Wirral Local Plan Air Quality Study

Wirral Metropolitan Borough Council

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Quality information

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Table of Contents

Figures

Tables

List of Acronyms and Abbreviations

Acronym / Abbreviation	Definition
AADT	Annual Average Daily Traffic
ANPR	Automatic Number Plate Recognition
AQAP	Air Quality Action Plan
AQMA	Air Quality Management Area
AQS	Air Quality Strategy
ASR	Annual Status Report
CAFE	Clean Air for Europe
CAZ	Clean Air Zone
CAP	Clean Air Plan
CO	Carbon monoxide
CO_2	Carbon dioxide
DfT	Department for Transport
DM	Do Minimum
DS	Do Something
Defra	Department for Environment Food & Rural Affairs
EC	European Commission
EFT	Emission Factor Toolkit
EPUK	Environmental Protection UK
EU	European Union
GHG	Greenhouse Gas
HDV	Heavy Duty Vehicle (HGVs plus buses)
HGV	Heavy Goods Vehicle (truck with a gross combination mass of over 3,500 kilograms)
IAQM	Institute of Air Quality Management
IMD	Index of Multiple Deprivation
JSNA	Joint Strategic Needs Assessment
LA	Local Authority
LAQM	Local Air Quality Management
LCC	Liverpool City Council
LCRCA	Liverpool City Region Combined Authority
LGV	Light Goods Vehicle (i.e. car, van)
LLPG	Local Land and Property Gazetteer
NO	Nitric oxide
NO_2	Nitrogen dioxide
NOx	Nitrogen oxides
NPPF	National Planning Policy Framework
O_3	Ozone
PM_{10}	Particulate matter less than 10 microns in diameter
$PM_{2.5}$	Particulate matter less than 2.5 microns in diameter
PPG	Planning Practice Guidance
RMSE	Root Mean Square Error
SO_2	Sulphur dioxide
SPD	Supplementary Planning Documents
WHO	World Health Organisation
WMBC	Wirral Metropolitan Borough Council

$\mu g/m^3$	Microgram (one-millionth of a gram) per cubic metre of air

Definition of Terms

Term	Definition
Active travel	Making journeys by physically active means i.e. walking, cycling
Background air quality	The component left after removing contribution from sources such as roads and industrial chimney stacks
Base year	The year against which performance is tested
Baseline conditions	A description of the environmental setting in which a project is to be developed, for example, nature of terrain/landscape, location of populated areas, ecological resources, agriculture, air quality and noise etc.
Concentration	The relative amount of a substance contained within a solution or mixture or in a volume of space
Cumulative	Increasing due to successive additions
Discharge (emission, effluent, waste)	Any release of pollutant(s) into the environment, be it of a gaseous, liquid or solid nature, or a combination thereof.
Emission	The direct or indirect release of substances, vibration, heat or noise from a source into air, water or land.
Exposure	A situation or condition that makes a receptor likely to be harmed by poor air quality
Green infrastructure	A network of multi-functional green space, urban and rural, which is capable of delivering a wide range of environmental and quality of life benefits for local communities
Impact	Any change to the physical, biological or social environment, either adverse or beneficial, wholly or partially resulting from Plan activities, products or services.
Indicator pollutant	A pollutant which gauges the state of air quality
Mitigation	Measures taken to reduce adverse impacts on the environment.
Monitoring	Measurement of the properties of a material (such as a discharge) or [usually] the sampling of a material together with immediate or subsequent analysis or other form of measurement.
Secondary particulate matter formation	Formed via photochemical processes from gaseous and naturally derived precursors
Source Apportionment	The deriving of information or data about pollution sources and the amount they contribute to ambient air pollution levels in comparison to each other
Sustainable	Able to be maintained at a certain rate or level

Executive Summary

AECOM was appointed by Wirral Metropolitan Borough Council (WMBC) to produce an air quality assessment of nitrogen dioxide (NO_2) and particulate matter (PM_{10} and $PM_{2.5}$), associated with emissions from the transport network, to support further evaluation of the draft Local Plan.

Six areas of concern due to new development or existing poor air quality were shortlisted by WMBC prior to the undertaking of the air quality works. The areas identified as likely to be of greatest concern following additional developments associated with the Local Plan include:

- A section of A59 Kingsway nearby the Kingsway (Wallasey) Tunnel;
- An area encompassing A5139 Dock Road, A554, Corporation Road, and Duke Street;
- A section of Conway Street;
- An area surrounding Birkenhead Central Railway Station including Borough Road and A41;
- A section of A41 New Chester Road in Port Sunlight; and
- An area of Liscard on Wallasey Road.

Baseline Air Quality

A review of current air quality was undertaken, summarising that:

- WMBC has not declared any air quality management areas (AQMA);
- the NO_2 national air quality objectives were not exceeded at any monitoring locations in 2018 except for one location at a taxi rank in Liscard. Measured NO_2 concentrations between 2014 and 2019 have steadily declined, at most locations, with the exception of a select few locations across WMBC's monitoring network that have an increasing trend between years, adjacent to the A552 and in Liscard;
- measured $PM_{2.5}$ concentrations (measured at one urban background location in 2018) were well below the national annual mean objective and also below the more stringent World Health Organisation (WHO) objective;
- the highest NO_2 background concentrations are found around the major road links, the highest PM_{10} and $PM_{2.5}$ background concentrations are found around Liscard and no exceedances of the national air quality objectives exist however, background levels of $PM_{2.5}$ in Liscard are noted to exceed the WHO guideline of 10 $\mu g/m^3$ as an annual mean; and
- the majority of NO_x background derive from rural sources with road exhaust emissions accounting for 6-7% whilst the majority of PM background originates from residual sources (dust and non-characterised sources) and sea salt, and secondary PM formation (formed via photochemical processes from gaseous and naturally derived precursors).

Screening

A screening assessment was undertaken, using the AECOM screening model, which was specifically designed to inform strategic development. The GIS-based tool incorporates spatial integration of road link-specific vehicle emissions data with screening-level dispersion estimates to provide a rapid, high-level analysis of air pollution impacts from road transport. Pollutant concentrations were calculated at 20 m intervals along each road link across the entire Wirral administrative area and predicted at a nominal 5 m distance set back from the kerb. The model considered the Preferred Option scenario and helped inform the spatial scope of the detailed dispersion modelling stage with consideration to the six areas of potential concern shortlisted by WMBC.

The screening model outputs were adjusted by comparison with monitored data to determine an appropriate study-wide bias adjustment factor. The comparison also allowed the model uncertainty to be quantified; the screening model performance was considered to be very good. As the screening model is designed to predict roadside concentrations on road links in strategic models, rather than discrete junction hot-spots or at tunnel portals, the screening results identified the indicative locations of the highest concentrations predicted in the dispersion modelling, however in areas where complex emissions exist such as A59 Kingsway, and in areas of congestion such as Birkenhead centre, the dispersion modelling results provided additional detail.

Screening was performed to understand air quality conditions in 2037, the final year of the Plan. However, in recognition of the fact that making predictions so far into the future is subject to significant uncertainty (for instance regarding vehicle emission characteristics), and some build-out will occur before that date, a hypothetical year of 2024 (but with 2037 traffic flows) was modelled. This approach ensured a robust and cautious assessment.

The screening identified that exceedances are estimated to be very unlikely across the majority of the Wirral. The screening also, however, highlighted a number of locations with a risk of exceedance of the annual mean NO_2 objective. The majority of locations identified from the screening as being considered necessary to include in the dispersion modelling roughly aligned with the six areas of concern identified by WMBC, along with two additional areas at the junction of Poulton Bridge Road with Dock Road, and a section of A552 Borough Road, nearby the junction with Whetstone Lane; these were consequently included in the detailed dispersion modelling extents.

The screening model results also indicated a risk of exceedance of the more stringent World Health Organisation $PM_{2.5}$ guideline at various locations across the Borough, including; the A59 Kingsway, A5139 Dock Road, Liscard, M53 motorway and junctions, central Birkenhead, Moreton, Woodchurch, the A552, and the A41 New Chester Road. Although this is noted in the most part due to a high background concentration as mentioned above which is predominantly from sources other than road transport.

Detailing Modelling

Following screening, detailed air quality dispersion modelling using ADMS-Roads was undertaken for areas identified. Dispersion modelling aimed to include consideration of any complexities of road emission dispersion. This allowed quantification in more detail of the likely effect on air quality of the Preferred Option, by comparison with a situation where the Local Plan development allocations are not implemented. Emissions from roads and from the Mersey tunnel portals and ventilation stacks were included in the dispersion model. The model was again verified by comparison with actual pollution measurements and found to be performing very well. Concentrations were predicted at a wide range of existing receptors, including residential properties and schools as well as those where development allocations were proposed.

There were no exceedances of the relevant England and Wales national air quality objectives predicted for all pollutants considered at any Preferred Option development allocation receptors in the future assessment year, and in terms of model performance, exceedances are considered very unlikely. The dispersion model results also demonstrate that annual mean concentrations for all assessed pollutants are predicted to be below the relevant England and Wales national air quality objectives in the Preferred Option scenario at the majority of assessed existing receptors.

The results of the dispersion modelling indicated that the highest predicted concentrations were located near the A59 Kingsway tunnel portal where four existing sensitive receptors in the Preferred Option 2037 scenario are predicted to experience concentrations above the annual mean NO_2 objective of 40 $\mu g/m^3$. Due to the A59 Kingsway being predicted to have a minimal increase in traffic flow changes as a result of the Preferred Option development allocations in 2037, a 'slight to moderate adverse' impact is predicted for annual mean NO_2 at these existing receptors, despite being predicted to increase by a maximum of only 0.3 $\mu g/m^3$ at this location, with reference to EPUK and IAQM guidance[1]. The impact descriptors have been derived with reference to the IAQM/EPUK methodology for local development planning. This guidance was not explicitly intended for use in strategic assessment but provides context for the magnitude and significance of the predicted local air quality effects. The impact criteria classification is such that if the impact had been instead 0.19 $\mu g/m^3$ at this location, the impact would have been derived as 'negligible'. It is for this reason that professional judgement has been employed in this instance to determine that 0.3 $\mu g/m^3$ is considered not significant. Impacts on all other existing receptors and pollutants are predicted to be 'negligible'.

An assessed existing sensitive receptor at the Queensway (Birkenhead) tunnel portal was predicted by the dispersion modelling to exceed the annual mean NO_2 objective in the Base 2018 scenario. This location is not, however, predicted to exceed in the future assessed scenarios, is not considered to be a risk of exceedance of objectives, and has negligible impact predicted from the Preferred Option development allocations. Additionally, a section of A41 New Chester Road between Bridle Road and Eastham Village Road in Eastham has been identified in the screening as an area which has a possible risk of annual mean NO_2 objective exceedance in the future assessed scenarios as there are nearby sensitive receptors, althoug the dispersion modelling indicates it is

[1] Moorcroft and Barrowcliffe. et al. (2017), Land-use Planning & Development Control: Planning for Air Quality. v1.2. Institute of Air Quality Management, London.

not likely to be an area of concern with regard to Preferred Option development allocations and the core purposes of this study.

The maximum predicted annual mean PM_{10} and $PM_{2.5}$ concentrations also fall near to the Kingsway Tunnel portal. The results demonstrate that annual mean concentrations of all the pollutants considered are below the relevant England and Wales PM_{10} and $PM_{2.5}$ national air quality objectives in the Preferred Option scenario. There are however numerous locations represented by existing and development allocation receptors that were predicted to fall above the WHO guideline of 10 µg/m^3 for annual mean $PM_{2.5}$; these locations are near to A59 Kingsway, in Liscard, and at a number of locations in Birkenhead. There is no 'safe' threshold for exposure to PM, and especially $PM_{2.5}$. It should be recognised that background pollutant concentrations represent a significant proportion of the total predicted concentrations, and although background concentrations were predicted to decrease in the future, PM in particular would not change by a large amount between the two years assessed. However, the total concentrations do not reflect the composition of PM (as described above to be predominantly from sources other than road transport), which is a significant factor influencing health effects.

Greenhouse Gases

Carbon dioxide (CO_2) emissions were also quantified; emissions were predicted to increase as a consequence of the Preferred Option for the year 2037, compared with a situation where the Local Plan is not implemented due to increased traffic.

The total CO_2 emissions from the modelled traffic network with the Preferred Option going ahead, which was a 1.3% increase in emissions compared to the future baseline. However, these values were modelled conservatively, and it is likely that a significant proportion of this fleet will be zero tail-pipe emission by 2037. Therefore, as the emissions profile improves year-on-year, these should be considered cautious values.

Recommendations

The emerging Draft Local Plan Preferred Option development allocations are not considered to significantly affect air quality in WMBC. However, it is recommended that monitoring of NO_2 be undertaken as a minimum, near to the existing receptors at the A59 Kingsway tunnel portal. Ideally PM would also be monitored at this location, however it is recognised that monitoring of particulate matter in this specific location may not be feasible due to practical siting constraints associated with providing power and safe access to monitoring instruments. Monitoring is considered necessary because this location has been predicted to be at risk of annual mean NO_2 objective exceedances and it was also the location of the highest predicted PM_{10} and $PM_{2.5}$ concentrations. It was also identified as experiencing the most significant air quality effects associated with the assessed Local Plan Preferred Option development allocations. This monitoring will provide an understanding of the absolute concentrations at this location, address whether there is exposure of sensitive receptors to poor air quality above the objectives and would additionally provide validation of predicted model concentrations. Monitoring here may also assist with the understanding of the air quality impact associated with individual planning applications and provide a baseline for developers to consider air quality impacts.

Should WMBC's monitoring network be reviewed, it is additionally recommended that the identified existing sensitive receptor on Cross Street at the Queensway tunnel portal and those nearby the identified section of A41 New Chester Road between Bridle Road and Eastham Village Road in Eastham be included in the NO_2 monitoring for the Borough. This is due to risks of exceedances of the annual mean NO_2 objective identified in dispersion modelling and screening, respectively, not due to impacts of the Preferred Option development allocations. Monitoring will, however, provide further understanding of the absolute concentrations at these locations. It was noted that pollutant concentrations were generally found to be higher in areas with greater socio-economic disparity, largely due to road transport sources.

It is noted that no AQMA is declared within WMBC as air quality is deemed to be consistently below air quality objectives at relevant exposure locations. This study has not indicated that the Preferred Option development allocations would lead to a declaration of an AQMA. The expanded monitoring network will also provide further reassurance of the predicted air quality conditions.

Opportunities for mitigation should be considerate of locations near the A59 Kingsway tunnel in particular and striving for the lowest practicable pollutant concentrations at this location will ensure the priority of air pollution within public health.

Following a review of the emerging Draft Local Plan, there are a number of Policies which refer directly to air quality, and others such as encouraging active travel, carbon emissions reduction and development design principles, that are identified as beneficial and are also beneficial to local air quality, but that is not always guaranteed to be the case. Focus is largely on reducing of emissions from transport however there is evidence that targeting industrial and point source emissions reduction would also be beneficial, not only to lowering all pollutant concentrations, but also with note to finer particulate matter fractions being particularly harmful to human health and therefore improving mortality rates.

Policy WD 14 Pollution and Risk is specifically dedicated to pollution with statements around air quality; given the current status of air quality in Wirral, this is considered an appropriate approach. The use of Supplementary Planning Documents or technical advice notes can, however, provide guidance for developers and applicants detailing how they can tailor their developments to minimise their impact on local air quality. A clear framework can be provided through these means to applicants as to what will be acceptable in terms of air quality. It would allow WMBC to direct developers to use set criteria to determine the development impact significance on air quality, inform the decision making process and whether proposals would have an 'unacceptable contribution' to air quality, and also cumulative air quality impacts, on key areas identified in this study.

From the source apportionment exercise undertaken for the A59 Kingsway, measures that target diesel cars and HGVs may have the most impact on improving air quality in this area, and it is suggested there may also be an opportunity to align actions to improve air quality identified by the Liverpool City Region Combined Authority listed in the main body of this report, with the implementation of the Emerging Draft Local Plan. Enhancements of policies and text to more frequently and comprehensively reference air quality within the Emerging Draft Local Plan is additionally an advisable option, with suggestions provided in Section 10.

Conclusion

The emerging Draft Local Plan Preferred Option development allocations are not considered to significantly affect air quality in WMBC. The largest air quality concentration increase is at A41 New Chester Road, to the south of the roundabout with Bolton Road in Port Sunlight, although this is not considered to be significant. There were no exceedances of the relevant England and Wales national air quality objectives predicted for all pollutants considered at any Preferred Option development allocation receptors in the future assessment year.

Further monitoring of NO_2 is, recommended to evidence that absolute air quality concentrations are not currently above the air quality objectives specifically prioritising sensitive receptors near to the Kingsway tunnel portal, on Wheatland Lane, but also on sensitive receptor on Cross Street at the Queensway tunnel portal and those nearby the identified section of A41 New Chester Road between Bridle Road and Eastham Village Road in Eastham. Ideally $PM_{2.5}$ would also be monitored at the exit of the Kingsway tunnel portal, however it is recognised that monitoring of particulate matter in this specific location may not be feasible due to practical siting constraints associated with providing power and safe access to monitoring instruments.

1. Introduction

Background

1.1 AECOM was appointed by Wirral Metropolitan Borough Council (WMBC) to produce an air quality assessment of nitrogen dioxide (NO_2) and particulate matter (PM_{10} and $PM_{2.5}$) from the transport network within the Wirral peninsula to support further evaluation of the growth options in the Emerging Draft Local Plan .

1.2 The Emerging Draft Local Plan sets out WMBC's proposed approach to meet the Borough's need for new homes and employment land between now and 2037.

1.3 Six areas of concern due to new development or existing poor air quality were shortlisted by WMBC prior to the undertaking of the air quality works. The areas identified as likely to be of greatest concern following additional developments associated with the Emerging Draft Local Plan include:

- A section of A59 Kingsway nearby the Kingsway (Wallasey) Tunnel;
- An area encompassing A5139 Dock Road, A554, Corporation Road, and Duke Street;
- A section of Conway Street;
- An area surrounding Birkenhead Central Railway Station including Borough Road and A41;
- A section of A41 New Chester Road in Port Sunlight; and
- An area of Liscard on Wallasey Road.

Scope of the Study

1.4 The overall objectives and outcomes of the air quality assessment were to:

- Review the existing baseline air quality;
- Review of local policies and their relevance to air quality;
- Undertake a screening assessment across the extent of the Borough for the Do Minimum (DM) 2037 and Preferred Option 2037 scenarios in order to determine whether the areas of potential concern shortlisted by WMBC were appropriate for detailed modelling and/or if other locations may be of greater concern. Screening was undertaken to highlight any initial concerns in relation to air quality (i.e. NO_2, and PM_{10} and $PM_{2.5}$) and carbon dioxide (CO_2) emissions from the Preferred Option development allocations (see Appendix A) proposed in the Emerging Draft Local Plan ;
- Undertake detailed air quality dispersion modelling for the following three scenarios in areas of air quality concern determined following the screening assessment:
    1. Baseline scenario in 2018 for the purposes of verifying the dispersion model results with monitoring data;
    2. Do-Minimum (DM) scenario in 2037 provides a comparison against which the Emerging Draft Local Plan Options scenarios can be compared. This scenario provides predictions for the event that the Local Plan is not carried out and as such only includes previously committed developments and general background growth; and
    3. Preferred Option (Do-Something (DS)) scenario in 2037 provides air quality predictions for the event that this option for the Emerging Draft Local Plan is carried out.
- Examine the potential air quality effects of the Emerging Draft Local Plan Preferred Option with regard to national air quality objectives at sensitive receptors located within the six shortlisted areas of concern due to new development or existing poor air quality;
- Summarise emission sources through source apportionment;

- A review of the Preferred Option in relation to the impact on the air quality of the relevant shortlisted areas of concern and potential opportunities for mitigating air quality impacts to inform WMBC's final Emerging Draft Local Plan decision; and
- Recommendations of reference to air quality within local policy.

Air Quality and COVID-19

1.5 The coronavirus pandemic (COVID-19) caused the UK government to enforce rules of social distancing commencing in March 2020; this significantly reduced some forms of air pollutant emissions and improved local air quality, particularly in towns and cities, reiterating the overriding contribution of road transport to urban air pollution[2]. The importance of good air quality is now coming to the forefront of public health, more than at any time in the past; this has been reinforced by recent studies showing those who were exposed to poorer air in the years preceding the pandemic experience far worse outcomes in terms of virus susceptibility than those who have breathed cleaner air.

1.6 It is important that a united effort starts planning beyond this event. Many of the changes introduced by social distancing measures may alter public behaviours in the long term and there will be implications of this upon the achievement of long-term positive changes to air quality. WMBC may look to use the tragic circumstances of the pandemic as an opportunity to enhance smarter travel choices in the longer term, which will ultimately have a positive impact on local air quality.

1.7 Unfortunately, there are no clear indications of exactly what is to happen to air quality legislation moving forward, and so this assessment must be written on the basis of the existing legislation.

1.8 WMBC are continuing to monitor levels of traffic on the network to compare with pre-COVID levels. Whilst current data suggests that traffic has not yet returned to previous levels, it is expected that traffic will increase with the easing of lockdown measures. The use of public transport and public confidence in using it will also be important in levels of traffic on the network and associated impact on air quality. WMBC will continue to work with colleagues within the Liverpool City Region Combined Authority (LCRCA) to assess public transport patronage to identify if there is any correlation with traffic levels.

[2] AECOM (2020) *Unintended consequences: coronavirus, air quality and transport trends*. Available at: https://aecom.com/without-limits/article/coronavirus-air-quality-and-tomorrows-transport/

2. Guidance and Legislation

National Air Quality Legislation

2.1 The UK is no longer a member of the European Union (EU). EU legislation as it applied to the UK on 31 December 2020 is now a part of UK domestic legislation, under the control of the UK's Parliaments and Assemblies, and is published on legislation.gov.uk.

2.2 Some types of EU legislation such as Regulations and Decisions, are directly applicable as law in an EU Member State. This meant that, as a Member State, these types of legislation applied automatically in the UK, under section 2(1) of the European Communities Act 1972 (c.68), without any further action required by the UK. These types of legislation are published by the Publications Office of the European Union on the EUR-Lex website. This legislation is now published on legislation.gov.uk as 'legislation originating from the EU'.

2.3 Other types of EU legislation, such as Directives, are indirectly applicable, which means they require a Member State to make domestic implementing legislation before becoming law in that State. In the UK this was often achieved by making Statutory Instruments rather than passing primary legislation. This implementing legislation has always been published on legislation.gov.uk.

2.4 EU legislation which applied directly or indirectly to the UK before 11.00 p.m. on 31 December 2020 has been retained in UK law as a form of domestic legislation known as 'retained EU legislation'. This is set out in sections 2 and 3 of the European Union (Withdrawal) Act 2018 (c. 16). Section 4 of the 2018 Act ensures that any remaining EU rights and obligations, including directly effective rights within EU treaties, continue to be recognised and available in domestic law after exit.

2.5 The Clean Air for Europe (CAFE)[3] programme consolidated and replaced (with the exception of the 4th Daughter Directive) preceding directives with a single legal act, the Ambient Air Quality and Cleaner Air for Europe Directive 2008/50/EC[4] (hereafter referred to as the 'EU Air Quality Framework Directive'). This directive is transcribed into UK legislation by the Air Quality Standards Regulations 2010 which came into force on 11th June 2010; these were amended by the Air Quality Standards Regulations 2016[5] (henceforth referred to as the "Air Quality Regulations"), which came into force on 31st December 2016. The limit values defined therein are legally-binding and are considered to apply everywhere (with the exception of the carriageway and central reservation of roads and any locations where the public do not have access).

2.6 The provisions of Part IV of the Environment Act 1995[6] establish a national framework for air quality management, which requires all Local Authorities to conduct local air quality reviews. Section 82(1) of the Act requires these reviews to include an assessment of the current air quality in the area and the predicted air quality in future years. Should the reviews indicate that the objectives prescribed in the UK Air Quality Strategy (AQS)[7] and the Air Quality Regulations will not be met, the Local Authority is required to designate an Air Quality Management Area (AQMA). Action must then be taken at a local level to ensure that air quality in the area improves.

2.7 The UK AQS identifies nine ambient air pollutants that have the potential to cause harm to human health. These pollutants are associated with local air quality problems, with the exception of ozone, which is instead considered to be a regional problem. Similarly, the Air Quality Regulations set objectives, but for just seven of the pollutants that are associated with local air quality. These objectives aim to reduce the health effects of the pollutants to negligible levels.

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[3] European Union (2001); *Clean Air for Europe (CAFE) Programme: Towards a Thematic Strategy for Air Quality*. Available at: https://www.eea.europa.eu/themes/air/links/research-projects/clean-air-for-europe-programme-cafe

[4] Council of the European Union, (2008); *Directive 2008/50/EC on Ambient Air Quality and Cleaner Air for Europe*. Available at: https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX:32008L0050

[5] H.M. Government, (2016); Air Quality Standards Regulations 2010. Available at: http://www.legislation.gov.uk/uksi/2010/1001/contents/made

[6] H.M. Government, (1995); *The Environment Act*. Available at: https://www.legislation.gov.uk/ukpga/1995/25/contents

[7] Department for Environment, Food and Rural Affairs, (2007); *The Air Quality Strategy for England, Scotland, Wales and Northern Ireland*. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69336/pb12654-air-quality-strategy-vol1-070712.pdf

2.8 The air quality objectives and limit values currently applicable to the UK can be split into two groups. Each has a different legal status and is therefore handled differently within the framework of UK air quality policy. These are:

- UK air quality objectives set down in regulations for the purposes of local air quality management; and
- Air quality limit values transcribed into UK legislation for which compliance is mandatory.

Emerging Environment Bill

2.9 The Environment Bill 2019-21[8] was emerging in UK Parliament at the time of writing this report. Air quality is set out as one of four priority areas of environmental targets. The Bill contains a target for $PM_{2.5}$, as follows:

"*2. Environmental targets: particulate matter*

(1) The Secretary of State must by regulations set a target ("the $PM_{2.5}$ *air quality target") in respect of the annual mean level of* $PM_{2.5}$ *in ambient air…"*

2.10 This target, if it were to remain within the Bill, may not be revoked, but can be further amended. The draft containing the regulation setting the $PM_{2.5}$ target has a deadline of 31 October 2022. The Secretary of State is responsible for achieving of this target and for detailing whether the target has been met.

2.11 Schedule 11 of the Environment Bill contains amendments to Part 4 of the Environment Act 1995 (air quality).

2.12 The following proposed amendments were relevant to the scheme:

- Strategies should include consideration to air quality for public authorities, local authorities in England, and county councils, where no district councils exist.
- Local authorities must:
  - identify parts of its jurisdiction which are not likely to achieve air quality standards or objectives;
  - identify relevant sources of emissions which are responsible for the failure to meet air quality standards or objectives;
  - where areas do not achieve these, prepare air quality action plans for that area to
    - set out how the LA will exercise its function to ensure air quality standards and objectives are met, and then maintained; and
    - set out particular measures the LA will take to achieve by specific dates.
- There is a duty of air quality partners to co-operate on air quality matters, these must be notified of [Air Quality Action Plans] AQAPs.

2.13 This is significant to local authorities, including WMBC. Should a target of $PM_{2.5}$ be implemented during the lifetime of the Emerging Draft Local Plan which is in line with other nations and the World Health Organisation (WHO) guideline of 10 $\mu g/m^3$, this will need to be carefully planned for.

Pollutants of Concern

Nitrogen Dioxide

2.14 The Government and the Devolved Administrations adopted two Air Quality Objectives for nitrogen dioxide (NO_2) which were to be achieved by the end of 2005. In 2010, mandatory EU air quality limit values on pollutant concentrations were to apply, although it continues to be breached in locations throughout the

[8] H.M. Government, (2020); *Environment Bill 2019-21*. Available at: https://services.parliament.uk/Bills/2019-21/environment.html

UK. The air quality limit values for NO_2 in relation to human health are the same as the national objectives[9]:

- An annual mean concentration of 40 µg/m^3 (micrograms per meter cubed); and
- An hourly mean concentration of 200 µg/m^3, to be exceeded no more than 18 times per year (99.79th percentile).

2.15 In practice, meeting the annual mean objective has been and is expected to be considerably more demanding than achieving the 1-hour objective. The annual mean objective of 40 µg/m^3 is currently widely exceeded at roadside sites throughout the UK, with exceedances also reported at urban background locations in major conurbations. Exceedances are associated almost exclusively with road source emissions.

2.16 There is considerable year-to-year variation in the number of exceedances of the hourly objective, driven by meteorological conditions which give rise to winter episodes of poor dispersion and summer oxidant episodes. Analysis of the relationship between 1-hour and annual mean NO_2 concentrations at roadside and kerbside monitoring sites indicate that exceedances of the 1-hour objective are unlikely where the annual mean is below 60 µg/m^3 [10].

2.17 NO_2 and nitric oxide (NO) are both oxides of nitrogen and are collectively referred to as NO_x. All combustion processes produce NO_x emissions, largely in the form of NO, which is then converted to NO_2, mainly as a result of its reaction with ozone in the atmosphere. Therefore, the ratio of NO_2 to NO is primarily dependent on the concentration of ozone and the distance from the emission source.

Particulate Matter

2.18 Particulate matter is composed of a wide range of materials arising from a variety of sources. Particulate matter is typically assessed as total suspended particulates or as a mass size fraction.

2.19 This assessment considers the annual mean and daily mean air quality objectives, as specified in the AQS for England, Scotland, Wales and Northern Ireland[9]. Two objectives have been adopted in England and Wales for PM_{10}, which were to be achieved by the end of 2004:

- An annual mean concentration of 40 µg/m^3 (gravimetric); and
- A 24-hour mean concentration of 50 µg/m^3 (gravimetric) to be exceeded no more than 35 times per year (90.4th percentile).

2.20 Both short-term and long-term exposure to ambient levels of particulate matter are consistently associated with respiratory and cardiovascular illness and mortality as well as other ill-health effects. Particles of less than 10 micrometres (µm) in diameter (PM_{10}) have the greatest likelihood of reaching the thoracic region of the respiratory tract. Here particles may remain resident and therefore have increased likelihood of doing harm.

2.21 It is not currently possible to discern a threshold concentration below which there are no effects on the whole population's health. Reviews by World Health Organisation and the Committee on the Medical Effects of Air Pollutants[11] have suggested exposure to a finer fraction of particles ($PM_{2.5}$, which typically make up around two thirds of PM_{10} emissions and concentrations) give a stronger association with the observed ill health effects, but also warn that there is evidence that the coarse fraction (between PM_{10} – $PM_{2.5}$) also has some effects on health.

[9] H.M. Government, (2016); Air Quality Standards Regulations 2010. Available at: http://www.legislation.gov.uk/uksi/2010/1001/contents/made

[10] DEFRA (2018); *Local Air Quality Management Technical Guidance (TG16)*. Available at: https://laqm.defra.gov.uk/documents/LAQM-TG16-February-18-v1.pdf

[11] Committee on the Medical Effects of Air Pollutants (unknown); *Statement on quantifying mortality associated with long-term average concentrations of fine particulate matter ($PM_{2.5}$)*. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/734813/COMEAP_PM_2.5_statement.pdf

2.22 One objective has been adopted for $PM_{2.5}$ in England and Wales which is an annual mean concentration of 25 µg/m³ (gravimetric). However, Defra is currently reconsidering a change[12] to ultimately tighten the objective to 10 µg/m³ as an annual mean, to match World Health Organisation guidelines, reflected in the Emerging Environment Bill, noted above. It is likely that the objective will be reduced to 10 µg/m³ during the construction of the scheme and reference has therefore also been made to this value throughout this assessment.

Air Quality Guidelines and Objectives

2.23 Table 1 summarises the UK air quality objectives described above. This document focuses on the UK objectives as these are the legal criteria which councils need to comply with, although reference has been made to the WHO guidelines for particulate matter which are health based and are more stringent, as noted in the above sections.

Table 1. Air Quality Objectives

Pollutant	Averaging Period	Value	Maximum Permitted Exceedances	Target Date
Nitrogen Dioxide (NO_2)	Annual Mean	40 µg/m³	None	31/12/2005
	Hourly Mean	200 µg/m³	18 times per year	31/12/2005
Particulate Matter (PM_{10})	Annual Mean	40 µg/m³	None	31/12/2004
	24-hour mean	50 µg/m³	35 times per year	31/12/2004
Fine Particulate Matter ($PM_{2.5}$)	Annual Mean	25 µg/m³ *	None	2020
	3-year running mean	15% reduction in average urban background concentrations against a 2010 baseline		2020

Note: * World Health Organisation guidelines 10 µg/m³ as an annual mean

Clean Air Strategy

2.24 National actions to improve air quality are described in the UK government's Clean Air Strategy[12], published in 2019. The strategy covers all sources of pollution, and provides a wide array of actions, measures and initiatives to improve air quality on both a national and local level.

2.25 The government committed within the 'The Road to Zero' strategy document[13] to "expect the majority of new cars and vans sold [by 2040] to be 100% zero emission and all new cars and vans to have significant zero emission capability."

2.26 The government has since committed to end the sale of new conventional petrol and diesel cars and vans by 2030; this will support a reduction in tailpipe emissions from road vehicles over the next 10 years.[14]

2.27 In addition to tailpipe emissions the government also states in its Clean Air Strategy that it will address non-exhaust particulate emissions from tyres and brakes.

2.28 New powers introduced in this document allow for the implementation and enforcement of clean air zones in areas where there is a persistent air pollution problem to restrict emissions.

2.29 It is noted within the strategy document that the "current legislative framework has not driven sufficient action at a local level". New legislation will seek to shift the focus towards prevention of exceedances rather than tackling pollution when limits have been surpassed. The shift of focus encourages more of a

[12] Department for Environment, Food and Rural Affairs, (2019); *UK Clean Air Strategy 2019*. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/770715/clean-air-strategy-2019.pdf
[13] H.M. Government, (2018); *The Road to Zero Next steps towards cleaner road transport and delivering our Industrial Strategy*. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/739460/road-to-zero.pdf
[14] Gov.UK (2020) *Government takes historic step towards net-zero with end of sale of new petrol and diesel cars by 2030*. Available from: https://www.gov.uk/government/news/government-takes-historic-step-towards-net-zero-with-end-of-sale-of-new-petrol-and-diesel-cars-by-2030 [Accessed: 24/11/2020]

proactive rather than reactive policy framework at regional and local levels on air quality. For local authorities such as WMBC, this will mean continuing to strive to reduce air pollution, even if air quality objectives are not currently being exceeded, which should be a key aspiration of a Local Plan.

2.30 In long term policy for local councils such as WMBC, this is set to emerge in the form of a focus on using cleanest modes of transport, including active travel.

National Planning Policy Framework

2.31 The National Planning Policy Framework (NPPF)[15] outlines the Government's planning policies for England, sets out the framework upon which all Councils determine their planning policy, and as such is relevant to all the Councils in the WMBC region. This NPPF was published in February 2019 and supersedes the previous NPPF published in March 2012. The NPPF sets out a presumption in favour of sustainable development which should be delivered with three main dimensions: economic; social and environmental (Paragraph 8). Within this, mitigating and adapting to climate change and moving to a low carbon economy is one of the broader objectives to achieving sustainable development.

2.32 In relation to promoting sustainable transport, Paragraph 103 of the NPPF states that:

> *"The planning system should actively manage patterns of growth in support of these objectives. Significant development should be focused on locations which are or can be made sustainable, through limiting the need to travel and offering a genuine choice of transport modes. This can help to reduce congestion and emissions, and improve air quality and public health."*

2.33 With regard to setting of local parking standards, for residential and non-residential development, policies should ensure that the provision of spaces for charging plug-in and other ultra-low emission vehicles are taken into account (Paragraph 105).

2.34 Air quality is considered as an important element of the natural environment. On conserving and enhancing the natural environment, Paragraph 170 states that:

> *"Planning policies and decisions should contribute to and enhance the natural and local environment by: …*
>
> *e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality …"*

2.35 Air quality in the UK has been managed through the Local Air Quality Management (LAQM) regime using national objectives. The effect of a proposed development on the achievement of such policies and plans may be a material consideration by planning authorities when making decisions for individual planning applications. Paragraph 181 of the NPPF states 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."*

2.36 The different roles of a planning authority and a pollution control authority are addressed by the NPPF in paragraph 183:

[15] Ministry of Housing, Communities & Local Government (2019); *National Planning Policy Framework*. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/810197/NPPF_Feb_2019_revised.pdf

> *"The focus of planning policies and decisions should be on whether proposed development is an acceptable use of land, rather than the control of processes or emissions (where these are subject to separate pollution control regimes). Planning decisions should assume that these regimes will operate effectively. Equally, where a planning decision has been made on a particular development, the planning issues should not be revisited through the permitting regimes operated by pollution control authorities."*

Planning Practice Guidance (PPG)

2.37 The Planning Practice Guidance (PPG) was published on the 6th March 2014[16] to provide more in-depth guidance to the NPPF. The PPG aims to make planning guidance more accessible, and to ensure that the guidance is kept up to date.

2.38 The PPG explains the role of air quality within plan-making, noting specifically that it is important to take AQMAs, Clean Air Zones and ecologically sensitive sites into account.

2.39 The PPG sets out what air quality assessments submitted as part of a planning application should contain. This is directly relevant to those interventions that will require planning permission. It provides examples for mitigating climate change by reducing emissions, and for adapting to a changing climate and notes that an integrated approach is integral for addressing climate change.

Local Policy

2.40 As WMBC does not have any AQMAs declared, it is not required to develop any statutory air quality action plans (AQAP). Actions being taken by WMBC to improve air quality in the Borough however are detailed in the 2019 Annual Status Report (ASR)[17]. The multidisciplinary Wirral Air Quality Group has been formed and meet regularly to review actions that can be taken by WMBC to improve local air quality.

2.41 WMBC has the following measures in place, relevant to air quality:

- Hybrid buses and retro fitted emissions reduction technology;
- An improved public bus services to encourage more people to travel by bus;
- A rail-based park and ride service;
- WMBC is a part of the 'Recharge' Scheme – the electric vehicle charging point network in the Liverpool City Region;
- Investment into the highway infrastructure, including measures to encourage active travel;
- Anti-idling legislation, enabling fixed penalty notices to be distributed in the event of drivers refusing to switch off engines when instructed;
- Traffic calming initiatives for 12% of the Wirral highway network;
- An increased number of cycling paths in the Wirral network;
- Measures on taxis licensing relating to passing of MOT and a Compliance Test; and
- Focussed on more public engagement regarding air quality.

