Sefton Clean Air Zone Feasibility Study

Sefton Metropolitan Borough Council

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1. Executive Summary

AECOM was appointed by Sefton Metropolitan Borough Council (SMBC) to undertake a detailed study of local air quality, to determine future baseline conditions of both nitrogen dioxide (NO_2) and fine particulate matter ($PM_{10}/_{2.5}$), and to understand the extent of the air quality challenge the borough faces and the improvements required. The study determines how the implementation of a Clean Air Zone (CAZ) could reduce emissions and contribute to improvements in local air quality, health and wellbeing of the local population.

The study included collection and analysis of Automatic Number Plate Recognition (ANPR) data to determine the age profile of the regional fleet and to assign an emissions profile, and to inform both the detailed modelling and a source apportionment study to determine the road transport major emission sources.

The whole Borough was modelled to identify all areas of concern with regard to poor air quality and to identify where the designation of a CAZ may have the greatest benefits or risks, within and outside the designated area.

High concentrations of NO_2 and PM_{10} were identified near major road junctions where there is regular queuing and congestion. The main emissions components in the majority of areas were diesel cars, but in specific areas with high concentrations there were also significant contribution from specific Euro-classifications within the van, HGV and bus fleets.

The highest concentrations were predicted to occur near the major junctions on the A5036, and exceedances were also predicted to occur at the A565 junction with the A5057, and the A565 junction with the A5058. No other areas of exceedance were identified, although relatively high roadside concentrations were predicted near junctions on Merton Road and Stanley Road. To the north of Bootle, relatively high concentrations were predicted in Crosby at the junction of A565 with South Road, and in Maghull at the junction of Westway and Liverpool Road. The majority of the areas of exceedance were outside the boundaries of the designated AQMAs, although they were clustered in the areas of known concern.

Several modelling scenarios were used to predict the effects of implementing a Clean Air Zone that encompasses the whole Borough, and the results appraised with regard to the predicted pollutant concentrations at sensitive locations. The scenario testing was used to inform the discussion of the potential effects resulting from a CAZ, and the risks and opportunities in terms of public exposure, inclusion and accessibility.

The emissions reduction achieved by targeting buses (CAZ type A) and HGVs (CAZ type B) mainly affect specific road links where these vehicles types are a dominant emission source, such as the A5036. However, the CAZ scenarios that include both vans (CAZ type C) and cars (CAZ type D) were predicted to have a more dispersed effect and would lead to more complex effects within, and outside, the extent of a designated CAZ.

Locations where specifically high annual mean NO_2 concentrations were predicted included: near the major junctions on the A5036; the A565 junction with A5057; and the junction with A5058 near Millers Bridge.

The model determined the number of properties would decrease significantly between a CAZ-A and CAZ-B, with relatively marginal improvements in CAZ-C and CAZ-D scenarios, with the largest changes predicted to occur on the A5036. Therefore, a CAZ that targets HGVs accessing the port by including the main access routes (i.e. the A5036 or A565), or a small area near the port, would achieve potentially significant benefits in terms of emissions reductions whilst minimising the likelihood of redistribution effects onto local roads.

The model also predicted there may be residual areas of high pollution concentrations, even with a CAZ-D (all vehicles) implemented across the borough. A CAZ may be complemented using screening or barriers in discrete areas where persistent high concentrations occur, where it may be used to promote sustainability using green infrastructure.

The implementation of any type of CAZ was predicted to reduce emissions within the defined zone, although there would be potential detrimental effects due to journey redistribution outside the zone. Therefore, it is recommended that behavioural demand modelling should be undertaken to properly understand how vehicle operators will respond and to ensure that such effects are minimised.

The direct public health costs would be potentially very significant in terms of health and socio-economic effects; both detrimental and beneficial.

