelled Worst-Case Receptors

Receptor ID	X	Y	Height (m)	Description
R1	354182.5	386898.4	1.5	No 3 Back Lane
R3	355374.2	387260.1	1.5	No 35 Cuerdley Road
R10	353423.6	386863.9	1.5	Ronaldshay (Backing onto A562)
R39	355560.5	387301	1.5	No 21 Newlyn Gardens (Backing onto A562 Widnes Road)

Receptor ID	X	Y	Height (m)	Description
FR1	354769.69	386485.16	1.5	Future Receptor 1
FR1_2	354769.69	386485.16	4.5	Future Receptor 1 (First Floor)
FR2	354867.56	386351.53	1.5	Future Receptor 2
FR2_2	354867.56	386351.53	4.5	Future Receptor 2 (First Floor)
FR3	355128.19	386438.84	1.5	Future Receptor 3
FR3_2	355128.19	386438.84	4.5	Future Receptor 3 (First Floor)
FR4	354636.91	386597.62	1.5	Future Receptor 4
FR4_2	354636.91	386597.62	4.5	Future Receptor 4 (First Floor)
FR5	354949.31	386627.22	1.5	Future Receptor 5
FR5_2	354949.31	386627.22	4.5	Future Receptor 5 (First Floor)

2.8.2 As set out in Table 2-3, the AQS objectives should not be applied to places of work (employment). The FF employment land is therefore not considered to be a sensitive receptor. Nonetheless, design principles and mitigation measures for air quality across the FF Allocation Site have been incorporated into the Development Framework as part of its preparation, as set out later in this technical note. Detailed assessments pursuant to each individual phase of development at Fiddlers Ferry will be prepared and submitted as part of the respective individual planning applications.

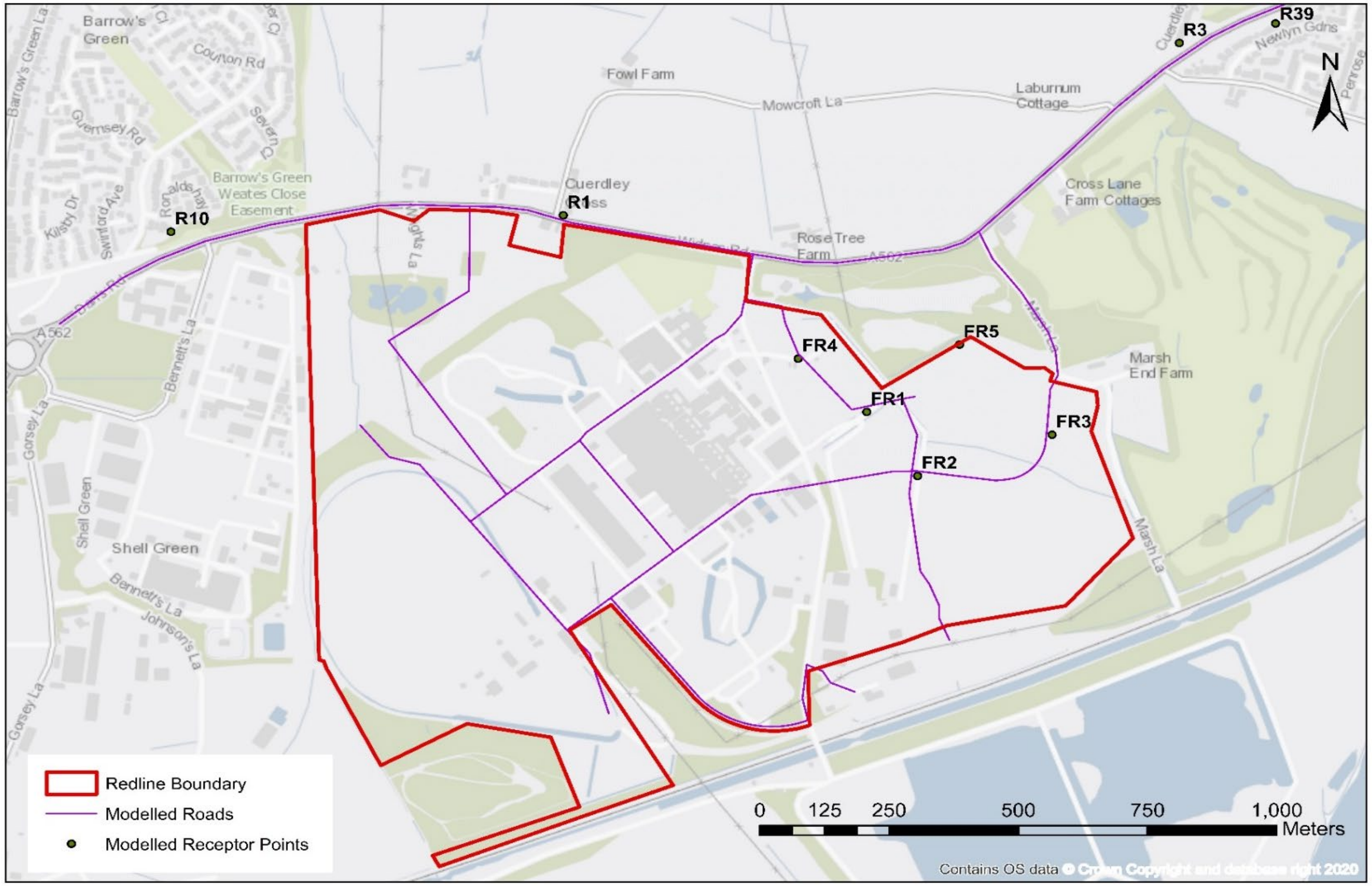

Figure 2 – Modelled Receptor Locations

2.9 Significance Criteria

2.9.1 Significance criteria for construction effects is as set out in the IAQM Construction Dust Guidance. For operational effects, the impacts of the FF Allocation Site have been assessed in accordance with the IAQM Control Guidance. The characterisation of air quality effects during operation is dependent upon the percentage change in pollutant concentration and the total concentration, relative to the relevant air quality objectives. The impact descriptors relative to the change metrics and air quality assessment levels are presented in Table 2-5.

Table 2-5 – IAQM Impact Descriptors for Individual Receptors

Long Term Average Concentration at Receptor in Assessment Year	**% Change in Concentration Relative to annual Air Quality Assessment Level (AQAL)**			
75% or less of AQAL	Negligible	Negligible	Slight	Moderate
76 – 94% of AQAL	Negligible	Slight	Moderate	Moderate
95 – 102% of AQAL	Slight	Moderate	Moderate	Substantial
103 – 109% of AQAL	Moderate	Moderate	Substantial	Substantial
110% or more of AQAL	Moderate	Substantial	Substantial	Substantial

2.9.2 The relevant Air Quality Assessment Level (AQAL) is 40µg/m^3 as an annual mean for both NO_2 and PM_{10}, and 25µg/m^3 as an annual mean for $PM_{2.5}$ as this reflects the current annual mean AQS objectives for each pollutant.

2.9.3 The IAQM guidance notes that the impact descriptors in are for individual receptors only and the overall significance of effect should be determined using professional judgement, taking into the degree of impact and factors such as:

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

2.9.4 The evaluation of the operational phase significance of effects was informed with the application of the above IAQM impact descriptors and professional judgement in accordance with the IAQM guidance (Ref 8).

2.10 Assessment of Short-Term Air Quality Assessment Level

2.10.1 Short-term pollutant concentrations have not been explicitly modelled. Instead, methods for comparing annual mean concentrations to the short-term concentrations has been used.

2.10.2 As outlined in LAQM.TG (22) (Ref 1) dispersion models cannot predict short-term concentrations as reliably as annual mean concentrations. A study carried out on behalf of Defra identified that exceedances of the 1-hour mean NO_2 AQS objective are unlikely to occur where the annual mean is below 60μg/m^3. Therefore, annual mean modelled NO_2 concentrations have been compared against 60μg/m^3, to establish if there could be potential exceedances of the 1-hour mean NO_2 AQS objective.

2.10.3 The prediction of daily mean concentrations of PM_{10} is available as an output option within the ADMS roads dispersion model for comparison against the short-term air quality objective. However, as the model output for annual mean concentrations is considered more accurate than the modelling of the daily mean, an empirical relationship has been used to determine daily mean PM_{10} concentrations. In accordance with LAQM.TG (22) (Ref 1) the following formula was used:

No. of 24-hour mean exceedances = -18.5 + 0.00145 x annual mean3 + (206 / annual mean)

2.10.4 Based on this formula, an exceedance of the 24-hour mean PM_{10} AQS objective is unlikely to occur where the annual mean PM_{10} concentration is less than 32μg/m^3.

2.11 Limitations and Assumptions

2.11.1 The air quality modelling predictions are based on the most robust and reasonable methodologies. However, there are uncertainties associated with the predictions, for example due to uncertainties in emissions and background air quality predictions. Modelling uncertainties have been addressed as far as practicable in the assessment and are not considered to adversely affect the adequacy of the assessment. Uncertainties have been addressed through using the latest Defra tools such as EFT, NO_X to NO_2 and background maps and through model verification in accordance with Defra LAQM.TG (22) (Ref 1). The verification process indicates that the RMSE of the modelled results is well within the Defra guidelines as set out in Defra LAQM.TG (22) (Ref 1).

2.11.2 There is a limitation to using five months' worth of monitoring survey data within the assessment. Due to using monitoring data from a short survey period, annualisation may have overpredicted monitoring concentrations and has therefore been adjusted using a verification factor of 3.01, as set out in Appendix D. Although there is a limitation to using five months' worth of monitoring survey data for verification, in the absence of local authority monitoring data surrounding the modelled roads, use of this data is suitable.

2.11.3 The traffic data used to inform this technical note is based on information available from modelling carried out as at the date of the assessment and does not include traffic data on the wider traffic network. Further modelling of onsite and offsite impacts on the wider traffic network will be completed at planning application stage.

3 Baseline

3.1 Existing Baseline

Local Air Quality Management

3.1.1 As required by the Environment Act 1995 (Amended 2021), Warrington Borough Council (WBC) has undertaken Review and Assessment of air quality within their area of jurisdiction. This process has indicated exceedances of the annual mean NO_2 Air Quality Strategy (AQS) objective in two areas, which are therefore designated as Air Quality Management Areas (AQMAs). These two AQMAs are AQMA 4 covering the link roads and town centre ring road and AQMA No 1 which covers an area 50m from the roadside around the M62, M6 and M56. These AQMA are located over 3km from the FF Allocation Site.