2.42 WMBC declared an environment and Climate Emergency in July 2019; the Wirral Climate Change Strategy 2014-2019[18] included a target of net zero climate damaging pollution to be achieved at the latest 2041.

2.43 The Birkenhead Urban Area includes Wirral Metropolitan Borough and Cheshire West and Chester. The air quality plan for this area was produced in 2017[19] by Defra which detailed that, whilst there were no

[16] Ministry of Housing, Communities & Local Government (2018); *The Planning Practice Guidance.* Available at: https://www.gov.uk/government/collections/planning-practice-guidance
[17] Wirral Metropolitan Borough Council (2019) 2019 Air Quality Annual Status Report (ASR)
[18] Wirral Metropolitan Borough Council (2014) Wirral Climate Change Strategy 2014-2019
[19] Department of Environment, Food and Rural Affairs (2017) Air Quality Plan for tackling roadside nitrogen dioxide concentrations in Birkenhead Urban Area. Available online at: https://uk-air.defra.gov.uk/assets/documents/no2ten/2017-zone-plans/AQplans_UK0020.pdf

NO_2 exceedances at the automatic monitoring station Wirral Tranmere in 2015, 6.4 km of road length was modelled by Defra in the base year of 2015 where the annual limit value was exceeded. The majority of these roads were within Cheshire West and Chester administrative area, with a section in Wirral Metropolitan Borough located in the A41 / Borough Road area of Birkenhead, where it is understood minimal relevant exposure exists. The model results suggested that based on model projections, compliance with the annual mean NO_2 objective was likely to be achieved by 2019. All measures identified to improve the air quality situation were for Cheshire West and Chester Local Authority.

2.44 WMBC falls within the wider area of the Liverpool City Region Combined Authority (LCRCA) and will have to adhere to air quality restraints outlined by this regional body. In their spatial planning statement published in 2019[20] they state:

"The LCR authorities and other partners will work together to address cross-boundary air quality issues and to deliver mitigation and measures to deliver air quality improvements across the City Region"

2.45 The Liverpool City Region Combined Authority (LCRCA) are currently working on publishing an Air Quality Action Plan (AQAP) which includes plans for a 600 km walking and cycling route, a zero-emission bus fleet by 2040 and a taxi scrappage scheme.

Wirral Joint Strategic Needs Assessment (2019)

2.46 Local authorities and Clinical Commissioning Groups have an equal statutory responsibility to prepare a Joint Strategic Needs Assessment (JSNA), therefore the Wirral Joint Strategic Needs Assessment published in November 2019 provides an assessment of current and future health and social care needs. The Outdoor Air Quality chapter within Environmental Health reviewed the needs of the Wirral population in relation to air quality[21].

2.47 The document cites the Public Health England publication where it was estimated that the fraction of deaths attributable to particulate pollution in Wirral was 3.9% in 2017 (4.4% in 2018)[22] and notes that whilst no AQMAs are in place, the reduction of air pollution remains a local public health priority. The estimated attributable fraction for Wirral is lower than reported for the North West (4.1%) and England (5.1%) in 2017.

2.48 Following the assessment, the document suggests that local action should prioritise co-benefit strategies to not only improve air quality, but wider health outcomes also. Engaging with populations most vulnerable to air pollution impacts is noted to be valuable when identifying mitigation measure.

Wirral Local Plan 2020-2035 Issues and Options

2.49 The Wirral Local Plan 2020-2035 Issues and Options document, published in January 2020[23], sets out the proposed approach to meet the Borough's need for new homes (up to 12,000) and employment land (minimum 80 hectares) between now and 2035.

2.50 Within Chapter 3, the document recognises infrastructure capacity constraints that may make the delivery of the growth more challenging, as well challenges associated with the ongoing declared Climate Emergency requiring new ways of working and new ways of delivering development. 12 strategic objectives are proposed capturing the economic social and environmental objectives of sustainable development. Strategic Objectives 1 and 4 aim to tackle climate change and reduce carbon emissions, Strategic Objective 5 identifies green infrastructure, nature and green space promotion whilst Strategic Objective 2 refers to air quality directly as it aims:

"To enable sustainable travel solutions to improve air quality, support behaviour change and reduce congestion

[20] Liverpool City Region Combined Authority (2019) Liverpool City Region Spatial Planning Statement of Common Ground
[21] Wirral Intelligence Service (2019) Environmental Health JSNA: Outdoor Air Quality
[22] Public Health Fingertips (2020) Public Health Profiles – Fraction of Mortality attributable to particulate air pollution - Wirral. Available online at: <https://fingertips.phe.org.uk/search/PARTICULATE%20AIR%20POLLUTION#page/4/gid/1/pat/6/par/E12000002/ati/102/are/E08000015/iid/30101/age/230/sex/4/cid/4 >
[23] Wirral Metropolitan Borough Council (2020) Wirral Local Plan 2020-2035 Issues and Options Consultation

Seek to improve and encourage improvements to public transport, walking and cycling, including access for all sections of the community to work, shopping, health, education, leisure, valued environments and other facilities.

Seek to encourage the implementation of a sustainable and integrated transport strategy making active travel the mode of choice for short journeys.

To reduce reliance on private cars for local journeys where possible, through spatial development choices and well-designed layout of communities.

To support the construction of new road infrastructure only where this is related to achieving sustainable development, environmental enhancement, public transport or road safety benefits.

To support sustainable freight distribution by road, rail and water.

To safeguard land required for new sustainable transport proposals, including active travel, public transport, road and water facilities, from prejudicial development."

2.51 The strategic spatial options to meet the local housing and employment options are outlined in the document. Within Chapter 7 – Our Physical and Social Infrastructure, WMBC's preferred approach is that new development is spatially coordinated and planned in locations where existing public transport provision is well provided, or where means is possible to create new public or active travel links. The improvement of existing public transport networks are also preferred and state that support will be given to initiatives to improve congestion, particularly if they will improve air quality. Electric vehicle infrastructure is also stated to be expected as part of proposals for new development.

2.52 Climate change is well addressed with a dedicated section within Chapter 8 – Our Environment with the development of a positive strategy to promote the delivery of renewable and low carbon energy including higher energy efficiency standards.

Emerging Draft Local Plan

2.53 Consultation on the Local Plan finished in summer 2020. WMBC are preparing a draft Local Plan aimed to be adopted in 2022, with policies within covering the period 2020 to 2037.

2.54 An emerging draft of the Local Plan contains direct reference to air quality as follows:

- Specified within the Vision with referral to an integrated transport network, a move to active travel and local travel being fossil fuel free.
- Within Strategic Objective 10 on reducing social, economic and environmental deprivation to include maintenance of good air quality.
- Within Policy WS 7 Design Principles stating that development proposals must take privacy and amenity into account specifically to address any air quality issues arising from development activity.
- Within WD 1 Landscaping, Trees and Hedgerows stating that design of landscaping should assist improvements in air quality.
- Within Policy WD 14 Pollution and Risk stating that development proposals will not be permitted that will result in an unacceptable increase in the risk to human health and the environment specifically noting the designation of an AQMA. It is further stipulated that proposals which potentially worsen air pollution will not be normally be permitted unless it is demonstrated that all practical measures have been taken to minimise the air pollution levels and the impact and exposure is mitigated.
- Policy WM 4 Oil and Gas Development, ensuring there are no adverse air quality effects associated with proposals for oil and gas developments.

2.55 Policies which do not directly refer to air quality, but are noted to inherently also affect air quality are as follows:

- Additional items within the Vision to include greenhouse gas reductions and Net Zero targets, energy efficient buildings, and clean power, heat and travel, and green infrastructure.
- Strategic Objective 1 and 3 regarding sustainable growth and travel with reducing local emissions for net zero carbon target which will have a knock-on positive effect to air quality emissions.
- Policy WS 1 The Development Strategy for Wirral 2020-2037 through reference to support to renewable energy growth, promotion of active travel networks and green spaces creation.
- Policy WS 5 Strategy for green and blue infrastructure, biodiversity and open space. This policy will create natural barriers to emission sources and sensitive receptors. Where air quality guidance suggests the assessment of development proposals upon ecological receptors, ensuring that there will be no adverse effect, also applies to air quality impacts.
- Policy WS 8 Strategy for Renewable and Low Carbon Energy. This Policy aims to reduce carbon emissions from construction, operation and decommissioning of development proposals, through the use of renewable energy and low carbon energy sources.
- Policy WS 9 Strategy for Transport. Greater use of public transport is a clear aim, along with schemes which support and encourage active travel and more efficient freight transport. Development proposals are required to promote sustainable travel options to reduce private car usage, measures such as electric vehicle charging, and a demonstration that resulting cumulative impacts will not be severe.
- Policy WS 11 Town Centres Strategy to provide community services and facilities at a local level this has the potential reduce the need for additional trips into the city centre and through areas or poorer air quality, and consequently improve air quality as a result. Impact assessments are stated to be required where development proposals exceed certain thresholds.
- Policy WD 15 Contamination and Instability which states that development proposals impacting contaminated land will require an assessment to protect various aspects, including human health.
- Policy WM 1 Proposals for Minerals Development stating that proposals should not cause issues, including dust, which may cause nuisance to sensitive receptors and that transport of minerals would be done in the most sustainable way, potentially benefiting air quality.

Land-use Planning & Development Control: Planning for Air Quality Guidance

2.56 Environmental Protection UK (EPUK) and the Institute of Air Quality Management (IAQM) have produced a guidance document[24] on how individual schemes may be considered in relation to air quality. This is not a legal document; however, it provides useful advice and guidance on land use planning and development control processes. The document sets out principles of dealing with planning applications but recognises that decisions made by local authorities should be made on a case by case basis.

2.57 The significance of the effects arising from air quality impacts depends on a number of factors including the long-term average concentration at sensitive receptor locations in the year the development is proposed to be operational and the percentage change in concentration relative to air quality assessment level. This is therefore key when attempting to consider what an unacceptable contribution may be upon air quality concentrations.

[24] EPUK/IAQM (2017); *Land-Use Planning & Development Control: Planning For Air Quality*. Available at: http://iaqm.co.uk/text/guidance/air-quality-planning-guidance.pdf

3. Baseline Characterisation

Local Air Quality Management

3.1 Under the requirements of Part IV of the Environment Act[25], WMBC has carried out a phased review and assessment of local air quality. WMBC has not declared any AQMAs in the Borough, as monitoring results have not indicated any breaches of the UK Air Quality Objective levels for air pollution.

Wirral Metropolitan Borough Council Monitoring Data

3.2 The most recent ASR available was published in June 2020[26], containing monitoring data from 2019. WMBC has a monitoring network comprising monitoring of NO_2, $PM_{2.5}$, ozone and benzene. WMBC reviewed the network at the end of 2018 where NO_2 concentrations were monitored at 31 locations; following both introduction of- and removal of some monitoring locations, there were 31 monitoring locations in 2019 and 37 locations in 2020.

3.3 This review focusses on the results and trends of NO_2 and $PM_{2.5}$. The monitoring network for the 2018 base year of the assessment includes 31 diffusion tube monitoring locations and two continuous monitoring sites located in Victoria Park (Wirral Tranmere – at an urban background location) and on A553 Conway Street (Wirral Birkenhead – classified as an urban centre monitoring location) in 2018. Monitoring site locations are presented within the screening model and detailed modelling domains in Appendix B1 and B3, respectively.

3.4 The NO_2 annual mean objective of 40 $\mu g/m^3$ was not exceeded at any monitoring locations in 2018, with the exception of W18 kerbside diffusion tube, noted within the 2019 ASR[27] to be located near to a taxi rank in Liscard, as having exceeded this for the previous five years, however not representing relevant exposure. The 2020 ASR does not contain 2019 results for this monitoring location as it was removed in July 2019 due to continuous unauthorised removal of the monitor. No exceedances of the 1-hour mean objective (200 $\mu g/m^3$ not to be exceeded more than 18 times/year) were recorded.

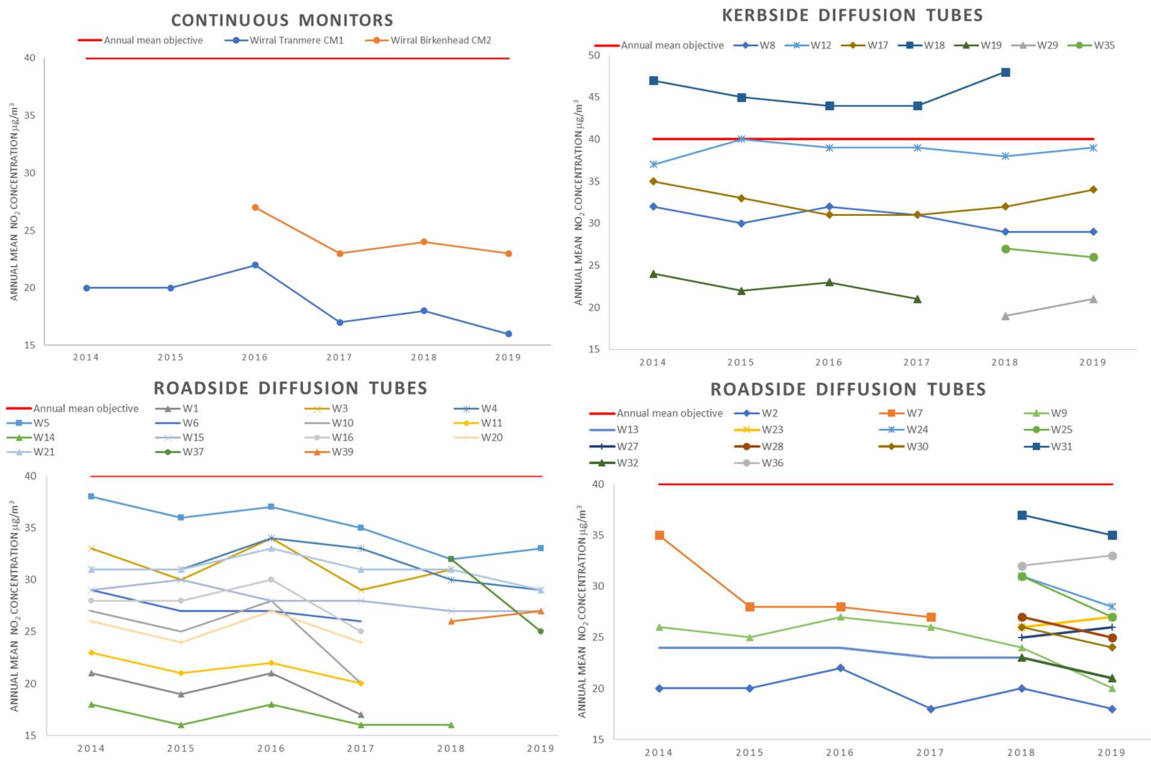
3.5 W12 has recorded annual mean NO_2 concentrations marginally below the 40 $\mu g/m^3$ objective consistently for the past five years, located on A41 New Chester Road, with one recorded exceedance in 2015.

3.6 Figure 1 presents the NO_2 monitoring trend between 2014 and 2019 at continuous monitors, and at kerbside and roadside diffusion tube monitoring locations. The data shows a steady decline in the majority of recorded concentrations since 2016, with the exception of a select few locations across WMBC's monitoring network that have an increasing trend between years, to include W3 and W20 located on the A552, and W17 and W18 in Liscard.

3.7 $PM_{2.5}$ concentrations were measured by the Wirral Tranmere urban background continuous monitor to be consistently well below the England and Wales annual mean objective of 25 $\mu g/m^3$ and also below the World Health Organisation annual mean objective of 10 $\mu g/m^3$.

[25] H.M. Government, (1995); *The Environment Act*. Available at: https://www.legislation.gov.uk/ukpga/1995/25/contents
[26] Wirral Metropolitan Borough Council (2020) 2020 Air Quality Annual Status Report (ASR)
[27] Wirral Metropolitan Borough Council (2019) 2019 Air Quality Annual Status Report (ASR)

Figure 1. NO_2 Monitoring Trends 2014-2019



Tunnel Monitoring

3.8 Liverpool City Region Combined Authority has a long-term operations and maintenance strategy document for the Mersey Tunnels, published in 2019[28]. Within this document it is noted that air quality inside and outside of the Mersey Tunnels is required to meet a set of pollutant concentration limits for NO_2, PM_{10}, $PM_{2.5}$ and carbon monoxide (CO). Pollution detectors are noted to constantly monitor vehicle emissions and trigger necessary forced ventilation control to maintain air quality standards above levels being experienced in an urban centre; however, no monitoring of these pollutants was available.

3.9 A report undertaken in 2013[29] modelled the predicted concentrations of the tunnel stacks, at receptor locations nearby to the stacks, with results indicating that ambient pollution levels were low at all locations assessed representative of exposure. This document has not been reviewed in detail as part of this assessment; however, it is understood that the tunnel portal emissions were not also modelled and therefore concentrations were not predicted at sensitive receptors nearby the portals.

Defra Background Concentrations

3.10 Defra publish estimates of 'background' pollutant concentrations for each square kilometer, based on national modelling studies[30]. The most recent background concentration maps, based on a reference year of 2018, have informed this section.

3.11 Background concentrations for Wirral, taken from Defra's background maps for the years 2018 and 2024 (to represent, conservatively the future assessment year of 2037) are presented in Table 2; 2018 backgrounds for NO_2, PM_{10} and $PM_{2.5}$ are plotted, included in Appendix C. For each year and pollutant, a

[28] LCRCA (2019) Mersey Tunnels Long Term Operations and Maintenance Strategy. Available online at: < https://moderngov.merseytravel.gov.uk/documents/s41725/Enc.%201%20for%20Mersey%20Tunnels%20Long%20Term%20Operations%20and%20Maintenance%20Strategy.pdf >
[29] REC (2013) Dispersion Modelling of Emissions from the Mersey Tunnels
[30] Department of Environment, Food and Rural Affairs (2021) Background Mapping data for local authorities - 2018. Available online at: https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2018

range is provided to reflect spatial variations. The rationale for the conservative approach for the future years is explained in Table 3 in Section 4.

3.12 To provide context for the wider study and the spatial contribution of background sources, the highest NO_2 background concentrations are found around the A41 New Chester Road in Bromborough, followed by central Birkenhead, A59 Kingsway and the M53 junction 2A. The highest PM_{10} and $PM_{2.5}$ background concentrations are found around Liscard, M53 junction 2A, and in central Birkenhead. No exceedances of the national air quality objectives exist however, background levels of $PM_{2.5}$ in Liscard are noted to exceed the WHO guideline of 10 μg/m^3 as an annual mean.

Table 2. Defra Background Concentrations in Wirral

Year	Annual Mean Background Concentration (μg/m^3)								
	NO_2			PM_{10}			$PM_{2.5}$		
2018	5.0	to	27.5	8.5	to	14.0	5.8	to	10.0
2024 (to represent the full plan year 2037)	4.1	to	25.4	7.7	to	13.0	5.2	to	9.3
Annual mean objective		40			40			25*	

Note: * World Health Organisation guidelines 10 μg/m^3 as an annual mean

3.13 Sources of average annual mean background concentrations of NO_X, PM_{10} and $PM_{2.5}$ across Wirral are shown in Figure 2.

3.14 The majority of background NO_x emissions in both 2018 and 2024 derive from rural sources. Road exhaust emissions account for 7% in 2018 and decrease to 6% in 2024. Rural emissions decrease from 2018 to 2024, with emissions from point sources, domestic sources, and other sources increasing.

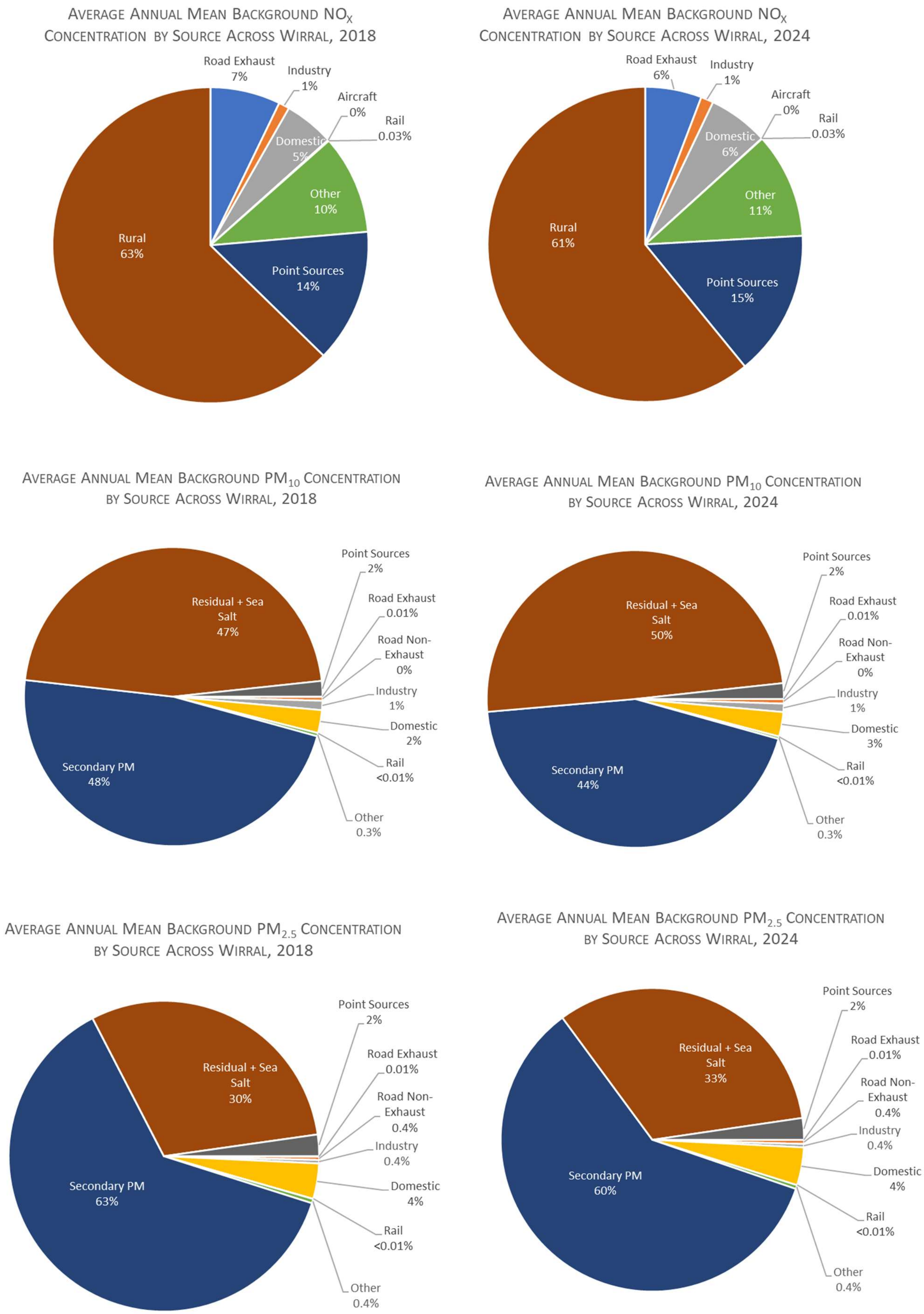
3.15 The majority of background PM_{10} emissions originate from residual sources (dust and non-characterised sources) and sea salt, followed by secondary PM formation (formed via photochemical processes from gaseous and naturally derived precursors). Secondary PM is the largest source of $PM_{2.5}$. Secondary PM_{10} and $PM_{2.5}$ emissions increase from 2018 to 2024. Domestic PM (for example emissions from home heating and other sources such as bonfires) is proposed to increase between 2018 and 2024.

3.16 Defra background concentrations include contributions from a variety of sources, including roads, rail, and industry. For use in the following screening and detailed modelling, a Defra tool[31] was used to remove the contribution to the background concentrations from sources that are directly modelled, ensuring that they are not double counted.

3.17 Contributions from motorways, primary A-roads, and trunk A-roads ‘in-square’ have been removed in this way, while minor roads and ‘out-of-square’ contributions have not been removed, as some, but not all of these sorts of contributions have been modelled; leaving them in the background concentrations therefore is the more conservative approach.

[31] Department of Environment, Food and Rural Affairs (2020) NO_2 Adjustment for NOx Sector Removal Tool v8.0. Available online at: < https://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html#NOxsector >

Figure 2. Defra Background Concentrations Source Apportionment



Predicted Baseline Pollutant Concentrations

3.18 Detailed modelling predicted annual mean concentrations of NO_2, PM_{10}, $PM_{2.5}$ and the number of exceedances of the 24-hour PM_{10} objective, at the selected existing air quality sensitive receptors in the 2018 baseline scenarios are provided in Appendix F and discussed in Section 6.

Point Sources of Air Pollution

3.19 This assessment considers the effects of changes to road traffic on local air quality, therefore non-road emissions sources have not been included in the screening or detailed modelling.

3.20 It is, however, recognised that other emissions sources contribute to the total exposure, as outlined above in the discussion of the background contribution.

Socio-Economic Indicators

3.21 Air quality impacts influence, and are influenced by, the health and wellbeing of the population via a complex matrix of interactions. These factors have been considered using the Indices of Multiple Deprivation.

3.22 The Index of Multiple Deprivation (IMD) 2019 is the official measure of relative deprivation for Lower Super Output Area (or neighbourhoods, with an average population of 1,500) in England[32]. The IMD ranks every neighbourhood in England from 1 to 32,844 (most to least deprived area, or greater to lesser socio-economic disparity). Deprivation quintiles are calculated by ranking the 32,844 neighbourhoods in England from most to least deprived and dividing them into equal groups. The index is based on scores for:

- Income;
- Employment;
- Education, Skills and Training;
- Health Deprivation and Disability;
- Crime;
- Barriers to housing & services; and
- Living Environment.

3.23 The IMD has been chartered across the WMBC administrative area. The IMD Score for each neighbourhood is shown in Appendix D; a score of 1 is the most deprived while 10 is the least deprived. Neighbourhoods in Birkenhead centre, extending north to Liscard, broadly following the M53 motorway were scored in the areas with greater socio-economic disparity in the Borough, as well as Moreton, Woodchurch, Rock Ferry suburbs, and Hooton in the south within Cheshire West and Chester Council. These data indicate that the urban areas listed have an overall higher level of deprivation in comparison to their rural counterparts.

[32] UK Government (2019) English indices of deprivation 2019. Available online at: < https://www.gov.uk/government/statistics/english-indices-of-deprivation-2019 >

4. Model Methodology

4.1 It is noted that the allocations assessed (shown in Appendix A), allow for the provision of more housing than is required for the Local Plan provisions; therefore traffic flow data and air quality impacts of the development allocations are considered a conservative representation of the level of development which will likely occur.

Screening Model

4.2 The AECOM screening model was specifically designed to inform strategic development and has been used to inform Local Plan proposals in other areas. The GIS-based tool incorporates spatial integration of road link-specific vehicle emissions data with screening-level dispersion estimates to provide a rapid, high-level analysis of air pollution impacts from road transport. The tool is designed to predict roadside concentrations on road links in strategic models, rather than discrete junction hotspots or areas of complex emissions dispersion such as tunnel portals.

4.3 The screening stage considered the whole of the Wirral administrative area at a relatively coarse level and helped inform the spatial scope of the detailed dispersion modelling stage. The approach used the AECOM's roadside screening model to make roadside NO_2 predictions using simple pollutant dispersion algorithms. Table 3 outlines the method followed and the following section describes the screening model verification methodology.

Table 3. Screening Model Method

Item	Method
Traffic data	2015 base year and 2037 Emerging Draft Local Plan scenario years were provided by the Project transport consultant. 24-hour annual average daily traffic (AADT) data, split by car, light goods vehicles (LGV), heavy goods vehicles (HGV) and bus proportions (HGV plus buses are termed heavy duty vehicles (HDV)), and modelled link speeds were available. The latest version of the EFT (v10) has an earliest year of 2018, as well as the greatest availability of monitoring data in this year. Therefore, to ensure modelling consistency with the future year scenarios the 2015 traffic data was modelled as 2018.
Model Domain	Considered all transport model road links in the Wirral area, as shown in Appendix B1.
Scenarios	Screening was undertaken for a 2018 base year. The projected future year traffic data was modelled for 2037; the final year of the Emerging Draft Local Plan scenarios. However, air quality modelling has relatively lower confidence as it is projected further into the future due to uncertainties about fleet projections. To ensure the assessment was robust and cautious, the future year applied to the screening model calculations was 2024.
Emissions	2018 and 2024 (to represent a cautious 2037) emissions of NOx, PM_{10}, $PM_{2.5}$ and carbon dioxide (CO_2) were calculated using Defra's Emissions Factor Toolkit (EFT, version 10.1)[33]
Background air quality	Defra backgrounds (closest 1 km grid square for each receptor/node) for 2018 and 2024[34], with contributions from motorways, primary A-roads, and trunk A-roads 'in-square' removed, as described in Paragraph 3.17.
Receptors	Roadside concentrations were calculated at 20 m intervals along each modelled road link. Concentrations were predicted at a nominal 5 m distance set back from the kerb. It is important to note that air quality modelling would usually focus attention on areas where the national annual mean air quality objectives apply, such as where sensitive receptors are located. The results presented are therefore worst case, to capture any areas which may necessitate further areas of dispersion modelling.
NOx to NO_2 conversion	To enable comparison between total NO_2 concentration (the data that air quality monitoring provides) with the NO_X concentration contributed by the screening model roads output, a conversion was applied using appropriate Defra tools[35]. For road transport emissions, a 'NO_X to NO_2' conversion spreadsheet has been made available by Defra to calculate the road NO_2 contribution from modelled road NO_X contributions; version 8.0 was used for all scenarios. The tool comes in the form of an MS Excel spreadsheet and uses borough-specific data to calculate annual mean concentrations of NO_2 from dispersion model output values of annual mean concentrations of NO_X. Due to the location of the study, the 'England-Urban' traffic setting was selected.

[33] Department of Environment, Food and Rural Affairs (2020) Emissions Factors Toolkit v 10.1. Available online at: < https://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html
[34] Department of Environment, Food and Rural Affairs (2020) 2018-based background maps for NOx, NO2, and PM10. Available online at: < https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2018
[35] Department of Environment, Food and Rural Affairs (2020) NOx to NO2 Calculator v 8.0 Available online at: < https://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html >

Item	Method

4.4 The screening model outputs were verified with measured air quality data. The screening model is intended to determine roadside concentrations near individual sections of road, rather than hotspots near junctions, which is better assessed using detailed dispersion modelling, and undertaken on areas identified as being at most at risk of high pollutant concentrations. Therefore, the monitoring sites used in verification were selected carefully and were required to fulfil the following conditions:

- The monitor must be on the network included in the screening model.
- The monitor is preferentially a 'kerbside' monitor. However, in this case this resulted in an inadequate number of monitors being suitable. Hence 'roadside' monitors that were equal to or less than 2 m from the road were also used. Monitors further back from the road were excluded as localised dispersion is likely to occur at these greater distances, significantly reducing the reliability of the screening model.
- The monitor must not be on, or very close to a junction. This condition is necessary because the screening model is relatively simple and recognises the contributions from only one link are modelled. In junction locations where there is a significant contribution from more than one link, the tool cannot adequately predict the measured concentration.

4.5 This analysis resulted in 15 monitors being selected for verification of the screening model results, as shown in Appendix B1.

4.6 The results of the monitoring in 2018 were compared to modelled results for those locations and a bias adjustment factor was calculated in line with method outlined in LAQM TG(16)[36]. Appendix B2 presents the technicalities of the screening model verification; the unadjusted model under-predicted annual mean concentrations of NO_2 at all 15 locations. To account for this bias, the factor of the difference between the modelled and measured road NO_X contributions (2.07) was used to adjust the model output at all receptors, for the base year, the future do-minimum and Preferred Option scenarios.

4.7 The accuracy of the adjusted model was considered using the Route Mean Square Error (RMSE) statistic. LAQM.TG16[35] states in Paragraph 7.542 that:

> *"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 40 μg/m^3, if an RMSE of 10 μg/m^3 or above is determined for a model, the local authority would be 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 4 μg/m^3 for the annual average NO_2 objective."*

4.8 The RMSE value for the adjusted model was 4.4 μg/m^3, which is 11% of the annual average NO_2 objective, within acceptable limits, and for a screening model should be considered to be very good. Following adjustment, data better fits within 25% confidence intervals.

Detailed Dispersion Modelling

4.9 The detailed modelling methodology was undertaken as presented in Table 4. The sections that follow detail specific parameters to include tunnel emissions in the modelling, the receptors used, model verification, and limitations and assumptions associated with the dispersion modelling.

Table 4. Detailed Dispersion Model Method

Item	Method
Traffic data	2015 base year and 2037 Emerging Draft Local Plan scenario years were provided by the Project transport consultant. 24-hour annual average daily traffic (AADT) data, split by car, light goods vehicles (LGV), heavy goods vehicles (HGV) and bus proportions (HGV plus buses are termed heavy duty vehicles (HDV)), and modelled link speeds were available. The latest version of the EFT (v10) has an earliest year of 2018, as well as the greatest availability of monitoring data in this year. Therefore, to ensure modelling consistency with the future year scenarios the 2015 traffic flow was modelled as 2018.

[36]Department for Environment, Food and Rural Affairs (2016) Local Air Quality Management Technical Guidance (TG16)

Item	Method	
Model Domain	The detailed modelling domain was determined based on the six areas of specific interest to WMBC, as identified in Section 1, with a slightly wider spatial scope to be able to make reliable assessment conclusions. No additional areas were identified during the screening stage as being at risk of NO_2 exceedance. The modelled domain is shown in Appendix B3.	
Model software	The detailed modelling used ADMS-Roads version 5.0.0.1[37] air dispersion model for road sources. ADMS is a modern dispersion model with an extensive published track record of use in the UK for the assessment of local air quality effects, including model validation and verification studies.	
Model input parameters	Surface roughness at source:	1 m
	Minimum Monin-Obukhov length for stable conditions:	30 m
	Meteorological data	1 year (2018) hourly sequential data from Crosby meteorological station
	Receptor locations	x, y coordinates determined by GIS, z=various
	Emission sources included	Roads, tunnels
	Emissions	NO_X, PM_{10}, $PM_{2.5}$
	Emission factors	EFT Version 10.1 emission factor dataset
	Emission profiles	No
	Model output	Long-term annual mean NOx concentrations Long-term annual mean PM_{10} concentrations Long-term annual mean $PM_{2.5}$ concentrations
Scenarios	Modelling was undertaken for a 2018 base year. The projected future year traffic data was modelled for 2037, the final year of the Emerging Draft Local Plan scenarios. However, air quality modelling has relatively lower confidence as it is projected further into the future due to uncertainties about fleet projections. To ensure the assessment was robust and cautious, the future year applied to the screening model calculations was 2024.	
Emissions	2018 and 2024 emissions of NO_x, PM_{10}, $PM_{2.5}$ and CO_2 were calculated using Defra's Emissions Factor Toolkit (EFT, version 10.1)[38]	
Background air quality	Defra backgrounds (closest 1 km grid square for each receptor/node) for 2018 and 2024[39], with contributions from motorways, primary A-roads, and trunk A-roads 'in-square' have been removed, as described in Paragraph 3.17.	
NOx to NO_2 conversion	To enable comparison between total NO_2 concentration (the data that air quality monitoring provides) with the NO_X concentration contributed by the screening model roads output, a conversion was applied using appropriate Defra tools[40]. For road transport emissions, a 'NO_X to NO_2' conversion spreadsheet has been made available by Defra to calculate the road NO_2 contribution from modelled road NO_X contributions; version 8.0 was used for all scenarios. The tool comes in the form of an MS Excel spreadsheet and uses borough-specific data to calculate annual mean concentrations of NO_2 from dispersion model output values of annual mean concentrations of NO_X. Due to the location of the study, the 'England-Urban' traffic setting was selected.	

Tunnel Parameters

4.10 Tunnel emissions were modelled for the Kingsway (Wallasey) and Queensway (Birkenhead) road tunnels. The approach to modelling these sources is provided below.

4.11 To derive total vehicle emissions from road traffic utilising the tunnels, the EFT v10.1[38] was used to calculate the road traffic emissions for the links within the tunnels. Tunnel portal emissions are modelled using the emissions on the outflow links (those leaving the tunnel). The tunnel portals are located at the Wirral end of the A59 Kingsway tunnel, and the Wirral end of the Queensway tunnel, at Kings Square.

4.12 On the Wirral side, there is one Kingsway tunnel vent located to the east of Denman Grove at the Promenade and two for the Queensway tunnel at the end of Pacific Road at Woodside, and at Sidney

[37] Cambridge Environmental Research Consultants (2020) ADMS-Roads Extra v5.0.1
[38] Department of Environment, Food and Rural Affairs (2020) Emissions Factors Toolkit v 10.1. Available online at: < https://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html
[39] Department of Environment, Food and Rural Affairs (2020) 2018-based background maps for NOx, NO2, and PM10. Available online at: < https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2018
[40] Department of Environment, Food and Rural Affairs (2020) NOx to NO2 Calculator v 8.0 Available online at: < https://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html >

Street; all at substantial release heights. There is no data available to determine the proportion of vehicle emissions that are released from the vents compared with those that disperse via the tunnel portal. For the purposes of the modelling, it was therefore assumed that emissions from the vents and portals would be proportional, as shown in Table 5. This was considered a suitable approach based on the available information.

4.13 The tunnel vents and portal locations are shown in Appendix B3.

Table 5. Modelled Tunnel Vent Parameters, Kingsway Tunnel

Emission Source	Type	Temperature (°C)	Height (m)	Flow Rate (m^3/s)	Emission Rate
Promenade	Vent	15	57.15	372.15	50% of Kingsway tunnels
Woodside	Vent	15	68.50	255.60	20% of Birkenhead to New Quay, 25% of Old Haymarket to Birkenhead, 25% of Birkenhead to Old Haymarket
Sidney Street	Vent	15	38.03	262.10	20% of Birkenhead to New Quay, 25% of Old Haymarket to Birkenhead, 25% of Birkenhead to Old Haymarket

Receptors

4.14 Receptors considered in the detailed modelling study included a selection of residential properties and other sensitive locations such as school, hospitals, medical centres etc. within 200 m of the modelled roads. A total of 269 existing receptors were modelled. The receptors were identified from a review of mapping and aerial photography of the area; all receptor points were chosen at the façade of the building.