2. Introduction

AECOM was appointed by Sefton Metropolitan Borough Council (SMBC) in January 2018 to undertake a detailed study of local air quality, to determine future baseline conditions of both nitrogen dioxide (NO_2) and fine particulate matter ($PM_{10}/_{2.5}$), and to understand the extent of the air quality challenge the borough faces and the improvements required. The study determines how the implementation of a Clean Air Zone (CAZ) could reduce emissions and contribute to improvements in local air quality, health and wellbeing of the local population.

2.1 The importance of good air quality

Good air quality is essential for a healthy population. Air pollution is now recognised as the greatest environmental risk to human health in the UK. In Sefton, it ranks third behind tobacco, and diet/weight related risk in terms of the contribution it makes to deaths from heart disease, lung disease and cancer, whereby both short-term and long-term exposure to air pollution affects health by shortening lives and contributing to chronic illness.

Air pollution also has direct impacts on the natural environment, such as contributing to climate change, damaging sensitive habitats, and reducing crop yields.

Taking action to improve air quality is good for the economy, through making a region a better place to live and work.

2.2 What is air quality currently like in Sefton?

The main contributor to poor air quality in Sefton is road vehicles, and so specific problem areas are found where traffic density is higher, and specifically in areas very close to busier and more congested roads. Air pollution levels drop off rapidly with distance from the source, and hence air quality tends to be much better at increasing distance from roads. The port is also an important emission source, in terms of both direct emissions from shipping and shore-side equipment, but also vehicles accessing and servicing the site. With the major expansion currently taking place at the Port of Liverpool, air pollution associated with vehicles accessing the port is a specific local concern, and includes parts of the A5036 and A565, which form the main transport links between the Port of Liverpool and the M57, M58 and M62.

The pollutant of most concern in Sefton, in terms of national and European targets, is nitrogen dioxide (NO_2). This is typical of most urban areas throughout the UK. However, fine particulate matter, known to cause health problems, is also a concern; whilst national and European targets are currently met, the Government has expressed its intention to tighten the target for very fine particulate material (referred to as $PM_{2.5}$) to match World Health Organisation guidelines, in recognition of the health threat of $PM_{2.5}$. Particulate matter is a complex atmospheric pollutant resulting from combustion, but also from road/tyre/brake wear, and other sources such as agriculture and sea-salt, where the associated health effects vary depending on the chemical composition and particle shape.

The problem of elevated NO_2 and PM_{10} levels close to busy roads has been recognised by the designation of four Air Quality Management Areas (AQMAs) near key junctions where monitoring and modelling have identified persistent high concentrations of NO_2 (see Figure A.39). There is also concern that without further action, these areas may not secure compliance with the National Air Quality Strategy (NAQS) objective and new areas may become non-compliant.

2.3 What is being done to improve air quality?

The Council is committed to reducing the exposure of residents to poor air quality in order to improve health and wellbeing. Action Plans have been implemented that target areas with high pollutant concentrations, and whilst these have achieved some success it is recognised that further strategic interventions may be necessary to maintain good air quality and to further promote health and wellbeing.

As the majority of practical interventions have already been implemented through the Action Plans; SMBC are now exploring the feasibility of a Clean Air Zone (CAZ). The establishment of a CAZ has been recognised as a possible tool for improving local air quality, but one which will require careful research to identify the economic, social and environmental impacts (positive and negative).

A Clean Air Zone (CAZ), can have two forms, non-charging or charging, and can be defined as either, (a) a geographical extent for action to improve air quality, or (b) people are required to pay a charge to enter or to move within the zone if they are driving a vehicle that does not meet the particular standard for their vehicle type in that zone. The latter type of CAZ may also be considered a Low Emissions Zone (LEZ).