3.2 Air Quality Monitoring

Local Authority

3.2.1 In the base year of 2019 WBC undertook continuous monitoring at three automatic sites, the closest of which (Selby Street CM1) is located 5km east of the FF Allocation Site. As this site is located far from the FF Allocation Site, it is not deemed representative of onsite concentrations.

3.2.2 The annual mean NO_2, PM_{10} and $PM_{2.5}$ concentrations monitored from 2015 to 2019 for the three automatic sites are summarised in Table 3-1 below.

Table 3-1 – Automatic Monitoring Concentrations

Site ID	Pollutant Type	OS Grid Ref X (m)	OS Grid Ref Y (m)	Annual Average Concentrations (µg/m³)[1]				
				2015	2016	2017	2018	2019
CM1 Selby Street	NO_2	359151	388218	24.4	25.0	21.0	21.4	20.5
	PM_{10}			15.0	16.0	12.0	13.0	17.0
	$PM_{2.5}$			11.0	11.0	10.0	9.0	11.0
CM2 Parker Street	NO_2	360015	387907	40.0	47.0	37.9	38.1	41
CM3 Chester Road	NO_2	360331	386454	37.0	34.0	32.0	30.0	30

[1] The AQAL is 40µg/m³ as an annual mean for both NO_2 and PM_{10}, and 25µg/m³ as an annual mean for $PM_{2.5}$.

3.2.3 In addition to automatic monitoring, WBC undertook NO_2 diffusion tube monitoring at locations around the borough in 2019, which are summarised in Table B-1 in Appendix B. In 2019 two exceedances of the annual mean NO_2 AQS objective were recorded. These were at sites DT5 (Manchester Road) and DT8 (Parker Street), both of which are located well over 5km away from the FF Allocation Site and as such are not representative of onsite exposure for future receptors.

Project Specific Monitoring Survey

3.2.4 A total of 11 NO_2 diffusion tubes were installed from August 2022 for a 6-month period, for a project specific monitoring survey. Information on the locations of the monitoring sites is provided in Appendix B. At this stage there are 5-months worth of available monitoring data. Monitored concentrations from August 2022 to January 2023 have been bias adjusted in accordance with LAQM.TG (22) (Ref 1), using collocated triplicate diffusion tubes at the Warrington Sankey Way automatic station. It should be noted that the 2023 automatic data used for bias adjustment is provisional data and has not yet been verified.

3.2.5 The monthly bias adjusted monitored concentrations are displayed in Table 3-2.

Table 3-2 – Project Specific Monitoring Monthly Bias Adjusted NO_2 Concentrations

Site ID	OS Grid Ref X (m)	OS Grid Ref Y (m)	Monthly Bias Adjusted Monitored NO_2 Concentrations ($\mu g/m^3$)				
			September 2022	October 2022	November 2022	December 2022	January 2023
FF_01	353338	386762	20.1	21.3	19.6	26.5	25.4
FF_02	352955	386382	15.4	15.6	17.7	22.2	NA
FF_03	358384	388107	23.2	18.7	23.3	29.3	25.3
FF_04	355474	387478	23.3	16.4	21.6	27.7	27.5
FF_05	356809	387679	24	21.3	23.6	29	23.9
FF_06	357470	387924	NA	14.9	15.2	22.6	16.4
FF_07	352183	385567	17.4	14.9	18.1	26.8	21.5
FF_08	356019	388625	23.7	23	23.8	30.3	18.8
FF_09	357241	390660	29.7	25.4	23.2	32.2	26.4
FF_10	352407	386395	24.9	25.8	24.8	34.6	23.9
FF_11	357254	388873	17.1	16.8	16.4	26.1	20.1

3.2.6 Table 3-2 above shows the NO_2 concentrations measured across the monitoring survey. The highest concentration across the survey period, was measured in December 2022 at site FF_10 (34.6 µg/m3), which is located on the B5178 in Widnes. This measured concentration coincides with the general trend of higher pollutant concentrations during the winter months, due to colder air being denser and more slowly moving than warm air, leading to decreased dispersion in winter. The lowest concentration was measured in October 2022 at site FF_06 (14.9 µg/m3), which is located on the A562 Penketh Rd, Warrington.

3.2.7 The closest monitoring site to the FF Allocation Site is FF_01, which is situated adjacent to the A562 Dan's Rd, ~400m west of the FF Allocation Site. Across the monitoring survey period, this site monitored an average NO_2 concentration of 22.6µg/m^3, based on professional experience this concentration is considered to be low. As explained above, monitored concentrations tend to be higher during the winter months, therefore the average concentration at FF_01 is considered worst-case. With the inclusion of monitored concentrations during the spring and summer months, it is anticipated that the annual average monitored concentrations will be lower than the period mean. It can therefore be reasonably assumed that there is unlikely to be a risk of existing/future receptors being exposed to poor onsite air quality, as the period mean concentration is below the annual mean NO_2 objective.

3.2.8 The above monitored concentrations have been annualised to the modelled base year of 2019, as previously done for the Phase 1 ES. This was done to account for uncertainties arising from changes brought about by the COVID-19 pandemic. They have also been bias adjusted in accordance with LAQM.TG (22) (Ref 1). It should be noted that the 2023 automatic data used for annualisation and bias adjustment is provisional data and has not yet been verified.

3.2.9 As displayed in Table 3-3 below, all of the 2019 annualised annual mean NO_2 concentrations are well below the Air Quality Strategy (AQS) annual mean NO_2 objective of 40µg/m^3. The closest tube to the FF Allocation Site (FF_01) monitored an annual mean concentration of 23µg/m^3, which is well below the annual mean NO_2 AQS objective. It is therefore unlikely that there will be a risk of exceedances of the NO_2 AQS objective at future onsite receptors and existing receptors surrounding the FF Allocation Site, especially when accounting for improvements in vehicle emissions that will occur between 2019 and the 2026 opening year of the FF Allocation Site.

Table 3-3 – Project Specific Monitoring 2019 Annualised NO_2 Concentrations

Site ID	OS Grid Ref X (m)	OS Grid Ref Y (m)	2019 Annualised Annual Average Concentrations (µg/m^3) 2019
FF_01	353338	386762	23.0
FF_02	352955	386382	18.1
FF_03	358384	388107	24.4
FF_04	355474	387478	14.5
FF_05	356809	387679	20.1
FF_06	357470	387924	24.4
FF_07	352183	385567	27.9

Site ID	OS Grid Ref X (m)	OS Grid Ref Y (m)	2019 Annualised Annual Average Concentrations (µg/m^3) 2019
FF_08	356019	388625	27.3
FF_09	357241	390660	19.7
FF_10	352407	386395	24.1
FF_11	357254	388873	26.3

Background Pollutant Concentrations

3.2.10 Predictions of background pollutant concentrations on a 1x1km grid basis have been produced by Defra for the entire of the UK to assist local authorities in their Review and Assessment of air quality. The Site is located within grid square 354500, 386500. Background pollutant data was downloaded from the Defra website (Ref 10) and is summarised in Table 3-4 below.

Table 3-4 – Background Pollutant Concentrations

Pollutant	2023 Predicted Background Concentration (µg/m^3)
NO_2	11.7
PM_{10}	11.6
$PM_{2.5}$	7.7

3.2.11 The 2023 background concentrations are well below the AQS objectives and as such the local area is considered an area of good existing air quality.

Defra Pollution Climate Mapping

3.2.12 In accordance with the Air Quality Standards (Regulations) 2010 (Ref 11), Defra use the Pollution Climate Mapping (PCM) model (Ref 12) to report compliance against NO_2 limit values across the UK road network. NO_2 concentrations have been predicted on the A562 Dan's Rd, which is the main source of emissions in the vicinity of the FF Allocation Site. In 2023 the PCM model predicts a roadside annual mean NO_2 concentration of 19.3µg/m^3, which is less than half of the annual mean Limit Value. As the concentration predicted at the roadside is well below the Limit Value and the FF residential allocation is situated over 200m from the A562 Dan's Rd, it can be reasonably assumed that there is unlikely to be a risk to future onsite concentrations exceeding the Limit Value for NO_2, where properties are closest to the A562.

Baseline Summary

3.2.13 WBC undertakes automatic and passive diffusion tube monitoring. All monitoring sites, automatic and diffusion tubes are over 5km away from the FF Allocation Site and are therefore not representative of onsite exposure.

3.2.14 To fill gaps in the existing local authority monitoring data, a 6-month project specific monitoring survey has been undertaken from August 2022 until January 2023. Monthly bias adjusted NO_2 concentrations from the 11 monitoring sites are low based on professional experience and judgement, especially along the A562 Dan's Rd near the FF Allocation Site. In addition to the monthly data, the results were annualised to the modelled base year of 2019, to account for uncertainties brought about by the COVID-19 pandemic. The annualised NO_2 concentrations are well below the AQS objective and as such indicates that there are unlikely to exceedances of the AQS objective and that the local area is an area of good existing air quality for existing and proposed residential receptors.

3.2.15 Defra background maps indicate that NO_2 concentrations are well below the annual mean AQS objective in 2023.

3.2.16 Baseline monitoring data and PCM modelled data indicate that NO_2 concentrations along the A562 Widnes/Dans Rd well below the annual mean AQS objective/Limit Value.

3.2.17 The baseline data indicates that the FF Allocation Site and the A562 Widnes/Dans Rd are located within an area of good existing air quality and therefore there is unlikely to be a risk of existing and proposed residential receptors being exposed to poor air quality within this area. Given that in future years there will be improvements in vehicle fleets, it is likely that by the opening year of the FF Allocation Site baseline concentrations will have reduced.

4 Constraints

4.1.1 Draft phasing plans have been reviewed and potential constraints and issues, relating to the current design and potential air quality effects on existing and proposed residential receptors, have been identified. The main source of air pollution in the vicinity of the FF Allocation Site is the A562 Widnes Rd/Dan’s Rd, which runs adjacent to the northern boundary of the FF Allocation Site. There is potential for emissions from this road to impact future receptors on the FF Allocation Site.

4.1.2 There is potential for emissions, associated with vehicles from the employment phase of the FF Allocation Site to impact on residential receptors within the residential phase of the FF Allocation Site. Current traffic data, representing the FF employment land has been used to predict impacts from employment related traffic, on onsite future residential receptors. The modelled results in Section 5 are inclusive of employment phase traffic. It should be noted that cumulative impacts between each of the development phases, shall be assessed at planning application stage when detailed data becomes available.