4.15 An additional 103 receptors were selected within 200 m of modelled roads and on the closest boundary to a modelled road of areas allocated for potential future development within the Preferred Option.

4.16 Locations of the existing and development allocation receptors are shown in Appendix B4. As noted in Paragraph 3.17, background sector removal has been undertaken where relevant for sources included in the dispersion modelling, to avoid double counting emissions.

Verification

4.17 The model verification process was undertaken through comparison with WMBC 2018 monitoring data.

4.18 Of those monitoring locations which had data available for 2018 in the northern model extent (known as Zone 1) model domain, the following were not included in the verification procedure for the following reasons, also shown in Appendix B3:

- Wirral Tranmere CM, W2, W3, W4, W8, W9, W14, W15, W21, W22, W26, W28, W29, W32, W33, W38 – monitoring locations are outside the study area;
- W34, W35 – monitoring locations are on an unmodelled road within the study area; and
- W18 – situated next to a taxi rank in Liscard was not considered representative of conditions across the model (i.e. highly localised queuing and idling).

4.19 There is no monitoring undertaken by WMBC at the two tunnel portals therefore the modelled emissions from tunnels have been verified with road sources. W34 and W35 are the closest WMBC monitors to the Kingsway tunnel portal therefore the inability of keeping these within the model verification is not ideal, however with reference to Defra guidance LAQM TG(16)[41], the locations are unjustifiably too far away being over 50 m and over 30 m, respectively from the nearest modelled road edge.

4.20 The results of the monitoring in 2018 were compared to modelled results for those locations and a bias adjustment factor was calculated in line with method outlined in LAQM TG(16). Appendix B5 presents the technicalities of the detailed model verification; the unadjusted model under-predicted annual mean concentrations of NO_2 at all 10 locations on average by 27%. To account for this bias, the factor of the

[41]Department for Environment, Food and Rural Affairs (2016) Local Air Quality Management Technical Guidance (TG16)

difference between the modelled and measured road NO_X contributions (3.48) was used to adjust the model output at all receptors, for the baseline, the future do-minimum and Preferred Option scenarios.

4.21 Following the application of the NO_X factor, modelled total NO_2 concentrations were on average within 1% of measured values across the study area. To quantify the accuracy of the adjusted dispersion model, the RMSE was calculated. Again, referring to current Defra guidance[42], an RMSE that is within 10% (4 $\mu g/m^3$) of measured values is considered the ideal. Following adjustment, the RMSE for the Zone 1 dispersion model is 3.2 $\mu g/m^3$ and therefore results are considered to be appropriate for use. Appendix B5 presents further statistics of modelled versus measured road contribution NO_2.

4.22 Of the four monitors available for verification (W5, W12, W13, W27) in the southern model extent (known as Zone 2), a lower model adjustment factor than that derived for Zone 1 was calculated. On this basis, for a conservative assessment, the 3.48 factor derived for Zone 1 was also applied to Zone 2 results.

4.23 Due to the absence of comparable monitoring data, the same adjustment factor for predicted road contributions of NO_X was also applied to the other primary pollutants PM_{10} and $PM_{2.5}$, at the specified receptor locations considered in this assessment.

Limitations and Assumptions

4.24 The following assumptions have been made in the detailed dispersion modelling:

- Road traffic emissions related impact predictions have been checked against baseline monitoring data to capture and adjust for variations in model performance. By carrying out model verification and adjusting the results in line with measured concentrations according to Defra's published guidance, the uncertainty in the predictions for the current baseline is reduced. As there are no monitoring locations able to verify the modelled tunnel emissions, the tunnel emissions have been verified within the road traffic emissions. The unavoidable assumption is that the model may under- or over-predict at this location (it is recommended that additional monitoring is undertaken in this area, discussed later in this report in Paragraph 9.39);
- Due to the earliest model year in the latest version of EFT (v10) being 2018, and also greater availability of air quality monitoring data in 2018, the 2015 traffic data was in this case used to represent the 2018 base year.
- The meteorological data has been sourced from Crosby meteorological station for the base year (2018), as this meteorological site is one of the closest and considered most representative of conditions at the site from which a full meteorological dataset is available. The 2018 data has been used to model all scenarios, including those of future years. The known and unavoidable limitation here being that whilst the most representative meteorological dataset has been used, it may not be an absolute reflection of true localised climatic conditions across all parts of the model domain. The second assumption is that meteorological conditions in 2018 will be representative of 2037;
- Worst case receptor locations have been assumed, which represent the location of maximum exposure to air pollutants within an area; and
- A greater level of uncertainty is associated with predictions for future years than for the base year, with greater uncertainty the further into the future the predictions are made. The assumptions made in relation to traffic flows, vehicle emission rates and vehicle fleet composition are expected to be the most uncertain but have been made in accordance with best practice approaches and modelled using the official Defra v10.1 emission factors.

[42] Department for Environment, Food and Rural Affairs (2016) Local Air Quality Management Technical Guidance (TG16)

5. Screening Model Results

5.1 The results of the screening exercise for annual mean NO_2, PM_{10} and $PM_{2.5}$ are shown in Appendix E for roadside locations in the Preferred Option scenario.

Nitrogen Dioxide

5.2 The Screening Model RMSE can be referenced to indicate the confidence in the predicted annual mean NO_2 concentrations in accordance with the thresholds summarised in Table 6. Where screening model receptors at 5 m distance from the road edge are predicted to experience a concentration of above 35.6 µg/m^3 (being the limit value (40) minus the RMSE value of the model (4.4)), there is deemed to be a highly possible risk of exceedance at any nearby sensitive receptors. Concentrations predicted by the screening model of between 31.2 µg/m^3 and 35.6 µg/m^3 have a possible risk of exceedance at any nearby sensitive receptors and predicted concentrations of between 26.8 µg/m^3 and 31.2 µg/m^3 are considered as having an unlikely risk of exceedance at any nearby sensitive receptors. Below this, exceedance is deemed very unlikely.

5.3 Where road links are identified in this process, this can highlight where there is a higher risk of exceedance where there is relevant sensitive receptor exposure. As described in Paragraph 4.2, this is more complicated where there are dual carriageways, junctions, or other areas where emissions dispersion is complex, such as tunnel portals, where the screening model will not consider the combination of emissions.

Table 6. Explanation of the Risk of Exceedance from Screening Model Results

Annual Mean Concentration of NO_2	Colour with reference to Figure E1 in Appendix E	Description
<26.8 µg/m^3	Dark green Blue	Exceedance very unlikely
26.8 - 31.2 µg/m^3	Light green	Exceedance unlikely
31.2 - 35.6 µg/m^3	Light orange	Exceedance possible
35.6 - 40 µg/m^3	Dark orange	Exceedance highly possible
> 40 µg/m^3	Red	Exceedance likely

5.4 As shown in Figure E1 in Appendix E, annual mean NO_2 concentrations are predicted to be highest (i.e. in the more than 40 µg/m^3 concentration band and therefore a likely risk of exceedance) in the Preferred Option 2037 scenario at the M53 junction 5 with A41 New Chester Road however there are no sensitive receptors within the vicinity of the M53 junction.

5.5 Annual mean NO_2 concentrations are predicted to be within the 35.6 to 40 µg/m^3 concentration band at Poulton Bridge Road at the junction with Dock Road therefore this is deemed to have a highly possible risk of exceedance of the objective. As this is located at a junction and there are existing residential receptors nearby, these were included in the dispersion modelling.

5.6 Annual mean NO_2 concentrations are predicted to be within the 31.2 to 35.6 µg/m^3 concentration band with a possible risk of exceedance, including at the following locations:

- M53 junction 6 – no nearby sensitive receptors;
- the A59 Kingsway from the tunnel portal to the roundabout with Gorsey Lane – there are nearby sensitive receptors and complex road emission sources, therefore these have been included in the dispersion modelling;
- A554 Birkenhead Road roundabout with Dock Road – despite the likely complexity of road sources at the junction, there are no nearby sensitive receptors;
- a section of Conway Street in central Birkenhead – there are likely to be complex emissions at this location therefore the closest sensitive receptors have been included in the dispersion modelling;

- a section of A552 Borough Road, near the junction with Whetstone Lane - there are likely to be complex emissions at this location therefore the closest sensitive receptors have been included in the dispersion modelling;
- M53 junction 4 – no nearby sensitive receptors;
- A section of A41 New Chester Road between Bridle Road and Eastham Village Road in Eastham – there are likely to be complex emissions at this location with some sensitive receptors nearby, however there is negligible impact from the Preferred Option in this location and so inclusion of this location is not considered necessary for the core purposes of this study; and
- A small section of A552 adjacent to an Asda Petrol Station, near M53 junction 3 – no nearby sensitive receptors.

5.7 The majority of locations identified above as being considered necessary to include in the dispersion modelling roughly align with the areas of concern identified by WMBC, along with the following additional areas:

- at the junction of Poulton Bridge Road with Dock Road; and
- a section of A552 Borough Road, nearby the junction with Whetstone Lane.

5.8 The screening identified a number of locations with a risk of exceedance. Dispersion modelling of these locations aims to include consideration of any complexities of road emission dispersion.

5.9 The section of A41 New Chester Road between Bridle Road and Eastham Village Road in Eastham with nearby sensitive receptors has been identified as an area within the base road network which has a possible risk of annual mean NO_2 objective exceedance in the future assessed scenarios and WMBC may wish to undertake NO_2 monitoring at this location to understand the absolute concentrations. This location however has not been recommended for inclusion with the further dispersion modelling as part of this assessment as the negligible impact from the Preferred Option in this location and so inclusion of this location is not considered necessary for the core purposes of this study.

Particulate Matter

5.10 Locations of the highest predicted annual mean PM_{10} and $PM_{2.5}$ concentrations include a number of portions of the M53 motorway as shown in Figures E2 and E3 in Appendix E.

5.11 The screening did not identify any areas at risk of exceedances of the PM_{10} and $PM_{2.5}$ England and Wales' annual mean objectives[43] with maximum concentrations predicted in 2037 future scenarios of 21.4 $\mu g/m^3$ and 12.9 $\mu g/m^3$, respectively. Exceedances of these objectives were therefore estimated to be very unlikely across most of the Wirral area, however there may be areas where the WHO guideline of 10 $\mu g/m^3$ annual mean $PM_{2.5}$ is exceeded. This includes numerous locations across the Borough, including; the A59 Kingsway, A5139 Dock Road, Liscard, M53 motorway and junctions, central Birkenhead, Moreton, Woodchurch, the A552, and the A41 New Chester Road. No further areas were considered for detailed modelling beyond those already included in the study area as a result of the outcomes of PM screening modelling.

5.12 It is however recognised that there is no 'safe' threshold for exposure to PM, and especially $PM_{2.5}$. As such, continuing to strive to make air quality a public health priority is recommended.

Greenhouse Gas

5.13 Greenhouse gases (GHG) were modelled as carbon dioxide (CO_2). CO_2 has been reported as total emissions from roads within the Wirral administrative area, and specifically the change in emissions resultant from the proposed development build-out in the Emerging Draft Local Plan assessment scenario.

[43] Department for Environment, Food and Rural Affairs (2010) The Air Quality Standards Regulations 2010 Statutory Instrument 2010 No. 64

5.14 The total CO_2 emissions from the modelled traffic network are presented in Table 7. CO_2 was predicted to increase by 5,464 tonnes with the Preferred Option going ahead, which was a 1.3% increase in emissions compared to the future baseline.

5.15 This method modelled the 2037 traffic flow data and build-out along with fleet emissions profiles for 2024 as a conservative assessment approach; it is likely that a significant proportion of this fleet will be zero tail-pipe emission by 2037, and electrical energy may be from renewable sources. Therefore, as the emissions profile improves year-on-year these should be considered cautious values that have been included here as an outcome for completeness.

Table 7. Carbon Dioxode (CO_2) Emissions from Roads in Wirral for the Assessed Scenarios

Scenario	2018 Baseline	2037 Baseline	Preferred Option
CO_2, tonnes per annum	297,855	430,483	435,947
Change vs Baseline	-	-	5,464
	-	-	+1.3%

6. Detailed Model Results

6.1 Annual mean concentrations of NO_2, PM_{10} and $PM_{2.5}$ have been predicted at assessed sensitive receptors for all of the aforementioned scenarios. The modelled pollutant concentrations for the assessed receptors can be found in Appendix F for all scenarios. Plots for the Preferred Option scenario are presented in Appendix G.

6.2 The magnitude of change and impact descriptors have been derived with reference to the IAQM/EPUK methodology[44] for local development planning. This guidance was not explicitly intended for use in strategic assessment but provides context for the magnitude and significance of the predicted local air quality effects in terms of planning and development.

Nitrogen Dioxide

6.3 When considering the detailed dispersion model confidence limits discussed in Paragraph 4.21, locations where predicted concentrations are above 36.8 µg/m^3 (being the limit value (40) minus the RMSE value of the model (3.2)), it is possible that annual mean NO_2 will exceed the annual mean objective of 40 µg/m^3. Using this same concept, locations with predicted concentrations of 33.6 to 36.8 µg/m^3 may be taken to be unlikely, and concentrations below 33.6 µg/m^3 would indicate a very low risk of exceedance of the annual mean objective with exceedances very unlikely. Where concentrations are predicted to be greater than 40 µg/m^3, exceedances are here considered to be likely. This is summarised in Table 8.

6.4 Table 9 summarises the number of receptors that are predicted to fall within the stated concentrations bands for annual mean NO_2.

Table 8. Explanation of Detailed Modelling Results - Risk of Annual Mean NO_2 Exceedance

Annual Mean NO_2 Concentration	Colour with reference to Figure G1, G2 and G3 in Appendix G			Description
<33.6 µg/m^3	Light green	Medium green	Dark green	Exceedance very unlikely
33.6 - 36.8 µg/m^3	Yellow			Exceedance unlikely
36.8 - 40 µg/m^3	Light orange			Exceedance possible
> 40 µg/m^3	Dark orange	Dark red		Exceedance likely

Table 9. Air Quality Statistics for Annual Mean NO_2 Concentrations at Assessed Receptor Locations

Annual Mean NO_2 (µg/m^3)	Number of Receptors in Each Concentration Band					
	2018		2037 DM		2037 With Preferred Option	
	Existing	Development Allocations	Existing	Development Allocations	Existing	Development Allocations
<30.4	133	n/a	158	n/a	158	102
30.4 to 33.6	11	n/a	3	n/a	3	1
33.6 to 36.8	16	n/a	0	n/a	0	0
36.8 to 40	0	n/a	1	n/a	1	0
>40 (objective)	6	n/a	4	n/a	4	0

6.5 A concentration of less than 30.4 µg/m^3 annual mean NO_2 is predicted at the majority of receptors modelled where the risk of exceedance is very unlikely. In the 2018 baseline scenario, there are six residential receptors (R3, R4, R5, R6, R7 – all located nearby the Kingsway tunnel portal, and R95 on Cross Street nearby the Queensway tunnel portal) predicted to be above the annual mean NO_2 objective of 40 µg/m^3 with a maximum predicted concentration of 58.4 µg/m^3 at receptor R5, located north west of

[44] Moorcroft and Barrowcliffe. et al. (2017), Land-use Planning & Development Control: Planning for Air Quality. v1.2. Institute of Air Quality Management, London.

the A59 Kingsway tunnel portal. Annual mean concentrations of NO_2 are such that there is no risk of an exceedance of the hourly mean NO_2 objective. It is, however, noted that no AQMA is declared within WMBC and therefore air quality is deemed to be consistently below air quality objectives at relevant exposure locations.

6.6 Despite some predicted air quality improvements as a result of changes to the traffic fleet, there are still exceedances of the annual mean objectives for NO_2 predicted at four of the existing residential receptors (R3, R4, R5, R7) located nearby the A59 Kingsway tunnel portal in the future scenarios assessed, indicating that exceedance at relevant exposure locations is likely. Receptor R6 also falls into the 36.8 to 40 µg/m^3 (possible risk of exceedance) band. R95 on Cross Street nearby the Queensway tunnel portal falls below 33.6 µg/m^3 therefore the exceedance at this location is considered unlikely in the future scenarios.

6.7 The highest annual mean NO_2 concentration with the Preferred Option allocations in 2037 was predicted to be 50.6 µg/m^3, again at receptor R5. This includes a background NO_2 contribution of 15.8 µg/m^3 (31% of total). At this location, with the Preferred Option allocations in 2037, there is a 0.3 µg/m^3 predicted increase in annual mean NO_2 concentration when compared to the Do-Minimum. The A59 Kingsway has approximately a 400 AADT increase due to the Preferred Option allocations. Annual mean concentrations of NO_2 increase by as much as 0.8 µg/m^3 at the worst affected location (Z2_4 shown on Figure G3 in Appendix G as south of the roundabout with Bolton Road) on A41 New Chester Road.

6.8 There are no exceedances predicted for any Preferred Option development allocation receptors in 2037 with all assessed receptors falling below 33.6 µg/m^3, indicating that exceedances are very unlikely. No change in the number of receptors in this band is observed between the DM and the With Preferred Option allocations scenario in 2037 which would indicate that there is a minimal possibility of a new exceedance of the annual mean NO_2 objective as a result of the Preferred Option Allocations although this should be confirmed through individual planning applications.

6.9 According to EPUK and IAQM guidance[45], the predicted annual mean NO_2 impacts of the Preferred Option development allocations are considered 'negligible' and not considered to be significant at the majority of sensitive receptors assessed, based on the magnitude of the change and the total concentrations predicted. However, due to future concentrations predicted over the air quality objective, three assessed sensitive receptors nearby the A59 Kingsway tunnel portal (R4, R5 and R7) have a 'moderate adverse' impact predicted for annual mean NO_2, and one with 'slight adverse' (R6) despite being predicted to increase by a maximum of only 0.3 µg/m^3 in this area.

Particulate Matter

6.10 Table 10 and Table 11 summarise the number of receptors that are predicted to fall within concentrations bands for annual mean PM_{10} and $PM_{2.5}$. There are no exceedances predicted of the England and Wales' annual mean PM_{10} and $PM_{2.5}$ objectives at any receptor locations across the detailed model domain. Due to this, concentrations have been presented in nominal bands. This does not necessarily indicate there is no health effect, again, recognising that there is no 'safe' threshold for exposure to PM, and especially $PM_{2.5}$.

6.11 Annual mean PM_{10} concentrations of 10 to 20 µg/m^3 are predicted at all of the existing and development allocation receptors assessed. The highest concentration predicted is 19 µg/m^3, again at receptor R5 north of the A59 Kingsway tunnel portal in the Preferred Option scenario; this includes a background contribution of 12.1 µg/m^3 of PM_{10} (63% of total).

6.12 Annual mean $PM_{2.5}$ concentrations of 5 to 15 µg/m^3 are predicted at all of the existing and development allocation receptors assessed, which falls below the England and Wales' annual mean objective, however many of the existing and development allocation receptors assessed are predicted to exceed the WHO guideline of 10 µg/m^3 in all scenarios. 23 existing receptors and 11 development allocation receptors are predicted to have exceedances of the WHO guideline of 10 µg/m^3 in the Preferred Option scenario. The highest concentration with the Preferred Option allocations was predicted to be 12.5 µg/m^3 of $PM_{2.5}$, again at receptor R5; this includes a background contribution of 8.2 µg/m^3 of $PM_{2.5}$ (66% of total).

[45] Moorcroft and Barrowcliffe. et al. (2017), Land-use Planning & Development Control: Planning for Air Quality. v1.2. Institute of Air Quality Management, London.

6.13 Some assessed receptors are predicted to experience improved PM concentrations in the future year when compared to 2018, however others are predicted to worsen.

6.14 No change in the number of existing receptors in PM concentration bands is observed between the DM and Preferred Option scenarios. Annual mean concentrations of PM_{10} and $PM_{2.5}$ are predicted to increase by a maximum of 0.2 µg/m^3 and 0.1 µg/m^3 respectively at existing receptors across the study area as a result of the Preferred Option allocations. According to EPUK and IAQM guidance[46], the predicted PM impacts of the Preferred Option allocations are considered 'negligible' and not considered to be significant at all of the sensitive receptors assessed, based on the magnitude of the change and the total concentrations predicted.

Table 10. Air Quality Statistics for PM_{10} Concentrations at Assessed Receptor Locations

Annual Mean PM_{10} (µg/m^3)	Number of Receptors in Each Concentration Band					
	2018		2037 DM		2037 With Preferred Option	
	Existing	Development Allocations	Existing	Development Allocations	Existing	Development Allocations
<10	0	n/a	0	n/a	0	0
10 to 20	166	n/a	166	n/a	166	103
20 to 30	0	n/a	0	n/a	0	0
30 to 40	0	n/a	0	n/a	0	0
>40 (objective)	0	n/a	0	n/a	0	0

Table 11. Air Quality Statistics for $PM_{2.5}$ Concentrations at Assessed Receptor Locations

Annual Mean $PM_{2.5}$ (µg/m^3)	Number of Receptors in Each Concentration Band					
	2018		2037 DM		2037 With Preferred Option	
	Existing	Development Allocations	Existing	Development Allocations	Existing	Development Allocations
<5	0	n/a	0	n/a	0	0
5 to 10	111	n/a	143	n/a	143	92
10 to 15	55	n/a	23	n/a	23	11
15 to 20	0	n/a	0	n/a	0	0
20 to 25	0	n/a	0	n/a	0	0
>25 (objective)	0	n/a	0	n/a	0	0

[46] Moorcroft and Barrowcliffe. et al. (2017), Land-use Planning & Development Control: Planning for Air Quality. v1.2. Institute of Air Quality Management, London.

7. Source Apportionment

7.1 A source apportionment analysis has been undertaken for the entire Wirral road network, to determine the relative contributions of cars and HGVs. This has then been used to investigate three specific key road links within the Wirral network, A59 Kingsway, M53 junction 1 to junction 7, and A41 New Chester Road (from near King's Square in Birkenhead to the roundabout with A41 New Chester Road to the south). These data were used to better inform the overall understanding of the traffic-source emissions in the study area.

All Wirral Road Network – Cars and Heavy Goods Vehicle Splits

7.2 Appendix H presents the entire Wirral road network utilised for the Screening modelling, displaying the percentage NOx emissions from cars and HGVs, in the 2037 Base scenario. As noted in Section 4, 2024 emissions were used to represent the future year of 2037 for a cautious approach.

7.3 A higher percentage of NOx emissions is attributed to cars on the more rural and suburban network (i.e. over 70%) whilst the key network including motorways and major A-roads have a lower percentage of NOx emissions from cars – i.e. between 40 to 60%.

7.4 20 to 40% of NOx emissions on motorways and major A-roads are predicted to be attributable to HGVs in the future year scenario. Up to 10% of NOx emissions are predicted to be from HGVs on rural, suburban and other non-haul routes within built up areas.

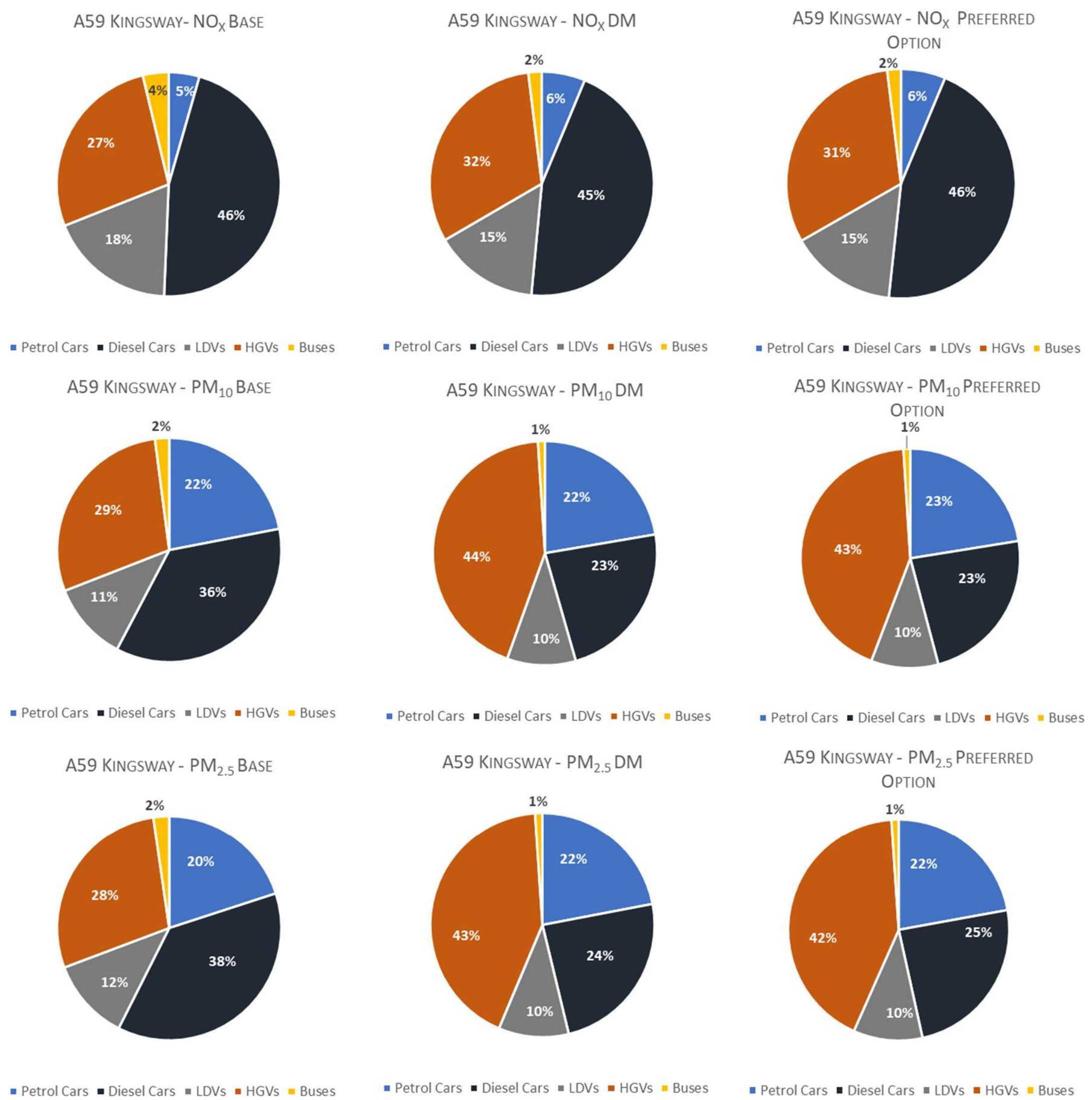
A59 Kingsway

7.5 Source apportionment for NOx, PM_{10} and $PM_{2.5}$ emissions for the A59 Kingsway, between the Kingsway tunnel and the M53, is shown in Figure 3. This is a major route through the northern area of Wirral connecting the Borough to Liverpool and represents a major route for freight and heavy goods vehicles.

7.6 In 2018 and future year scenarios, diesel cars are estimated to be the largest emitters of NOx. In the 2018 base year, diesel cars make up the largest proportion of PM emissions however in the future year the largest contribution is from HGVs. PM emissions from petrol cars are more significant than from NOx in all scenarios. Buses make up a small proportion of all pollutant emissions in all scenarios.

7.7 It is notable there is no discernible change in the proportion of emissions with, or without, the Preferred Option Emerging Draft Local Plan allocations.

Figure 3. Source Apportionment: A59 Kingsway (Base, DM and Preferred Option Scenarios)



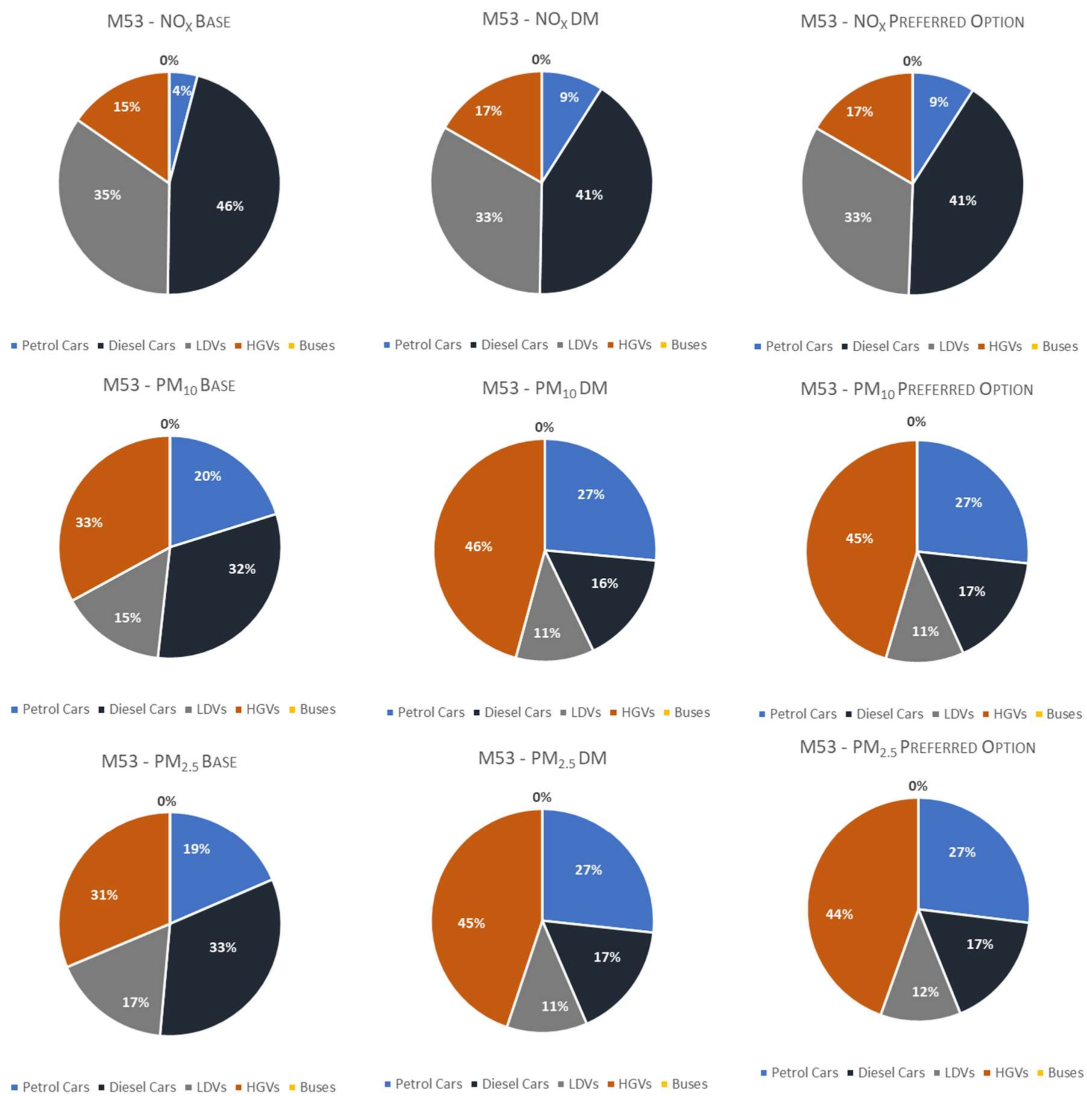
M53 (J1 to J7)

7.8 Source apportionment for NOx, PM_{10} and $PM_{2.5}$ emissions for the M53 motorway, between junction 1 and junction 7, is shown in Figure 4. This is a major route linking the district to the wider national motorway network and the regional centre in Chester and represents a major route for freight and goods vehicles. There are no buses in any scenario on this section of road.

7.9 In both the 2018 base year and future year scenarios, diesel cars are estimated to be the largest emitters of NOx with LDVs also making a large contribution, followed by HGVs. In the future scenarios, NOx emissions contribution is predicted to increase from HGVs and petrol cars.

7.10 The largest PM_{10} and $PM_{2.5}$ emissions are relatively equally shared between HGVs and diesel cars in the 2018 base year, with the HGVs contribution increasing in both future scenarios.

Figure 4. Source Apportionment: M53 (J1 - J7) (Base, DM and Preferred Option Scenarios)



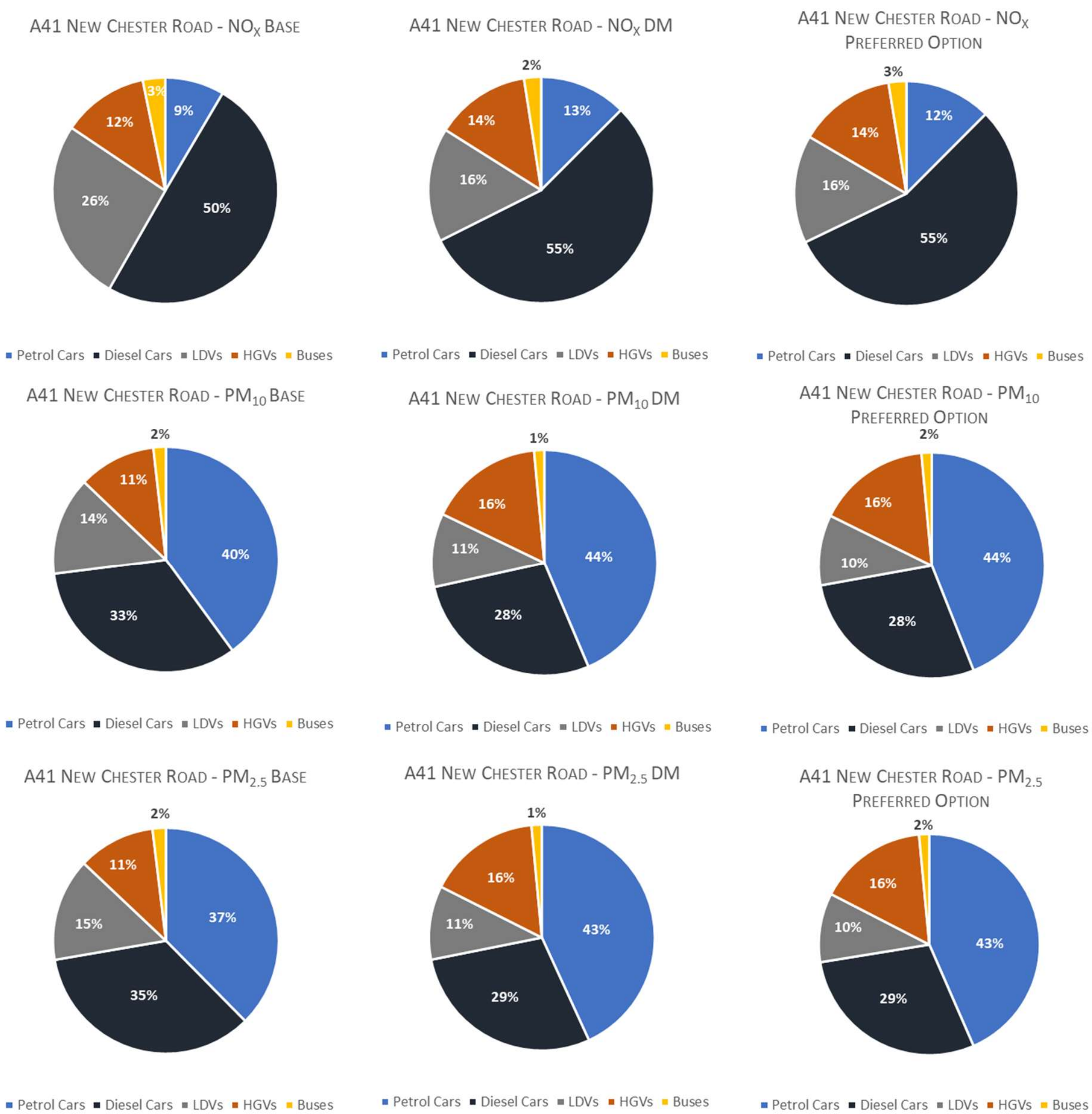
A41 New Chester Road

7.11 Source apportionment for NO_X, PM_{10} and $PM_{2.5}$ emissions for the A41 New Chester Road to the south of the roundabout with Bolton Road in Port Sunlight, is shown in Figure 5. This is a major route linking the docks and industrial areas to the M56 corridor between North Wales and the North-west of England.

7.12 In the 2018 base year, diesel cars are estimated to be the largest emitters of NO_x on this road. In the scenarios, this proportion increases further as emissions from LDVs become less significant.

7.13 PM_{10} and $PM_{2.5}$ emissions are relatively equalled shared between petrol and diesel cars in the 2018 base year, with the petrol cars contribution increasing slightly in both future scenarios.

Figure 5. Source Apportionment: A41 New Chester Street (Base, DM and Preferred Option Scenarios)



Regional Fleet Projections

7.14 The emissions modelling (both screening and detailed) was undertaken using the nominal (default) fleet for urban areas in England outside London, as set out in the EFT and described in Table 3 and Table 4 for 2016. Liverpool City Council (LCC) have however undertaken regional fleet profile analyses using Automated Number Plate Recognition (ANPR) data to determine the classification, fuel and age composition in the city to inform the Clean Air Plan (CAP) (see information following Paragraph 9.14). The presentation of these data here was kindly authorised by the air quality officer at LCC.

7.15 Compared to the nominal fleet in the EFT (the previous version; v9, in order to correlate with years <2018), the data recorded in Liverpool indicated that the fleet was broadly similar, although there are specific instances where the local fleet was slightly older than that published in the EFT, such as for diesel cars and rigid HGVs.

7.16 The bus fleet is subject to discrete funding and national bidding opportunities, and so may be stable for a few years at a time and then improve in steps as large numbers of vehicles are replaced or retrofitted with exhaust abatement technology. Therefore, it tends to change in slightly different ways to the rest of the fleet, which is more gradual due to organic turnover and market trends.

7.17 With regard to the relevance to this study, the predicted pollutant concentrations in the modelled future year should be considered to be cautious, as they apply the 2037 traffic flows to a much earlier emissions year (2024).