2.4 Report Structure

The purpose of the feasibility study was essentially to determine, through analysis, an understanding of current and future air quality in Sefton and whether the implementation of a Clean Air Zone(s) would be feasible and how it would benefit Sefton in achieving an improvement in air quality in its AQMAs and elsewhere. The report is structured as follows:

- Section 2: Guidance and Legislation, including the Defra Plan
- Section 3: Baseline Air Quality; review of existing conditions and discussion of the effectiveness of existing policies and interventions, and potential additional interventions.
- Section 4: Traffic Data; explanation of the traffic data used for the modelling assessments.
- Section 5: Existing and Future Baseline – Air Quality Modelling Methodology. Dispersion Modelling Assessment methodology to determine pollutant concentrations at kerbside.
- Section 6: Existing and Future Baseline – Air Quality Modelling Results: pollutant concentrations were predicted at kerbside locations to enable comparisons with national objective in the base year and future years.
- Section 7: Existing and Future Baseline – Emissions Modelling. A source apportionment study was undertaken for the base year and future years to understand how the fleet composition will change over time so as to identify the vehicle types the CAZ needs to target.
- Section 8: CAZ Emissions Assessment
- Section 9: Implementation of a CAZ
- Section 10: Social- Economic Effects
- Section 11: Conclusions

3. Guidance and Legislation

The principal air quality legislation within the United Kingdom is the Air Quality Standards Regulations 2010 (as amended by the Air Quality Standards (Amendment) Regulations 2016), which transposes relevant EU Air Quality Directives into national legislation and sets legally binding limits for concentrations in outdoor air of major air pollutants that impact public health such as particulate matter (PM_{10} and $PM_{2.5}$) and nitrogen dioxide (NO_2). The following section outlines how this is implemented in the UK.

3.1 National Air Quality Legislation

The provisions of Part IV of the Environment Act 1995 (H.M. government, 1995) 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) (Defra, 2007) and the Air Quality Standards Regulations 2010 (Defra, 2010) (henceforth referred to as 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. Traditionally this is done through Air Quality Action Plans.

The UK AQS (AQS) (Defra, 2007) identifies nine ambient air pollutants that have the potential to cause harm to human health. 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. Table 1 provides the national air quality objectives for NO_2 and particulate matter as these are the pollutants of concern in SMBC.

The health effects of the primary pollutants of concern (NO_2 and $PM_{10/2.5}$) are discussed in Section 11.1.

Table 1. National Air Quality Objectives

Pollutant	*Objective*	*Concentration Measured as*
NO_2	200µg/m³ not to be exceeded more than 18 times a year	1 hour Mean
	40 µg/m³	Annual Mean
PM_{10}	50 µg/m³ not to be exceeded more than 35 times a year	24 hour mean
	40 µg/m³	Annual Mean
$PM_{2.5}$	25 µg/m³	Annual Mean to be achieved by 2020
	10 µg/m³	Annual Mean to be achieved by 2025 to reduce the number of people living in locations above the WHO guideline level by 50%.

3.2 Sefton Metropolitan Borough Council Air Quality Action Plan

The Council has implemented a number of actions in recent years to improve air quality in the AQMAs and across the borough as either targeted site-specific measures or general measures[1]:

- A package of measures contained within the A565 Route Management Strategy and Action Plan, which includes junction improvements to the South Road/Crosby Road North/ Haigh Road, Waterloo junction.
- Hurry Call traffic management system to allow HGVs through the Millers Bridge/ Derby Road traffic lights without having to stop/start on the incline at Millers Bridge, thus reducing pollution from this vehicle type.

[1] Sefton MBC (2018) Local Air Quality Management Annual Status Report 2018

- Effective regulatory control and monitoring of industrial sites within the Port of Liverpool to minimise their impact on PM_{10} levels.
- A study on HGVs using the A5036, to gain information on destination, age of vehicle & Euro emission standard.
- HGV booking system to improve movement of HGVs within the Port of Liverpool, and hence minimise emissions.
- ECO Stars fleet recognition scheme to improve emissions from HGV fleet operators using roads in Sefton (including Sefton Council's own fleet of vehicles).
- Port expansion mitigation measures. These include a Defra funded study looking at an alternative fuels strategy (AFS) for HGVs and buses in Sefton and the Liverpool City Region (LCR), rather than using diesel as a fuel.
- An HGV parking demand study.