4.1.3 Existing receptors along the A562 Widnes Rd/Dan’s Rd could potentially be affected by emissions associated with the employment phase of the FF Allocation Site.

5 Modelling Results

5.1.1 Table 5-1 below presents the predicted NO_2 concentrations at modelled receptors, for the base year (2019), without development (2026) and with development (2026) scenarios.

Table 5-1 – Modelled Annual Mean NO_2 Receptor Concentrations

	Annual Mean NO_2 Concentration (µg/m^3)			
Receptor ID	**Base Year (2019)**	**Without development (2026)**	**With development (2026)**	**Change**
R1	23.1	15.9	20.4	4.5
R3	16.9	12.3	14.1	1.8
R10	19.9	16.0	17.6	1.6
R39	15.0	11.3	12.4	1.1
FR1	N/A	N/A	12.7	1.9
FR1_2	N/A	N/A	12.1	1.3
FR2	N/A	N/A	12.4	1.7
FR2_2	N/A	N/A	11.8	1.1
FR3	N/A	N/A	10.2	0.6
FR3_2	N/A	N/A	10.0	0.4
FR4	N/A	N/A	13.7	2.9
FR4_2	N/A	N/A	12.5	1.7
FR5	N/A	N/A	11.3	0.5
FR5_2	N/A	N/A	11.3	0.5

FR = Future Receptor

N/A = Future Receptors do not exist in the Base Year without development scenarios

5.1.2 The predicted NO_2 concentrations in Table 5-1 above indicate that there are no exceedances of the annual mean NO_2 AQS objective (40µg/m^3) at any of the modelled receptors. In accordance with LAQM.TG (22) (Ref 1), as none of the modelled annual mean NO_2 concentrations exceed 60µg/m^3, exceedances of the 1-hour mean NO_2 ASQ Objective are unlikely.

5.1.3 In accordance with the IAQM Impact descriptors outlined in Table 5-2, the changes in annual mean NO_2 concentrations with the FF Allocation Site are all negligible apart from at receptors R1 where the change is moderate. The maximum predicted NO_2 concentration, 20.4µg/m^3 was modelled at receptor R1 in the with development (2026) scenario.

5.1.4 Table 5-2 below presents the predicted PM_{10} concentrations at modelled receptors, for the base year (2019), without development (2026) and with development (2026) scenarios.

Table 5-2 – Modelled Annual Mean PM_{10} Receptor Concentrations

	Annual Mean PM_{10} Concentration (µg/m^3)			
Receptor ID	**Base Year (2019)**	**Without development (2026)**	**With development (2026)**	**Change**
R1	13.4	12.5	13.9	1.4
R3	13.1	12.4	12.9	0.5
R10	15.5	14.6	15.2	0.6
R39	12.9	12.1	12.4	0.3
FR1	N/A	N/A	11.9	0.5
FR1_2	N/A	N/A	11.8	0.4
FR2	N/A	N/A	11.8	0.4
FR2_2	N/A	N/A	11.7	0.3
FR3	N/A	N/A	11.7	0.1
FR3_2	N/A	N/A	11.7	0.1
FR4	N/A	N/A	12.2	0.8
FR4_2	N/A	N/A	11.9	0.5
FR5	N/A	N/A	11.6	0.2
FR5_2	N/A	N/A	11.6	0.2

FR = Future Receptor

N/A = Future Receptors do not exist in the Base Year Without FF Allocation Site scenarios

5.1.5 The predicted PM_{10} concentrations in Table 5-2 above, indicate that there are no exceedances of the PM_{10} AQS objective (40µg/m^3) at any of the modelled receptors. In accordance with LAQM.TG (22) (Ref 1), as none of the modelled annual mean PM_{10} concentrations exceed 32µg/m^3, exceedances of the 24-hour mean AQS Objective are unlikely to occur.

5.1.6 In accordance with the IAQM Impact descriptors Table 5-3, the changes in annual mean PM_{10} concentrations with the FF Allocation Site are all negligible.

5.1.7 Table 5-3 below presents the predicted $PM_{2.5}$ concentrations at modelled receptors, for the base year (2019), Without FF Allocation Site (2026) and With FF Allocation Site (2026) scenarios.

Table 5-3 – Modelled Annual Mean $PM_{2.5}$ Receptor Concentrations

Annual Mean $PM_{2.5}$ Concentration (µg/m^3)				
Receptor ID	**Base Year (2019)**	**Without development (2026)**	**With development (2026)**	**Change**
R1	9.0	8.3	9.1	0.8
R3	8.5	7.9	8.2	0.3
R10	11.4	10.6	11.0	0.4
R39	8.3	7.7	7.9	0.2
FR1	N/A	N/A	7.9	0.3
FR1_2	N/A	N/A	7.8	0.2
FR2	N/A	N/A	7.8	0.2
FR2_2	N/A	N/A	7.7	0.1
FR3	N/A	N/A	7.3	0.1
FR3_2	N/A	N/A	7.3	0.1
FR4	N/A	N/A	8.0	0.4
FR4_2	N/A	N/A	7.8	0.2
FR5	N/A	N/A	7.7	0.1
FR5_2	N/A	N/A	7.7	0.1

FR = Future Receptor

N/A = Future Receptors do not exist in the Base Year Without FF Allocation Site scenarios

5.1.8 The predicted $PM_{2.5}$ concentrations in Table 5-3 above, indicate that there are no exceedances of the $PM_{2.5}$ AQS objective (25µg/m^3) at any of the modelled receptors. In accordance with the IAQM Impact descriptors outlined in Table 5-3. the changes in annual mean PM_{10} concentrations with the FF Allocation Site are all negligible.

6 Assessment of Residual Effects

6.1 Construction Dust

6.1.1 In accordance with the IAQM construction dust guidance (Ref 7) construction dust activities are considered to be medium risk, as shown in Table 6-1. However, residual impacts associated with the construction phase would be negligible, as the adopted measures will serve to reduce or eliminate impacts on dust soiling and human health.

Table 6-1 – Summary of the Risk of Dust Effects

Potential Impact	Potential Risk			
	Demolition	Earthworks	Construction	Trackout
Dust soiling	N/A	Medium Risk	Medium Risk	Medium Risk
Human health	N/A	Low Risk	Low Risk	Low Risk
Ecological	N/A	Low Risk	Low Risk	Low Risk

6.2 Operation

6.2.1 With and without development scenario pollutant concentrations were predicted for NO_2, PM_{10} and $PM_{2.5}$ at a total of 14 receptor locations. The air quality modelling results predicted no exceedances of the AQS objectives for NO_2, PM_{10} and $PM_{2.5}$. All modelled concentrations are well below the respective AQS objectives in the with and without development scenarios.

6.2.2 The highest modelled annual mean NO_2 concentration is 20.4µg/m^3, which was modelled in the with development (2026) scenario at R1. R1 is located at Back Lane. At R1 there is an increase of 4.5µg/m^3, which is associated with a change in AADT flows of ~13,000. The increase in annual mean NO_2 predicted at R1 is deemed as Moderate Adverse in accordance with the IAQM impact descriptors, all others are deemed negligible (Ref 8).

6.2.3 The highest annual mean PM_{10} concentration was modelled at R10 in the 2019 base year (15.5 µg/m^3) This receptor is located at Ronaldshay (Backing onto the A562). As observed with NO_2 modelling results, the largest increase in annual mean PM_{10} was predicted at R1, Back Lane. The total PM_{10} concentration predicted at R1 is well below the AQS objective and therefore this slight increase of 1.4µg/m^3, is considered to be negligible in accordance with the IAQM impact descriptors (Ref 8). All other modelled PM_{10} concentrations are below the AQS objective and impacts are considered negligible in accordance with the IAQM impact descriptors (Ref 8).

6.2.4 As with NO_2 and PM_{10}, the modelling results predict that $PM_{2.5}$ concentrations are below the AQS objective at all of the modelled receptor locations in the opening year scenarios with or without the FF Allocation Site. The highest annual mean $PM_{2.5}$ concentration was modelled at R10 in the 2019 base year (11.4 µg/m^3). This receptor is located at Ronaldshay (Backing onto the A562). The largest increase in $PM_{2.5}$ is predicted at R1, where this an increase of 0.8µg/m^3.

6.2.5 Modelled pollutant concentrations of NO_2, PM_{10} and $PM_{2.5}$ are all well below the respective AQS objectives, in each of the modelled scenario years. In accordance with the IAQM Impact descriptors, there is only one change in NO_2 concentrations with the FF Allocation Site that is considered Moderate Adverse. All other changes in NO_2, PM_{10} and $PM_{2.5}$ concentrations with the FF Allocation Site are negligible. Taking this into account impacts of the FF Allocation Site on air quality at existing and future receptors is considered not significant.

7 Design and Mitigation

7.1 Design principles

7.1.1 As part of the preparation of the Development Framework, design principles relating to air quality have been incorporated across the FF Allocation Site. These include:

- landscape buffers between the FF employment land and FF residential land of the FF Allocation Site, to increase the distance between residential receptors and vehicle traffic associated with the FF employment land.
- landscape buffers along the northern boundary of the FF employment land, in order to increase the distance between existing receptors on the A562 Widnes Road and introduced emissions from vehicles associated with the FF Allocation Site.
- Where feasible habitable rooms within residential units should be located away from busy roads.

7.1.2 It is also recommended that detailed design of each phase take account of these.

7.2 Construction Dust

7.2.1 The IAQM construction dust guidance (Ref 7) provides potential mitigation measures to reduce impacts as a result of fugitive dust emissions during the construction phase. These have been adapted for the FF Allocation Site based on the unmitigated risk of dust effects and are detailed in full in Table A-13 in Appendix A. The measures include but are not limited to the following:

- Communication;
- Dust and site management;
- Monitoring;
- Preparing and maintaining the site; and
- Specific measures for assessed construction activities.

7.2.2 It is anticipated that the mitigation measures determined for construction dust effects will be included in a Construction Environment Management Plan (CEMP).

7.3 Operation

7.3.1 There are no significant air quality effects in the operational phase and as such, no operational phase mitigation is recommended.

7.3.2 It should be noted that this technical note is based on current data and a full detailed construction and operational assessment informing design and mitigation shall be required at planning application stage when the detailed layout and specific impacts of that phase are finalised.