7.18 Furthermore, with regard to the effects of fleet profiles discussed above, this may have relevance where mitigation may be targeted towards individual vehicles, such as HGVs or vans, and it is important to understand whether parts of the fleet may be relatively older or newer and, therefore, if it is feasible to make improvements such as informing funding for specific parts of the fleet; e.g. bus retrofit.

Figure 6. Default vs LCC Fleet Profile – Petrol Cars, 2016

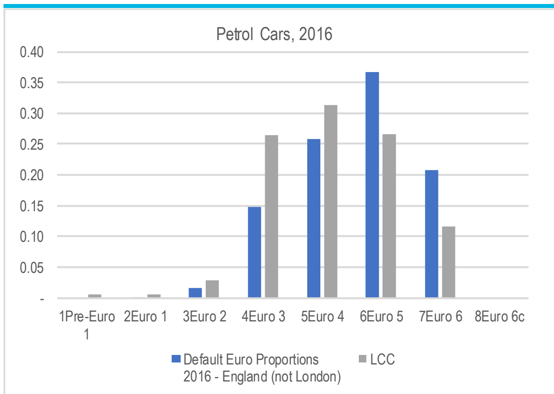


Figure 7. Default vs LCC Fleet Profile - Diesel Cars, 2016

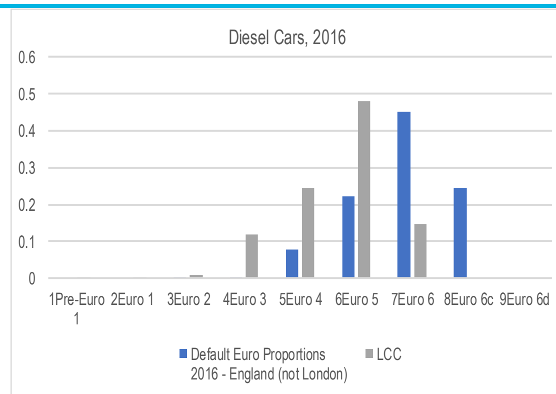


Figure 8. Default vs LCC Fleet Profile - Diesel LGVs, 2016

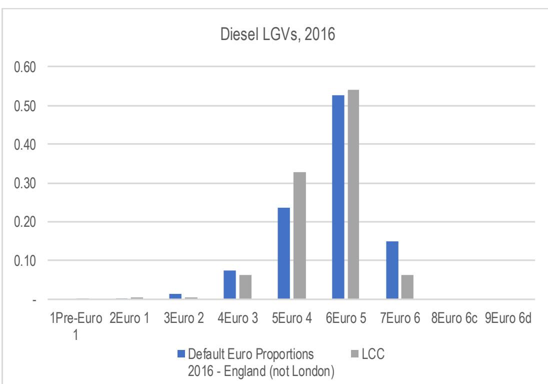


Figure 9. Default vs LCC Fleet Profile - Rigid HGVs, 2016

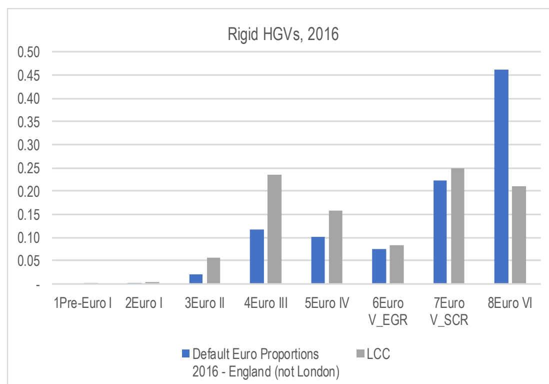


Figure 10. Default vs LCC Fleet Profile - Articulated HGVs 2016

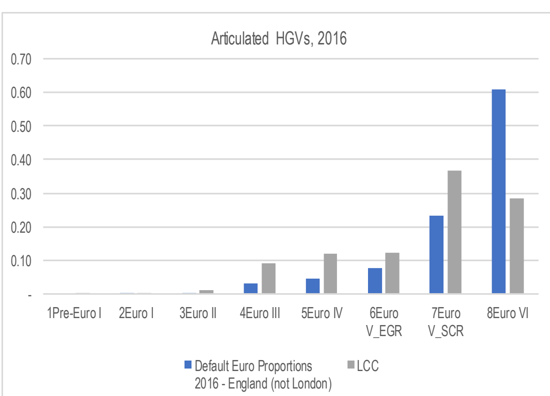
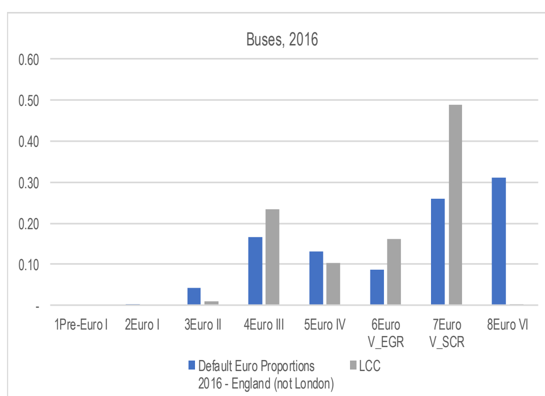


Figure 11. Default vs LCC Fleet Profile - Buses, 2016



8. Poor Air Quality and Socio-Economic Disparity

Linking Air Quality to Socio-Economic Factors

8.1 The IMD used in this study to indicate the potential health effects of changes in air quality, and to indicate the ability of a population to adapt to potential interventions, where accessibility or economic impacts may occur.

8.2 It is broadly understood that people living in more areas of greater socio-economic disparity may be disproportionally sensitive to the cumulative health effects of poor air quality. People in areas with a low IMD (and especially, with low health index scores) are at greatest risk of detrimental effects from poor air quality. For example, where respiratory or cardiovascular disease is already prevalent in a population, the cumulative effects of air pollution are worse than in an otherwise healthy population.

8.3 The most significant health benefits may therefore be attained by targeting interventions in areas where existing poor air quality coincides with low IMD and health index scores. Whilst the greatest benefits may be achieved by targeting interventions in areas with low IMD, there are also potential risks associated with this approach, as the populations in these areas may be least able to respond to the economic or practical effects of the interventions.

8.4 Therefore, it is essential that interventions intended to reduce emissions and public exposure do not contribute to reduced accessibility or social inclusion, such as penalising owners of older vehicles without ensuring suitable alternative travel opportunities are in place. Potential mitigation must, therefore, be targeted based on the ability of a population to adopt them:

- Interventions to stimulate the purchase of compliant vehicles may have lower take-up in areas of low IMD where older, more polluting vehicles are kept on the road longer as the upfront cost of purchasing a new (or newer) vehicle may be prohibitive;
- Interventions to promote the use of public transport are expected to be less effective in areas of high IMD where household budgets are more likely to be able to stretch to private car ownership;
- Interventions to promote walking and cycling are expected to be less effective in areas of low IMD where there are higher barriers to participation including large distances from the home to essential services and poorer health, including disability, which may preclude these activities partially or entirely; and
- Interventions based around education and engagement may be less effective in areas of low IMD where baseline education levels of the population may be lower.

Effects of Local Plan Options with reference to Air Quality and Socio-Economic Disparity

8.5 Ordnance Survey address point data was provided under licence[47] for the WMBC Local Authority region. These datasets were used in order to indicate the road links which were within 50 m of a location of relevant exposure as these links will have the greatest human health impacts within WMBC. The address data was also used in the production of IMD plots where each address listed was assigned an IMD score based on the neighbourhood/area to provide an overview of socio-economic disparity at receptors and to identify those locations at greatest risk of detrimental effects resultant from poor air quality.

8.6 Appendix D summarises the IMD scores for the properties included in the screening modelling (i.e. within 50 m of modelled roads).

8.7 The areas with the highest pollutant concentrations as shown in the results of the dispersion modelling in Appendix G for all years and scenarios are broadly consistent with the neighbourhoods identified as in the

[47] PSMA Standard Form Contractor Licence v2.0 November 2011 Crown Copyright

areas of greater socio-economic disparity in the Borough in Birkenhead centre, extending north to Liscard. Dispersion modelling has not been undertaken on the entire Wirral network however, referencing the screening results would also support this. The other identified neighbourhoods outside of the scope of the dispersion modelling which also scored as areas of greater socio-economic disparity include the area surrounding the M53 motorway, Moreton, Woodchurch, Rock Ferry suburbs, and Hooton in the south within Cheshire West and Chester Council, are also areas where higher pollutant concentrations are predicted.

8.8 This supports the research paper by Pye et al. (2006) which suggests that NO_2 concentrations are higher in more deprived areas, largely due to road transport sources[48].

[48] Pye, S., King, K. & Sturman, J (AEA Technology) (2006). Air Quality and Social Deprivation in the UK: an environmental inequalities analysis. (AEA Technology, Oxon, UK). Available online at: < https://uk-air.defra.gov.uk/assets/documents/reports/cat09/0701110944_AQinequalitiesFNL_AEAT_0506.pdf >

9. Effects and Mitigation

Summary of Effects

9.1 As the screening model is designed to predict roadside concentrations on road links in strategic models, rather than discrete junction hot-spots or at tunnel portals, the screening results identified the high level locations of the highest concentrations predicted in the dispersion modelling, however in areas where complex emissions exist such as A59 Kingsway, and in areas of congestion such as Birkenhead centre, the screening model results did not indicate the extent of the predicted concentrations that the dispersion modelling results displayed. Any further work to look at absolute concentrations to advise Emerging Draft Local Plan allocation decisions is therefore recommended to include dispersion modelling.

9.2 The screening identified a number of locations with a risk of exceedance of the annual mean NO_2 air quality objective in the Preferred Option scenario. The majority of locations identified from the screening model as being considered necessary to include in the dispersion modelling roughly aligned with the six areas of concern initially identified by WMBC before undertaking the work, along with the following additional areas that were consequently included in the dispersion modelling:

- at the junction of Poulton Bridge Road with Dock Road; and
- a section of A552 Borough Road, nearby the junction with Whetstone Lane.

9.3 A section of A41 New Chester Road between Bridle Road and Eastham Village Road in Eastham with nearby sensitive receptors has been identified by the screening as an area which has a possible risk of annual mean NO_2 objective exceedance in the future assessed scenarios. It has not however been recommended for inclusion with the further dispersion modelling as part of this assessment as the negligible impact from the Preferred Option in this location and so inclusion of this location is not considered necessary for the core purposes of this study.

9.4 The screening model results also indicated a risk of exceedance of the more stringent World Health Organisation $PM_{2.5}$ objective at various locations across the Borough, including; the A59 Kingsway, A5139 Dock Road, Liscard, M53 motorway and junctions, central Birkenhead, Moreton, Woodchurch, the A552, and the A41 New Chester Road, although this is noted in the most part due to a high background contribution.

9.5 CO_2 was predicted to increase by 5,464 tonnes with the Preferred Option going ahead; a 1.3% increase in emissions for the modelled roads within the administrative boundary compared to the future baseline.

9.6 Dispersion modelling results indicated that there were no exceedances of the relevant England and Wales national air quality objectives predicted for all pollutants considered at any Preferred Option development allocation receptors in 2037 and that exceedances are considered very unlikely.

9.7 The dispersion model results demonstrate that annual mean NO_2 concentrations are predicted to be below the relevant England and Wales national air quality objective in the Preferred Option scenario at the majority of assessed existing receptors. There are however four locations in the future Preferred Option scenario nearby the Kingsway tunnel portal where existing residential receptors are predicted to experience concentrations above the annual mean objective of 40 $\mu g/m^3$; the highest concentration predicted of 50.6 $\mu g/m^3$ is at assessed receptor R5, an existing dwelling to the north west of the portal. Model confidence levels mean that the exceedance of the annual mean objective for NO_2 at this location of relevant exposure is considered likely.

9.8 The maximum predicted annual mean PM_{10} and $PM_{2.5}$ concentrations also fall in this same location to the north west of the Kingsway portal. The results indicate that annual mean concentrations at existing and development allocation receptors will be below the relevant England and Wales PM_{10} and $PM_{2.5}$ national air quality objectives in the Preferred Option scenario. There are, however, numerous locations represented by existing and development allocation receptors that were predicted to fall above the WHO guideline of 10 $\mu g/m^3$ for annual mean $PM_{2.5}$; these locations are near to A59 Kingsway, in Liscard where $PM_{2.5}$ background concentrations are already above this level, and at a number of locations in Birkenhead.

9.9 Table 12 presents the composition of total predicted pollutant concentrations at the location of maximum concentration north west of the Kingsway tunnel portal for all pollutants in the Preferred Option scenario. This highlights that background pollutant concentrations represent a significant proportion of the total predicted concentrations, especially for PM, however there is an ability to improve emissions from roads at this location for all pollutants. Furthermore, although background concentrations are predicted to decrease in the future, PM in particular would not change by a large amount between the two years assessed. However, the total concentrations do not reflect the composition of PM, which is a significant factor influencing health effects.

Table 12. Total Predicted Pollutant Concentrations Composition at Receptor R5 (located north west of the Kingsway tunnel portal) in Preferred Option Scenario

Pollutant	Annual mean objective, µg/m^3	Total Predicted Annual Mean Concentration, µg/m^3	2024 Defra Background, µg/m^3 (percentage of total concentration)**	Road Contribution, µg/m^3 (percentage of total concentration)
NO_2	40	50.6	18.9 (37%)	31.7 (63%)
PM_{10}	40	19.0	12.1 (64%)	6.9 (36%)
$PM_{2.5}$	25*	12.5	8.2 (66%)	4.3 (34%)

* World Health Organisation guidelines 10 µg/m^3 as an annual mean

** Contribution of motorways, trunk roads, and A-roads have been removed from these values, to avoid double counting

9.10 In terms of air quality impact from the Preferred Option Emerging Draft Local Plan development allocations upon existing sensitive receptors, with reference to EPUK and IAQM guidance[49], the predicted annual mean NO_2 and PM impacts of the Preferred Option allocations are considered 'negligible' and not considered to be significant at the majority of sensitive receptors assessed. However, due to concentrations being predicted over the air quality objective, three assessed sensitive receptors nearby the A59 Kingsway tunnel portal have a 'moderate adverse' impact predicted for annual mean NO_2, and one with a 'slight adverse' impact, despite being predicted to increase by a maximum of only 0.3 µg/m^3 in this area.

9.11 The modelling undertaken for this assessment is not strictly comparable to the predicted 2015 exceedances identified at the A41 / Borough Road area of Birkenhead in the modelling undertaken by Defra for the Birkenhead Urban Area[50]. This is because this assessment has considered relevant areas of exposure as opposed to all roadside locations. However, the nearest existing receptors assessed to this general area are receptors R95, R123 and R124. The predicted maximum annual mean NO_2 concentration of these three receptors was 40 µg/m^3 at R95 in 2018, nearby the Queensway tunnel portal. The area surrounding the Queensway tunnel entrance (Kings Square) and Conway Road roundabouts in Birkenhead centre identified as amongst those with the highest concentrations for this assessment therefore supports the findings of the Defra modelling.

9.12 Liverpool City Council (LCC) undertook regional fleet profile analyses considered to be broadly representative of the vehicle fleet in the Wirral. Compared to the nominal fleet in the EFT utilised in this assessment, the regional fleet split data recorded in Liverpool indicated that it was broadly similar, although there are specific instances where the local fleet was slightly older than that published in the EFT, such as for diesel cars. This means road emissions may be slightly higher, although this was compensated somewhat through the validation exercise comparing the modelled and monitored data and cautious use of projected model years. However, it may be more significant in terms of consideration for managing specific fleet components, such as informing funding for improving specific parts of the fleet; e.g. bus retrofit.

9.13 The areas with the highest pollutant concentrations as shown in the results of the dispersion modelling are broadly consistent with the neighbourhoods identified as in the areas with greater socio-economic disparity in the Borough in Birkenhead centre, extending north to Liscard. As detailed dispersion modelling has not been undertaken for the entire Wirral area, reference was made to the screening model outputs. The locations of higher predicted pollutant concentrations were also found to be within the other identified

[49] Moorcroft and Barrowcliffe. et al. (2017), Land-use Planning & Development Control: Planning for Air Quality. v1.2. Institute of Air Quality Management, London.

[50] Department of Environment, Food and Rural Affairs (2017) Air Quality Plan for tackling roadside nitrogen dioxide concentrations in Birkenhead Urban Area. Available online at: https://uk-air.defra.gov.uk/assets/documents/no2ten/2017-zone-plans/AQplans_UK0020.pdf

neighbourhoods which scored in the areas with greater socio-economic disparity, including the area surrounding the M53 motorway, Moreton, Woodchurch, Rock Ferry suburbs, and Hooton in the south within Cheshire West and Chester Council. Pollutant concentrations have therefore been found to be higher in areas with greater socio-economic disparity, largely due to road transport sources.

Mitigation

Liverpool City Clean Air Plan

9.14 Liverpool City Council were mandated to undertake a Clean Air Plan study by the Defra / DfT Joint Air Quality Unit (JAQU) due to annual mean NO_2 concentrations at roadside locations that were not compliant with the EU limit value. The mandate required LCC to consider the effects of a Clean Air Zone (CAZ) that may restrict access to a defined geographical area in the city for specific category of vehicle based on the Euro emission classification.

9.15 This work is ongoing, and it is not yet confirmed if, or how, a CAZ or similar scheme may be implemented. However, as the routes from Wirral to Liverpool are limited to the Mersey Tunnels, and to a lesser degree across the Mersey Gateway bridge, it is possible to infer the potential effects that may occur.

9.16 The effects of a CAZ may include re-routing of non-compliant vehicles to avoid the zone, with a correlating incentive for compliant vehicles to utilise the released road-capacity. This is complemented by some journeys being cancelled, changed destination, modal shift towards other types of journey or investment in a new vehicle.

9.17 It was not appropriate or possible to model all possible outcomes in this study, although it may be surmised that a CAZ that restricts access on one of the cross-river tunnels will lead to a re-routing onto the other tunnel, and so may lead to detriment on the routes leading to one of the tunnels, but improvements on the other. Only the A59 Kingsway tunnel carries HDV traffic, so if this were included in the CAZ if would incentivise non-compliant traffic to travel south to the M56 and so improve air quality around the A59 tunnel portal, which was one of the areas of concern identified by the dispersion modelling.

9.18 The source apportionment undertaken as part of this assessment indicates that in the future model scenario 32% of emissions near the Kingsway tunnel portal are sourced from HGVs, whereas 15% are vans and 51% cars, for the Do Minimum (DM) 2037 scenario. Therefore, the potential effect that may occur if higher-emissions Heavy Duty Vehicles are restricted from accessing the Kingsway tunnel would be within the 32% range due to emissions from these vehicles on routes approaching the tunnel. However, the fleet breakdowns indicate that approximately 20-30% of HGVs were already compliant in 2018, and so subject to the type of restrictions imposed then non-compliant vehicles would necessarily need to re-route or upgrade, and so it may lead to emissions benefits on other roads in the district.

9.19 In addition to the discrete effects at the tunnel portals, a CAZ may have a potential short-term effect of displacing vehicles out from Liverpool into neighbouring districts. However, it is expected this would be compensated for in the design of the scheme, and so there should be long-term benefits across the region from encouraging the fleet to upgrade faster than natural turnover.

9.20 The regional benefits will likely be exemplified with improvements to the bus fleet through retrofit and replacement so the majority of buses will be compliant sooner. Furthermore, the private fleet turnover may be encouraged through planning incentives, such as EV charging integrated with new developments, and working in partnerships with groups such as Merseytravel to support travel choice for alternative, sustainable and public transport.

LCRCA Air Quality Action Plan

9.21 The LCRCA published an Initial Air Quality Action Plan in November 2019. This was approved by the scrutiny committee and will be implemented by the LCRCA Air Quality Task Force comprising elected and other representatives from across the six local authority area of the city region[51].

9.22 The AQAP was informed by a series of evidence sessions and the preliminary air quality feasibility study completed in 2018 that defined a quantified ranking of measures[52]. The outcome from this was a recognition of the current best-practice in LCR; political commitment, use of regulatory powers, strong policies and funding package, and education and awareness.

9.23 The resultant Action Plan was divided into main areas of responsibility: Combined Authority, local authorities and partners, residents, communities and businesses, and Central Government and its agencies. Within this, local authority actions comprise initial Actions that are focussed on specific topics:

- Joined-up communications and campaigns;
- Local planning powers and the creation of create clean, liveable and safe places; and
- Enforcement of idling vehicles to reduce pollution at source.

9.24 The Plan also included long-term actions that would be suitable to include in the Local Plan as part of development planning and control:

- Green infrastructure and the mitigation of pollution, which can have holistic risks and opportunities, and so should be designed carefully to ensure beneficial overall effects can be achieved. Recent guidance outlines the local and regional effects of planting, including dispersion and disrupting the exposure pathways, and also the choice of specifies to best support biodiversity and long-term resilience of the planting[53].
- Speed management and restriction as part of a wider approach to transport management and an aspiration to improve modal shift away from cars in favour of active and public travel options for short journeys on local roads.

Targeted Mitigation

9.25 The Local Plan represents the core planning and development framework for the Borough for the next 15-years, and so represents an opportunity to continue to strive to reduce air pollution, even if air quality objectives are not currently being exceeded, in line with the Clean Air Strategy.

9.26 Notably, there is no 'safe' threshold for exposure to PM, and especially $PM_{2.5}$; exceedances of the annual mean NO_2 national air quality objectives were predicted at sensitive receptors nearby the A59 Kingsway Tunnel portal in the future scenarios; however, no other national air quality objectives were predicted. There were numerous modelled receptors predicted to exceed the WHO $PM_{2.5}$ annual mean target of 10 $\mu g/m^3$ (see Section 2.25) with the maximum concentration location also at the A59 Kingsway tunnel portal and many others predicted to be above this level nearby the A59 Kingsway, in Liscard (where background levels are already above this level), and in areas of Birkenhead.

9.27 There is scope to improve emissions from roads at the location of maximum predicted pollutant concentrations if, for example, the A59 Kingsway is targeted for mitigation. Opportunities for mitigation should be considerate of these locations near the A59 Kingsway tunnel in particular, and options which favour lower concentrations at this location should be preferred. From the source apportionment exercise undertaken in Paragraph 7.6 for A59 Kingsway, measures that target diesel cars and HGVs may have the most impact on improving air quality in this area.

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[51] LCRCA (2019) Tackling Poor Air Quality across the Liverpool City Region. Available online at: < https://moderngov.merseytravel.gov.uk/documents/s43067/Enc.%201%20for%20Tackling%20poor%20air%20quality%20across%20the%20Liverpool%20City%20Region.pdf >

[52] LCRCA (2018) Review into air quality across the Liverpool City Region – Final Report by the Task and Finish Group. Available online at: < https://moderngov.merseytravel.gov.uk/documents/s33860/Appendix.pdf >

[53] TfL (2019) Using Green Infrastructure to Protect People from Air Pollution < https://www.london.gov.uk/WHAT-WE-DO/environment/environment-publications/using-green-infrastructure-protect-people-air-pollution >

9.28 This striving for the lowest practicable pollutant concentrations at this location will ensure the priority of air pollution within public health, supporting recommendations made by the Wirral JSNA.

Socio-economic Disparity

9.29 Health effects are not distributed equally; they often disproportionally affect societal groups with limited income or other constraint and are least able to respond to either poor air quality, or to the interventions that may be introduced to tackle it.

9.30 For example, electric vehicles are promoted to improve poor air quality, although these are relatively more expensive to purchase than a petrol/diesel car, and those members of society who could benefit from the local air quality improvements are least likely to be able to afford to buy one. However, with regard to exposure to PM, EV have no exhaust emissions, but do still contribute to tyre, brake and road abrasion, and so it is currently unclear how vehicle using this technology may contribute to reduced exposure to PM.

9.31 Therefore, it is recommended that the environmental health officers with a remit to undertake LAQM duties engage with public health, planning and development control, highways and travel planning teams, as well as external stakeholders such as PHE and NHS, and the regional groups at LCRCA and Merseytravel. This should increase the opportunities to identify beneficial holistic outcomes linked to travel choice, modal shift, accessibility and inclusion.

Planning and Development Control Policy

9.32 The traffic flow data used in this assessment is intended to be strategic, based on the growth aspirations assigned to the allocation areas and land uses. Therefore, the air quality assessment should be interpreted in this context, and it is advised that specific local air quality effects of individual allocations will be subject to the detailed design, land use and built-out programmes for individual developments.

9.33 The Adopted Local Plan focus has policies on pollution, transport and waste that that make provision for assessing the impacts from new development on air quality. The introduction of a more specific air quality policy within the Emerging Draft Local Plan would allow WMBC to frame a Supplementary Planning Document (SPD) providing a clear framework to applicants as to what will be acceptable in terms of air quality. A SPD would allow WMBC to direct developers to use a set criteria to determine the development impact significance on air quality; this would inform the decision making process and whether proposals would have an 'unacceptable contribution' to air quality, and also cumulative air quality impacts, on key areas identified in this study.

9.34 The data used in this report comprised a strategic study, and it is therefore recommended that specific local impacts associated with individual planning applications should be screened for traffic flow effects in accordance with the IAQM guidance on planning and development control, whereby significant road traffic changes should be appraised for associated air quality impacts. Other design measures could also be recommended at this stage which strive for the lowest air quality impact, such as decreasing the proximity to busy roads where practicable, and/or consideration of exposure pathways. This should ensure a robust and consistent approach to managing the effects of new development on air quality whilst tracking cumulative effects on a local scale.

9.35 Furthermore, the IAQM guidance includes a definition of 'significance' of effects derived from the magnitude of change and absolute concentrations of pollutants, with reference to the annual mean objectives and EU limit values. It is advised this is subject to further consideration to understand the prioritisation of compliance and exposure within the context of the socio-economic and health disparity discussed in this report.

Journeys and Travel Choice

9.36 The Local Plan includes an aspiration for development of urban centres, so services and workplaces are collocated with residential areas that may reduce the need to travel. This may be completed with suitable access to public transport and infrastructure to support active travel, such as segregated walking routes and cycleways.

9.37 Where possible, it is expected that development allocation should not rely on access to a private car and support travel choice. This would complement the aspiration to reduce emissions, and benefit accessibility for the most sensitive socio-economic population groups that may be reliant on alternative transport.

Further Modelling

9.38 It is advised that further quantification using a suitable model may be undertaken at a later stage in the development of the Emerging Draft Local Plan if the predicted traffic flows differ significantly from any of the scenarios presented in this report. The appropriate method may include screening or detailed modelling, or a quantification of emissions in terms of local pollutants or CO_2.

Further Monitoring

9.39 Due to the area surrounding the A59 Kingsway tunnel having a likely risk of annual mean NO_2 objective exceedance and also the location of the highest predicted PM_{10} and $PM_{2.5}$ concentrations, it is recommended that monitoring of all pollutants be undertaken at, or as near to this location as possible. This will ensure that there is no exposure of sensitive receptors to poor air quality above the objectives. This monitoring will provide an understanding of the absolute concentrations at this location and may validate the model concentrations. It is, however, recognised that monitoring of particulate matter in this specific location may not be feasible due to practical siting constraints associated with providing power and safe access to monitoring instruments.

9.40 An assessed existing sensitive receptor at the Queensway tunnel portal was predicted to exceed the annual mean objective in the Base 2018 scenario. This location is not however predicted to exceed in the future assessed scenarios, is not considered to be a risk of exceedance of objectives and has negligible impact predicted from the Preferred Option development allocations. Should WMBC's monitoring network be reviewed, it is recommended that this location be included in the NO_2 monitoring for the Borough. This will provide an understanding of the absolute concentrations at this location.

9.41 A section of A41 New Chester Road between Bridle Road and Eastham Village Road in Eastham has been identified as an area within the base road network which has a possible risk of annual mean NO_2 objective exceedance in the future assessed scenarios as there are nearby sensitive receptors. NO_2 monitoring may therefore be useful to understand absolute concentrations at this location, however it is not likely to be an area of concern with regard to Preferred Option development allocations and the core purposes of this study.

10. Draft Plan Discussion

10.1 One of the simpler ways to potentially develop air quality specific policy within a Local Plan is to reference examples of existing Local Plans from other Local Authorities, many of which directly reference air quality.

10.2 This section first looks at three other Local Authority approaches to incorporating air quality within Local Plans, then discusses this regarding the outcomes from this Project. Finally, two advisable options are presented; one which creates a standalone air quality policy, and another which enhances the present policy content.

Local Authority Policy Examples

10.3 Some examples are summarised here to provide context to the potential options available to WMBC. Whilst the scale of air quality issues is different in different locations, and therefore air quality is given varied weighting, this does provide a reference point for WMBC.

Winchester City Council

10.4 Winchester City Council's (WCC) Local Plan[54] references air quality through multiple policies such as Policy WT1 - Development Strategy for Winchester Town, stating the spatial planning vision for Winchester Town will be achieved through:

> *"implementation of the Winchester Access Plan and the Winchester Air Quality Action Plan (AQAP) to ensure that transport provision and access to and within the Town provides opportunities for sustainable transport provision and reduces pollution and carbon emissions".*

10.5 Referencing an AQAP is a clear way to set the air quality agenda in the Plan, as the AQAP can clearly be much more prescriptive with regard to specific policies. WCC's AQAP also states the intention to produce an Air Quality Supplementary Planning Document (SPD) that is integrated into the planning process. An SPD provides developers with clear advice on how to assess air quality as part of their proposals when applying to the planning authority and would ensure that air quality is appropriately considered proportionally to the scale of each development proposal. This example may be more commensurate with an area with poorer air quality than Wirral but could be enacted depending on WMBC's ambition with respect to air quality. The central policy governing air quality is tied with various other pollution types, as follows:

Policy DM19 – Development and Pollution

Development which generates pollution or is sensitive to it, and accords with the Development Plan, will only be permitted where it achieves an acceptable standard of environmental quality. As a minimum, development should not result in unacceptable impacts on health or quality of life.

Proposals should comply with all national statutory standards relating to environmental quality and include a statement setting out how such requirements have been met, where relevant, in designing the proposal.

The potential for unacceptable pollution, resulting in adverse health or quality of life impacts, should be addressed by applications. Where there is potential for adverse impacts to occur on the following matters a detailed assessment should be conducted:

i. odour;
ii. light intrusion;
iii. ambient air quality;
iv. water pollution;
v. contaminated land; and
vi. construction phase pollution impacts for large or prolonged developments.

The report should identify and detail any mitigation measures that are necessary to make the development acceptable in respect of the adverse impacts on health and quality of life. The Local Planning Authority may require specific mitigation measures to be undertaken in order to make developments acceptable in terms of matters relating to pollution.

[54] Winchester City Council (2018) Local Plan (Part 1). Available at: https://www.winchester.gov.uk/planning-policy/local-plan-part-1/adoption/

10.6 This policy sets an agenda to ensure air quality is appropriately considered as part of individual applications. Incorporating other types of pollution with the policy gives it added relevance within the Plan and does not give air quality un-warranted precedence over other pollutants. This is comparable to WMBC Emerging Draft Plan Policy WD14 Pollution and Risk.

Salford City Council

10.7 Salford's current Draft Plan[55] affords a full chapter to air quality and contains multiple other references through policies relating to climate change (CC1), health (HH1) and transport (A5). Having a stand-alone air quality chapter clearly gives much greater weight to the issue within the context of the Plan and allows the wider context to be presented to the reader. Whilst this may not be appropriate for WMBC given the lesser scale of the air quality issues, it shows the relative credence given as compared to other Local Plans in locations where air quality is more of a concern. For example, in context of WMBC and the assessment undertaken within this Report, should the recommended monitoring at the Kingsway Tunnel portal result in WMBC deciding to put a greater weight to air quality in this area, a standalone policy may in that instance, be beneficial.

10.8 The main policy specific to air quality is AQ1, which states:

Policy AQ1 Air quality
A substantial improvement will be sought in Salford's air quality, and particularly in air quality management areas, including by:
1) Reducing emissions from road vehicles through a wide range of measures such as: A) Minimising the need to travel and maximising the ability to do so by walking, cycling and public transport, B) Promoting the use of low and zero emission vehicles, C) Investigating the potential for Clean Air Zones;
2) Supporting the electrification of rail lines through the city to reduce diesel emissions;
3) Carefully controlling industrial uses and energy generation schemes that could increase the emission of air pollutants;
4) Enhancing the green infrastructure network to assist in the absorption of air pollutants;
5) Designing the built environment to minimise the potential for air pollution to become trapped close to the ground;
6) Requiring development to minimise and mitigate pollution as far as practicable, both during the construction and operational phases of development; and
7) Locating sensitive uses away from areas of high air pollution, and, where this is not possible, incorporating mechanical ventilation as appropriate.

10.9 Clear reference to AQMAs gives a spatial variation to the level of air quality provision likely to be imposed on developers, and targets potentially more stringent assessment and mitigation at areas which are most likely to be in need of them.

10.10 This Policy also ties in multiple other elements such as renewable transport and green infrastructure within the context of the air quality policy. This is something WMBC could also do to create stronger and more specific ties between air quality and other policies and measures, and link with the LCRCA Air Quality Action Plan.

[55] Salford City Council (2019) Revised Draft Local Plan. Available at: https://www.salford.gov.uk/media/393434/revised-draft-local-plan-final.pdf

St Helens Council

10.11 St Helen's Draft Local Plan[56] again contains a standalone air quality policy, Policy LPD09, and is mentioned in several other supporting policies related to transport (LPA07), green infrastructure (LPA09) and health (LPA11).

Policy LPD09: Air Quality
1. Development proposals must demonstrate that they will not: a) impede the achievement of any objective(s) or measure(s) set out in an Air Quality Management Area (AQMA) Action Plan; or b) introduce a significant new source of any air pollutant, or new development whose users or occupiers would be particularly susceptible to air pollution, within an AQMA; or c) lead to a significant deterioration in local air quality resulting in unacceptable effects on human health, local amenity or the natural environment, that would require a new AQMA to be created; or d) having regard to established local and national standards, lead to an unacceptable decline in air quality in any area.
2. Major development schemes should demonstrably promote a shift to the use of sustainable modes of transport to minimise the impact of vehicle emissions on air quality.
3. New development that would result in increased traffic flows on the M62 past Manchester Mosses Special Area of Conservation (SAC) of more than 1000 vehicles per day or 200 Heavy Goods Vehicles (HGVs) per day must be accompanied by evidence identifying whether the resultant impacts on air quality would cause a significant effect on ecological interests within the SAC. Where such effects are identified they would need to be considered in accordance with Policy LPC06.

10.12 This is perhaps the most comprehensive of the provided examples, and also incorporates ecological considerations as well as the more conventional references to AQMAs and AQAPs, which may be relevant to WMBC, and in particular the ecology protection referenced in Policy WS5 Strategy for Green and Blue Infrastructure, Biodiversity and Open Space.

10.13 These examples are by no means a comprehensive list but do provide a reference against which specific policies could be developed if required, and should WMBC wish to continue to strive to reduce air pollution, even if air quality objectives are not currently being exceeded, as per the aspirations of the Government's UK Clean Air Strategy, cited in Paragraph 2.24.

WMBC Local Plan Policy Opportunities

Standalone Policy

10.14 In terms of a standalone Policy, this would perhaps sit best within a Chapter which focusses on wider environmental issues. Whilst it is apparent that air quality is mostly improving in Wirral, with a select few locations where improvement has not been a recent trend, a standalone Policy helps to ensure that continual improvements in air quality are made.

10.15 With accompanying text which could easily be drafted by WMBC's planning team or Environmental Health Officer, a Policy similar to that included by St Helens could be incorporated in the Plan, as follows:

Policy XX: Air Quality
1. Development proposals must demonstrate that they will not: a) impede the achievement of any air quality objective(s), particularly in locations currently or historically declared as Air Quality Management Areas (AQMAs); b) introduce a significant new source of any air pollutant, or a new development whose users or occupiers would be exposed to concentrations in excess of air quality objectives; c) lead to a significant impact on, and deterioration of, local air quality resulting in unacceptable effects on human health, local amenity or the natural environment;
2. Major development schemes should demonstrably promote a shift to the use of sustainable modes of transport and energy generation to minimise the impact of increased emissions on air quality.
3. New development should demonstrate that no unacceptable effects would result in increased traffic flows on roads adjacent or within any of the Council's 10 Sites of Special Scientific Interest (SSSI) or 6 Local Nature Reserves (LNR).

[56] St Helens Borough Council (2019) St Helens Borough Local Plan 2020 – 2035, A Balanced Plan for A Better Future. Available at: https://www.sthelens.gov.uk/media/9525/local-plan-written-plan-web.pdf

10.16 Specific reference may be made to mitigation, such as mechanical ventilation or green infrastructure, within the Policy as appropriate, but it is considered unlikely to be required at this stage given there are no exceedances of objectives within WMBC. Item 1 of the above example Policy covers this to a certain extent, as significant impacts would have to be mitigated by the developer in order to satisfy the Policy, but WMBC could simply enhance the Policy with those additions.

10.17 The above example Policy could be enhanced still further by defining how the developers may demonstrate their impacts through a Supplementary Planning Document (SPD), at WMBC's discretion, allowing more detail to prescribe air quality assessment method and focus for development proposals.