These measures have achieved some improvements in local air quality, although long-term trends have not changed significantly, and it is recognised they may have limited scope to achieve significant further benefits. Therefore, without further actions, such as the implementation of a CAZ, the areas of Sefton which are currently experiencing pollutant concentrations above the objectives are unlikely to secure compliance with NAQS objectives.

3.3 Additional Measures

This study has considered a number of potential measures that may be implemented to complement, or in-place of a CAZ, with consideration to the magnitude of air quality affects that a CAZ may achieve and the economic and political commitment that would be required to implement such measures.

3.3.1 Infrastructure Changes

The highest roadside pollutant concentrations have been identified near the major junctions on the A5036 between the port and the Switch Island interchange, and around Millers Bridge at the junction of Derby Road and Balliol Road, which is subject to planned engineering works. However, this is a strategic trunk-road under the responsibility of Highways England, and so it was determined that SMBC have very limited opportunity to make major physical changes to the route.

3.3.2 Freight Regulation

The predominant emission source from road traffic on the A5036 was predicted to be HGVs and diesel cars. Therefore, consideration was made to restriction and control of HGV movements.

The potential opportunities to regulate HGVs, excluding CAZ, were based on:

- Freight consolidation;
- Freight convoys and strict control of HGVs on major corridors; and
- UTMC controls and dedicated lanes.

These options were not considered to be feasible without statutory regulatory powers along with support and engagement from private groups to ensure it can be technically implemented.

3.3.3 UTMC

The Urban Traffic Management System (UTMC) is employed to regulate the traffic flow at key junctions to minimise journey time, with concurrent reductions in queuing and congestion.

The opportunities to prioritise local air quality over journey time were discussed with the UTMC managers, and it was determined there was not sufficient capacity in the network to undertake any meaningful changes.

3.3.4 Screening and Barriers

A number of studies have been undertaken nationally that indicate the potential efficacy of various types of screening and barriers in reducing concentrations of pollution resultant from road emissions[2].

Where local planting is installed at roadside it can be used to interrupt the exposure pathway and substantially alter the dispersion of emissions by effectively acting as a barrier[3]. The porosity and surface roughness of a barrier will affect how air moves around and through the planting on a micro-scale, which regulates the rate of deposition and absorption of pollutants. Birmingham and Lancaster Universities have concluded green walls were the most effective at removing pollutants relative to vegetation in other locations and that significant affects could be achieved on a street-by-street basis. The study found that for roads with street-canyon characteristics 100% covered in vegetation, at roadside locations annual mean NO_2 and PM_{10} could decrease by as much as 40% and 60% respectively.

The efficiency of planting, either as a barrier or a wall, is highly dependent on a number of variables including the species of vegetation, the vegetation coverage, the wind speeds and the shape of road canyons. There are also risks to the implementation of individual schemes, such as preserving sight-lines for drivers and pedestrians, and ensuring that planting (and any associated debris) does not encroach onto the highway.

Further considerations may apply to such barriers, such as road safety and visibility, as well as the complex physical design of the barrier that would likely entail fluid dynamics modelling to ensure it was effective. The timescales would also be a factor, with consideration to the detailed design and construction time relative to the projected compliance year. It is therefore necessary to assess the practicalities of any roadside screening or barrier schemes on a case by case basis to ensure effectiveness and long-term sustainability.

3.3.5 Driver Training

Driver training has been shown in a number of studies to reduce fuel consumption by around 5%[4] and this is likely to in turn reduce NO_X emissions. Sefton MBC subscribe to the Ecostars[5] driver training programme, which includes a focus on driving training and performance for Council staff and partner organisations.

Quantifying the emissions effect is difficult as it depends on numerous factors such as terrain, weather and engine temperature. One study[6] estimated a reduction in emissions by as much as 8% and showed that drivers decreased the time spent in excessive speed and excessive engine speed by 24% and 38% respectively. A reduction in the number of events such as extreme accelerations and decelerations was also observed. The results indicated an average 4.8% fuel consumption decrease.

However, it should be noted that the study compared a control group and an experimental group and the control group were aware they were being monitored. This may mean that the control group would naturally look to increase the standard of driving as a result of the monitoring and so real world improvements could be even greater.