8 Conclusion

8.1.1 The purpose of this technical note was to undertake an appraisal of the FF Allocation Site, using currently available baseline, construction and traffic data, suitable to inform the preparation of the Development Framework. Review of the baseline air quality information for the area surrounding the FF Allocation Site indicates that pollutant concentrations are well below the AQS objectives and as such the location of the FF Allocation Site is suitable for uses set out in the Development Framework (e.g., residential and employment).

8.1.2 The main source of air pollution within the vicinity of the FF Allocation Site are emissions from the A562 Widnes Rd/Dan's Rd. There is potential for emissions from this road to effect new residential receptors within the FF residential land. There is also the potential for traffic associated with the FF Allocation Site to effect existing receptors along the A562 Widnes Rd/Dan's Rd.

8.1.3 The construction dust assessment shows that construction dust activities are considered medium risk, if left unmitigated. However, residual impacts associated with the construction phase would be negligible, as the adopted measures will serve to reduce or eliminate impacts on dust soiling and human health.

8.1.4 Air quality modelling shows that concentrations of NO_2, PM_{10} and $PM_{2.5}$ are all well below the respective AQS objectives, in each of the modelled scenario years. In accordance with the IAQM Impact descriptors, there is only one change in NO_2 concentrations with the FF Allocation Site that is considered Moderate Adverse. All other changes in NO_2, PM_{10} and $PM_{2.5}$ concentrations with the FF Allocation Site are negligible. Taking this into account impacts of the FF Allocation Site on air quality at existing and future receptors is considered not significant.

8.1.5 In regard to mitigation measures for the operational phase, no additional mitigation measures are required outside of those already embedded in the Development Framework.

8.1.6 It should be noted that this technical note supports the Development Framework and further detailed assessment is required for each individual phase of development at Fiddlers Ferry.

References

Reference	Title
Ref 1	Defra (2022), Local Air Quality Management Technical Guidance (TG22)
Ref 2	UK Government (2021), Environment Act 1995, amended 2021. Available from: https://www.legislation.gov.uk/ukpga/2021/30/contents/enacted
Ref 3	Defra (2007), The Air Quality Strategy for England, Scotland, Wales and Northern Ireland.
Ref 4	UK Government (2019), The Air Quality (Amendment of Domestic Regulations) (EU Exit) Regulations 2019
Ref 5	Ministry of Housing, Communities and Local Government (2021), National Planning Policy Framework
Ref 6	Warrington Borough Council (2021), Draft Local Plan 2021 – 2038. Available from: https://www.warrington.gov.uk/LocalPlan
Ref 7	Institute of Air Quality Management (2014), Assessment of Dust from Demolition and Construction. Available from: http://iaqm.co.uk/text/guidance/construction-dust-2014.pdf
Ref 8	Institute of Air Quality Management (2017), Guidance on Land-Use Planning and Development Control: Planning for Air Quality. Available from: https://iaqm.co.uk/text/guidance/air-quality-planning-guidance.pdf
Ref 9	DEFRA NOx to NO2 Calculator V8.1 Available from https://laqm.defra.gov.uk/air-quality/air-quality-assessment/nox-to-no2-calculator/
Ref 10	DEFRA Background Maps 2018. Available from https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2018
Ref 11	United Kingdom Government (2010). The Air Quality Standards Regulations. Available from https://www.legislation.gov.uk/uksi/2010/1001/contents/made
Ref 12	DEFRA PCM Model 2020. Available from https://uk-air.defra.gov.uk/library/no2ten/2020-no2-pm-projections-from-2018-data

Appendix A

Construction Dust Risk Assessment Methodology

The dust risk assessment has been carried out in accordance with the Institute of Air Quality Management (IAQM) construction dust guidance. The latest version of this guidance is *Guidance on the Assessment of Dust from Demolition and Construction v1.1* (IAQM, 2014) (hereafter referred to as the IAQM construction dust guidance).

The steps for assessing dust emissions in accordance with the IAQM construction dust guidance are detailed in the following sections.

Step 1

Step 1 screens the requirement for a more detailed assessment. Should human receptors be identified within 350m of the boundary or 50m from the construction vehicle route up to 500m from the site entrance, then the assessment proceeds to Step 2. Additionally, should ecological receptors be identified within 50m of the site or 50m from the construction vehicle route, then the assessment also proceeds to Step 2.

Should sensitive receptors not be present within the relevant distances then negligible impacts would be expected and further assessment is not necessary.

Step 2

Step 2 assesses the risk of potential dust impacts. A site is allocated a risk category based on two factors:

- The scale and nature of the works, which determines the magnitude of dust arising as: small, medium or large (Step 2A); and,
- The sensitivity of the area to dust impacts, which can be defined as low, medium or high sensitivity (Step 2B).

The two factors are combined in Step 2C to determine the risk of dust impacts without mitigation applied.

Step 2A defines the potential magnitude of dust emission through the construction phase. The relevant criteria are summarised in Table A-1.

Table A-1 – Construction Dust - Magnitude of Emission (IAQM, 2014)

Magnitude	Activity	Criteria
Large	Demolition	Total building volume greater than 50,000m^3
		Potentially dusty construction material (e.g., concrete)
		On-site crushing and screening
		Demolition activities greater than 20m above ground level
	Earthworks	Total site area greater than 10,000m^2
		Potentially dusty soil type (e.g., clay, which will be prone to suspension when dry due to small particle size)
		More than 10 heavy earth moving vehicles active at any one time.
		Formation of bunds greater than 8m in height
		More than 100,000 tonnes of material moved
	Construction	Total building volume greater than 100,000m^3
		On site concrete batching
		Sandblasting

Magnitude	Activity	Criteria
	Trackout	More than 50 HDV trips per day Potentially dusty surface material (e.g., high clay content) Unpaved road length greater than 100m
Medium	Demolition	Total building volume 20,000m³ to 50,000m³ Potentially dusty construction material Demolition activities 10m to 20m above ground level
	Earthworks	Total site area 2,500m² to 10,000m² Moderately dusty soil type (e.g., silt) 5 to 10 heavy earth moving vehicles active at any one time. Formation of bunds 4m to 8m in height Total material moved 20,000 tonnes to 100,000 tonnes
	Construction	Total building volume 25,000m³ to 100,000m³ Potentially dusty construction material (e.g., concrete) On site concrete batching
	Trackout	10 to 50 HDV trips per day Moderately dusty surface material (e.g., high clay content) Unpaved road length 50m to 100m
Small	Demolition	Total building volume under 20,000m³ Construction material with low potential for dust release (e.g., metal cladding or timber) Demolition activities less than 10m above ground level Demolition during wetter months
	Earthworks	Total site area less than 2,500m² Soil type with large grain size (e.g., sand) Less than 5 heavy earth moving vehicles active at any one time Formation of bunds less than 4m in height Total material moved less than 20,000 tonnes Earthworks during wetter months
	Construction	Total building volume less than 25,000m³ Construction material with low potential for dust release (e.g., metal cladding or timber)
	Trackout	Less than 10 HDV trips per day Surface material with low potential for dust release Unpaved road length less than 50m

Step 2B defines the sensitivity of the area around the development to potential dust impacts. The influencing factors are shown in Table A-2.

Table A-2 – Construction Dust - Examples of Factors Defining Sensitivity of an Area (IAQM, 2014)

Receptor Sensitivity	Examples	
	Human Receptors	**Ecological Receptors**
High	Users expect of high levels of amenity High aesthetic or value property People expected to be present continuously for extended periods of time. Locations where members of the public are exposed over a time period relevant to the air quality objective for particulate matter less than 10 microns in diameter (PM_{10}). e.g., residential properties, hospitals, schools and residential care homes	Internationally or nationally designated site e.g., Special Area of Conservation, and the designated features may be affected by dust soiling. Locations where there is a community of a particular dust sensitive species such as vascular species included in the Red Data List for Great Britain
Medium	Users would expect to enjoy a reasonable level of amenity. Aesthetics or value of their property could be diminished by soiling. People or property wouldn't reasonably be expected to be present here continuously or regularly for extended periods as part of the normal pattern of use of the land e.g., parks and places of work	Nationally designated site e.g., Sites of Special Scientific Interest with dust sensitive features Locations where there is a particularly important plant species, where its dust sensitivity is uncertain or unknown
Low	Enjoyment of amenity would not reasonably be expected. Property would not be expected to be diminished in appearance. Transient exposure, where people would only be expected to be present for limited periods. e.g., public footpaths, playing fields, shopping streets, playing fields, farmland, footpaths, short term car park and roads	Locally designated site e.g., Local Nature Reserve where the features may be affected by dust deposition

The guidance also provides the following factors to consider when determining the sensitivity of an area to potential dust impacts:

- Any history of dust generating activities in the area;
- The likelihood of concurrent dust generating activity on nearby sites;
- Any pre-existing screening between the source and receptors;
- Any conclusions drawn from analysing local meteorological data which accurately represent the area; and if relevant the season during which works will take place;
- Any conclusions drawn from local topography;
- Duration of the potential impact, as a receptor may become more sensitive over time; and,
- Any known specific receptor sensitivities which go beyond the classifications given in the document.

These factors were considered during the undertaking of the assessment.

The criteria for determining the sensitivity of the area to dust soiling effects on people and property is summarised in Table A-3.

Table A-3 – Construction Dust - Sensitivity of the Area to Dust Soiling Effects on People and Property (IAQM, 2014)

Receptor Sensitivity	Number of Receptors	Distance from the Source (m)			
		Less than 20	**Less than 50**	**Less than 100**	**Less than 350**
High	More than 100	High	High	Medium	Low
	10 - 100	High	Medium	Low	Low
	1 - 10	Medium	Low	Low	Low
Medium	More than 1	Medium	Low	Low	Low
Low	More than 1	Low	Low	Low	Low

Table A-4 outlines the criteria for determining the sensitivity of the area to human health impacts.