Enhancing Present Content

10.18 Making enhancements to existing policies and text to more frequently and comprehensively reference air quality within the Emerging Draft Local Plan, either without the need for a standalone Policy or to supplement the specific air quality Policy, is an option at the discretion of WMBC. Possible additions are:

- Policy WS 7 Design Principles could be expanded to include reference for air pollution pathways to be considered within development design.
- Within Policy WD 14 Pollution and Risk, the addition of reference to an SPD would be well placed following reference to the designation of an AQMA to allow for further detail to prescribe to developers, at the discretion of WMBC.
- Additions could be made to Strategic Objective 3 to include reference to better air quality in line with active travel encouragement.
- Specific reference within WS1 The Development Strategy could be made to air quality to be mindful of separation distances and pollution pathways to air quality emission sources, in a similar way as included for items such as flooding; this could also detail avoidance of existing areas of air quality concern, at the discretion of WMBC.
- A specific link to air quality could be identified within Policy WS 5 Strategy for Green and Blue Infrastructure, Biodiversity and Open Space with a note to consideration of separation distances between emission sources and sensitive receptors and pollution pathways and effective use of green and blue infrastructure to support this. This Policy can also be enhanced to include reference to air quality and nutrient nitrogen and acid deposition requiring the assessment of impact of the development proposals on nutrient nitrogen and acid deposition on designated sites (where the designated feature is sensitive to this).
- It would be relatively straightforward to incorporate air quality into Policy WS8 Strategy for Renewable and Low Carbon Energy, as improvements made as a result of this Policy will also be beneficial to air quality. Addition to the note of support to renewable and low carbon energy schemes can be made with reference to also addressing any adverse impacts on the environment, with a list of applicable environment factors, to include air quality at the discretion of WMBC. This policy may also benefit from greater clarification on the types of energy generation acceptable for development, for example specifying if biomass installations are to be discouraged in urban areas (due to emissions of particulates), the specification of low NO_X boilers (<40 mg/kWh) where conventional heating types are employed, and other similar considerations.
- Policy WS 9 Strategy for Transport could directly reference the beneficial linkage of this Policy to air quality and it could also go further and reference the need for air quality assessment of major developments in the same instance where a Transport Statement and/or Travel Plan is stated to be required.
- Policy WS11 Town Centres Strategy may be well placed to reference amenity and air quality within the impact assessment requirement.

10.19 The following additional items, which are common to air quality policies and guidance could be considered for addition at the discretion of the Council, within suitable policies / explanatory text:

- Within the Construction Phase - Emissions Mitigation and Assessment from construction stage required;

- Electric Vehicle Charging Infrastructure - details of charging points and plugs specifications for both exterior and garage situations at a specified ratio;
- Heating and Hot Water Generating Appliances e.g. All gas-fired boilers to meet a minimum standard of 40mgNOx/kWh and/or consideration of alternative heat sources; and,
- Damage cost calculation is required as part of an air quality assessment, and mitigation offset to an equivalent value.

Discussion

10.20 Making the inherent connection between the Policy set out to address key objectives, such as sustainable travel and reducing carbon emissions, and air quality is a way to ensure it is considered alongside those initiatives intended to also play an important role in reducing air pollution issues.

10.21 Given that there is currently both national and local policy demanding a call to action on air quality and its negative health impacts, and new legislation which will seek to shift the focus towards continual improvements and prevention of exceedances rather than tackling pollution only when limits have been surpassed, there are a number of ways in which the air quality stance can be improved in the Emerging Draft Local Plan. Local authorities such as WMBC will need comply with the Defra Clean Air Strategy which will mean continuing to strive to reduce air pollution, even if air quality objectives are not currently being exceeded, which should be a key aspiration of the Emerging Draft Local Plan.

10.22 Encouraging active travel resonates through national and regional policy which in turn has the potential to impact on the air quality position; the measures within the Emerging Draft Local Plan policies support this. Several policies in this area within the Emerging Draft Local Plan may assist in minimising air quality impact.

10.23 Fuel technology projections are an intrinsic part of planning for the adoption and management of new transport technology, where planning must recognise opportunities to promote and enable those technologies with beneficial effects and discourage risks. For example, diesel fuel was promoted by central Government due to the CO_2 savings, but relatively recent understanding of the increased local air quality effects led to a re-evaluation of this approach. Industry expectations are for the overall trend to shift towards a broadly 30% split for each of the major fuel-types in 2030[57]. WMBC should ensure it has a good understanding of emerging technologies and market adoption and ensure that appropriate policy and infrastructure is established to support this.

10.24 Policy which may reduce air quality emissions have largely been grouped around reducing transport emissions, due to transport emissions being noted as one of the largest contributors to poor air quality. This is true in that transport emissions do make up a large proportion to NO_X emissions, however almost double quantities of road emissions of NO_X emissions come from point and industrial sources. This may also not be as true for PM, with a relatively smaller proportion of PM_{10} and $PM_{2.5}$ emissions coming from transport sources. Given this, and the larger mortality rates associated with $PM_{2.5}$ pollution, this may introduce an opportunity for policy enhancement to target emission sources other than transport, as Salford's policy AQ1 does, for example. This would support the Wirral JSNA aim to reduce health impacts and number of deaths associated with poor air quality and would prepare WMBC for any future more stringent targets for $PM_{2.5}$. Background levels of $PM_{2.5}$ are currently above the level of the objective set by the World Health Organisation in Liscard in particular.

10.25 Whilst there are a number of policies where air quality has the potential to be affected, there is currently no specific and standalone air quality policy. There is a Policy specifically dedicated to Pollution, which, given the current status of air quality in Wirral, is considered an appropriate approach. Should a standalone policy be adopted, this could contain a multitude of guidelines for developers and residents alike, and there are numerous examples from other Council's Local Plans which could be used as a reference, in addition to those in identified earlier in this Section. This would support, and help to strengthen, the stated intention to not only maintain, but improve air quality in the Borough.

10.26 Many Local Authorities have prepared SPDs which provide guidance for developers and applicants detailing how they can tailor their developments to minimise their impact on local air quality. The

[57] Defra (2017) Emission Factor Toolkit version 8.0.1

introduction of a specific policy would allow WMBC to frame the SPD on that, providing a clear framework to applicants as to what will be acceptable on air quality grounds, or, in the case of the existing Pollution overview focussed Policy, this could be still be referenced. An SPD would allow WMBC to direct developers to use set criteria to determine the development impact significance on air quality; this would inform the decision-making process and whether proposals would have an ‘unacceptable contribution’ to air quality as defined by WMBC. This approach would also vastly assist with communication with applicants where sites may have an impact near the Kingsway tunnel in particular. Striving for the lowest practicable pollutant concentrations at this location will ensure the priority of air pollution within public health, supporting recommendations made by the Wirral JSNA. It is additionally suggested there may be an opportunity to align the Actions identified by the LCRCA with the implementation of the Emerging Draft Local Plan.

10.27 Enhancements of policies and text to more frequently and comprehensively reference air quality within the Emerging Draft Local Plan is additionally an advisable option, as presented above. There is an opportunity to tie air quality in with key linkages, in a similar way to SCC’s current Draft Plan through climate change, health and transport. The aim for reduction of carbon emissions is well addressed within the Emerging Draft Local Plan, with a specific Policy dedicated to addressing the issues associated with it. As stated above, many of the policies identified as beneficial for this are also beneficial to local air quality, but that is not always guaranteed to be the case (for example, the historic prioritisation of diesel cars for reasons of carbon efficiencies lead to a greater prevalence of diesel vehicles within the vehicle fleet, which is detrimental to local air quality) so caution should be exercised if associating and packaging climate and local air quality policies together in a ‘one size fits all’ approach.

11. Conclusions

11.1 WMBC has not declared any AQMAs in the Borough. The NO_2 annual mean objective of 40 µg/m^3 was not exceeded at any of the 33 monitoring locations in 2018, with the exception of W18 kerbside diffusion tube, noted within the 2019 ASR to be located near to a taxi rank in Liscard, and not representing exposure. No exceedances were reported at any monitoring location in 2019. No exceedances of annual mean $PM_{2.5}$ concentrations were historically measured by the Wirral Tranmere continuous monitor. Monitoring data shows a steady decline in the majority of recorded concentrations since 2016, with the exception of a select few locations across WMBC's monitoring network that have an increasing trend between years; these are adjacent to the A552 and in Liscard.

11.2 The screening identified a number of locations with a risk of exceedance of the annual mean NO_2 objective. The majority of locations identified from the screening model as being considered necessary to include in the dispersion modelling roughly aligned with the six areas of concern identified by WMBC, along with two additional areas at the junction of Poulton Bridge Road with Dock Road, a section of A552 Borough Road, nearby the junction with Whetstone Lane, consequently included in the dispersion modelling. Dispersion modelling of these locations aimed to include consideration of any complexities of road emission dispersion.

11.3 The screening model results also indicated a risk of exceedance of the more stringent World Health Organisation $PM_{2.5}$ objective at various locations across the Borough, including; the A59 Kingsway, A5139 Dock Road, Liscard, M53 motorway and junctions, central Birkenhead, Moreton, Woodchurch, the A552, and the A41 New Chester Road, although this is noted in the most part due to a high background concentration mentioned above.

11.4 As the screening model is designed to predict roadside concentrations on road links in strategic models, rather than discrete junction hot-spots or at tunnel portals, the screening results identified the high level locations of the highest concentrations predicted in the dispersion modelling, however in areas where complex emissions exist such as A59 Kingsway, and in areas of congestion such as Birkenhead centre, the screening model results did not show the extent of the predicted concentrations that the dispersion modelling results displayed. Any further work to look at absolute concentrations to advise Emerging Draft Local Plan allocation decisions is therefore recommended to include dispersion modelling.

11.5 Dispersion modelling results indicated that there were no exceedances of the relevant England and Wales national air quality objectives predicted for all pollutants considered at any Preferred Option development allocation receptors in 2037 and exceedances are considered very unlikely.

11.6 The dispersion model results also demonstrate that annual mean NO_2 concentrations are predicted to be below the relevant England and Wales national air quality objective in the Preferred Option scenario at the majority of assessed existing receptors. There are however four locations in the Preferred Option scenario nearby the Kingsway tunnel portal where existing residential receptors are predicted to experience concentrations above the annual mean limit value of 40 µg/m^3. Due to the A59 Kingsway experiencing traffic changes as a result of the Preferred Option development allocations in 2037, a 'slight to moderate adverse' impact is predicted for annual mean NO_2 at these existing receptors, despite being predicted to increase by a maximum of only 0.3 µg/m^3 in this area, with reference to EPUK and IAQM guidance[58]. Impacts on all other existing receptors and pollutants are however predicted to be 'negligible'.

11.7 The maximum predicted annual mean PM_{10} and $PM_{2.5}$ concentrations also fall in this same location to the north west of the Kingsway tunnel portal. The results demonstrate that annual mean concentrations of all the pollutants considered are below the relevant England and Wales PM_{10} and $PM_{2.5}$ national air quality objectives in the Preferred Option scenario. There are however numerous locations represented by existing and development allocation receptors that were predicted above the WHO guideline of 10 µg/m^3 for annual mean $PM_{2.5}$; these locations are near to A59 Kingsway, in Liscard, and at a number of locations in Birkenhead.

[58] Moorcroft and Barrowcliffe. et al. (2017), Land-use Planning & Development Control: Planning for Air Quality. v1.2. Institute of Air Quality Management, London.

11.8 There is however, no ‘safe’ threshold for exposure to PM, and especially $PM_{2.5}$. Pollutant concentrations were found to be higher in areas with greater socio-economic disparity, largely due to road transport sources.

11.9 It is recommended that as a minimum, monitoring of NO_2 be undertaken at relevant exposure locations nearby the A59 Kingsway tunnel portal, to ensure that there is no exposure of sensitive receptors to poor air quality above the objectives. This monitoring location would ideally include monitoring of $PM_{2.5}$ however it is recognised that monitoring of particulate matter in this specific location may not be feasible due to practical siting constraints associated with providing power and safe access to monitoring instruments. This monitoring is suggested because of the risk of exceedances of the annual mean NO_2 objective, and to understand the maximum absolute concentrations of annual mean $PM_{2.5}$ within the Wirral administrative area. The impact of the Preferred Option development allocations is predicted to have an impact on air quality in this area, therefore this can additionally be a focus area of developer planning applications to demonstrate the level of air quality impact, and air quality monitoring at this location will assist in this process. This monitoring may also be used to validate the model concentrations.

11.10 An assessed existing sensitive receptor at the Queensway tunnel portal was predicted by the dispersion modelling to exceed the annual mean objective in the Base 2018 scenario. This location is not however predicted to exceed in the future assessed scenarios, is not considered to be a risk of exceedance of objectives and has negligible impact predicted from the Preferred Option development allocations. Additionally, a section of A41 New Chester Road between Bridle Road and Eastham Village Road in Eastham has been identified in the screening as an area which has a possible risk of annual mean NO_2 objective exceedance in the future assessed scenarios as there are nearby sensitive receptors, however it is not likely to be an area of concern with regard to Preferred Option development allocations and the core purposes of this study. Should WMBC’s monitoring network be reviewed, it is therefore recommended that this location be included in the NO_2 monitoring for the Borough. This will provide an understanding of the absolute concentrations at these locations.

11.11 No AQMA has been declared within WMBC as air quality is deemed to be consistently below air quality objectives at relevant exposure locations, and this study has not indicated that the Preferred Option development allocations would lead to a declaration. The expanded monitoring network will also provide further reassurance of the predicted air quality conditions.

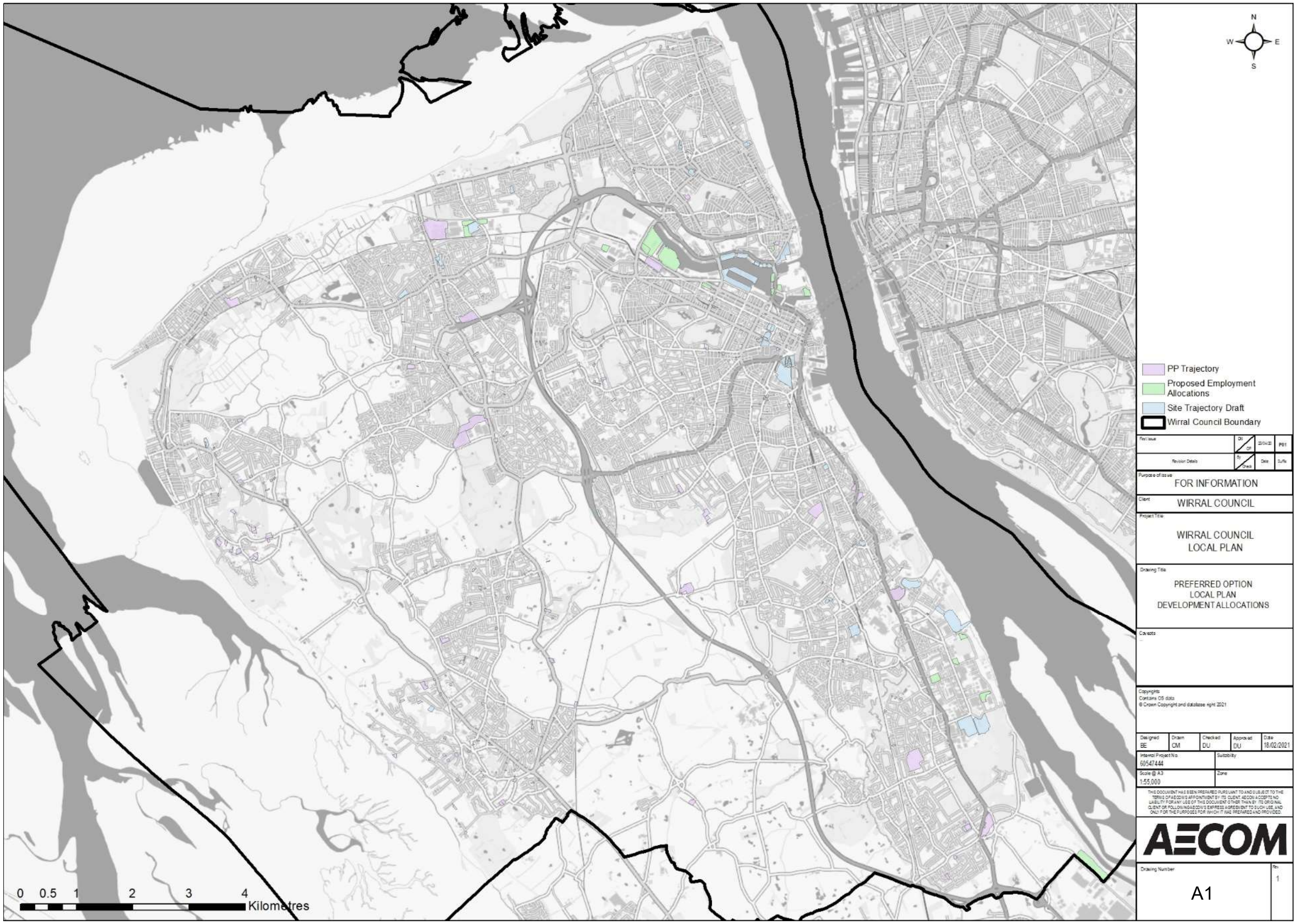
11.12 Background pollutant concentrations represent a significant proportion of the total predicted concentrations, especially for PM, however dispersion modelling has shown that there is scope to improve air quality at the location of maximum predicted concentrations, at the Kingsway tunnel portal, if for emissions from roads are targeted for mitigation. Opportunities for mitigation should be considerate of locations near the A59 Kingsway tunnel in particular, and options which favour lower concentrations at this location should be preferred. Striving for the lowest practicable pollutant concentrations at this location will ensure the priority of air pollution within public health, supporting recommendations made by the Wirral JSNA.

11.13 Strategic support for mitigation controls is also published and coordinated by Merseytravel on behalf of the LCRCA complement the Emerging Draft Local Plan and ensure consistency with surrounding districts. Specifically, a framework for supporting the adoption of Green Infrastructure, and using speed management to incentivise the uptake of active and public travel options for short, local journeys. Therefore, it is suggested there may be an opportunity to align the Actions identified by the LCRCA with the implementation of the Emerging Draft Local Plan.

11.14 The Local Plan represents the core planning and development framework for the Borough for the next 15-years, and so represents an opportunity to continue to strive to reduce air pollution, even if air quality objectives are not currently being exceeded, in line with the Clean Air Strategy.

11.15 Following a review of the Emerging Draft Plan, there are a number of Policies which refer directly to air quality, and others such as encouraging active travel, carbon emissions reduction and development design principles, that are identified as beneficial and are also beneficial to local air quality, but that is not always guaranteed to be the case. Focus is largely on reducing of emissions from transport, although there is evidence that targeting industrial and point source emissions reduction would also be beneficial not only to lowering all pollutant concentrations, but also with note to finer particulate matter fractions being particularly harmful to human health. Policy WD 14 Pollution and Risk is specifically dedicated to pollution with statements around air quality; given the current status of air quality in Wirral, this is considered an appropriate approach. The use of SPD or technical advice notes can however provide guidance for developers and applicants detailing how they can tailor their developments to minimise their impact on local air quality. A clear framework can be provided through these means to applicants as to what will be acceptable in terms of air quality. It would allow WMBC to direct developers to use set criteria to determine the development impact significance on air quality, inform the decision making process and whether proposals would have an ‘unacceptable contribution’ to air quality, and also cumulative air quality impacts, on key areas identified in this study. Enhancements of policies and text to more frequently and comprehensively reference air quality within the Emerging Draft Local Plan is additionally an advisable option, with suggestions provided in Section 10.

Appendix A Local Plan Preferred Option Allocations


N
W
E
S
PP Trajectory
Proposed Employment Allocations
Site Trajectory Draft
Wirral Council Boundary
Purpose of issue
FOR INFORMATION
Client
WIRRAL COUNCIL
Project Title
WIRRAL COUNCIL LOCAL PLAN
Drawing Title
PREFERRED OPTION LOCAL PLAN DEVELOPMENT ALLOCATIONS
Caveats
Copyrights
Contains OS data
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Designed BE
Drawn CM
Checked DU
Approved DU
Date 18/02/2021
Internal Project No. 60547444
Suitability
Scale @ A3 1:55,000
Zone
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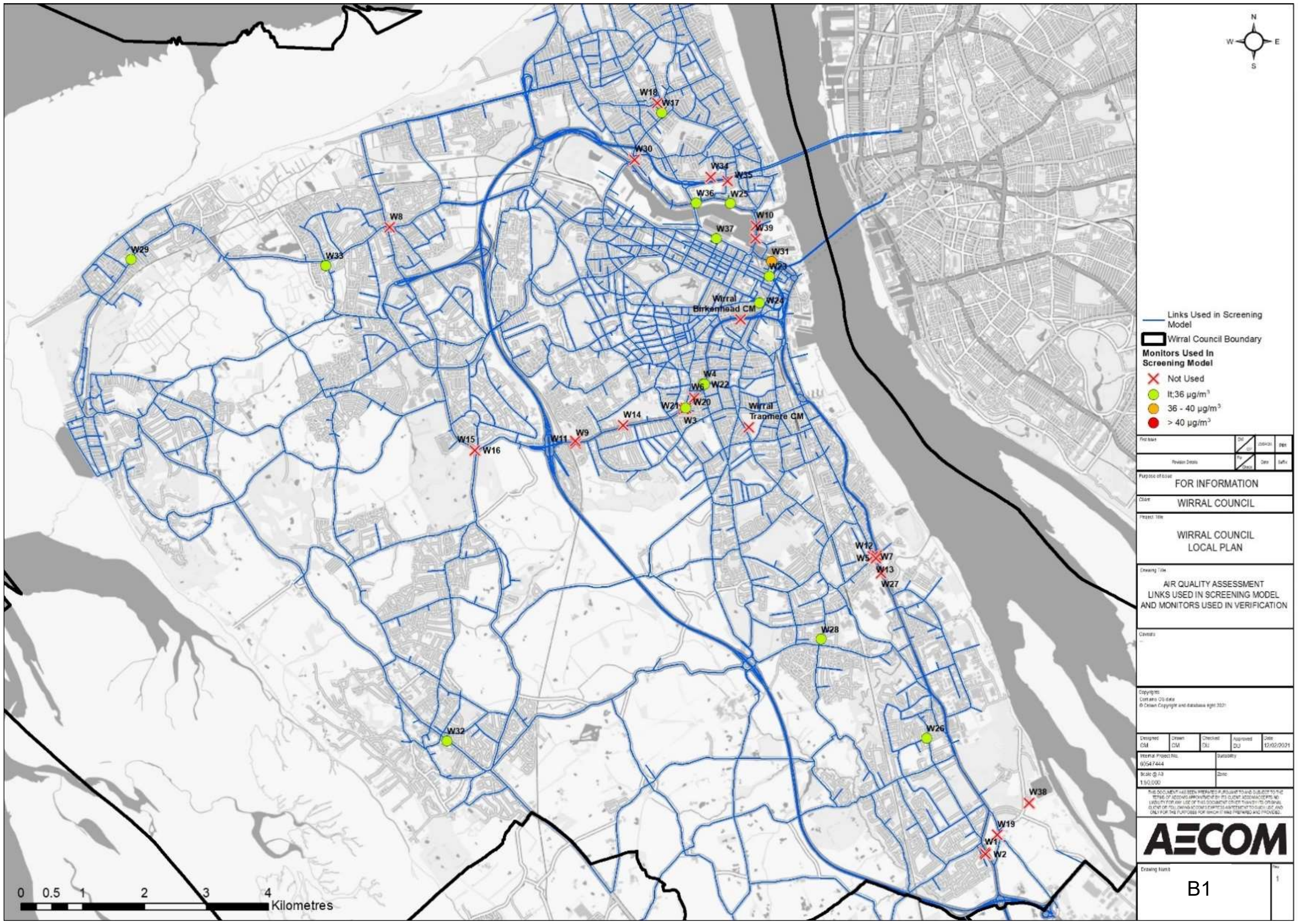
Drawing Number
A1
Rev
1
0 0.5 1 2 3 4
Kilometres

Appendix B Model Technicalities

B1 - Screening Model Road Links and Monitors in Verification



B2 - Screening Model Verification

The table below demonstrates that the unadjusted model under-predicted annual mean concentrations of NO_2 at all 15 locations. To account for this bias, the factor of the difference between the modelled and measured road NOX contributions (2.07) was used to adjust the model output at all receptors, for the base year and the future do-minimum and Preferred Option scenarios.

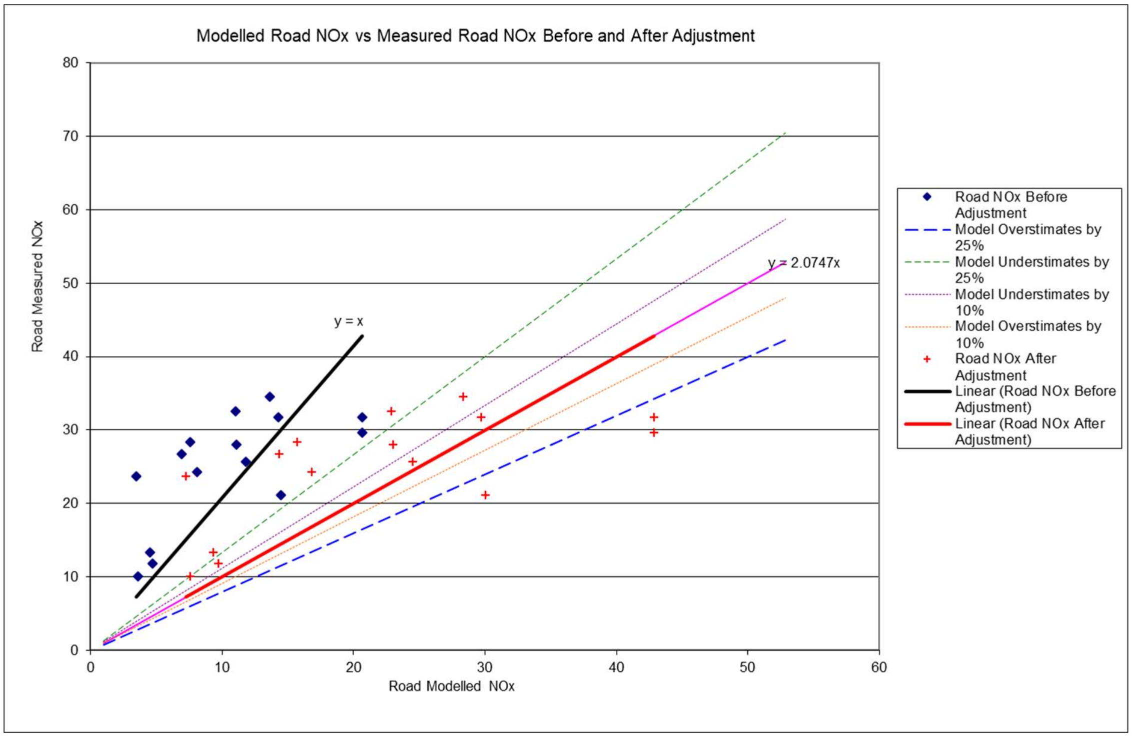
The accuracy of the adjusted model was considered using the Route Mean Square Error (RMSE) statistic. LAQM.TG16 [7] states in Paragraph 7.542 that:

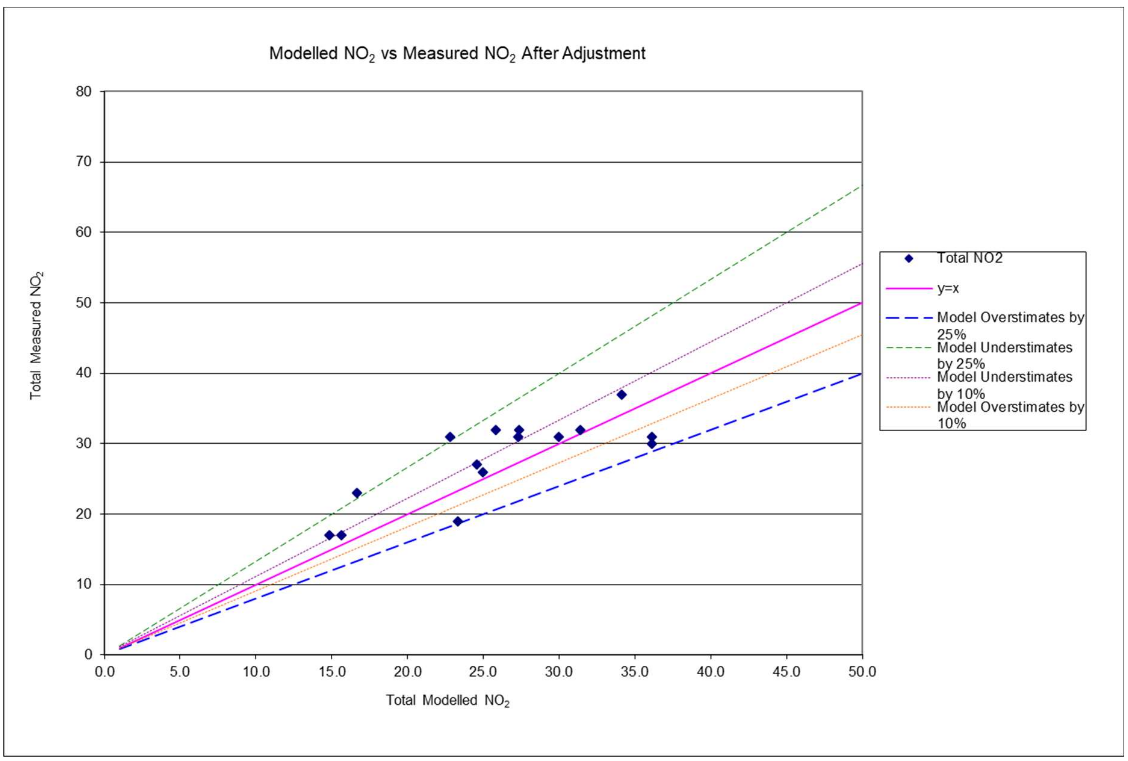
> *"If the RMSE values are higher than ±25% of the objective being assessed, it is recommended that the model inputs and verification should be revisited in order to make improvements. For example, if the model predictions are for the annual mean NO2 objective of 40 µg/m^3, if an RMSE of 10 µg/m3 or above is determined for a model, the local authority would be 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 4 µg/m^3 for the annual average NO_2 objective."*

The RMSE value for the adjusted model was 4.4 µg/m^3, which is 11% of the annual average NO_2 objective, which is within acceptable limits, and for a screening model should be considered to be very good. The statistical graphs below present of modelled versus measured road contribution NO_2 and total measured versus modelled total NO_2; these show that following adjustment, data better fits within 25% confidence intervals.

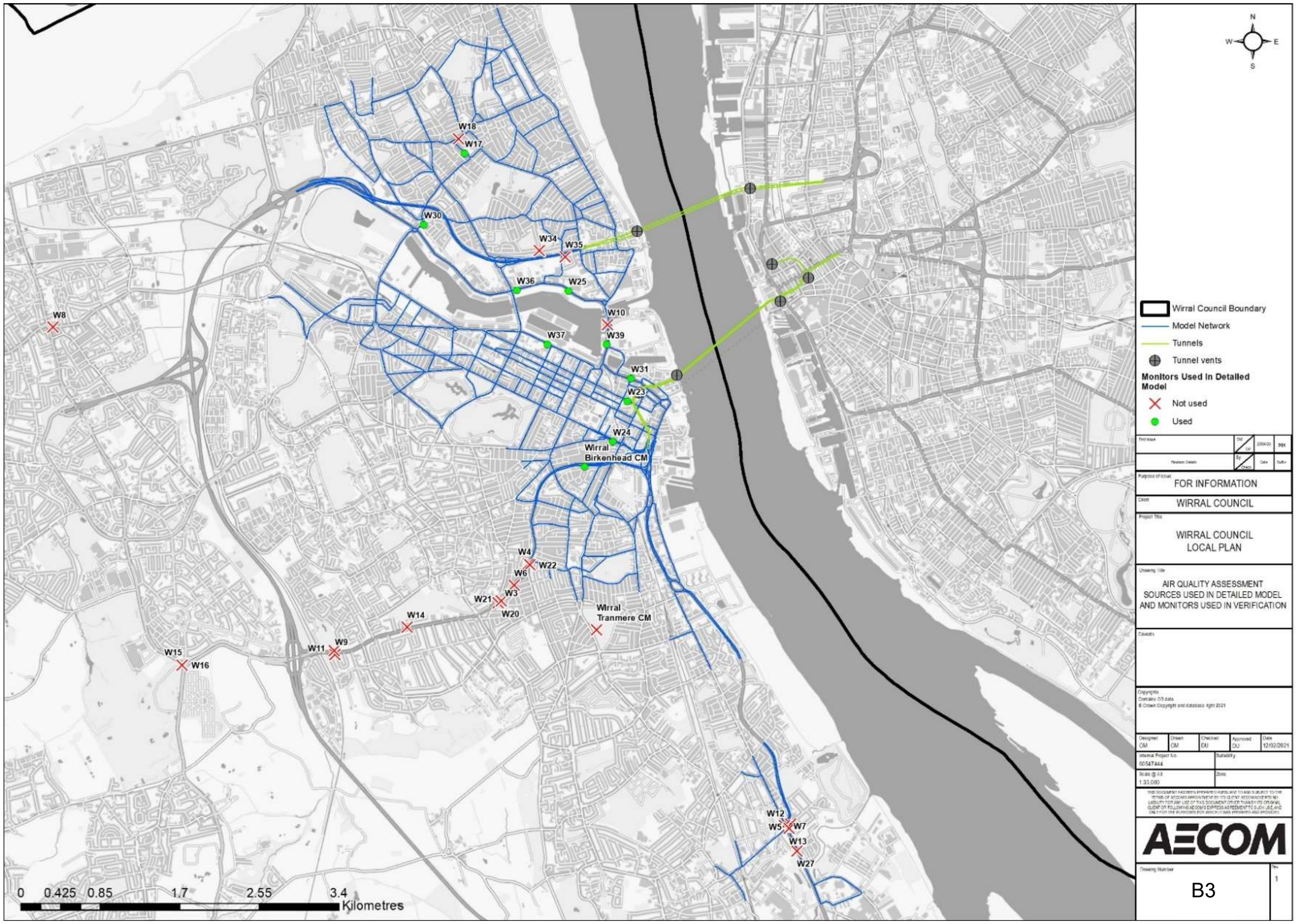
Comparison of Measured and Modelled Concentrations used in NO_2 Verification of Screening Model

Site ID	Measured Total NO_2 (µg/m^3)	Measured Road NO_X (µg/m^3)	Modelled Road NO_X (µg/m^3)	Ratio of measured / modelled road NO_x	Adjusted modelled road NOx (µg/m^3)	Adjusted Modelled Total NO_2 (µg/m3)	% Total NO_2 difference (adjusted modelled / measured total NO_2)
W4	30.0	29.7	20.6	1.4	42.8	36.1	20.4%
W17	32.0	32.6	11.0	2.9	22.9	27.3	-14.5%
W21	31.0	31.8	14.3	2.2	29.7	30.0	-3.2%
W22	31.0	31.8	20.6	1.5	42.8	36.1	16.5%
W23	26.0	11.8	4.7	2.5	9.7	25.0	-4.0%
W24	31.0	24.3	8.1	3.0	16.8	27.3	-12.0%
W25	31.0	23.7	3.5	6.7	7.3	22.8	-26.5%
W26	17.0	10.1	3.6	2.8	7.6	15.6	-7.9%
W28	27.0	28.0	11.1	2.5	23.0	24.5	-9.1%
W29	19.0	21.2	14.5	1.5	30.1	23.3	22.8%
W31	37.0	34.5	13.7	2.5	28.3	34.1	-7.8%
W32	23.0	26.8	6.9	3.9	14.3	16.7	-27.6%
W33	17.0	13.4	4.5	3.0	9.3	14.9	-12.6%
W36	32.0	25.7	11.8	2.2	24.5	31.4	-1.8%
W37	32.0	28.3	7.6	3.7	15.7	25.8	-19.3%
				2.07	**Average Bias Adjustment Factor**		


Modelled Road NOx vs Measured Road NOx Before and After Adjustment
Road Measured NOx
Road Modelled NOx
y = x
y = 2.0747x
Road NOx Before Adjustment
Model Overstimates by 25%
Model Understimates by 25%
Model Understimates by 10%
Model Overstimates by 10%
Road NOx After Adjustment
Linear (Road NOx Before Adjustment)
Linear (Road NOx After Adjustment)


Modelled NO_2 vs Measured NO_2 After Adjustment
Total Measured NO_2
Total Modelled NO_2
Total NO2
y=x
Model Overstimates by 25%
Model Understimates by 25%
Model Understimates by 10%
Model Overstimates by 10%

B3 - Detailed Model Domain, Sources and Monitors Used in Verification



B4 - Detailed Model Sensitive Receptor Locations Modelled


N
S
W
E
Sensitive Receptors
Development
Hospital
Residential
School
Tunnel vents
Tunnels
Model Network
PP Trajectory
Proposed Employment Allocations
Site Trajectory Draft
FOR INFORMATION
WIRRAL COUNCIL
WIRRAL COUNCIL LOCAL PLAN
AIR QUALITY ASSESSMENT MODELLED ROAD AND TUNNEL SOURCES AND SENSITIVE RECEPTORS
AECOM
B4.2
0 0.15 0.3 0.6 0.9 1.2
Kilometres
R38
R37
D91
R36
R50
R51
D89
D73
D86
R35
R15
R14
R12
R13
R49
R26
R48
R52
R27
R28
R34
D88
S13
R47
S1
S20
R29
D99
D98
S15
R32
D105
D104
D115
D125
D126
D127
D124
D175
R108
R71
D176
R33
D170
D119
D123
D118
D116
D111
D113
D114
R95
R124
D120
R72
D129
D128
R104
R107
R60
R16
D130
D168
D167
R25
D131
R103
R105
R58
S18
R23
D132
R106
R22
D136
R24
R57
R56
R59
R70
R20
R19
D141
R21
R18
R17
D169
D147
D138
D146
D145
D139
D151
D143
R54
R94
D155
R53
R55
H1
D154
R93
R125
R121
R92
D177
R122


N
W
E
S
Z2_18
Z2_19
Z2_13
Z2_7
Z2_14
Z2_1
Z2_9
Z2_10
Z2_15
Z2_6
Z2_8
Z2_2
Z2_5
Z2_11
Z2_12
Z2_4
Z2_3
Z2_Development_3
Z2_Development_5
Z2_Development_2
Z2_16
Z2_17
0 0.1 0.2 0.4 0.6 0.8
Kilometres
Sensitive Receptors
Development
Hospital
Residential
School
Tunnel vents
Tunnels
Model Network
PP Trajectory
Proposed Employment Allocations
Site Trajectory Draft
First Issue
CM
CP
23/04/20
P01
Revision Details
By
Check
Date
Suffix
Purpose of Issue
FOR INFORMATION
Client
WIRRAL COUNCIL
Project Title
WIRRAL COUNCIL LOCAL PLAN
Drawing Title
AIR QUALITY ASSESSMENT MODELLED ROAD AND TUNNEL SOURCES AND SENSITIVE RECEPTORS
Caveats
Copyrights
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Designed CM
Drawn CM
Checked DU
Approved DU
Date 05/02/2021
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Suitability
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Drawing Number
B4.3
Rev
1

B5 – Detailed Model Verification

The model verification process was undertaken through comparison with WMBC 2018 monitoring data. Of the monitors with data for 2018, there were a total of 13 monitors within the northern model extent (known as Zone 1) model domain.