Where an 8% emissions reduction can be achieved, this would be significant in comparison with the other measures that have been identified, and would be good value in terms of the cost / benefit. However, the targeted fleet would need to be within the influence of the Council, such as buses, in order to reach a large group.

3.4 Development Planning and Regional Growth

The transport model used in the study incorporated projected regional growth, as well as increased port traffic on key routes. The data also included several significant developments near the A5036, including Atlantic Park,

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[2] Anja H. Tremper and David C. Green (2018) The impact of a green screen on concentrations of nitrogen dioxide at Bowes Primary School, Enfield, Kings College, London
[3] Birmingham University (Kessler R, http://ehp.niehs.nih.gov/121-a14/ (accessed January 2016)
[4] Beusen, B., et al. (2009). Using on-board logging devices to study the longer-term impact of an eco-driving course. Transportation Research
Zarkadoula, M., Zoidis, G., & Tritopoulou, E. (2007). Training urban bus driver
pilot program. Transportation Research Part D, Volume 12 (pp. 449-541).
Part D: Transport and Environment, Volume 14, Issue 7, October 200 (pp. 514-520)
[5] https://www.ecostars-uk.com/
[6] Rolim et al (2014) Impacts of on-board devices and training on Light Duty Vehicle Driving Behaviour, Procedia - Social and Behavioural Sciences 111 (2014) 711 – 720

Chancery Gate, Senate Business Park, housing on the former St Wilfs School and industrial uses on Heysham Road.

3.4.1 Joint Air Quality Unit

Defra and DfT operate a combined resource called the Joint Air Quality Unit (JAQU), which supports local authorities that have road links that have been predicted to contribute to exceedances of the annual mean NO_2 EU limit value. These 'non-compliance' links were identified by JAQU through a national modelling study, but it is recognised that local data is essential to verify and refine the predicted conditions. CAZ feasibility studies were mandated to be undertaken by the authorities with exceedances predicted at defined compliance links.

Sefton were mandated in March 2019 to undertake a Targeted Feasibility Study focussed on a projected non-compliant link on Derby Road; the non-compliance was based on national modelling of roadside NO_2 concentrations 4m from the kerb, 2m height and >25 from a major junction. The mandate required that specific measures should be defined to achieve compliance with the annual mean NO_2 objective in the shortest possible time. The timescale for submission was defined as the end of July 2019, although at the time of writing Sefton was coordinating a response with Liverpool City Council who were mandated to submit the Outline Business Case for an Air Quality Local Plan by the end of October 2019.

Sefton was not mandated by JAQU to undertake a CAZ feasibility study. However, it is recognised that a CAZ represents one of the most effective means of achieving the EU limit value for NO_2 within the shortest possible time, and so this study was undertaken to provide an initial evidence base to determine the potential effects that may be achieved in Sefton.

4. Baseline Air Quality

A review of existing air quality conditions across the Borough has been undertaken based on existing air quality monitoring and modelling, including an overview of major sources of air pollution and recent trends in air quality to gain an understanding of the spatial extent of the air quality concerns. In addition, the effectiveness or otherwise of existing actions, as set out in Sefton's air quality action plan, has been discussed.

The Council have designated four discrete AQMAs:

- AQMA 2: An area encompassing Princess Way A5036 from Ewart Road flyover up to and including the Roundabout and flyover at the junction with Crosby Road South A565 designated for annual mean NO_2;
- AQMA 3: The area around the junction of Millers Bridge A5058 and Derby Road A565 designated for annual mean NO_2 and PM_{10} (at the time of writing the Council was considering revoking the designation for PM_{10} in this area);
- AQMA 4: The area around the junction of Crosby Road North A565 and South Road, Waterloo designated for annual mean NO_2; and,
- AQMA 5: The area around the junction of Hawthorne Road B5422 and Church Road A5036, Litherland designated for annual mean NO_2.