Table A-4 – Construction Dust - Sensitivity of the Area to Human Health Impacts (IAQM, 2014)

Receptor Sensitivity	Annual Mean PM_{10} Conc.	Number of Receptors	Distance from the Source (m)				
			Less than 20	**Less than 50**	**Less than 100**	**Less than 200**	**Less than 350**
High	Greater than 32µg/m^3	More than 100	High	High	High	Medium	Low
		10 - 100	High	High	Medium	Low	Low
		1 - 10	High	Medium	Low	Low	Low
	28-32µg/m^3	More than 100	High	High	Medium	Low	Low
		10 - 100	High	Medium	Low	Low	Low
		1 - 10	High	Medium	Low	Low	Low
	24-28µg/m^3	More than 100	High	Medium	Low	Low	Low
		10 - 100	High	Medium	Low	Low	Low
		1 - 10	Medium	Low	Low	Low	Low
	Less than 24µg/m^3	More than 100	Medium	Low	Low	Low	Low
		10 - 100	Low	Low	Low	Low	Low
		1 - 10	Low	Low	Low	Low	Low
Medium	Greater than 32µg/m^3	More than 10	High	Medium	Low	Low	Low
		1 - 10	Medium	Low	Low	Low	Low
	28-32µg/m^3	More than 10	Medium	Low	Low	Low	Low

Receptor Sensitivity	Annual Mean PM_{10} Conc.	Number of Receptors	Distance from the Source (m)				
			Less than 20	**Less than 50**	**Less than 100**	**Less than 200**	**Less than 350**
		1 - 10	Low	Low	Low	Low	Low
	24-28µg/m³	More than 10	Low	Low	Low	Low	Low
		1 - 10	Low	Low	Low	Low	Low
	Less than 24µg/m³	More than 10	Low	Low	Low	Low	Low
		1 - 10	Low	Low	Low	Low	Low
Low	-	More than 1	Low	Low	Low	Low	Low

Table A-5 outlines the criteria for determining the sensitivity of the area to ecological impacts.

Table A-5 – Construction Dust - Sensitivity of the Area to Ecological Impacts (IAQM, 2014)

Receptor Sensitivity	Distance from the Source (m)	
	Less than 20	**Less than 50**
High	High	Medium
Medium	Medium	Low
Low	Low	Low

Step 2C combines the dust emission magnitude with the sensitivity of the area to determine the risk of unmitigated impacts.

Table A-6 – outlines the risk category from demolition activities.

Table A-6 – Construction Dust - Dust Risk Category from Demolition Activities (IAQM, 2014)

Receptor Sensitivity	Dust Emission Magnitude		
	Large	**Medium**	**Small**
High	High	Medium	Medium
Medium	High	Medium	Low
Low	Medium	Low	Negligible

Table A-7 outlines the risk category from earthworks and construction activities.

Table A-7 – Construction Dust - Dust Risk Category from Earthworks and Construction Activities (IAQM, 2014)

Receptor Sensitivity	Dust Emission Magnitude		
	Large	**Medium**	**Small**
High	High	Medium	Low
Medium	Medium	Medium	Low
Low	Low	Low	Negligible

Table A-8outlines the risk category from trackout activities.

Table A-8 – Construction Dust - Dust Risk Category from Trackout Activities (IAQM, 2014)

Receptor Sensitivity	Dust Emission Magnitude		
	Large	**Medium**	**Small**
High	High	Medium	Low
Medium	Medium	Low	Negligible
Low	Low	Low	Negligible

Step 3

Step 3 requires the identification of site-specific mitigation measures within the guidance to reduce potential dust impacts based upon the relevant risk categories identified in Step 2. For sites with negligible risk, mitigation measures beyond those required by legislation are not required. However, additional controls may be applied as part of good practice.

Step 4

Once the risk of dust impacts has been determined and the appropriate mitigation measures identified, the final step is to determine the significance of any residual impacts. For almost all construction activity, the aim should be to control effects using effective mitigation. Experience shows that this is normally possible, hence the residual effect will normally be not significant.

Construction Dust Risk Assessment

Step 1

The undertaking of activities such as on-site concrete batching has the potential to result in fugitive dust emissions throughout the construction works. Vehicle movements both on-site and on the local road network also have the potential to result in the re-suspension of dust from highway surfaces.

The potential for impacts at sensitive receptors depends significantly on local weather conditions during the undertaking of dust generating activities, with the most significant effects likely to occur during dry and windy conditions.

The desk-study using Google Earth and MAGIC identified a number of sensitive receptors within 350m of the site boundary. As such, a detailed assessment of potential dust impacts has been undertaken.

Step 2

The following section assesses the risk of potential dust impacts of each of the four potential dust generating activities.

Demolition

No demolition activities will occur at the site as part of the works. Therefore, demolition activities have not been considered further in the assessment.

Earthworks

The emission magnitude for earthworks is considered to be large because the total site area is over 10,000m^2, there is expected to be over 10 heavy earth moving vehicles active at any one time and the total material moved is likely to be over 100,000 tonnes.

Construction

The emission magnitude for construction is considered to be large because the total building volume used for construction is over 100,000m^3 and the main construction material is concrete which can be a relatively dusty compared to other materials.

Trackout

The emission magnitude for trackout is considered to be large because during normal operation there are expected to be over 50 heavy duty vehicles and with a surface material that is likely to be dusty (e.g., has a high clay content).

The dust emission magnitude for each dust generating activity is summarised in Table A-9 –

Table A-9 – Construction Dust - Magnitude of Emission

Activity	Dust Emission Magnitude
Demolition	Negligible
Earthworks	Large
Construction	Large
Trackout	Large

Receptors sensitive to potential dust impacts were approximated from a desktop study of the area up to 350m from the site boundary for earthworks and construction and up to 50m from the road network within 500m of the site accesses for trackout based on the site being classed as large in size (trackout may occur up to 500m from large sites, 200m from medium sites and 50m from small sites, as measured from the site exits in accordance with the IAQM construction dust guidance). These are summarised in below Table A-10.

Table A-10 – Approximate Number of Dust Sensitive Receptors

Distance from Site (m)	Approximate Number of Human Receptors and Sensitivities	Number of Ecological Receptors and Sensitivities
Earthworks and Construction		
Less than 20	>1 Receptor(s) with High Sensitivity	0 Receptor(s) with Low Sensitivity
Less than 50	>1 Receptor(s) with High Sensitivity	0 Receptor(s) with Low Sensitivity
Less than 100	10 to 100 Receptor(s) with High Sensitivity	0 Receptor(s) with Low Sensitivity
Less than 200	10 to 100 Receptor(s) with High Sensitivity	0 Receptor(s) with Low Sensitivity
Less than 350	>100 Receptor(s) with High Sensitivity	0 Receptor(s) with Low Sensitivity
Trackout		
Less than 20	>1 Receptor(s) with High Sensitivity	0 Receptor(s) with Low Sensitivity
Less than 50	10 to 100 Receptor(s) with High Sensitivity	0 Receptor(s) with Low Sensitivity

Using the number of receptors and receptor sensitivities determined in Table A-10, and the criteria outlined in Table A-3, Table A-4 – and Table A-5, the overall sensitivity of the receiving environment to specific dust impacts is summarised in Table A-11 .

Table A-11 – Summary of the Sensitivity of the Study Area

Potential Impact	Sensitivity of the surrounding area			
	Demolition	**Earthworks**	**Construction**	**Trackout**
Dust soiling	Medium Sensitivity	Medium Sensitivity	Medium Sensitivity	Medium Sensitivity
Human health	Medium Sensitivity	Medium Sensitivity	Medium Sensitivity	Medium Sensitivity
Ecological	Low Sensitivity	Low Sensitivity	Low Sensitivity	Low Sensitivity

Table A-12 – Summary of the Risk of Dust Effects

Potential Impact	Potential Risk			
	Demolition (Negligible)	**Earthworks (Large)**	**Construction (Large)**	**Trackout (Large)**
Dust soiling	N/A	Medium Risk	Medium Risk	Medium Risk
Human health	N/A	Medium Risk	Medium Risk	Medium Risk

Potential Impact	Potential Risk			
	Demolition (Negligible)	Earthworks (Large)	Construction (Large)	Trackout (Large)
Ecological	N/A	Low Risk	Low Risk	Low Risk

Step 3

The IAQM guidance on the assessment of dust from demolition and construction provides potential mitigation measures to reduce impacts as a result of fugitive dust emissions during the construction phase. These have been adapted for the FF Allocation Site based on the risk of dust effects for each activity and for the overall site (

Table A-12 –) and are summarised in Table A-13.

Table A-13 – Proposed Dust Mitigation Measures based on the IAQM Construction Dust Guidance

Mitigation Measure	Medium Risk Measures H=Highly Recommended. D=Desirable
Communications	
Develop and implement a stakeholder communications plan that includes community engagement before work commences on site.	H
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.	H
Display the head or regional office contact information.	H
Dust Management	
Develop and implement a Dust Management Plan (DMP), which may include measures to control other emissions, approved by the Local Authority.	H
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.	H
Make the complaints log available to the local authority when asked.	H
Record any exceptional incidents that cause dust and/or air emissions, either on- or off-site, and the action taken to resolve the situation in the log book.	H
Monitoring	

Mitigation Measure	Medium Risk Measures H=Highly Recommended. D=Desirable
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.	D
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.	H
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.	H
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.	H
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.	H
Erect solid screens or barriers around dusty activities or the site boundary so that are at least as high as any stockpiles on site.	H
Fully enclose site or specific operations where there is a high potential for dust production and the site is active for an extensive period.	H
Avoid site runoff of water or mud.	H
Keep site fencing, barriers and scaffolding clean using wet methods.	H
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.	H
Cover, seed or fence stockpiles to prevent wind whipping.	H
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	H

Mitigation Measure	Medium Risk Measures H=Highly Recommended. D=Desirable
Ensure all vehicles switch off engines when stationary - no idling vehicles.	H
Avoid the use of diesel or petrol powered generators and use mains electricity or battery powered equipment where practicable.	H
Impose and signpost a maximum-speed-limit of 15mph on surfaced and 10mph 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).	D
Produce a Construction Logistics Plan to manage the sustainable delivery of goods and materials.	H
Implement a Travel Plan that supports and encourages sustainable travel (public transport, cycling, walking, and car-sharing).	D
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.	H
Ensure an adequate water supply on the site for effective dust/particulate matter suppression/mitigation, using non-potable water where possible and appropriate.	H
Use enclosed chutes and conveyors and covered skips.	H
Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate.	H
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.	H
Waste Management	
Avoid bonfires and burning of waste materials.	H
Earthworks	
Re-vegetate earthworks and exposed areas/soil stockpiles to stabilise surfaces as soon as practicable.	D

Mitigation Measure	Medium Risk Measures H=Highly Recommended. D=Desirable
Use Hessian, mulches or trackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable.	D
Only remove the cover in small areas during work and not all at once.	D
Construction	
Avoid scabbling (roughening of concrete surfaces) if possible.	D
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.	H
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.	D
For smaller supplies of fine powder materials ensure bags are sealed after use and stored appropriately to prevent dust.	D
Trackout	
Use water-assisted dust sweeper(s) on the access and local roads, to remove, as necessary, any material tracked out of the site. This may require the sweeper being continuously in use.	H
Avoid dry sweeping of large areas.	H
Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport.	H
Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable.	H
Record all inspections of haul routes and any subsequent action in a site log book.	H
Install hard surfaced haul routes, which are regularly damped down with fixed or mobile sprinkler systems, or mobile water bowsers and regularly cleaned.	H
Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable).	H
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.	H

Mitigation Measure	Medium Risk Measures H=Highly Recommended. D=Desirable
Access gates to be located at least 10 m from receptors where possible.	H

Step 4

Assuming the relevant mitigation measures outlined in Table A-13 are implemented, the residual effect from all dust generating activities is predicted to be negligible.