Of these 13 monitoring locations the following were not included in the verification procedure for the following reasons:

- W34, W35 – monitoring locations are on an unmodelled road within the study area; and
- W18 – situated next to a taxi rank in Liscard, not considered representative of conditions across the model.

W34 and W35 are the closest WMBC monitors to the Kingsway tunnel portal therefore the inability of keeping this within the model verification is not ideal, however the locations are unjustifiably too far away being over 50m and over 30m, respectively from the nearest modelled road edge, with reference to Defra guidance[53].

The table below presents the Zone 1 monitors and demonstrates that the unadjusted model under-predicted annual mean concentrations of NO_2 at all 10 remaining monitoring locations on average by 27%.

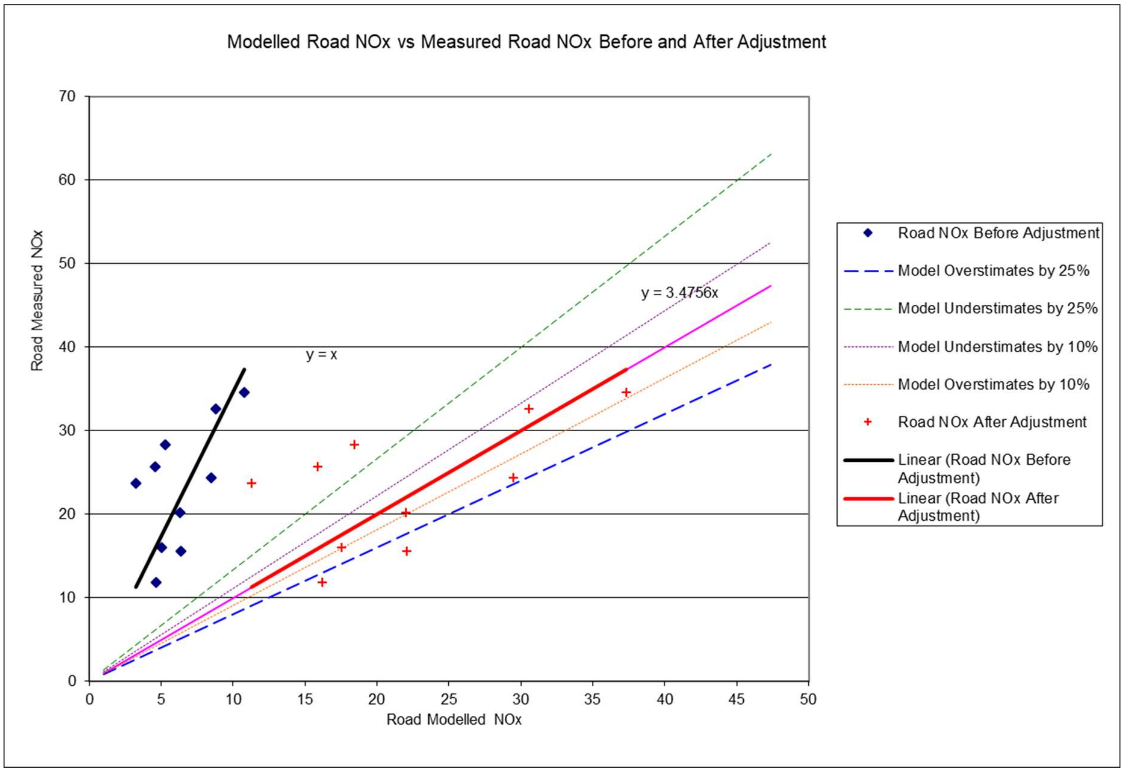
To account for this bias, the factor of the difference between the modelled and measured road NOX contributions (3.48) was used to adjust the model output at all receptors, for the base year, the future do-minimum and Preferred Option scenarios.

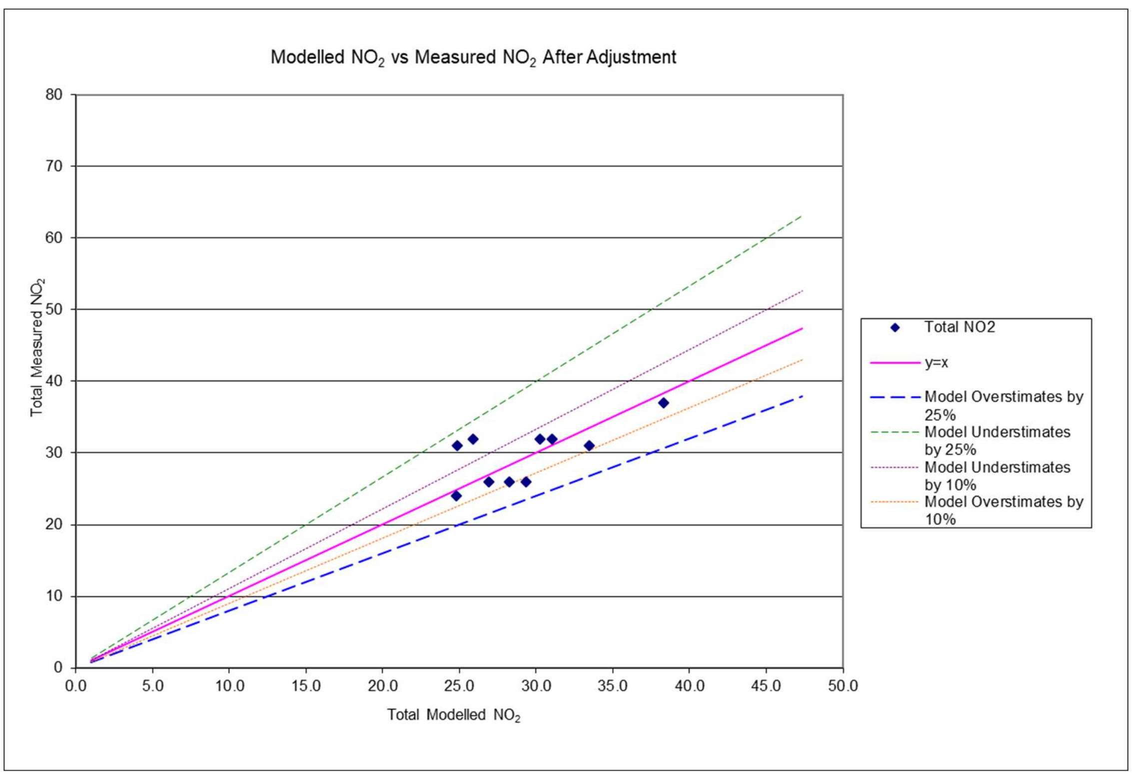
Following the application of the NO_X factor, modelled total NO_2 concentrations were on average within 1% of measured values across the study area. To quantify the accuracy of the adjusted dispersion model, the RMSE was calculated. Again referring to current Defra guidance[59], an RMSE that is within 10% (4 μg/m^3) of measured values is considered the ideal. Following adjustment, the RMSE for the Zone 1 dispersion model is 3.2 μg/m^3. The statistical graphs below present modelled versus measured road contribution NO_2 and total measured versus modelled total NO_2; these show that following adjustment, data better fits within 25% confidence intervals.

Comparison of Measured and Modelled Concentrations used in NO_2 Verification of Detailed Dispersion Modelling

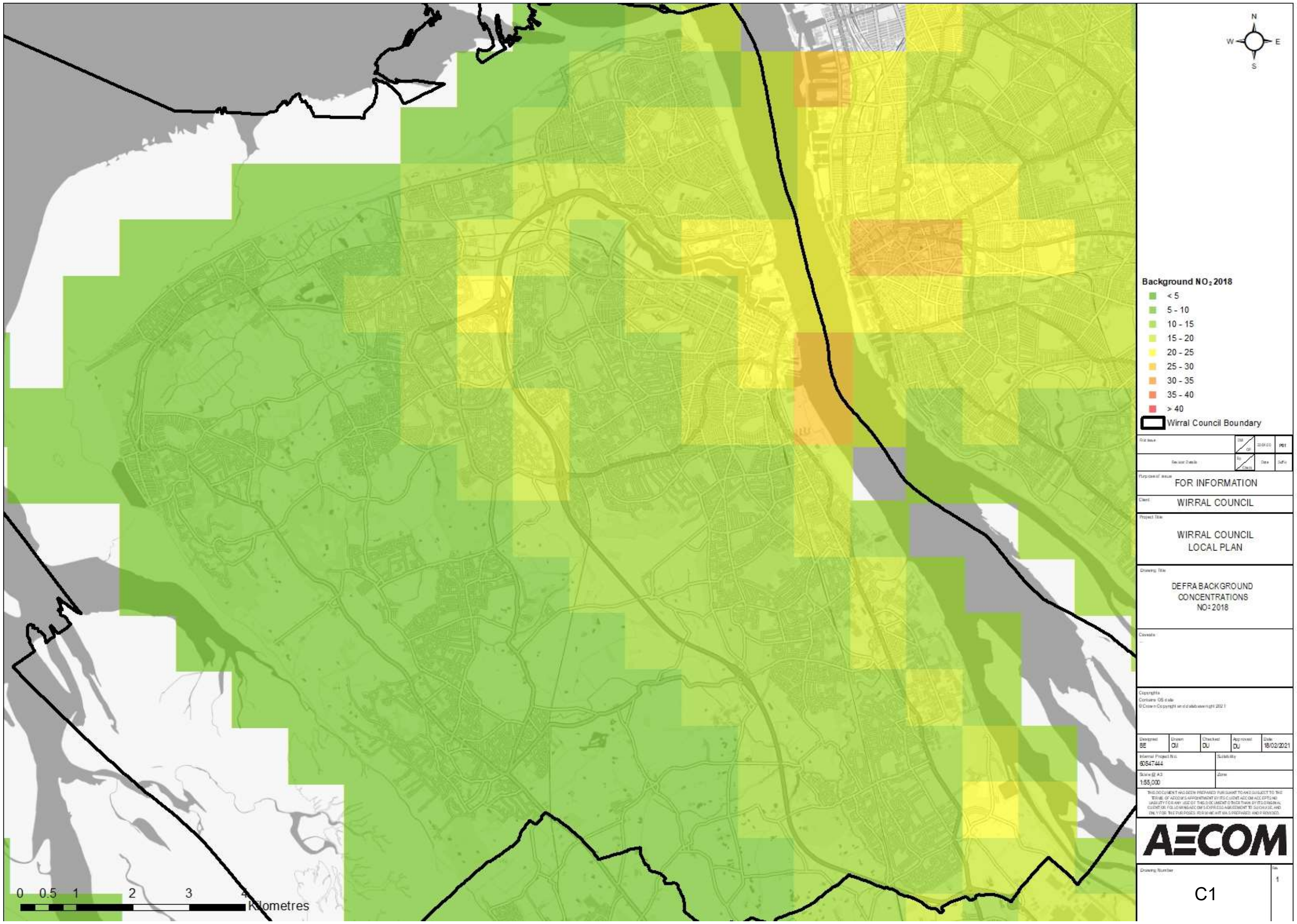
Site ID	Measured Total NO_2 (μg/m^3)	Measured Road NO_X (μg/m^3)	Modelled Road NO_X (μg/m^3)	Ratio of measured / modelled road NO_x	Adjusted modelled road NOx (μg/m^3)	Adjusted Modelled Total NO_2 (μg/m3)	% Total NO_2 difference (adjusted modelled / measured total NO_2)
Wirral Birkenhead CM	24.0	16.0	5.0	3.2	17.5	24.8	3.2
W17	32.0	32.6	8.8	3.7	30.6	31.1	-3.0%
W23	26.0	11.8	4.7	2.5	16.2	28.2	8.6%
W24	31.0	24.3	8.5	2.9	29.5	33.5	8.0%
W25	31.0	23.7	3.2	7.3	11.3	24.8	-19.9%
W30	26.0	20.2	6.3	3.2	22.0	26.9	3.5%
W31	37.0	34.5	10.7	3.2	37.3	38.3	3.5%
W36	32.0	15.5	6.3	2.4	22.0	30.2	-5.6%
W37	32.0	25.7	4.6	5.6	15.9	25.9	-19.1%
W39	26.0	28.3	5.3	5.3	18.4	29.3	12.8%
				3.48	**Average Bias Adjustment Factor**		

[59] Department for Environment, Food and Rural Affairs (2016) Local Air Quality Management Technical Guidance (TG16)


Modelled Road NOx vs Measured Road NOx Before and After Adjustment
Road Measured NOx
Road Modelled NOx
y = 3.4756x
y = x
Road NOx Before Adjustment
Model Overstimates by 25%
Model Understimates by 25%
Model Understimates by 10%
Model Overstimates by 10%
Road NOx After Adjustment
Linear (Road NOx Before Adjustment)
Linear (Road NOx After Adjustment)


Modelled NO_2 vs Measured NO_2 After Adjustment
Total Measured NO_2
Total Modelled NO_2
Total NO2
y=x
Model Overstimates by 25%
Model Understimates by 25%
Model Understimates by 10%
Model Overstimates by 10%

Appendix C Air Quality Background 2018 Plots


N
W
E
S
0 0.5 1 2 3 4
Kilometres
Background NO_2 2018
< 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40
> 40
Wirral Council Boundary
Purpose of issue
FOR INFORMATION
Client
WIRRAL COUNCIL
Project Title
WIRRAL COUNCIL
LOCAL PLAN
Drawing Title
DEFRA BACKGROUND
CONCENTRATIONS
NO_2 2018
Caveats
Copyrights
Contains OS data
© Crown Copyright and database right 2021
Designed BE
Drawn CM
Checked DU
Approved DU
Date 18/02/2021
Internal Project No. 60547444
Suitability
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Zone
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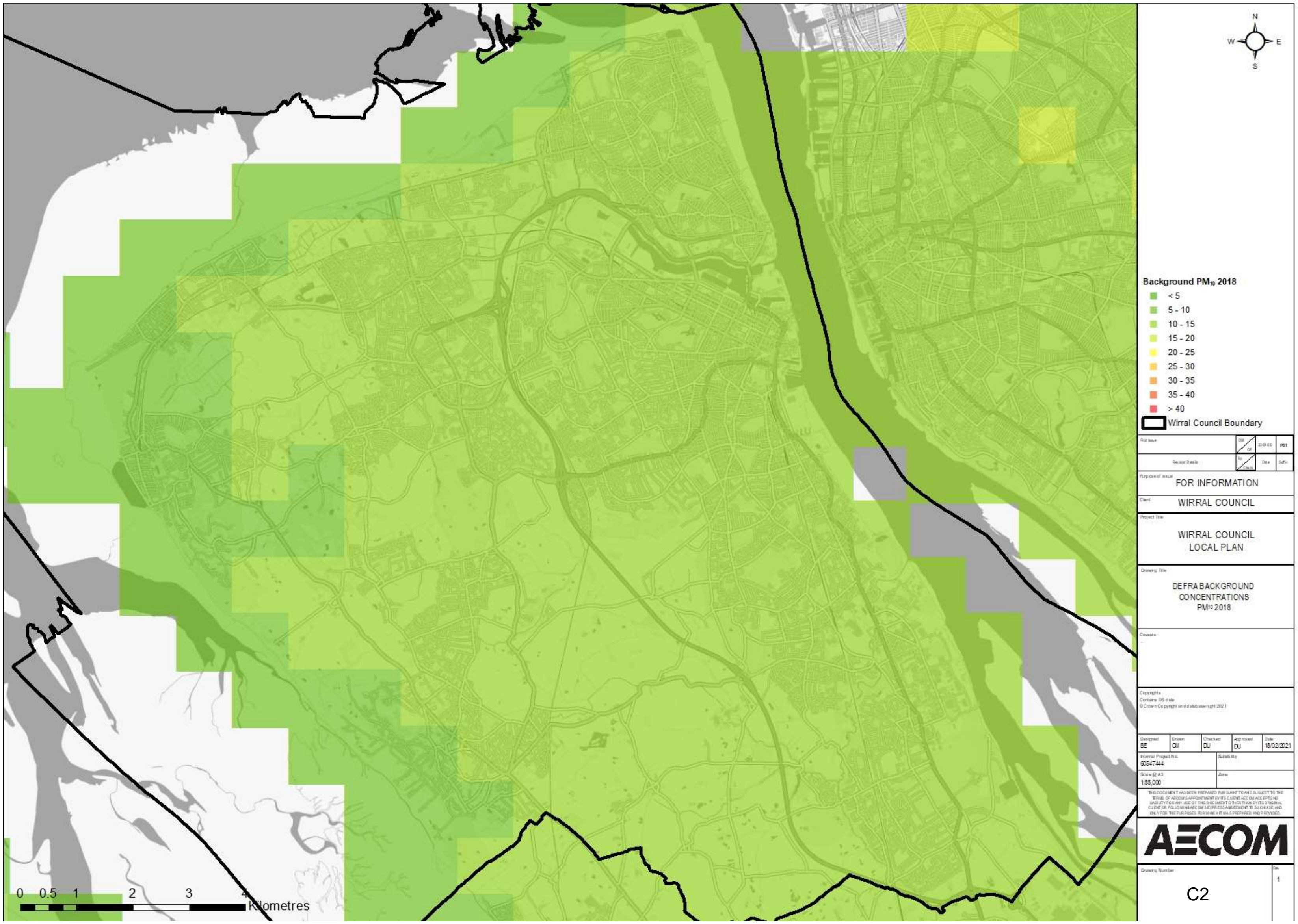
Drawing Number
C1
Rev
1


N
W
E
S
0 0.5 1 2 3 4 Kilometres
Background PM10 2018
< 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40
> 40
Wirral Council Boundary
FOR INFORMATION
WIRRAL COUNCIL
WIRRAL COUNCIL
LOCAL PLAN
DEFRA BACKGROUND
CONCENTRATIONS
PM10 2018
BE
CM
DU
DU
18/02/2021
60547444
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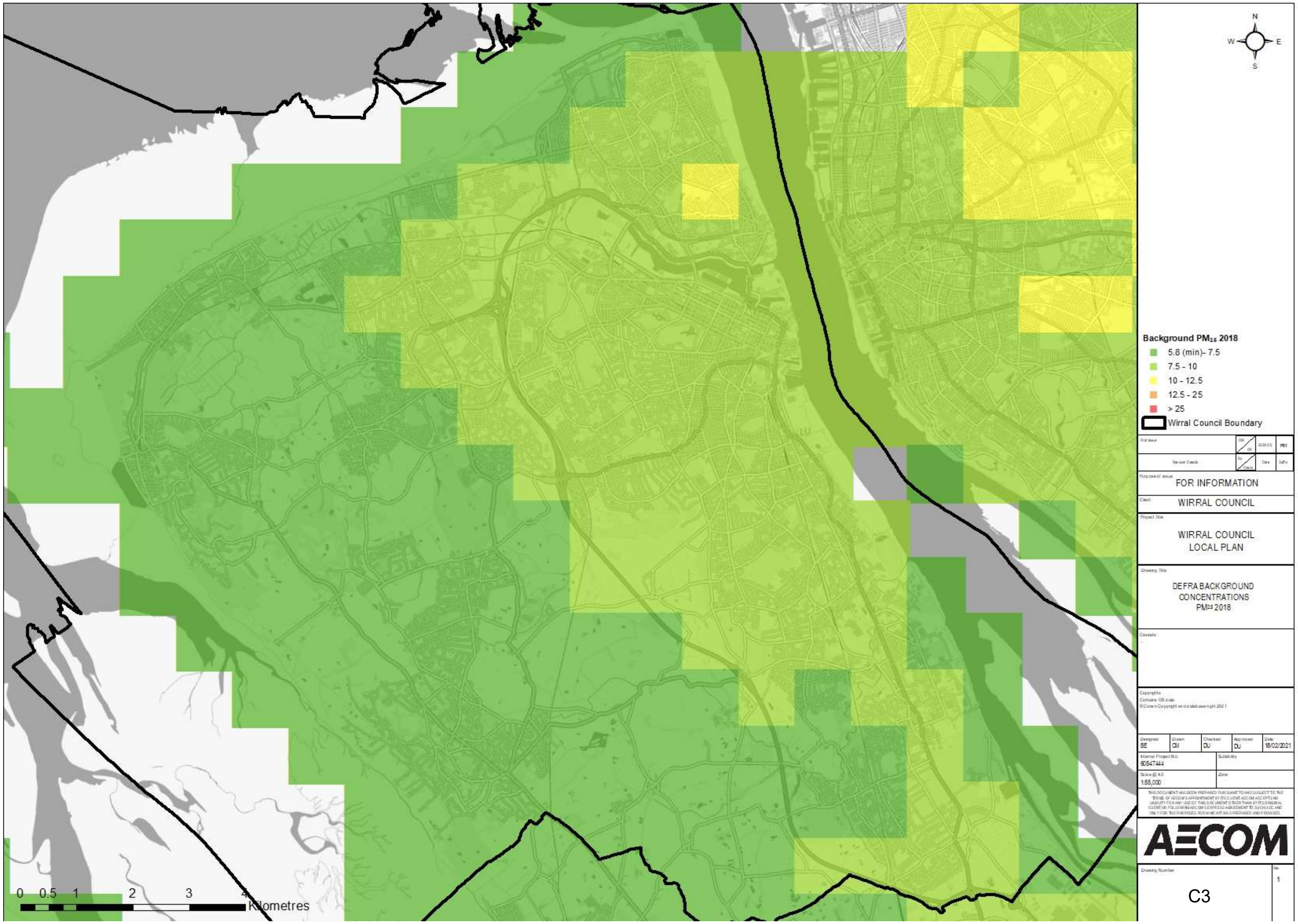
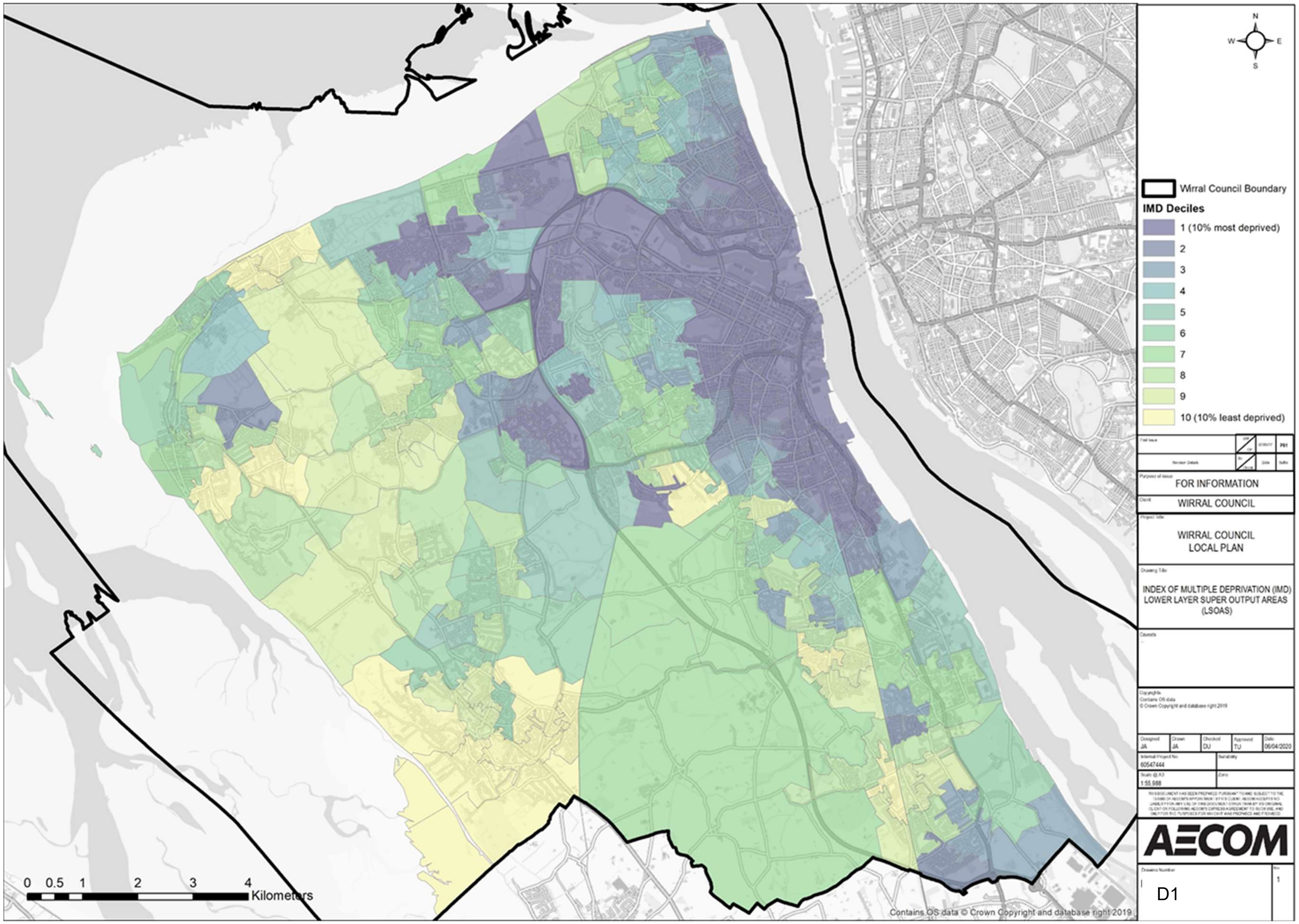
AECOM
C2
1


N
W
E
S
Background PM2.5 2018
5.8 (min)- 7.5
7.5 - 10
10 - 12.5
12.5 - 25
> 25
Wirral Council Boundary
P01
FOR INFORMATION
WIRRAL COUNCIL
WIRRAL COUNCIL
LOCAL PLAN
DEFRA BACKGROUND
CONCENTRATIONS
PM2.5 2018
AECOM
C3
0 0.5 1 2 3 4 Kilometres

Appendix D Index of Multiple Deprivation 2019


N
W
E
S
Wirral Council Boundary
IMD Deciles
1 (10% most deprived)
2
3
4
5
6
7
8
9
10 (10% least deprived)
FOR INFORMATION
WIRRAL COUNCIL
WIRRAL COUNCIL
LOCAL PLAN
INDEX OF MULTIPLE DEPRIVATION (IMD)
LOWER LAYER SUPER OUTPUT AREAS
(LSOAS)
Designed JA
Drawn JA
Checked DU
Approved TU
Date 06/04/2020
60547444
1:55,988
AECOM
D1
1
0 0.5 1 2 3 4
Kilometers
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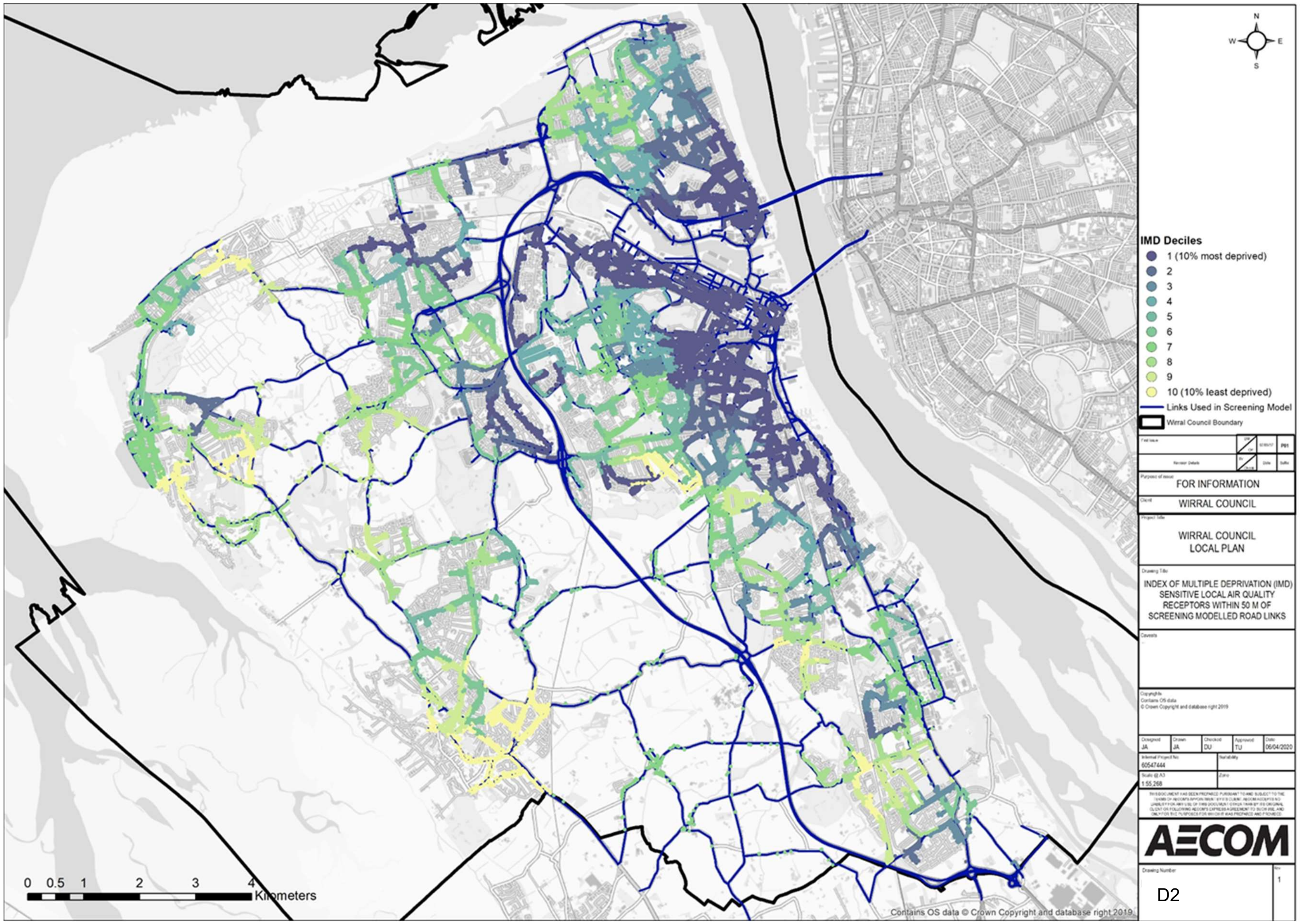
N
W
E
S
IMD Deciles
1 (10% most deprived)
2
3
4
5
6
7
8
9
10 (10% least deprived)
Links Used in Screening Model
Wirral Council Boundary
Purpose of issue
FOR INFORMATION
Client
WIRRAL COUNCIL
Project Title
WIRRAL COUNCIL
LOCAL PLAN
Drawing Title
INDEX OF MULTIPLE DEPRIVATION (IMD)
SENSITIVE LOCAL AIR QUALITY
RECEPTORS WITHIN 50 M OF
SCREENING MODELLED ROAD LINKS
Caveats
Copyrights
Contains OS data
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Drawn JA
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Date 06/04/2020
Internal Project No
60547444
Suitability
Scale @ A3
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Zone
AECOM
Drawing Number
D2
Rev
1
0 0.5 1 2 3 4
Kilometers
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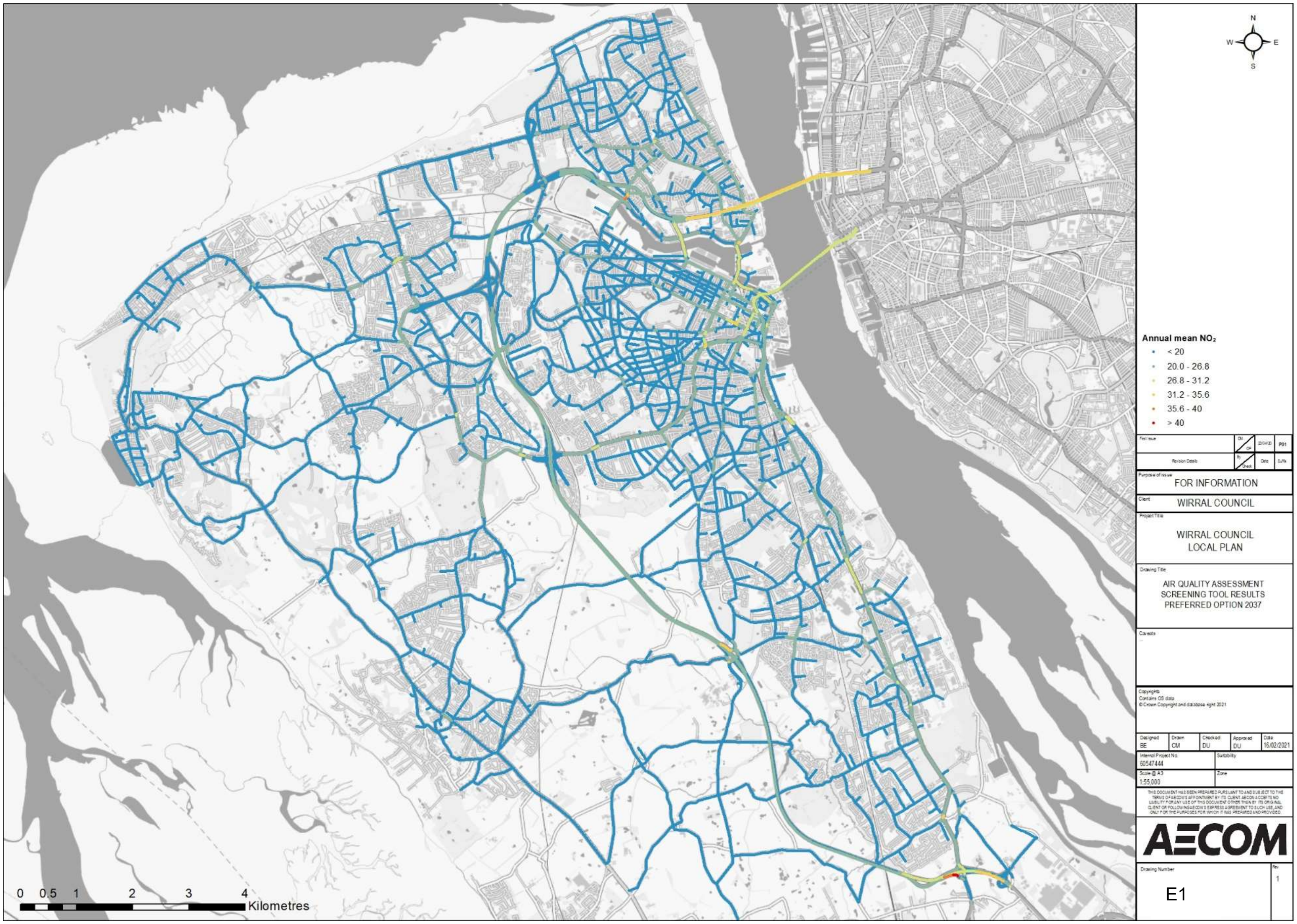
Appendix E Screening Model Results Plots


N
W
E
S
Annual mean NO_2
< 20
20.0 - 26.8
26.8 - 31.2
31.2 - 35.6
35.6 - 40
> 40
0 0.5 1 2 3 4
Kilometres
Purpose of issue
FOR INFORMATION
Client
WIRRAL COUNCIL
Project Title
WIRRAL COUNCIL
LOCAL PLAN
Drawing Title
AIR QUALITY ASSESSMENT
SCREENING TOOL RESULTS
PREFERRED OPTION 2037
Caveats
Copyrights
Contains OS data
© Crown Copyright and database right 2021
Designed BE
Drawn CM
Checked DU
Approved DU
Date 16/02/2021
Internal Project No. 60547444
Suitability
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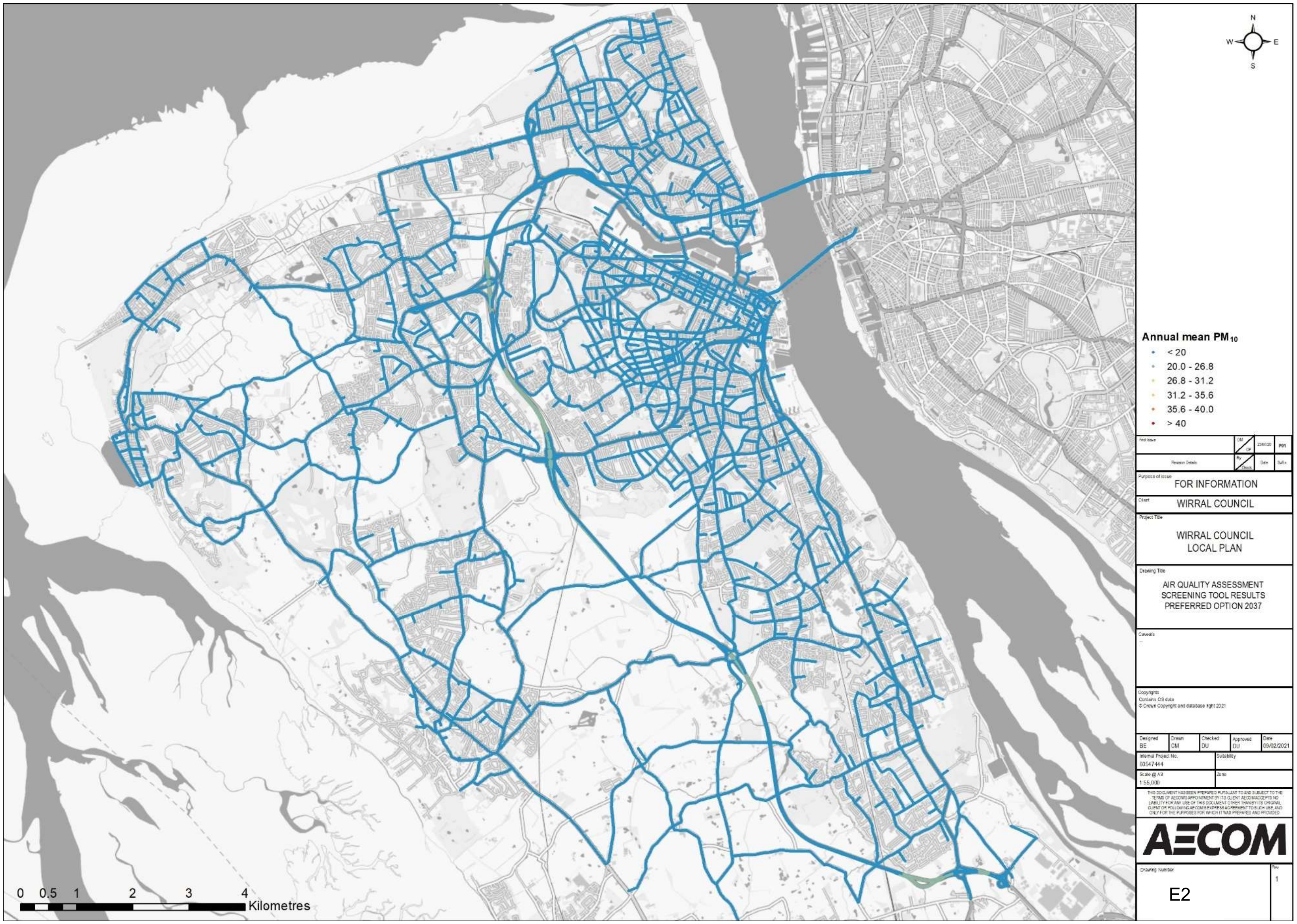
Zone
AECOM
Drawing Number
E1
Rev
1