The AQMAs have been declared in relation to the annual mean NO_2 objective (AQMA 2, 3, 4 and 5) and/or the annual mean PM_{10} objective (AQMA 3), recognising that both pollutants are of concern across the borough.

4.1 Local Air Quality Monitoring

SMBC undertakes passive (94 locations) and automatic (five locations) air quality monitoring for NO_2. The passive diffusion tube monitoring results are provided in the appendix, Table 11, and the automatic chemiluminescent monitoring results are in Table 2. SMBC also undertakes monitoring for PM_{10} (five locations), $PM_{2.5}$ (one location) and SO_2 (one location). These locations are shown in Figure A.38.

The monitoring has identified a small number of locations where the annual mean concentration of NO_2 has been persistently higher than the objective, these sites are located in areas already declared as AQMAs . The majority of locations are below this threshold. The high concentrations are mainly near major road junctions where there is regular queuing and congestion.

The PM_{10} and $PM_{2.5}$ monitoring has not recorded any exceedance of the objective values.

The long-term data do not indicate any clear up or downwards trend, with roadside and background locations remaining fairly stable year-on-year. This suggests that projected improvements to air quality without interventions may be optimistic, and reflects findings by Defra that roadside air quality has not improved since 2015[7]. This has been accounted-for in the methodology applied to this study, whereby the background concentrations in the future have not been reduced in the future.

Table 2. Automatic Air Quality Monitoring for NO_2

Location			Coordinates		Annual Mean NO_2, $\mu g/m^3$					
ID	Location	Type	X	Y	2012	2013	2014	2015	2016	2017
CM2	Crosby Rd North Waterloo	Roadside	332175	398475	36.1	35.4	33.4	30.6	32.2	34.9
CM3	Millers bridge Bootle	Roadside	333772	394603	37.9	36.3	36.6	34.8	37.7	**40.6**
CM4	Princess Way Seaforth	Roadside	332647	396940	**45.9**	**42.8**	**44.2**	**40.6**	**41.6**	39.7
CM5	Hawthorne Rd Litherland	Roadside	333821	397512	**41.5**	39	**40.7**	36.9	37.1	36.5
CM6	Crosby Rd South Seaforth	Urban bknd	332871	396550	-	-	-	34.6	33.2	29.6

Note: Exceedances in bold

[7] https://www.gov.uk/government/statistics/air-quality-statistics

Table 3. Automatic Air Quality Monitoring for PM_{10}

Location			Coordinates		Annual Mean PM_{10}, µg/m³ (No. of daily exceedances in brackets)					
ID	Location	Type	X	Y	2012	2013	2014	2015	2016	2017
CM2	Crosby Rd North Waterloo	Roadside	332175	398475	-	28.3 (17)	23.6 (8)	23.7 (4)	17 (2)	21.1 (6)
CM3	Millers bridge Bootle	Roadside	333772	394603	-	28.1 (17)	28.8 (14)	28.7 (15)	25.4 (5)	23.9 (17)
CM4	Princess Way Seaforth	Roadside	332647	396940	-	26.5 (12)	26.5 (12)	26.7 (14)	23.8 (6)	23.1 (7)
CM5	Hawthorne Rd Litherland	Roadside	333821	397512	-	-	-	-	-	23.9 (2)
CM6	Crosby Rd South Seaforth	Urban bknd	332871	396550	-	-	-	25.3 (5)	22.4 (2)	19.5 (1)

Table 4. Automatic Air Quality Monitoring for $PM_{2.5}$

Location			Coordinates		Annual Mean PM10, µg/m³					
ID	Location	Type	X	Y	2012	2013	2014	2015	2016	2017
CM3	Millers bridge Bootle	Roadside	333772	394603	-	-	-	-	-	7.1

5. Traffic Data

The purpose of the feasibility study is to gain an understanding of existing and future trends in air quality and then explore CAZ options to achieve the necessary reduction in pollution concentrations in the AQMAs and borough wide, to achieve compliance with the national objectives.