Appendix B

Baseline Conditions

Table B-1 – Warrington Borough Council 2019 NO2 Diffusion Tube Concentration

Site ID	OS Grid Ref X (m)	OS Grid Ref Y (m)	Type	2019 Annual Average NO_2 ($\mu g/m^3$)	2019 Percentage Data Capture
DT1	366949	392004	Rural	16.3	91.7
DT2	359152	388218	Urban Background	19.7	100
DT3	359152	388218	Urban Background	20.4	91.7
DT4	359152	388218	Urban Background	20.2	91.7
DT5	366102	389214	Roadside	41.0	91.7
DT6	361655	391914	Roadside	23.5	91.7
DT7	360233	381994	Roadside	32.5	58.3
DT8	360044	388048	Roadside	43.8	100
DT9	360309	387848	Roadside	36.1	75.0
DT10	359509	388235	Roadside	30.7	83.3
DT11	359452	388111	Urban Centre	39.1	83.3
DT12	359430	387947	Roadside	31.7	100
DT13	360648	387388	Roadside	34.1	100
DT14	360407	386237	Roadside	30.7	100
DT15	360450	386052	Roadside	31.4	100
DT16	360880	387247	Roadside	28.8	83.3
DT17	361220	386874	Roadside	29.7	83.3
DT18	361319	386508	Roadside	30.6	91.7
DT19	361470	385981	Roadside	25.1	91.7

Site ID	OS Grid Ref X (m)	OS Grid Ref Y (m)	Type	2019 Annual Average NO_2 ($\mu g/m^3$)	2019 Percentage Data Capture
DT20	361898	387430	Roadside	29.9	91.7
DT21	362810	387187	Urban Centre	32.5	100
DT22	362779	387288	Roadside	34.8	100
DT23	362604	387222	Roadside	31.0	100
DT24	361005	388145	Roadside	35.3	100
DT25	360462	388501	Roadside	30.6	91.7
DT26	360040	388406	Roadside	33.4	100
DT27	362392	389101	Roadside	35.1	100
DT28	362235	389248	Roadside	32.5	100
DT29	362060	389170	Roadside	34.1	100
DT30	362131	389473	Roadside	35.9	100
DT31	360598	389820	Roadside	30.2	100
DT32	360484	390416	Roadside	36.6	83.3

Table B-2 – *Project Monitoring: Annualised and Adjusted Annual Average 2019 NO2 Concentrations*

Site ID	OS Grid Ref X (m)	OS Grid Ref Y (m)	Description	2019 Annualised/Adjusted NO_2 Concentration ($\mu g/m^3$)
FF_01	353337.8	386761.5	Dan's Rd, A562, near Bennett's Lane.	23.0
FF_02	352954.9	386381.7	Kingham Close near Fiddlers Ferry Road.	18.1
FF_03abc	358383.8	388106.6	Triplicate co-location at Sankey Way	24.4

Site ID	OS Grid Ref X (m)	OS Grid Ref Y (m)	Description	2019 Annualised/Adjusted NO_2 Concentration (µg/m^3)
			Automatic Station	
FF_04	355474.3	387478	96 Farnworth Road, A5080	14.5
FF_05	356808.6	387679.1	118 Warrington Rd, A562.	20.1
FF_06	357470.4	387924.3	15 Penketh Rd, A562	24.4
FF_07	352183.3	385566.5	Fiddlers Ferry Road, A562	27.9
FF_08	356018.9	388625.2	503 Liverpool Road, A57	27.3
FF_09	357240.6	390660.4	Burtonwood Road	19.7
FF_10	352406.6	386395.3	Halton View Road, B5178	24.1
FF_11	357254.3	388873.1	Whittle Avenue	26.3

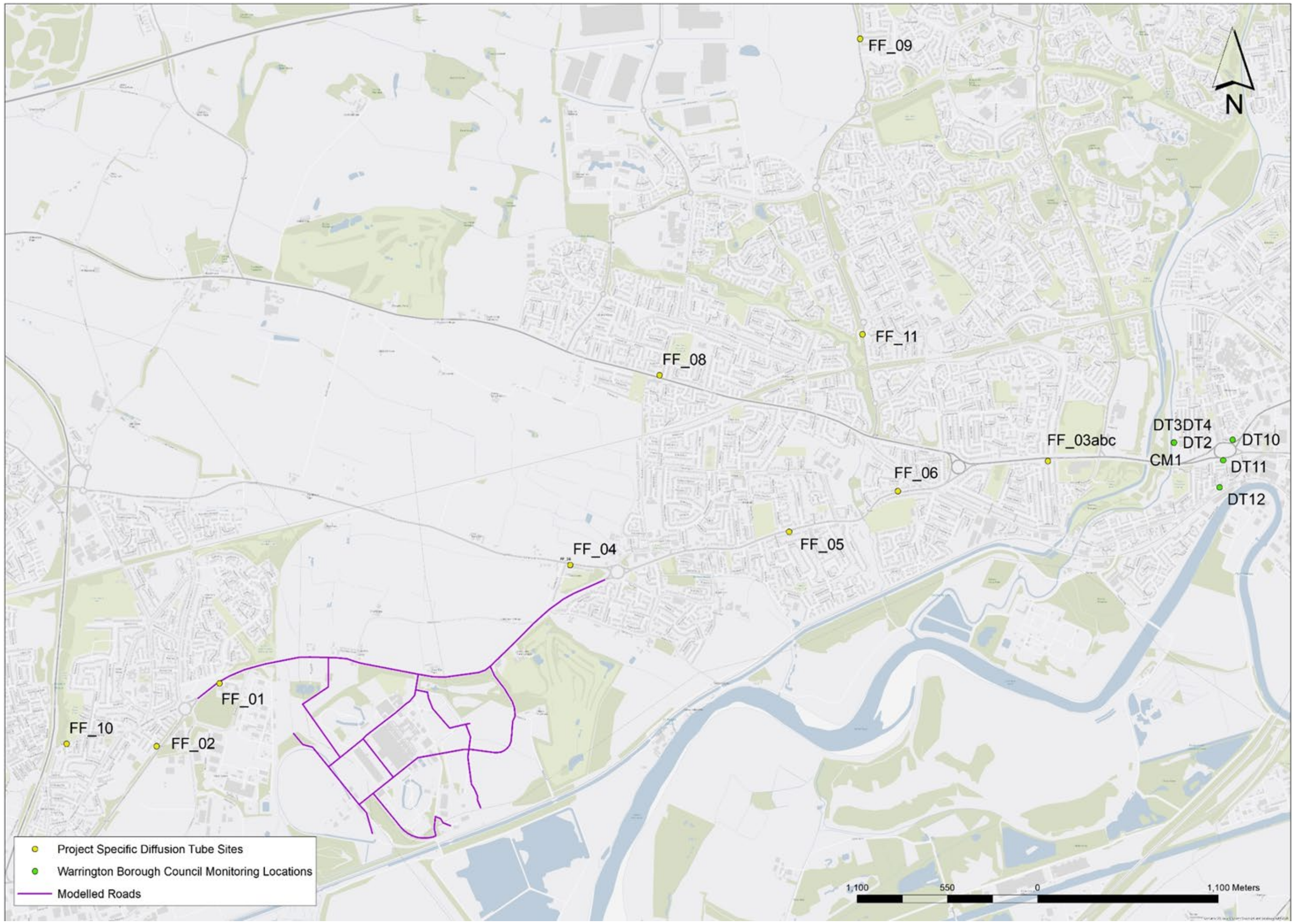

Figure B-1 – Air Quality Baseline

Appendix C

Model Inputs

Meteorological Data

Meteorological data used in this assessment was taken from the Liverpool/John Lennon Airport meteorological station over the period 1st January to 31st December 2019. The station is located at grid reference 343364,382259, which is approximately 12km southwest. Defra guidance LAQM.TG (22) (Ref 9.6) recommends meteorological stations within 30km of an assessment area as being suitable for detailed modelling.

All meteorological records used in the assessment were provided by Atmospheric Dispersion Modelling (ADM) Ltd, which is an established distributor of data within the UK. Figure C-1 below shows the window rose of utilised meteorological data.

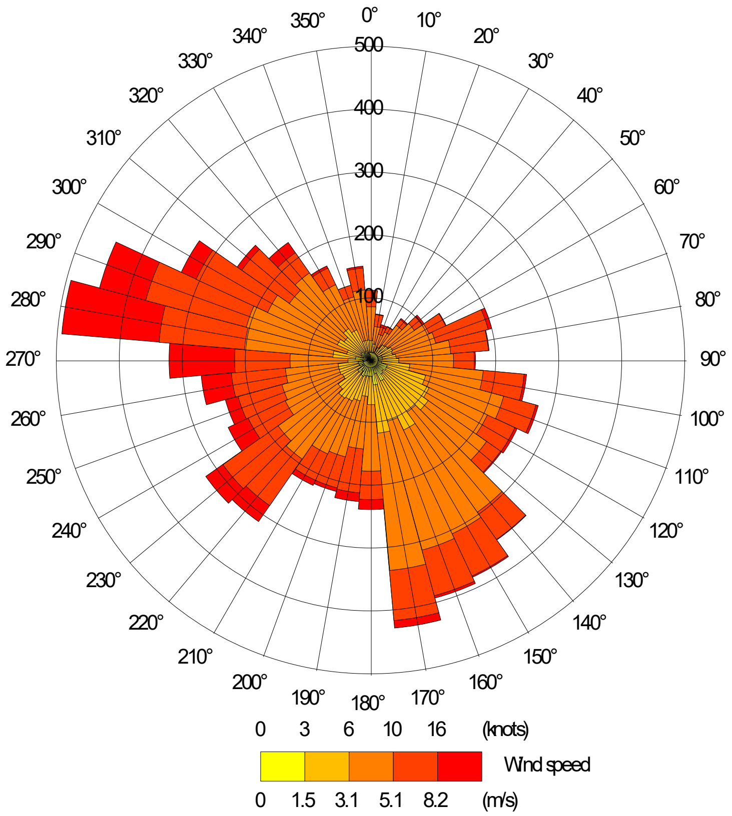

Figure C-1 – Liverpool/John Lennon Airport 2019 Meteorological Data Wind Rose

Roughness Length

A roughness length (z0) of 0.5m was used within the dispersion model. This value of z0 is considered appropriate for the morphology of the assessment area and is suggested within ADMS-Roads as being suitable for 'parkland, open suburbia'.