N
W
E
S
Annual mean PM_{10}
< 20
20.0 - 26.8
26.8 - 31.2
31.2 - 35.6
35.6 - 40.0
> 40
First issue
DM
OP
23/04/20
P01
Revision Details
By
Check
Date
Suffix
Purpose of issue
FOR INFORMATION
Client
WIRRAL COUNCIL
Project Title
WIRRAL COUNCIL
LOCAL PLAN
Drawing Title
AIR QUALITY ASSESSMENT
SCREENING TOOL RESULTS
PREFERRED OPTION 2037
Caveats
Copyrights
Contains OS data
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Drawn CM
Checked DU
Approved DU
Date 09/02/2021
Internal Project No. 60547444
Suitability
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Zone
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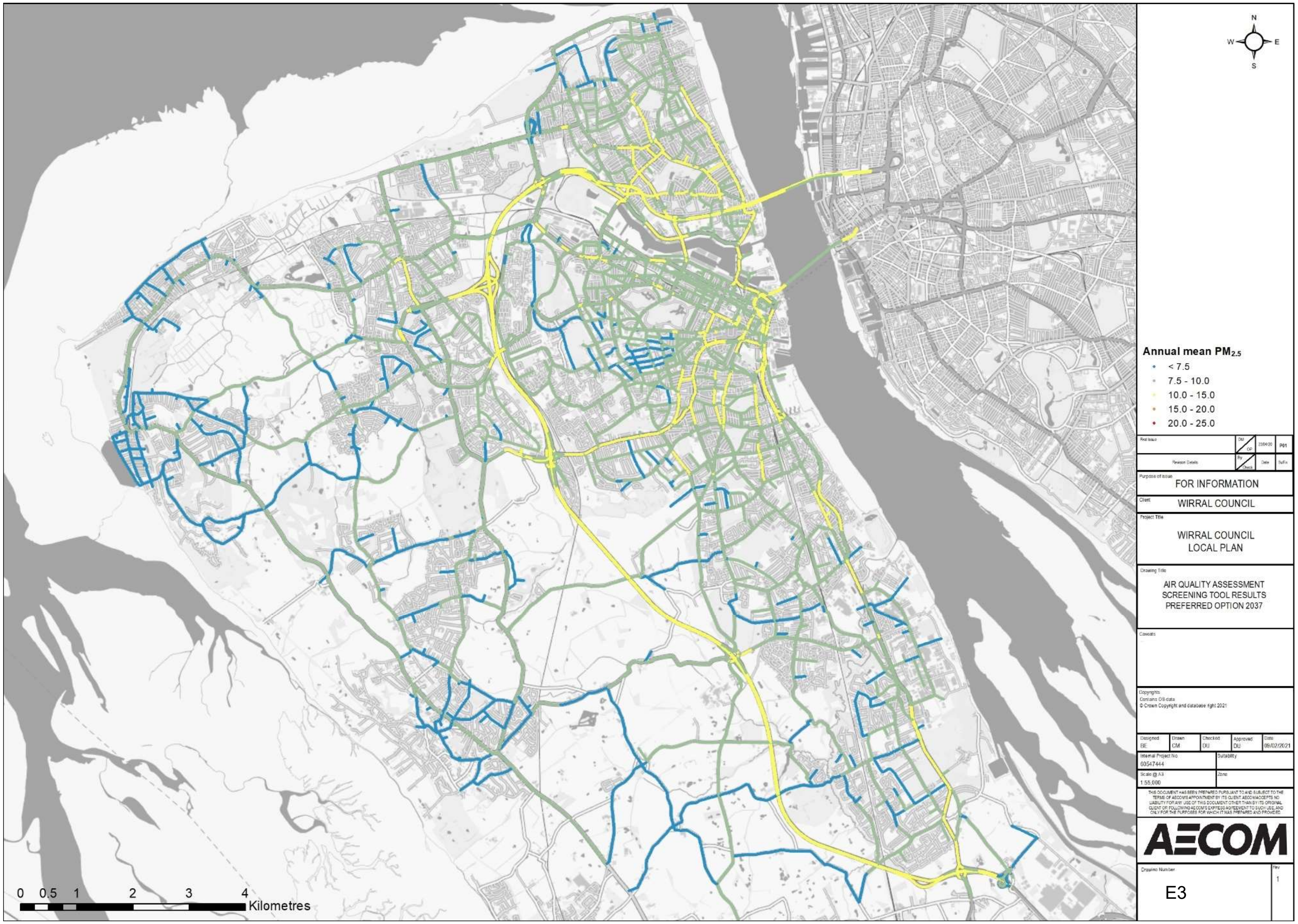
AECOM
Drawing Number
E2
Rev
1
0 0.5 1 2 3 4
Kilometres


N
W
E
S
Annual mean $PM_{2.5}$
< 7.5
7.5 - 10.0
10.0 - 15.0
15.0 - 20.0
20.0 - 25.0
First Issue
DM
OP
23/04/20
P01
Revision Details
By
Check
Date
Suffix
Purpose of issue
FOR INFORMATION
Client
WIRRAL COUNCIL
Project Title
WIRRAL COUNCIL
LOCAL PLAN
Drawing Title
AIR QUALITY ASSESSMENT
SCREENING TOOL RESULTS
PREFERRED OPTION 2037
Caveats
Copyrights
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Drawing Number
E3
Rev
1
0 0.5 1 2 3 4
Kilometres

Appendix F Detailed Model Results

ID	Existing Baseline (2018)				Future Baseline (2037)				Preferred Option (2037)				Change				Impacts*		
	Annual Mean Conc. (μg/m³)			Days PM_{10} >50 μg/m³	Annual Mean Conc. (μg/m³)			Days PM_{10} >50 μg/m³	Annual Mean Conc. (μg/m³)			Days PM_{10} >50 μg/m³	Annual Mean Conc. (μg/m³)			Days PM_{10} >50 μg/m³	NO_2	PM_{10}	$PM_{2.5}$
	NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$				
R1	30.3	14.4	9.8	0	25.8	13.8	9.3	0	25.9	13.9	9.3	0	0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R2	32.7	14.6	10.0	0	27.9	14.3	9.6	0	28.1	14.3	9.6	0	0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R3	**54.9**	17.3	11.8	1	**47.6**	18.0	12.0	2	**47.8**	18.1	12.0	2	0.2	<0.1	<0.1	0	Negligible	Negligible	Negligible
R4	**54.5**	17.7	12.0	2	**46.6**	18.3	12.1	2	**46.8**	18.4	12.1	2	0.3	<0.1	<0.1	0	Moderate Adverse	Negligible	Negligible
R5	**58.4**	18.0	12.2	2	**50.4**	18.9	12.5	3	**50.6**	19.0	12.5	3	0.3	<0.1	<0.1	0	Moderate Adverse	Negligible	Negligible
R6	**45.5**	16.5	11.2	1	38.5	16.7	11.1	1	38.7	16.8	11.1	1	0.2	<0.1	<0.1	0	Slight Adverse	Negligible	Negligible
R7	**49.4**	17.0	11.5	1	**42.0**	17.4	11.5	1	**42.2**	17.5	11.5	2	0.3	<0.1	<0.1	1	Moderate Adverse	Negligible	Negligible
R8	29.4	14.7	10.0	0	23.7	14.2	9.4	0	23.8	14.2	9.5	0	0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R9	27.1	14.6	9.8	0	20.4	14.0	9.3	0	20.5	14.0	9.3	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R10	35.9	15.0	10.2	1	31.0	14.9	10.0	1	31.2	14.9	10.0	1	0.2	<0.1	<0.1	0	Negligible	Negligible	Negligible
R11	34.2	14.9	10.2	1	29.8	14.9	9.9	1	30.0	15.0	10.0	1	0.2	<0.1	<0.1	0	Negligible	Negligible	Negligible
R12	25.2	14.1	9.2	0	20.2	12.8	8.5	0	20.7	12.9	8.6	0	0.6	0.2	<0.1	0	Negligible	Negligible	Negligible
R13	25.3	13.9	9.2	0	20.4	12.9	8.6	0	21.0	13.0	8.7	0	0.6	0.2	<0.1	0	Negligible	Negligible	Negligible
R14	25.2	13.9	9.2	0	20.5	13.0	8.6	0	21.0	13.1	8.7	0	0.5	0.2	<0.1	0	Negligible	Negligible	Negligible
R15	24.2	13.6	9.1	0	19.7	12.7	8.5	0	20.1	12.9	8.6	0	0.4	0.1	<0.1	0	Negligible	Negligible	Negligible
R16	31.3	15.4	10.2	1	24.5	14.7	9.6	0	24.7	14.8	9.6	0	0.2	<0.1	<0.1	0	Negligible	Negligible	Negligible
R17	29.6	15.4	10.4	1	24.4	14.9	9.9	1	24.6	15.0	9.9	1	0.2	<0.1	<0.1	0	Negligible	Negligible	Negligible
R18	26.1	14.7	9.9	0	21.3	14.0	9.4	0	21.4	14.1	9.4	0	0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R19	23.0	14.1	9.6	0	18.5	13.3	9.0	0	18.6	13.3	9.0	0	0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R20	24.0	13.9	9.3	0	19.1	13.0	8.6	0	19.2	13.0	8.6	0	0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R21	23.6	14.2	9.7	0	18.7	13.4	9.0	0	18.9	13.4	9.0	0	0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R22	28.3	14.7	9.8	0	22.4	14.1	9.2	0	22.6	14.2	9.3	0	0.2	<0.1	<0.1	0	Negligible	Negligible	Negligible
R23	32.2	15.3	10.1	1	25.5	14.8	9.6	0	25.6	14.8	9.6	1	0.2	<0.1	<0.1	1	Negligible	Negligible	Negligible

ID	Existing Baseline (2018)				Future Baseline (2037)				Preferred Option (2037)				Change				Impacts*		
	Annual Mean Conc. (µg/m³)			Days PM_{10} >50 µg/m³	Annual Mean Conc. (µg/m³)			Days PM_{10} >50 µg/m³	Annual Mean Conc. (µg/m³)			Days PM_{10} >50 µg/m³	Annual Mean Conc. (µg/m³)			Days PM_{10} >50 µg/m³	NO_2	PM_{10}	$PM_{2.5}$
	NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$				
R24	28.2	14.6	9.7	0	21.7	13.9	9.1	0	21.9	13.9	9.1	0	0.2	<0.1	<0.1	0	Negligible	Negligible	Negligible
R25	35.0	15.6	10.3	1	27.9	15.1	9.8	1	28.0	15.2	9.8	1	0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R26	25.4	14.2	9.2	0	20.6	12.8	8.6	0	21.1	12.9	8.6	0	0.5	0.1	<0.1	0	Negligible	Negligible	Negligible
R27	25.0	13.8	9.1	0	20.3	12.7	8.5	0	20.7	12.8	8.6	0	0.4	<0.1	<0.1	0	Negligible	Negligible	Negligible
R28	34.1	15.3	9.9	1	25.8	14.3	9.2	0	25.9	14.3	9.2	0	0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R29	25.5	13.6	9.2	0	21.0	13.0	8.7	0	21.1	13.1	8.7	0	0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R30	23.8	15.1	10.5	0	18.3	14.3	9.8	0	18.4	14.3	9.8	0.0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R31	19.6	14.4	10.1	0	15.5	13.5	9.4	0	15.5	13.5	9.4	0.0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R32	26.3	14.4	9.8	0	20.0	13.6	9.2	0	20.4	13.7	9.3	0.0	0.4	0.1	<0.1	0	Negligible	Negligible	Negligible
R33	19.7	13.6	9.3	0	15.6	12.6	8.6	0	15.8	12.7	8.7	0.0	0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R34	26.2	13.7	9.3	0	20.7	12.9	8.6	0	21.0	13.0	8.7	0.0	0.3	<0.1	<0.1	0	Negligible	Negligible	Negligible
R35	25.4	14.2	9.7	0	20.3	13.7	9.2	0	20.8	13.8	9.3	0.0	0.4	0.1	<0.1	0	Negligible	Negligible	Negligible
R36	20.8	13.6	9.3	0	16.5	12.9	8.7	0	16.7	13.0	8.8	0.0	0.2	<0.1	<0.1	0	Negligible	Negligible	Negligible
R37	17.2	12.9	8.9	0	13.8	12.0	8.2	0	13.9	12.1	8.3	0.0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R38	19.0	13.2	9.1	0	15.3	12.5	8.5	0	15.5	12.5	8.5	0.0	0.2	<0.1	<0.1	0	Negligible	Negligible	Negligible
R39	16.2	12.8	8.8	0	12.8	11.9	8.2	0	12.9	11.9	8.2	0.0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R40	23.0	13.8	9.4	0	17.1	13.0	8.8	0	17.3	13.0	8.8	0.0	0.2	<0.1	<0.1	0	Negligible	Negligible	Negligible
R41	20.3	13.1	8.8	0	15.5	12.4	8.2	0	15.7	12.4	8.2	0.0	0.2	<0.1	<0.1	0	Negligible	Negligible	Negligible
R42	17.5	12.6	8.5	0	13.6	11.8	7.9	0	13.7	11.8	7.9	0.0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R43	16.1	12.4	8.4	0	12.9	11.6	7.8	0	12.9	11.6	7.8	0.0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R44	23.7	13.3	9.0	0	17.9	12.6	8.4	0	18.2	12.7	8.4	0.0	0.3	<0.1	<0.1	0	Negligible	Negligible	Negligible
R45	18.9	13.3	9.1	0	14.9	12.4	8.5	0	15.0	12.4	8.5	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R46	22.0	13.9	9.5	0	16.9	13.1	8.9	0	16.9	13.1	8.9	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible

ID	Existing Baseline (2018) Annual Mean Conc. ($\mu g/m^3$)			Existing Baseline (2018) Days PM_{10} >50 $\mu g/m^3$	Future Baseline (2037) Annual Mean Conc. ($\mu g/m^3$)			Future Baseline (2037) Days PM_{10} >50 $\mu g/m^3$	Preferred Option (2037) Annual Mean Conc. ($\mu g/m^3$)			Preferred Option (2037) Days PM_{10} >50 $\mu g/m^3$	Change Annual Mean Conc. ($\mu g/m^3$)			Change Days PM_{10} >50 $\mu g/m^3$	Impacts*		
	NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$
R47	22.3	13.0	8.9	0	18.3	12.2	8.2	0	18.4	12.2	8.2	0	0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R48	23.7	13.4	9.0	0	19.8	12.6	8.5	0	20.1	12.7	8.5	0	0.3	<0.1	<0.1	0	Negligible	Negligible	Negligible
R49	21.9	13.1	8.9	0	18.4	12.3	8.3	0	18.6	12.4	8.4	0	0.2	<0.1	<0.1	0	Negligible	Negligible	Negligible
R50	18.3	13.1	9.0	0	15.2	12.4	8.4	0	15.5	12.4	8.5	0	0.3	<0.1	<0.1	0	Negligible	Negligible	Negligible
R51	22.5	13.0	8.9	0	18.2	12.1	8.2	0	18.3	12.2	8.2	0	0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R52	22.1	13.2	8.9	0	18.3	12.2	8.2	0	18.5	12.3	8.3	0	0.2	<0.1	<0.1	0	Negligible	Negligible	Negligible
R53	18.8	13.4	9.2	0	15.8	12.5	8.5	0	15.7	12.5	8.5	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R54	23.3	15.1	10.4	1	19.6	14.7	10.0	0	19.7	14.7	10.0	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R55	23.1	15.1	10.4	1	18.5	14.4	9.8	0	18.5	14.4	9.8	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R56	22.4	14.8	10.2	1	17.7	14.0	9.6	0	17.8	14.1	9.6	0	0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R57	20.8	13.8	9.4	0	16.6	12.9	8.8	0	16.6	12.9	8.8	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R58	27.3	14.8	10.1	1	21.5	14.2	9.5	0	21.6	14.2	9.5	0	0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R59	19.5	14.2	9.9	0	15.4	13.3	9.2	0	15.4	13.3	9.2	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R60	25.1	14.5	9.9	0	19.6	13.8	9.3	0	19.7	13.8	9.3	0	0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R61	17.6	13.3	9.3	0	14.6	12.4	8.7	0	14.7	12.4	8.7	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R62	19.2	13.6	9.5	0	16.6	13.0	9.0	0	16.8	13.0	9.0	0	0.2	<0.1	<0.1	0	Negligible	Negligible	Negligible
R63	17.7	13.3	9.3	0	14.7	12.4	8.7	0	14.8	12.5	8.7	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R64	18.3	13.4	9.4	0	15.6	12.7	8.8	0	15.7	12.7	8.8	0	0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R65	23.9	14.6	10.1	0	19.7	14.1	9.6	0	20.0	14.2	9.7	0	0.3	<0.1	<0.1	0	Negligible	Negligible	Negligible
R66	20.8	14.0	9.7	0	17.2	13.3	9.2	0	17.4	13.4	9.2	0	0.2	<0.1	<0.1	0	Negligible	Negligible	Negligible
R67	18.1	13.4	9.4	0	15.0	12.5	8.7	0	15.0	12.5	8.7	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R68	20.1	14.0	9.8	0	15.4	12.9	9.0	0	15.5	12.9	9.1	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R69	19.0	14.3	10.0	0	15.4	13.6	9.4	0	15.5	13.6	9.4	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible

ID	Existing Baseline (2018) Annual Mean Conc. (µg/m³)			Existing Baseline (2018) Days PM_{10} >50 µg/m³	Future Baseline (2037) Annual Mean Conc. (µg/m³)			Future Baseline (2037) Days PM_{10} >50 µg/m³	Preferred Option (2037) Annual Mean Conc. (µg/m³)			Preferred Option (2037) Days PM_{10} >50 µg/m³	Change Annual Mean Conc. (µg/m³)			Change Days PM_{10} >50 µg/m³	Impacts*		
	NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$
R70	23.0	14.1	9.7	0	18.1	13.3	9.0	0	18.2	13.4	9.1	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R71	33.8	14.9	10.2	1	22.8	14.0	9.4	0	23.4	14.1	9.5	0	0.6	0.1	<0.1	0	Negligible	Negligible	Negligible
R72	34.9	15.6	10.3	1	26.1	14.9	9.7	1	26.3	15.0	9.7	1	0.2	<0.1	<0.1	0	Negligible	Negligible	Negligible
R73	27.5	14.4	9.8	0	21.4	14.0	9.4	0	21.4	14.0	9.4	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R74	30.3	14.8	10.0	0	23.5	14.6	9.7	0	23.5	14.6	9.7	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R75	26.5	15.4	10.6	1	20.9	14.8	10.1	1	21.0	14.9	10.1	1	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R76	28.7	15.7	10.9	1	23.1	15.3	10.4	1	23.1	15.3	10.4	1	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R77	33.7	16.7	11.4	1	25.7	16.1	10.9	1	25.9	16.1	10.9	1	0.2	<0.1	<0.1	0	Negligible	Negligible	Negligible
R78	25.3	14.3	9.6	0	18.9	13.5	9.0	0	19.1	13.5	9.0	0	0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R79	24.1	15.2	10.7	1	19.4	14.4	10.1	0	19.6	14.4	10.1	0	0.2	<0.1	<0.1	0	Negligible	Negligible	Negligible
R80	25.6	14.0	9.5	0	21.6	13.3	9.0	0	21.7	13.4	9.0	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R81	22.3	14.8	10.5	1	18.6	14.1	9.9	0	18.6	14.1	9.9	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R82	23.2	14.9	10.5	1	19.0	14.1	9.9	0	19.1	14.2	10.0	0	0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R83	19.6	14.4	10.2	0	16.3	13.6	9.6	0	16.4	13.6	9.6	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R84	24.4	15.4	10.8	1	19.4	14.6	10.2	0	19.4	14.6	10.2	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R85	26.8	15.7	11.0	1	21.2	14.9	10.4	1	21.4	15.0	10.4	1	0.2	<0.1	<0.1	0	Negligible	Negligible	Negligible
R86	21.3	14.7	10.4	0	17.2	13.7	9.7	0	17.3	13.8	9.7	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R87	22.0	12.9	8.9	0	18.3	12.1	8.2	0	18.3	12.1	8.2	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R88	20.0	14.5	10.3	0	16.4	13.5	9.6	0	16.5	13.5	9.6	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R89	23.2	13.8	9.4	0	18.8	12.9	8.7	0	19.0	12.9	8.7	0	0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R90	17.2	13.2	9.3	0	14.3	12.3	8.6	0	14.4	12.3	8.6	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R91	17.3	13.5	9.5	0	14.1	12.5	8.8	0	14.1	12.5	8.8	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R92	18.4	12.5	8.5	0	14.9	11.6	7.8	0	15.0	11.6	7.8	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible

ID	Existing Baseline (2018)				Future Baseline (2037)				Preferred Option (2037)				Change				Impacts*		
	Annual Mean Conc. ($\mu g/m^3$)			Days PM_{10} >50 $\mu g/m^3$	Annual Mean Conc. ($\mu g/m^3$)			Days PM_{10} >50 $\mu g/m^3$	Annual Mean Conc. ($\mu g/m^3$)			Days PM_{10} >50 $\mu g/m^3$	Annual Mean Conc. ($\mu g/m^3$)			Days PM_{10} >50 $\mu g/m^3$	NO_2	PM_{10}	$PM_{2.5}$
	NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$				
R93	20.1	13.7	9.3	0	16.6	12.7	8.7	0	16.7	12.7	8.7	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R94	21.1	13.9	9.5	0	17.5	13.0	8.8	0	17.6	13.0	8.8	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R95	**40.0**	17.2	11.2	1	33.3	17.6	11.2	2	33.4	17.6	11.2	2	0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R96	31.9	16.1	11.1	1	25.1	15.9	10.8	1	25.1	15.9	10.8	1	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R97	32.4	16.1	11.2	1	25.3	15.9	10.9	1	25.3	15.9	10.9	1	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R98	35.0	16.6	11.4	1	27.8	16.5	11.2	1	27.7	16.5	11.2	1	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R99	34.8	16.5	11.4	1	27.4	16.4	11.1	1	27.4	16.4	11.1	1	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R100	29.9	15.9	11.0	1	26.9	15.5	10.5	1	27.0	15.6	10.6	1	0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R101	31.0	16.1	11.1	1	25.8	15.8	10.7	1	25.8	15.8	10.7	1	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R102	28.8	15.8	10.9	1	23.6	15.3	10.4	1	23.6	15.4	10.4	1	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R103	27.9	14.8	10.1	0	21.6	14.0	9.4	0	21.7	14.1	9.5	0	0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R104	25.1	14.2	9.7	0	19.4	13.4	9.1	0	19.5	13.4	9.1	0	0.2	<0.1	<0.1	0	Negligible	Negligible	Negligible
R105	22.6	13.9	9.6	0	17.3	13.0	8.9	0	17.4	13.0	8.9	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R106	31.2	15.2	10.3	1	21.9	14.1	9.5	0	22.0	14.1	9.5	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R107	28.1	14.6	10.0	0	21.5	13.8	9.3	0	21.7	13.8	9.3	0	0.2	<0.1	<0.1	0	Negligible	Negligible	Negligible
R108	35.6	15.2	10.1	1	27.2	14.4	9.4	0	27.9	14.6	9.6	0	0.7	0.2	0.1	0	Negligible	Negligible	Negligible
R109	20.0	14.5	10.1	0	15.9	13.7	9.5	0	16.0	13.7	9.5	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R110	20.5	13.6	9.0	0	16.4	12.9	8.5	0	16.4	12.9	8.5	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R111	23.8	14.3	9.5	0	18.9	13.7	8.9	0	19.0	13.8	8.9	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R112	22.6	13.6	9.2	0	17.9	13.0	8.7	0	17.9	13.0	8.7	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R113	26.6	14.7	9.7	0	21.5	14.4	9.3	0	21.5	14.4	9.3	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R114	25.9	15.4	10.6	1	20.1	14.7	10.0	0	20.2	14.7	10.0	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R115	22.9	15.0	10.4	1	17.9	14.2	9.7	0	18.0	14.2	9.8	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible

ID	Existing Baseline (2018) Annual Mean Conc. (µg/m³)			Existing Baseline (2018) Days PM_{10} >50 µg/m³	Future Baseline (2037) Annual Mean Conc. (µg/m³)			Future Baseline (2037) Days PM_{10} >50 µg/m³	Preferred Option (2037) Annual Mean Conc. (µg/m³)			Preferred Option (2037) Days PM_{10} >50 µg/m³	Change Annual Mean Conc. (µg/m³)			Change Days PM_{10} >50 µg/m³	Impacts* NO_2	Impacts* PM_{10}	Impacts* $PM_{2.5}$
	NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$				
R116	22.5	14.3	10.0	0	17.3	13.3	9.3	0	17.3	13.3	9.3	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R117	21.1	14.1	9.9	0	16.9	13.3	9.2	0	17.0	13.3	9.2	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R118	30.0	15.1	10.5	1	22.6	14.4	9.9	0	22.8	14.4	9.9	0	0.2	<0.1	<0.1	0	Negligible	Negligible	Negligible
R119	26.4	15.4	10.7	1	20.6	14.7	10.0	0	20.7	14.7	10.1	0	0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R120	19.6	14.4	10.2	0	15.9	13.4	9.5	0	16.0	13.4	9.5	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R121	20.5	13.1	8.8	0	16.1	12.2	8.2	0	16.2	12.3	8.2	0	0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R122	17.8	12.5	8.5	0	14.4	11.6	7.8	0	14.4	11.6	7.8	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
R123	35.3	16.2	10.6	1	29.2	16.2	10.4	1	29.4	16.3	10.5	1	0.2	<0.1	<0.1	0	Negligible	Negligible	Negligible
R124	36.2	16.1	10.6	1	29.3	16.0	10.3	1	29.5	16.0	10.3	1	0.2	<0.1	<0.1	0	Negligible	Negligible	Negligible
R125	20.7	13.8	9.4	0	16.9	12.8	8.7	0	17.0	12.9	8.8	0	0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
Z2_1	21.1	12.1	8.2	0	17.3	11.2	7.5	0	17.3	11.2	7.5	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
Z2_2	30.2	13.8	9.2	0	24.2	12.9	8.4	0	24.6	12.9	8.5	0	0.4	<0.1	<0.1	0	Negligible	Negligible	Negligible
Z2_3	27.3	13.3	8.9	0	22.0	12.3	8.1	0	22.5	12.3	8.2	0	0.4	<0.1	<0.1	0	Negligible	Negligible	Negligible
Z2_4	34.6	14.7	9.7	0	27.6	13.7	8.9	0	28.3	13.8	9.0	0	0.8	<0.1	<0.1	0	Negligible	Negligible	Negligible
Z2_5	25.0	12.8	8.6	0	20.0	11.9	7.9	0	20.1	11.9	7.9	0	0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
Z2_6	20.6	12.0	8.2	0	17.0	11.1	7.4	0	17.0	11.1	7.4	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
Z2_7	30.5	14.0	9.3	0	23.4	13.2	8.6	0	23.5	13.3	8.7	0	0.2	<0.1	<0.1	0	Negligible	Negligible	Negligible
Z2_8	36.0	14.7	9.7	0	27.0	13.7	8.9	0	27.4	13.8	9.0	0	0.3	<0.1	<0.1	0	Negligible	Negligible	Negligible
Z2_9	31.9	13.8	9.2	0	23.1	12.7	8.4	0	23.2	12.8	8.4	0	0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
Z2_10	32.1	13.9	9.3	0	24.0	12.9	8.5	0	24.2	13.0	8.5	0	0.2	<0.1	<0.1	0	Negligible	Negligible	Negligible
Z2_11	33.9	14.5	9.6	0	26.4	13.5	8.8	0	27.0	13.6	8.8	0	0.6	<0.1	<0.1	0	Negligible	Negligible	Negligible
Z2_12	30.9	14.0	9.3	0	24.9	13.0	8.5	0	25.4	13.0	8.5	0	0.5	<0.1	<0.1	0	Negligible	Negligible	Negligible
Z2_13	26.3	13.0	8.7	0	20.2	12.0	8.0	0	20.3	12.1	8.0	0	0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible

ID	Existing Baseline (2018)				Future Baseline (2037)				Preferred Option (2037)				Change				Impacts*		
	Annual Mean Conc. ($\mu g/m^3$)			Days PM_{10} >50 $\mu g/m^3$	Annual Mean Conc. ($\mu g/m^3$)			Days PM_{10} >50 $\mu g/m^3$	Annual Mean Conc. ($\mu g/m^3$)			Days PM_{10} >50 $\mu g/m^3$	Annual Mean Conc. ($\mu g/m^3$)			Days PM_{10} >50 $\mu g/m^3$	NO_2	PM_{10}	$PM_{2.5}$
	NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$				
Z2_14	22.1	12.3	8.3	0	17.9	11.4	7.6	0	18.0	11.4	7.6	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
Z2_15	22.2	12.3	8.3	0	18.0	11.4	7.6	0	18.0	11.4	7.6	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
Z2_16	14.7	12.0	8.2	0	12.0	11.1	7.5	0	12.1	11.1	7.5	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
Z2_17	15.3	12.1	8.2	0	12.8	11.3	7.6	0	12.8	11.3	7.6	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
Z2_18	23.1	13.3	9.0	0	16.2	12.2	8.1	0	16.3	12.2	8.1	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
Z2_19	26.7	13.3	8.9	0	20.9	12.5	8.2	0	21.0	12.6	8.3	0	0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
H1	19.4	14.3	9.9	0	16.0	13.6	9.3	0	16.0	13.6	9.3	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
H2	19.7	14.4	10.1	0	15.6	13.5	9.4	0	15.6	13.5	9.4	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
S1	22.1	13.1	8.9	0	18.1	12.1	8.2	0	18.2	12.2	8.2	0	0.2	<0.1	<0.1	0	Negligible	Negligible	Negligible
S2	18.0	12.7	8.6	0	13.8	11.9	8.0	0	13.9	11.9	8.0	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
S3	17.8	13.0	9.0	0	14.8	12.3	8.4	0	15.0	12.3	8.4	0	0.2	<0.1	<0.1	0	Negligible	Negligible	Negligible
S4	25.3	13.9	9.5	0	21.3	13.1	8.9	0	21.3	13.2	8.9	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
S5	25.3	13.9	9.5	0	21.3	13.1	8.9	0	21.3	13.2	8.9	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
S6	18.8	13.2	9.1	0	16.1	12.6	8.6	0	16.4	12.7	8.6	0	0.3	<0.1	<0.1	0	Negligible	Negligible	Negligible
S7	20.6	14.5	10.1	0	16.3	13.7	9.5	0	16.3	13.7	9.5	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
S8	18.5	13.1	9.0	0	14.7	12.3	8.4	0	14.8	12.3	8.4	0	0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
S9	23.8	13.3	9.1	0	19.3	12.4	8.4	0	19.4	12.5	8.4	0	0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
S10	23.8	13.3	9.1	0	19.3	12.4	8.4	0	19.4	12.5	8.4	0	0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
S11	36.3	14.7	9.9	0	30.9	14.4	9.5	0	31.0	14.4	9.5	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
S12	28.7	14.4	9.8	0	23.9	13.8	9.3	0	24.1	13.8	9.3	0	0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
S13	21.3	12.9	8.8	0	17.5	12.0	8.1	0	17.7	12.0	8.1	0	0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
S14	25.2	14.2	9.4	0	20.0	13.8	9.0	0	20.1	13.8	9.0	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
S15	23.3	13.2	9.0	0	18.8	12.3	8.3	0	19.1	12.4	8.3	0	0.2	<0.1	<0.1	0	Negligible	Negligible	Negligible

ID	Existing Baseline (2018) Annual Mean Conc. (µg/m³)			Existing Baseline (2018) Days PM_{10} >50 µg/m³	Future Baseline (2037) Annual Mean Conc. (µg/m³)			Future Baseline (2037) Days PM_{10} >50 µg/m³	Preferred Option (2037) Annual Mean Conc. (µg/m³)			Preferred Option (2037) Days PM_{10} >50 µg/m³	Change Annual Mean Conc. (µg/m³)			Change Days PM_{10} >50 µg/m³	Impacts*		
	NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$
S16	25.0	14.3	9.5	0	20.1	13.8	9.0	0	20.1	13.9	9.0	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
S17	26.2	15.5	10.7	1	19.5	14.6	10.0	0	19.5	14.6	10.0	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
S18	19.6	13.6	9.3	0	15.7	12.7	8.7	0	15.7	12.7	8.7	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
S19	17.8	13.1	8.8	0	14.4	12.3	8.1	0	14.4	12.3	8.1	0	<0.1	<0.1	<0.1	0	Negligible	Negligible	Negligible
S20	23.2	13.2	9.0	0	19.0	12.4	8.3	0	19.2	12.4	8.3	0	0.2	<0.1	<0.1	0	Negligible	Negligible	Negligible
D2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.9	13.5	8.8	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	16.6	12.8	8.4	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	24.1	14.4	9.5	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D15	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.3	13.1	8.8	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D17	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20.6	13.4	9.0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D23	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	21.3	13.1	8.6	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D24	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	25.5	14.2	9.2	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	26.6	14.6	9.5	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D26	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	24.9	13.8	9.0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D27	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	28.2	15.0	9.6	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D28	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	30.2	15.7	9.9	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D29	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	31.7	16.2	10.4	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D30	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	21.8	13.1	8.5	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D31	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	25.0	14.1	9.0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D32	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	27.8	15.1	9.9	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D33	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	23.4	15.1	10.5	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D34	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.3	12.5	8.3	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D35	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.2	12.5	8.3	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A

ID	Existing Baseline (2018)				Future Baseline (2037)				Preferred Option (2037)				Change				Impacts*		
	Annual Mean Conc. (µg/m³)			Days PM_{10} >50 µg/m³	Annual Mean Conc. (µg/m³)			Days PM_{10} >50 µg/m³	Annual Mean Conc. (µg/m³)			Days PM_{10} >50 µg/m³	Annual Mean Conc. (µg/m³)			Days PM_{10} >50 µg/m³	NO_2	PM_{10}	$PM_{2.5}$
	NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$				
D36	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	23.6	13.9	9.1	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D40	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	18.3	12.3	8.2	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D42	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	17.9	13.9	9.8	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D43	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	17.3	13.7	9.7	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D45	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.0	13.0	8.7	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D46	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	15.7	13.5	9.4	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D49	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	21.6	13.2	8.9	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D50	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	21.0	13.0	8.7	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D51	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	21.9	13.3	8.9	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D52	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	15.8	13.6	9.4	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D56	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	23.0	15.4	10.6	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D57	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	17.3	13.8	9.7	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D58	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	17.0	13.7	9.7	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D61	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	24.4	14.2	9.3	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D62	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	13.9	12.0	8.0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D63	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	14.6	12.2	8.1	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D64	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	15.0	12.4	8.2	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D65	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	16.0	13.1	8.7	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D66	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	16.0	13.0	8.7	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D67	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	15.8	13.0	8.7	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D70	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	17.5	13.1	8.8	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D71	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	18.5	12.3	8.3	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D72	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	17.3	13.0	8.8	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A

ID	Existing Baseline (2018) Annual Mean Conc. (µg/m³)			Existing Baseline (2018) Days PM_{10} >50 µg/m³	Future Baseline (2037) Annual Mean Conc. (µg/m³)			Future Baseline (2037) Days PM_{10} >50 µg/m³	Preferred Option (2037) Annual Mean Conc. (µg/m³)			Preferred Option (2037) Days PM_{10} >50 µg/m³	Change Annual Mean Conc. (µg/m³)			Change Days PM_{10} >50 µg/m³	Impacts*		
	NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$
D73	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.9	12.6	8.5	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D86	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.6	12.6	8.4	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D88	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	17.9	12.1	8.2	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D89	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	21.2	13.5	9.0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D90	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	15.2	12.7	8.5	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D91	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	16.0	12.7	8.6	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D98	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	22.2	13.2	8.6	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D99	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	22.4	13.4	8.6	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D104	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20.5	12.6	8.2	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D105	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	21.8	13.0	8.4	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D111	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	21.2	13.6	8.9	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D113	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	22.7	14.0	9.2	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D114	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	25.8	14.8	9.6	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D115	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	21.1	13.1	8.7	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D116	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	22.9	14.1	9.2	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D118	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	22.0	13.7	9.0	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D119	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	25.7	14.5	9.5	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D120	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.0	12.9	8.6	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D123	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	24.2	14.3	9.3	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D124	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	29.4	14.9	9.7	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D125	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20.4	13.1	8.7	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D126	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	21.9	14.0	9.4	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D127	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	29.7	15.8	10.4	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A

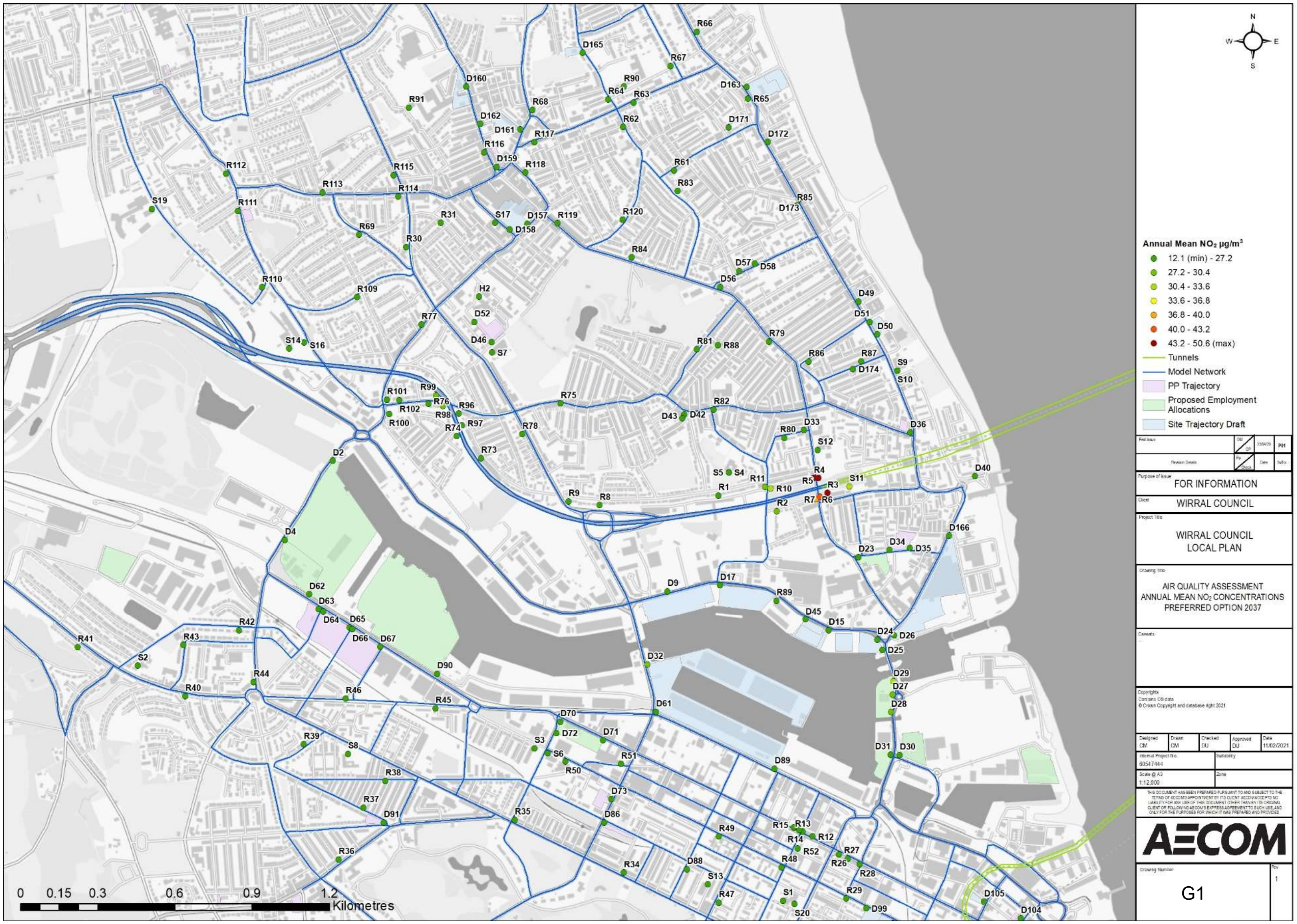
ID	Existing Baseline (2018) Annual Mean Conc. (µg/m³)			Existing Baseline (2018) Days PM_{10} >50 µg/m³	Future Baseline (2037) Annual Mean Conc. (µg/m³)			Future Baseline (2037) Days PM_{10} >50 µg/m³	Preferred Option (2037) Annual Mean Conc. (µg/m³)			Preferred Option (2037) Days PM_{10} >50 µg/m³	Change Annual Mean Conc. (µg/m³)			Change Days PM_{10} >50 µg/m³	Impacts*		
	NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$
D128	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	24.2	14.6	9.5	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D129	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	27.6	15.7	10.2	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D130	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	21.4	13.7	9.0	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D131	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.1	13.0	8.6	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D132	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	18.2	12.7	8.5	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D136	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	17.5	13.2	9.0	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D138	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	22.6	14.7	9.8	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D139	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	16.6	12.7	8.7	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D141	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.9	13.6	9.2	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D143	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	17.0	13.8	9.5	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D145	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	24.3	16.4	10.9	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D146	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20.3	14.0	9.4	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D147	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	22.6	15.8	10.6	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D151	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	22.4	14.5	9.7	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D154	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	16.0	13.6	9.4	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D155	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	15.7	12.5	8.5	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D157	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	22.6	15.6	10.6	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D158	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	22.3	15.5	10.5	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D159	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	24.2	14.5	10.0	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D160	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	16.8	13.4	9.3	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D161	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	17.7	13.5	9.4	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D162	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	15.8	13.0	9.1	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D163	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.0	13.9	9.5	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A

ID	Existing Baseline (2018) Annual Mean Conc. (µg/m³)			Existing Baseline (2018) Days PM_{10} >50 µg/m³	Future Baseline (2037) Annual Mean Conc. (µg/m³)			Future Baseline (2037) Days PM_{10} >50 µg/m³	Preferred Option (2037) Annual Mean Conc. (µg/m³)			Preferred Option (2037) Days PM_{10} >50 µg/m³	Change Annual Mean Conc. (µg/m³)			Change Days PM_{10} >50 µg/m³	Impacts*		
	NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$		NO_2	PM_{10}	$PM_{2.5}$
D165	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	15.2	12.8	9.0	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D166	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	21.9	13.3	8.8	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D167	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	24.1	14.8	9.6	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D168	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	23.8	14.6	9.5	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D169	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	15.8	13.4	9.2	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D170	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	18.0	13.2	9.0	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D171	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	15.0	12.5	8.7	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D172	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.1	13.9	9.5	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D173	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	23.2	15.5	10.7	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D174	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	18.3	12.1	8.2	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D175	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	30.3	15.6	10.3	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D176	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20.3	13.5	9.1	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D177	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20.2	13.0	8.6	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Z2_Development_2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	25.5	13.0	8.6	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Z2_Development_3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	15.8	10.8	7.3	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Z2_Development_5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	16.9	11.0	7.4	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A

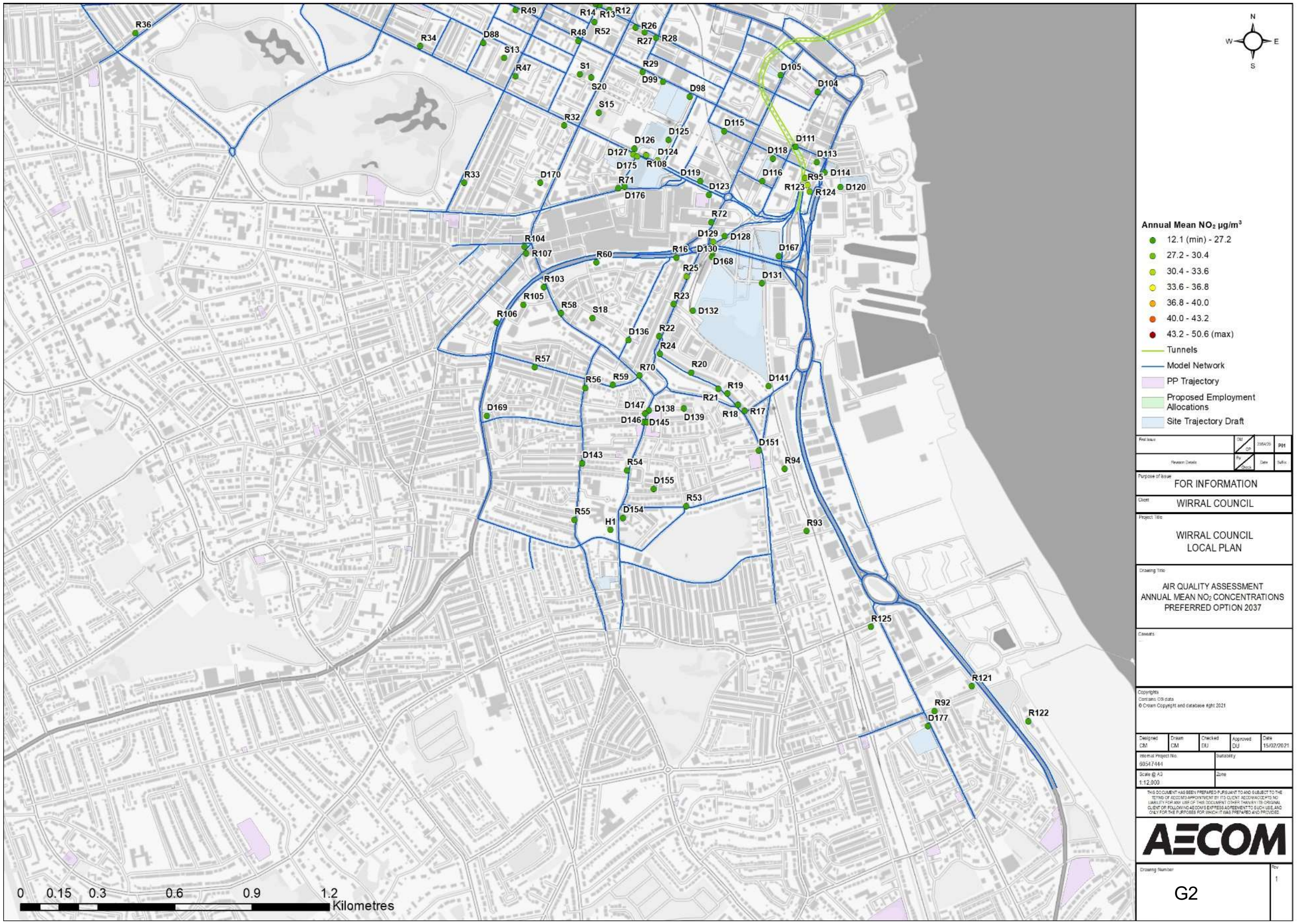
Bold, red text indicates exceedances of the objectives.

* The impact descriptors have been derived with reference to the IAQM/EPUK methodology for local development planning. This guidance was not explicitly intended for use in strategic assessment but provides context for the magnitude and significance of the predicted local air quality effects.

Appendix G Detailed Model Results Plots



N
W
E
S
Annual Mean NO_2 µg/m³
12.1 (min) - 27.2
27.2 - 30.4
30.4 - 33.6
33.6 - 36.8
36.8 - 40.0
40.0 - 43.2
43.2 - 50.6 (max)
Tunnels
Model Network
PP Trajectory
Proposed Employment Allocations
Site Trajectory Draft
FOR INFORMATION
WIRRAL COUNCIL
WIRRAL COUNCIL LOCAL PLAN
AIR QUALITY ASSESSMENT
ANNUAL MEAN NO_2 CONCENTRATIONS
PREFERRED OPTION 2037
AECOM
G1
0 0.15 0.3 0.6 0.9 1.2
Kilometres


N
W
E
S
Annual Mean NO₂ µg/m³
12.1 (min) - 27.2
27.2 - 30.4
30.4 - 33.6
33.6 - 36.8
36.8 - 40.0
40.0 - 43.2
43.2 - 50.6 (max)
Tunnels
Model Network
PP Trajectory
Proposed Employment Allocations
Site Trajectory Draft
FOR INFORMATION
WIRRAL COUNCIL
WIRRAL COUNCIL LOCAL PLAN
AIR QUALITY ASSESSMENT
ANNUAL MEAN NO₂ CONCENTRATIONS
PREFERRED OPTION 2037
AECOM
G2
0 0.15 0.3 0.6 0.9 1.2
Kilometres


N
W
E
S
Z2_19
Z2_18
Z2_13
Z2_7
Z2_14
Z2_1
Z2_15
Z2_9
Z2_6
Z2_10
Z2_5
Z2_8
Z2_2
Z2_11
Z2_12
Z2_Development_3
Z2_3
Z2_4
Z2_Development_5
Z2_Development_2
Z2_16
Z2_17
0 0.05 0.1 0.2 0.3 0.4
Kilometres
Annual Mean NO₂ µg/m
12.1 (min) - 27.2
27.2 - 30.4
30.4 - 33.6
33.6 - 36.8
36.8 - 40.0
40.0 - 43.2
43.2 - 50.6 (max)
Tunnels
Model Network
PP Trajectory
Proposed Employment Allocations
Site Trajectory Draft
FOR INFORMATION
WIRRAL COUNCIL
WIRRAL COUNCIL LOCAL PLAN
AIR QUALITY ASSESSMENT
ANNUAL MEAN NO₂ CONCENTRATIONS
PREFERRED OPTION 2037
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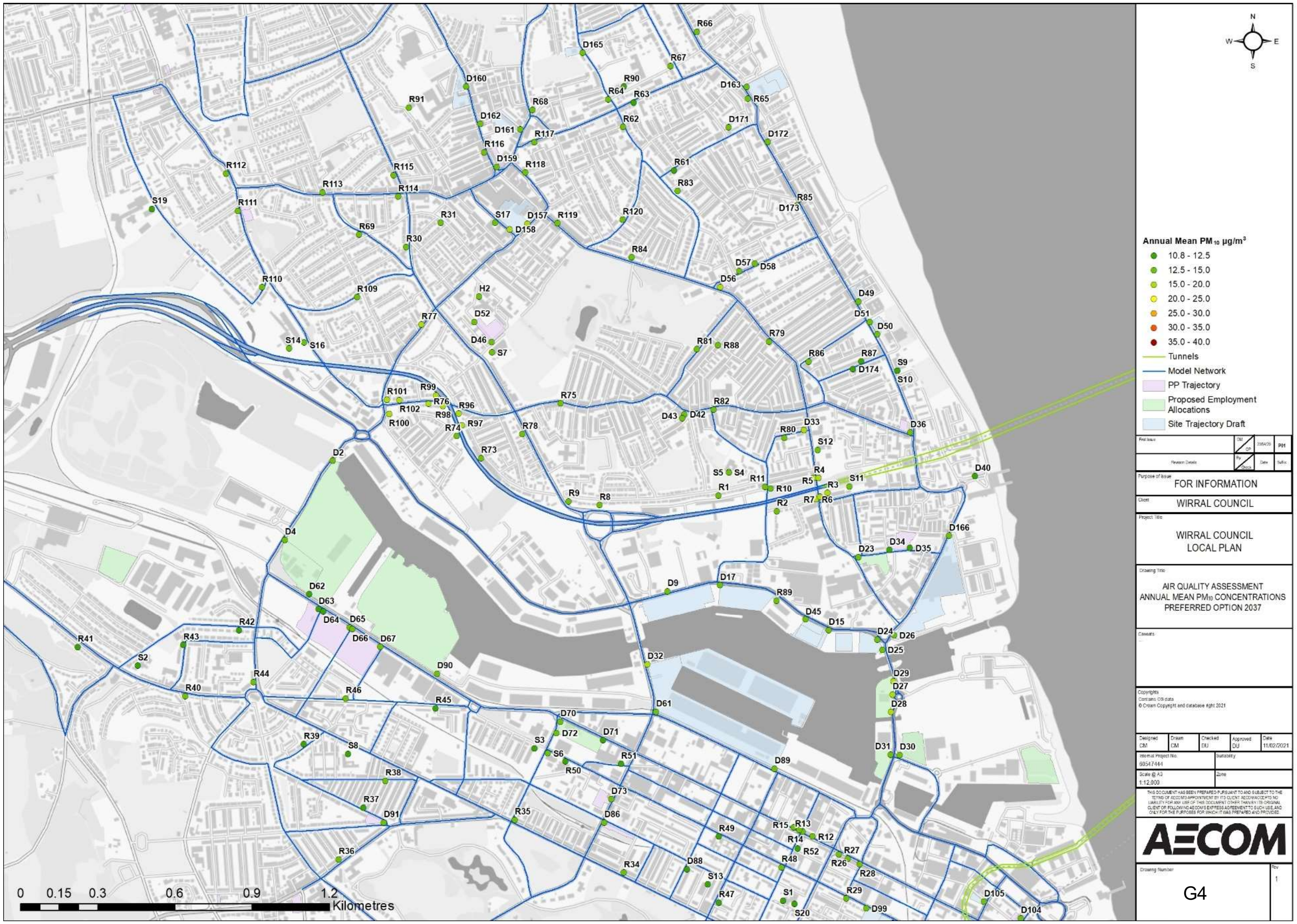
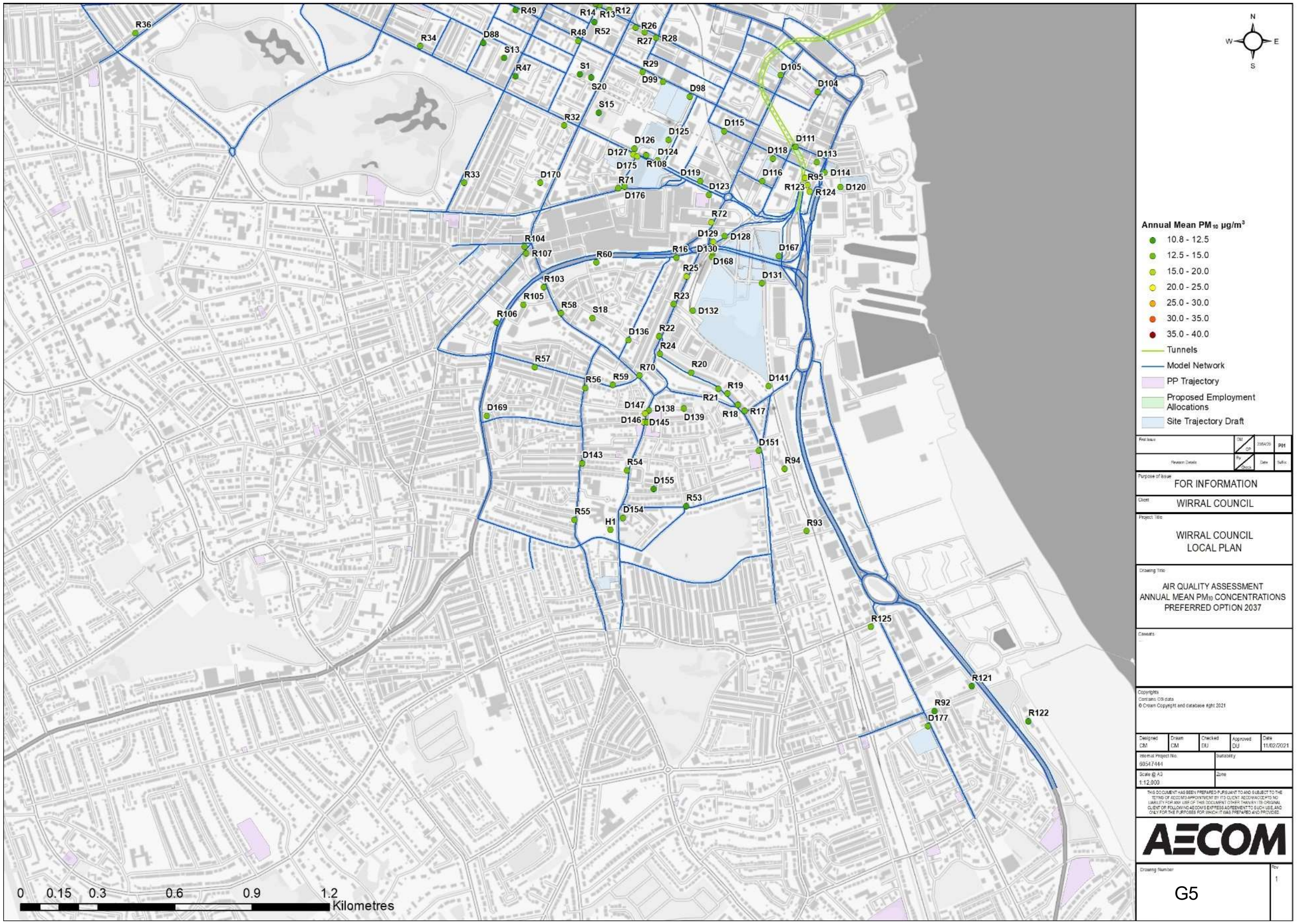
AECOM
G3


Annual Mean PM10 µg/m³
10.8 - 12.5
12.5 - 15.0
15.0 - 20.0
20.0 - 25.0
25.0 - 30.0
30.0 - 35.0
35.0 - 40.0
Tunnels
Model Network
PP Trajectory
Proposed Employment Allocations
Site Trajectory Draft
FOR INFORMATION
WIRRAL COUNCIL
WIRRAL COUNCIL LOCAL PLAN
AIR QUALITY ASSESSMENT ANNUAL MEAN PM10 CONCENTRATIONS PREFERRED OPTION 2037
AECOM
G4
0 0.15 0.3 0.6 0.9 1.2 Kilometres


Annual Mean PM$_{10}$ µg/m^3
10.8 - 12.5
12.5 - 15.0
15.0 - 20.0
20.0 - 25.0
25.0 - 30.0
30.0 - 35.0
35.0 - 40.0
Tunnels
Model Network
PP Trajectory
Proposed Employment Allocations
Site Trajectory Draft
0 0.15 0.3 0.6 0.9 1.2 Kilometres
FOR INFORMATION
WIRRAL COUNCIL
WIRRAL COUNCIL LOCAL PLAN
AIR QUALITY ASSESSMENT ANNUAL MEAN PM$_{10}$ CONCENTRATIONS PREFERRED OPTION 2037
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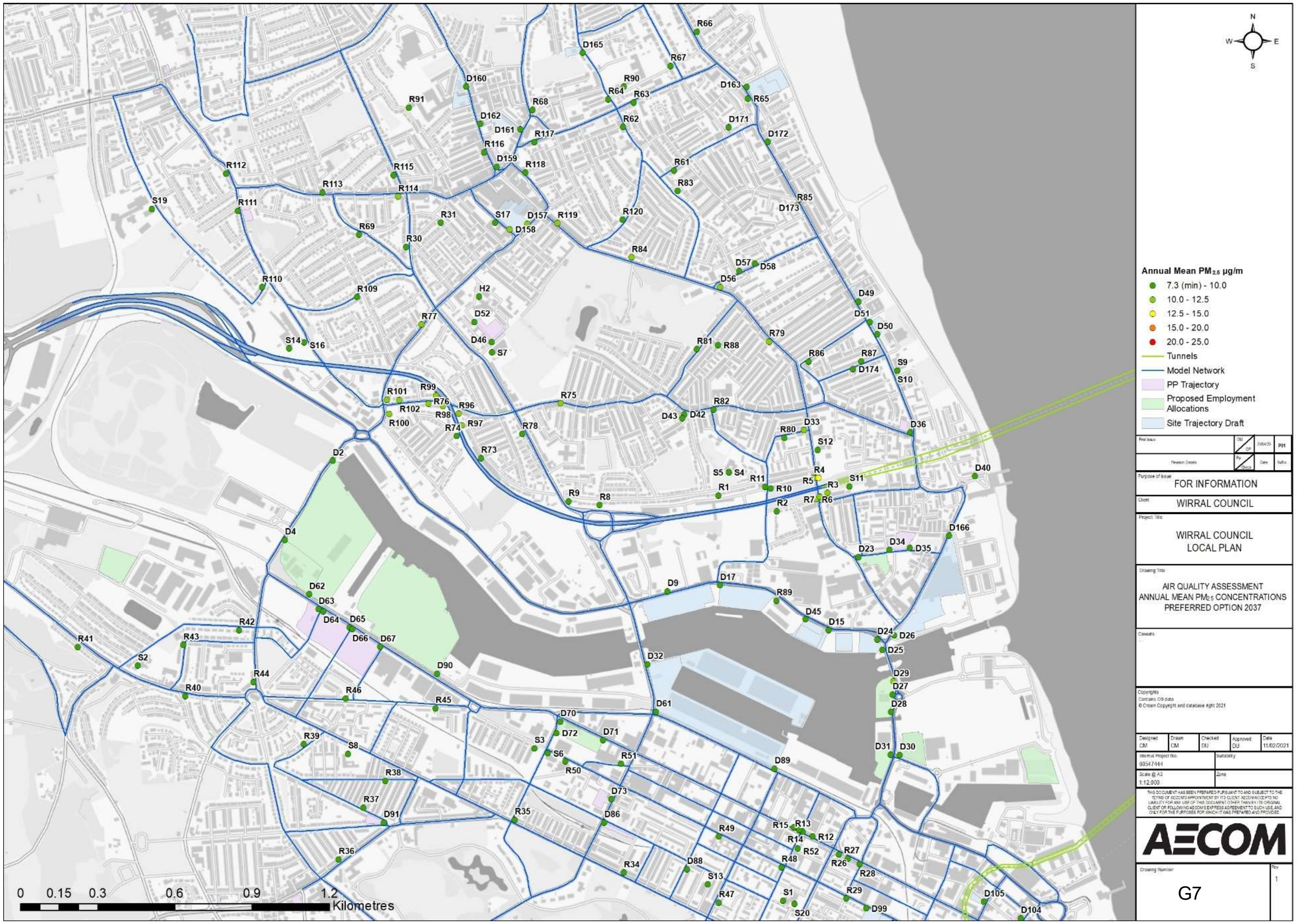
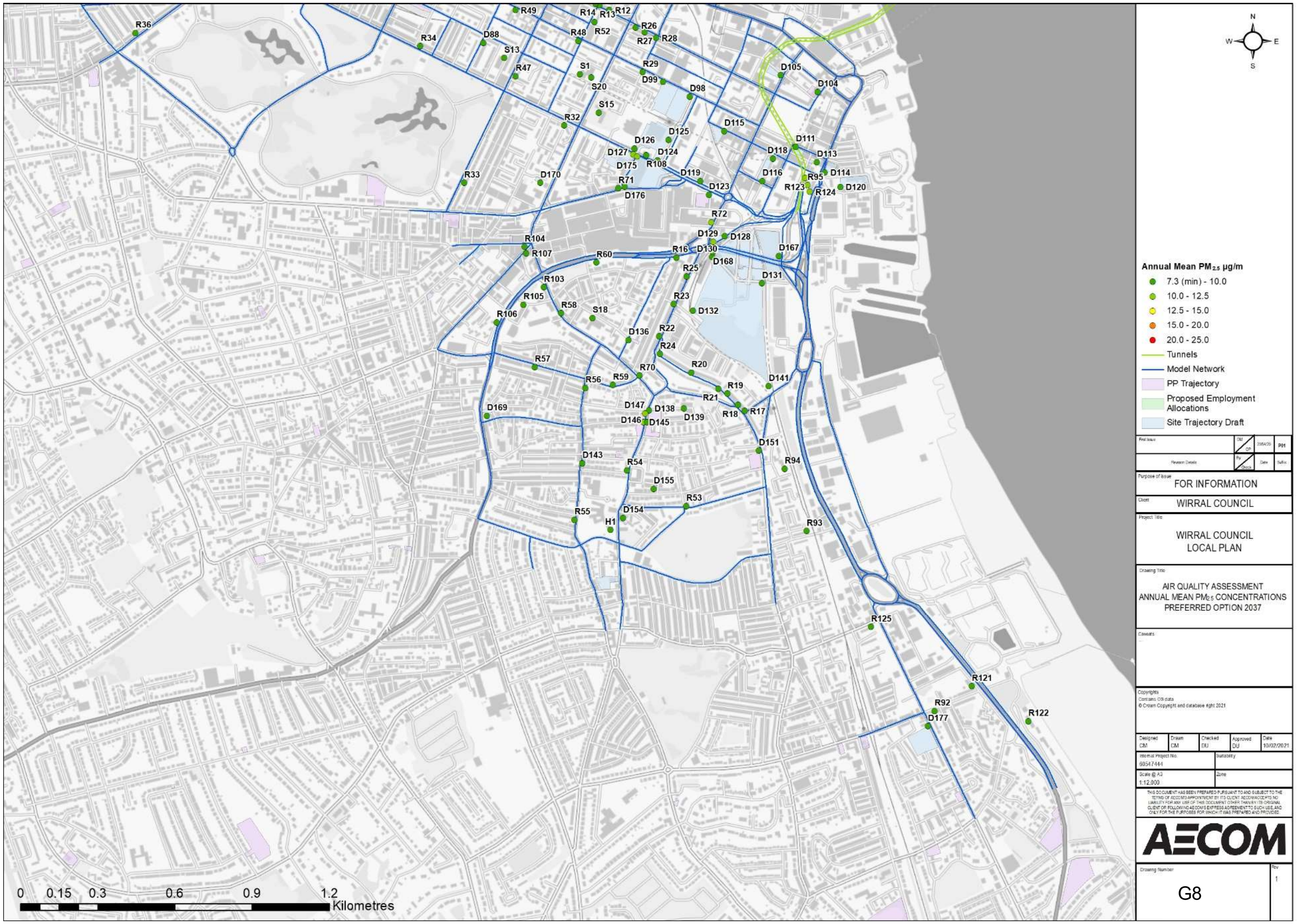
AECOM
G5

Z2_18
Z2_19
Z2_13
Z2_7
Z2_14
Z2_15
Z2_1
Z2_9
Z2_6
Z2_10
Z2_5
Z2_8
Z2_2
Z2_11
Z2_12
Z2_4
Z2_3
Z2_Development_3
Z2_Development_5
Z2_Development_2
Z2_16
Z2_17
G5
0.1 0.2 0.3 0.4
Kilometres
N
W
E
S
Annual Mean PM10 µg/m3
10.8 - 12.5
12.5 - 15.0
15.0 - 20.0
20.0 - 25.0
25.0 - 30.0
30.0 - 35.0
35.0 - 40.0
Tunnels
Model Network
PP Trajectory
Proposed Employment Allocations
Site Trajectory Draft
First Issue
Revision Details
Date
Suffix
Purpose of issue
FOR INFORMATION
Client
WIRRAL COUNCIL
Project Title
WIRRAL COUNCIL
LOCAL PLAN
Drawing Title
AIR QUALITY ASSESSMENT
ANNUAL MEAN PM10 CONCENTRATIONS
PREFERRED OPTION 2037
Caveats
AECOM
G6


Annual Mean PM2.5 µg/m
7.3 (min) - 10.0
10.0 - 12.5
12.5 - 15.0
15.0 - 20.0
20.0 - 25.0
Tunnels
Model Network
PP Trajectory
Proposed Employment Allocations
Site Trajectory Draft
FOR INFORMATION
WIRRAL COUNCIL
WIRRAL COUNCIL LOCAL PLAN
AIR QUALITY ASSESSMENT ANNUAL MEAN PM2.5 CONCENTRATIONS PREFERRED OPTION 2037
AECOM
G7
0 0.15 0.3 0.6 0.9 1.2 Kilometres


Annual Mean PM2.5 µg/m
7.3 (min) - 10.0
10.0 - 12.5
12.5 - 15.0
15.0 - 20.0
20.0 - 25.0
Tunnels
Model Network
PP Trajectory
Proposed Employment Allocations
Site Trajectory Draft
N
S
W
E
FOR INFORMATION
WIRRAL COUNCIL
WIRRAL COUNCIL LOCAL PLAN
AIR QUALITY ASSESSMENT ANNUAL MEAN PM2.5 CONCENTRATIONS PREFERRED OPTION 2037
AECOM
G8
0 0.15 0.3 0.6 0.9 1.2
Kilometres


N
W
E
S
Z2_19
Z2_18
Z2_13
Z2_7
Z2_14
Z2_1
Z2_15
Z2_9
Z2_6
Z2_10
Z2_5
Z2_8
Z2_2
Z2_11
Z2_12
Z2_3
Z2_4
Z2_Development_3
Z2_Development_5
Z2_Development_2
Z2_16
Z2_17
0 0.05 0.1 0.2 0.3 0.4
Kilometres
Annual Mean PM2.5 µg/m³
7.3 (min) - 10.0
10.0 - 12.5
12.5 - 15.0
15.0 - 20.0
20.0 - 25.0
Tunnels
Model Network
PP Trajectory
Proposed Employment Allocations
Site Trajectory Draft
First Issue
P01
Revision Details
By
Check
Date
Suffix
Purpose of issue
FOR INFORMATION
Client
WIRRAL COUNCIL
Project Title
WIRRAL COUNCIL
LOCAL PLAN
Drawing Title
AIR QUALITY ASSESSMENT
ANNUAL MEAN PM2.5 CONCENTRATIONS
PREFERRED OPTION 2037
Caveats
Copyrights
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Designed CM
Drawn CM
Checked DU
Approved DU
Date 10/02/2021
Internal Project No. 60547444
Suitability
Scale @ A3 1:5,000
Zone
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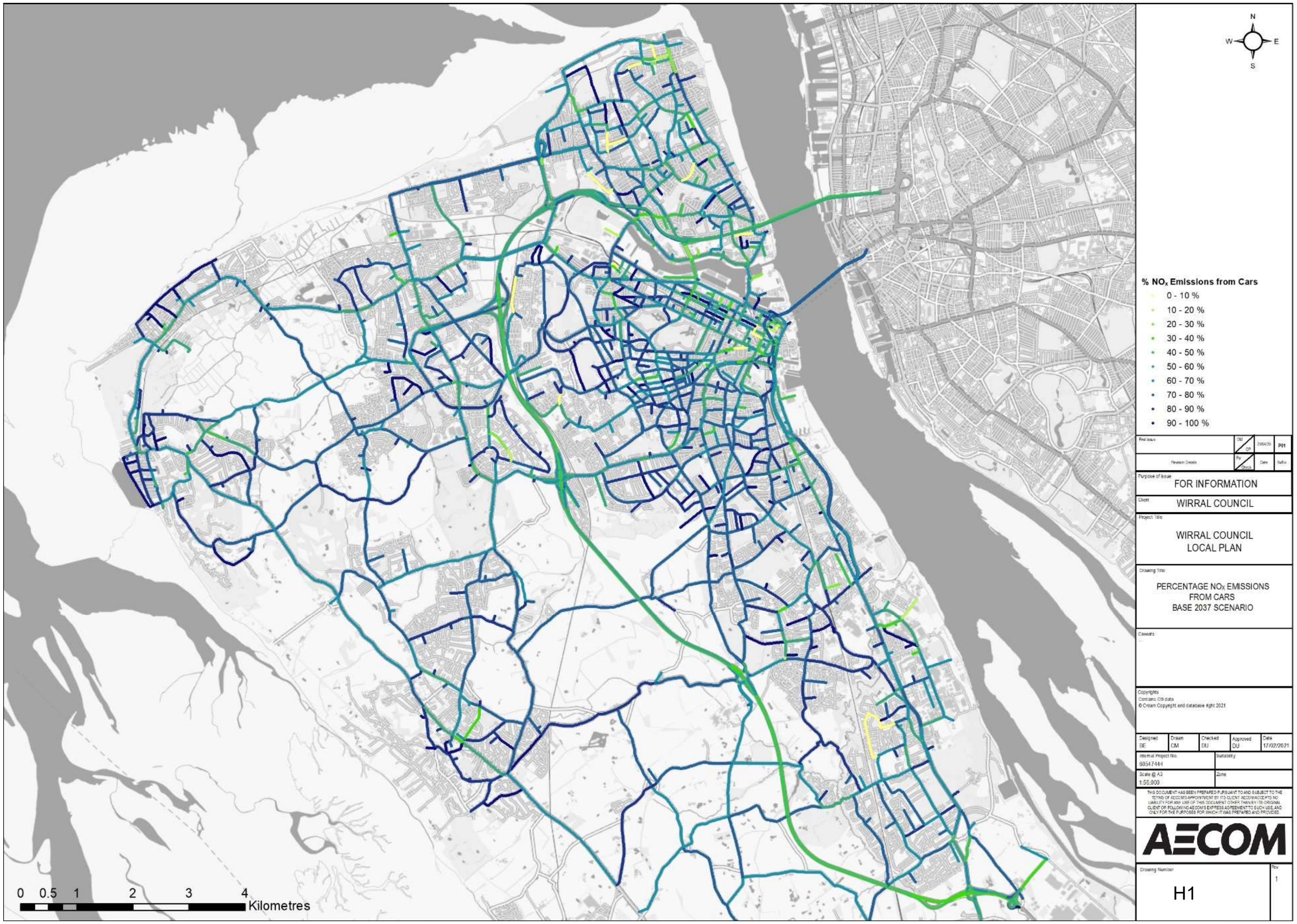
Rev
1

Appendix H Source Apportionment


N
W
E
S
% NO_x Emissions from Cars
0 - 10 %
10 - 20 %
20 - 30 %
30 - 40 %
40 - 50 %
50 - 60 %
60 - 70 %
70 - 80 %
80 - 90 %
90 - 100 %
0 0.5 1 2 3 4
Kilometres
First Issue
P01
Revision Details
Date
Suffix
Purpose of issue
FOR INFORMATION
Client
WIRRAL COUNCIL
Project Title
WIRRAL COUNCIL
LOCAL PLAN
Drawing Title
PERCENTAGE NO_X EMISSIONS
FROM CARS
BASE 2037 SCENARIO
Caveats
Copyrights
Contains OS data
© Crown Copyright and database right 2021
Designed BE
Drawn CM
Checked DU
Approved DU
Date 17/02/2021
Internal Project No. 60547444
Suitability
Scale @ A3 1:55,000
Zone
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Drawing Number
H1
Rev
1


N
W
E
S
% NOx Emissions from HGVs
0 - 10 %
10 - 20 %
20 - 30 %
30 - 40 %
40 - 50 %
50 - 60 %
60 - 70 %
70 - 80 %
80 - 90 %
90 - 100 %
0 0.5 1 2 3 4
Kilometres
First Issue
P01
Revision Details
By
Check
Date
Suffix
Purpose of issue
FOR INFORMATION
Client
WIRRAL COUNCIL
Project Title
WIRRAL COUNCIL
LOCAL PLAN
Drawing Title
PERCENTAGE NOx EMISSIONS
FROM HEAVY GOODS VEHICLES
BASE 2037 SCENARIO
Caveats
Copyrights
Contains OS data
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Designed BE
Drawn CM
Checked DU
Approved DU
Date 17/02/2021
Internal Project No. 60547444
Suitability
Scale @ A3 1:55,000
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