Monin-Obukhov Length

The Monin-Obukhov length provides a measure of the stability of the atmosphere. A minimum Monin-Obukhov length of 30m was used in the dispersion modelling study. This value is considered appropriate for the nature of the assessment area and is suggested within ADMS-Roads as being suitable for 'mixed urban/ industrial'.

Traffic Data

Traffic data was provided by Curtins Consultancy for use in the assessment. Traffic data used for air quality modelling purposes included modelled AADT flows, HDV % and speeds (kph) for each scenario. Road widths were approximated using Google Earth imagery at the locations closest to the modelled receptors located along each link. Emission factors for each link were calculated, using the relevant traffic flows and the updated Emissions Factor Toolkit (v11) released in November 2021, for the Base Year and Opening Year scenarios.

The traffic data used in the air quality assessment is displayed in Table C-1 below.

Table C-1 –Traffic Data Inputs

Model Link	Road Type	Base Year (2019)			Without Scheme (2026)			With Scheme (2026)			Road Width (m)
		Traffic Flow	%HDV	Speed (kph)	Traffic Flow	%HDV	Speed (kph)	Traffic Flow	%HDV	Speed (kph)	
1_1	Motorway (Not London)	13451	5	80	14704	5	80	25565	9	80	7.5
1_2	Rural (Not London)	0	0	48	0	0	48	17991	29	48	7.5
1_3	Motorway (Not London)	13451	5	80	14704	5	80	27664	19	80	7.5
2_1	Motorway (Not London)	13451	5	80	14704	5	80	25561	8	80	7.5
2_2	Rural (Not London)	0	0	48	0	0	48	4496	13	48	7.5
2_3	Motorway (Not London)	13451	5	80	14704	5	80	25800	9	80	7.5
3_1	Motorway (Not London)	13451	5	80	14728	5	80	25619	8	80	7.5
3_2	Rural (Not London)	0	0	48	0	0	48	1062	0	48	7.5
3_3	Motorway (Not London)	13451	5	80	14704	5	80	25589	8	80	7.5

Model Link	Road Type	Base Year (2019)			Without Scheme (2026)			With Scheme (2026)			Road Width (m)
		Traffic Flow	%HDV	Speed (kph)	Traffic Flow	%HDV	Speed (kph)	Traffic Flow	%HDV	Speed (kph)	
4	Rural (not London)	0	0	32	0	0	32	17991	29	32	7.5
5	Rural (not London)	0	0	32	0	0	32	17991	29	32	7.5
6	Rural (not London)	0	0	32	0	0	32	17991	29	32	7.5
7	Rural (not London)	0	0	32	0	0	32	17991	29	32	7.5
8	Rural (not London)	0	0	32	0	0	32	17991	29	32	7.5
9	Rural (not London)	0	0	32	0	0	32	4496	13	32	7.5
10	Rural (not London)	0	0	32	0	0	32	4496	13	32	7.5
11	Rural (not London)	0	0	32	0	0	32	1062	0	32	7.5
12	Rural (not London)	0	0	32	0	0	32	4496	13	32	7.5
13	Rural (not London)	0	0	32	0	0	32	4496	13	32	7.5

Model Link	Road Type	Base Year (2019)			Without Scheme (2026)			With Scheme (2026)			Road Width (m)
		Traffic Flow	%HDV	Speed (kph)	Traffic Flow	%HDV	Speed (kph)	Traffic Flow	%HDV	Speed (kph)	
14	Rural (not London)	0	0	32	0	0	32	4496	13	32	7.5
15	Rural (not London)	0	0	32	0	0	32	1062	0	32	7.5

Appendix D

Model Verification

Model Verification Parameters

The comparison of modelled concentrations with local monitored concentrations is a process termed 'verification'. Model verification identifies any discrepancies between modelled and measured concentrations, which can arise for a range of reasons. The following are examples of potential causes of such discrepancies:

- Estimates of background pollutant concentrations
- Meteorological data uncertainties
- Traffic data uncertainties
- Emission factor uncertainties
- Model input parameters, such as 'roughness length'; an
- Overall limitations of the ability of the dispersion model to model dispersion in a complex urban environment.

The verification process involves a review of the modelled pollutant concentrations against corresponding monitoring data to determine how well the air quality model has performed. Depending on the outcome it may be considered that the model has performed adequately and that there is no need to adjust any of the modelled results.

Alternatively, the model may perform poorly against the monitoring data, as a result there is a need to check all the input data to ensure that it is reasonable and accurately represented in the air quality modelling process. Where all input data, such as traffic data, emissions rates and background concentrations have been checked and considered reasonable, then the modelled results may require adjustment to best align them with the monitoring data. This may be either be a single verification adjustment factor to be applied to the modelled concentrations across the study area or a range of different adjustment factors to account for different situations within the study area.

Residual Uncertainty

Residual uncertainty may remain after systematic error or 'overall model accuracy' has been accounted for in the final predictions. Residual uncertainty may be considered synonymous with the 'residual inaccuracies' of the model predictions, i.e., how wide the scatter or residual variability of the predicted values compare with the monitored 'true value', once systematic error has been allowed for. The quantification of final model accuracy provides an estimate of how the final predictions may deviate from the 'true' (monitored) values at the same location over the same period. It must though be recognised that some of the residual uncertainty will be down to uncertainties in the monitored values. This uncertainty is greater for monitoring using diffusion tubes than for automatic monitors.

Local air quality monitoring data has been used to validate the dispersion model prediction and obtain adjustment factors which can be applied to predictions of pollutant concentrations in the base and future years.

Model Performance

An evaluation of model performance has been undertaken to establish confidence in model results. LAQM.TG(22) identifies a number of statistical procedures that are appropriate to evaluate model performance and assess the uncertainty. The statistical parameters used in this assessment are:

- Root mean square error (RMSE);
- Fractional bias (FB); and
- Correlation coefficient (CC).

A brief explanation of each statistic is provided in Table D-1 below.

Table D-1 – Statistical Parameters used to Estimate Model Performance

Statistical Parameter	Comments	Ideal Value
RMSE	RMSE is used to define the average error or uncertainty of the model. The units of RMSE are the same as the quantities compared. If the RMSE values are higher than 25% of the objective being assessed, it is recommended that the model inputs and verification should be revisited in order to make improvements. For example, if the model predictions are for the annual mean NO_2 objective of 40µg/m^3, if an RMSE of 10µg/m^3 or above is determined for a model it is advised to revisit the model parameters and model verification. Ideally an RMSE within 10% of the air quality objective would be derived, which equates to ±4µg/m^3 for the annual mean NO_2 objective.	0.01
FB	It is used to identify if the model shows a systematic tendency to over or under predict. FB values vary between +2 and -2 and have an ideal value of zero. Negative values suggest a model over-prediction and positive values suggest a model under-prediction.	0.00
CC	It is used to measure the linear relationship between predicted and observed data. A value of zero means no relationship and a value of 1 means absolute relationship. This statistic can be particularly useful when comparing a large number of model and observed data points.	1.00

These parameters estimate how the model results agree or diverge from the observations. These calculations have been carried out prior to, and after, adjustment and provide information on the improvement of the model predictions as a result of the application of the verification adjustment factors.

Monitoring Verification

All air quality monitoring data collected as part of this assessment was reviewed to determine the suitability of each of the monitoring locations for inclusion into the model verification process. The criteria used to determine the suitability of the monitoring for inclusion into the verification exercise is outlined below:

- Within 200m of the modelled road network;
- Greater than 75% data capture;
- Sites classified as roadside; and

- Location confirmed to a satisfactory standard.

Project specific diffusion tube concentrations were used for verification. Following the removal of the monitoring locations which did not adhere to the aforementioned criteria, only one monitoring sites was selected for use in the verification, these are detailed in Table D-2 below.

Table D-2 Monitoring data used for Verification

Site ID	X	Y	Site Type	2019 NO_2 Concentration (µg/m³)	2019 Data Capture (%)
FF_01	353337.8	386761.5	Roadside	32.8	100

For FF tubes 100% Data Capture = 100% Data Capture across the five-month monitoring survey

The five month project specific monitoring data, has been back casted and annualised to 2019, in accordance with LAQM.TG(22) using an annualisation factor of 1.02 and adjusted for bias, using a national factor of 0.79.

Verification Methodology

The verification method used for this assessment follows the process detailed in LAQM.TG(22) (Ref x). The initial verification was undertaken by comparing the modelled versus monitored Road NO_x. Road NO_x measured at the monitoring sites were calculated using the latest Defra NO_x to NO_2 calculator (v8.1), as diffusion tubes only measure NO_2 and do not directly measure NO_x.

For each monitoring site, the relevant 1x1km 2019 background concentrations for NO_x and NO_2 were acquired. The NO_2 to NO_x tool was used to calculate the total road NOx at each monitoring site.

Table D-3 summarises the background (BG) NO_x/NO_2 concentrations, raw (i.e., no adjustment) modelled and monitored road NO_x concentrations and raw modelled and monitored total NO_2 concentrations.

Table D- 3 Unadjusted Modelled versus Monitored NO_2 and Road NO_X

Site ID	BG NO_2 (µg/m³)	Monitored NO_2 (µg/m³)	Modelled Total NO_2 (µg/m³)	Ratio of Monitored v Modelled Total NO_2	Monitored Road NO_x (µg/m³)	Modelled Road NO_x (µg/m³)	Ratio of Monitored v Modelled Road NO_x
FF_01	17.01	23.0	19.0	1.2	11.4	3.8	3.0

The modelled versus monitored road NO_X component concentrations were plotted on a scatter graph as shown in Figure D-1.

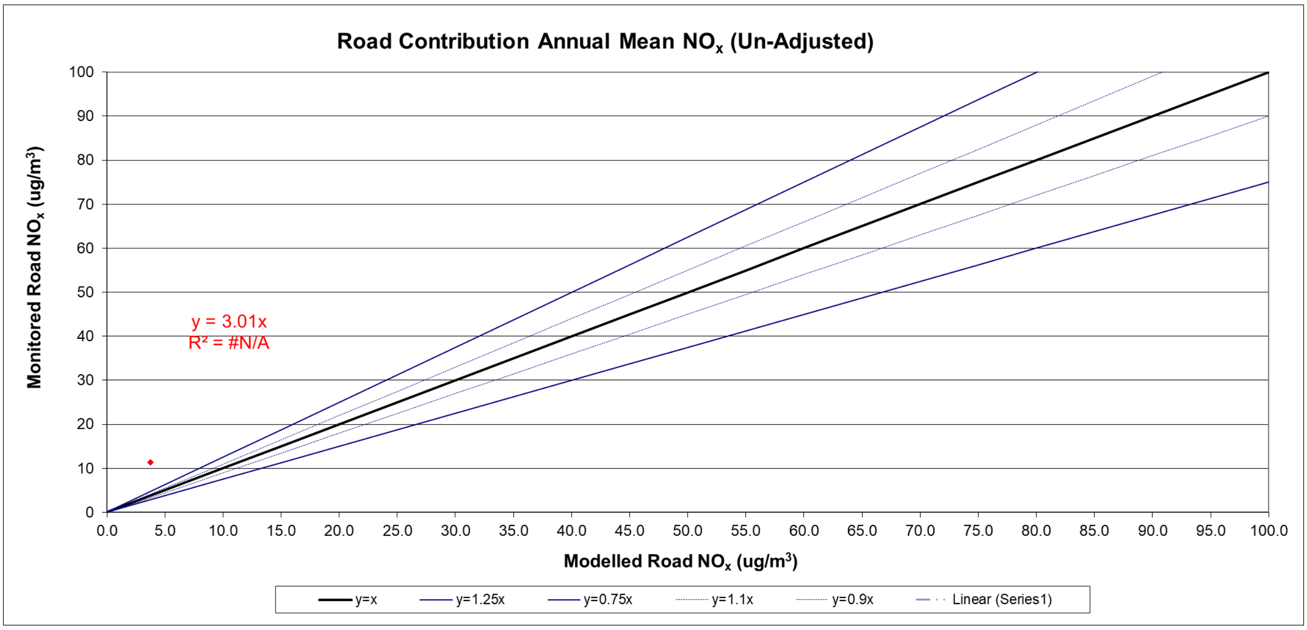

Figure D-1 – Un-adjusted modelled versus monitored road NOx

The verification factor derived from the model verification as shown in the graph above was 3.01, showing that the model underestimates pollutant concentrations in relation to the monitored concentrations.

Adjusted modelled versus monitored road NO_x concentrations are presented in Figure D-1. Figure D-3 presents the verified modelled versus monitored total NO_2 using the verification factor of 3.01. Figure D-3 demonstrates that once adjusted for road NO_x, total modelled NO_2 concentrations are closer to monitored total NO_2 concentrations.

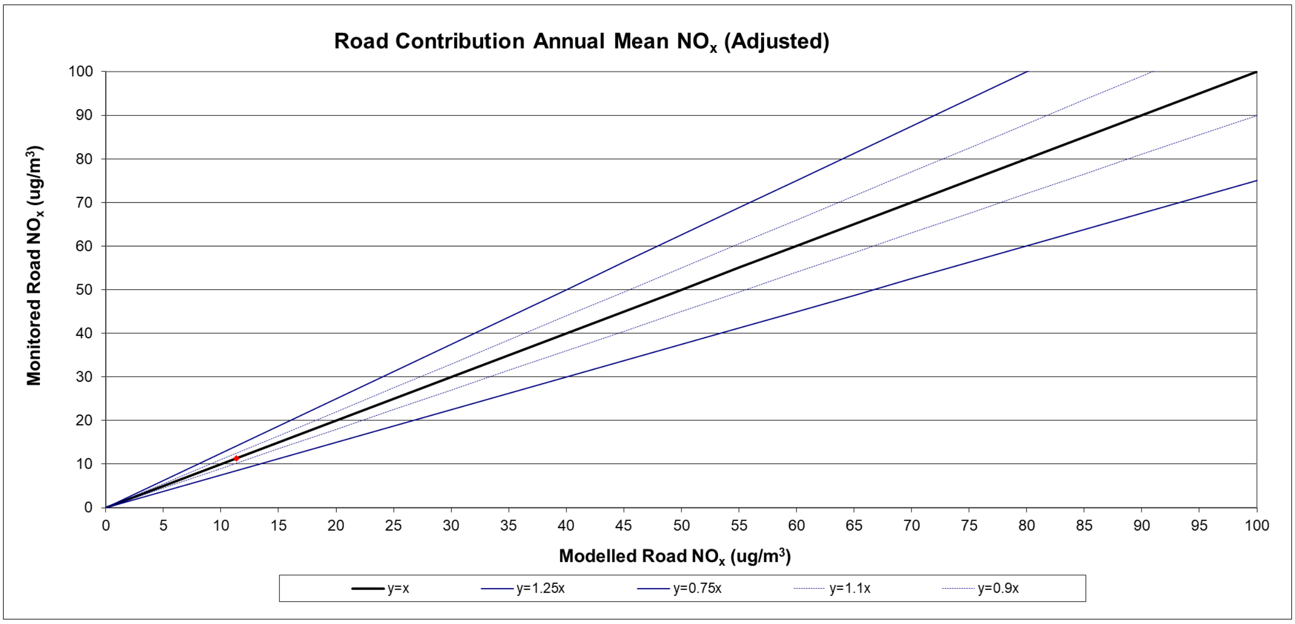

Figure D-2 – Adjusted Monitored versus Modelled Road NO_X

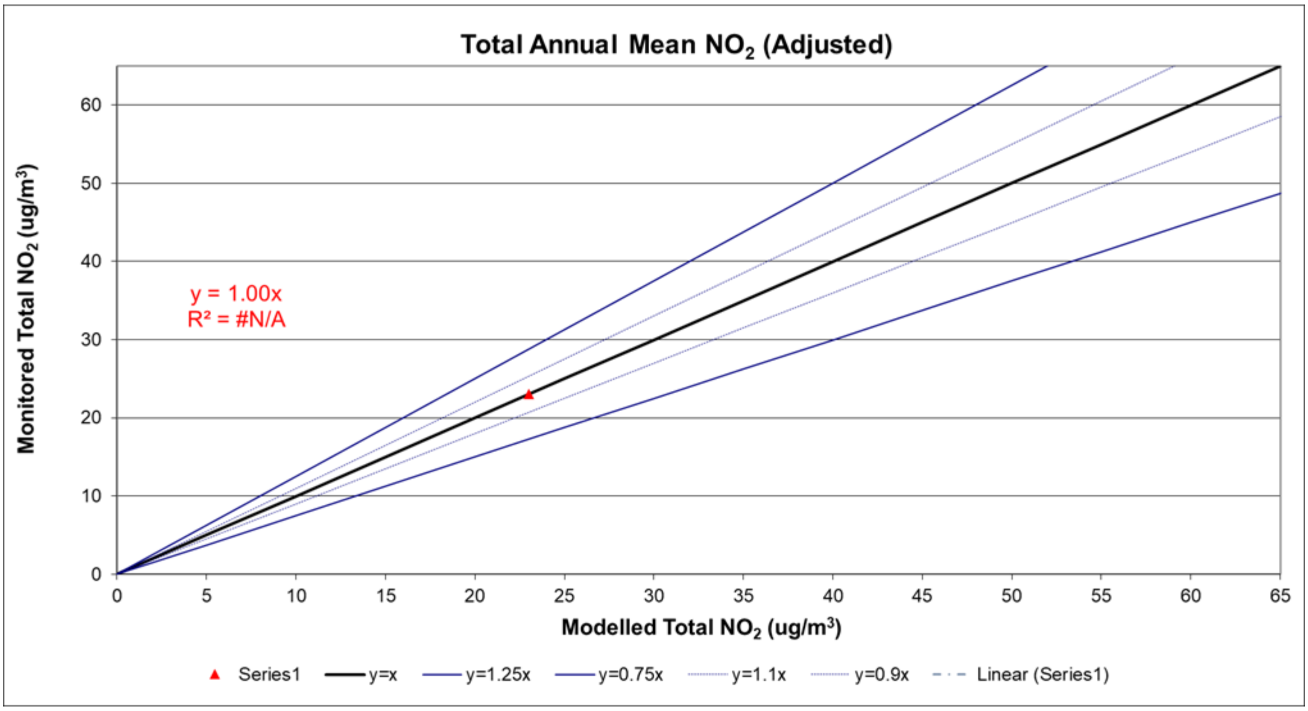

Figure D-3 – Adjusted Monitored versus Modelled Total NO_2

Table D-4 below summarises the model performance statistics for before and after adjustment.

Table D-4 Model Performance Statistics

Summary Table	Before Adjustment	Following Adjustment
Within +10%	0	0
Within -10%	0	1
Within +-10%	0	1
Within +10 to 25%	0	0
Within -10 to 25%	1	0
Within -+10 to 25%	1	0
Over 25%	0	0
Under 25%	0	0
Greater +-25%	0	0
Within +-25%	1	1
Total	1	1
Correlation	**0**	**0**
RMSE	1.06	0.01
Fractional Bias	0.2	0

The model statistics show that the model had a tendency to under predict actual concentrations because the fractional bias was greater than zero. When road NO_x is adjusted by applying the verification factor, the RMSE is reduced from 1.06μg/m^3 to 0.01μg/m^3. This RMSE is within the ideal 4 μg/m^3 guideline, as shown in Table D-1. The adjusted model thus provides a much-improved model performance.

To provide a robust assessment, the verification factor was applied to the modelling results for all receptors. The same verification factors were applied for both NO_x, PM_{10} and $PM_{2.5}$ modelled results at each relevant receptor as no PM_{10} or $PM_{2.5}$ monitoring data was available for verification purposes.

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