As such, two types of air quality assessments have been undertaken:

- Detailed Dispersion Modelling to determine annual mean NO_2 and PM_{10} concentrations in 2015, 2020 and 2025. Thus allowing direct comparisons with the national objectives to determine the trend in area of compliance and non-compliance in Sefton.
- An emissions source apportionment study was undertaken to understand which types of vehicles contribute to pollution and to what degree in different key areas of Sefton in 2018, 2020 and 2025. This is essential when developing CAZ options to understand what types of vehicles need to be targeted.

Understanding which types of vehicles contribute to pollution and to what degree in different key areas has been undertaken using Automatic Number Plate Recognition (ANPR) data.

Defra's emissions factor toolkit (EFT) was then used to project the ANPR data to 2020 and 2025 which were required for the future year assessments.

5.1 Traffic Data

The ANPR survey was undertaken by Nationwide Data Collection between 07:00 to 19:00 on Tuesday 24 April 2018, Wednesday 25 April 2018 and Thursday 26 April 2018. The survey was undertaken at 10 sites to record two-way flows, with individual lanes also classified at Site 8 (see Appendix B). The survey took place on weekdays during school term-time to be as representative as possible of the usual types of vehicles encountered throughout the year.

The ANPR survey obtained the vehicle registration data of every vehicle passing the camera. These data were then cross referenced with DVLA records to provide additional vehicle details to enable further analysis

The ANPR survey sites are provided in Figure B.40. Each vehicle counted was assigned a category (car, LGV, HGV, bus), fuel type and Euro-classification that was translated to the format required by the EFT to extract the detailed local emissions profiles.

From this data, the vehicle types on each road link were extracted from the peak hour flows in the AM, inter-peak, PM and off-peak periods and converted to proportions of the total flow. Buses were not included in the transport model and so the proportions for this vehicle type were calculated separately from the AM, inter-peak and PM flows by the transportation consultants.

5.2 Fleet Projections

The vehicles fleets obtained from the ANPR surveys were input to version 8.0.1a of the EFT and projected into the future assessment years (2020 and 2025) using the fleet projection tool tab.

The bus fleet projections were further adjusted with reference to the funding and upgrades programmed for the LCR bus fleet. The fleets in 2020 and 2025 were comprised of vehicles with later Euro classifications than in 2015 and an increased proportion of alternative technologies. In 2020 the HDV fleet (bus and HGV) still had a significant component of pre-Euro VI vehicles.

The LCR bus fleet is predominantly composed of Euro V vehicles, with a large Euro III component. There are also eight Euro II vehicles, and two pre-Euro vehicles in the fleet. The fuel type is predominantly diesel, although approximately 30% of the fleet are biodiesel, biogas and hybrid vehicles.

The current aspiration is to achieve a minimum level of Euro V in 2020, with a possible stretch target of Euro VI compliant vehicles, with a focus on smaller operators of retrofitting vehicles that recognises the average age of vehicles already being achieved by the main operators. Merseytravel has recently been successful in two rounds of funding for bus retrofit technology, with one upgrade completed and another due to proceed.

5.2.1 Confidence in Fleet Projections

The fleet projections are the core component of the emissions model, which is based on an accurate baseline ANPR survey that is then projected into the future using standard Defra tools. Whilst this is considered to be the most appropriate method to incorporate changes into the fleet due to natural turnover and replacement, the further the projections reach into the future the less confidence may be attributed.

The EFT includes a complex range of fuel types for each vehicle category, but excludes an editable breakdown of petrol / diesel LGVs. There are currently very few petrol LGVs commercially available, but this is anticipated to change in the future as fleet operators seek to replace diesel vehicles and want to avoid EV options due to operational requirements (see Figure 24).

The uptake of new Euro 6/VI vehicles (both internal combustion engines (ICE) and hybrid) has been significantly affected by the introduction in 2017 of the Worldwide Harmonised Light Vehicle Test Procedure (WLTP), which has been linked to a significant decrease year-on-year of new registrations due to manufacturing and delivery bottlenecks corresponding to testing and compliance. The introduction of the WLTP has had an effect on the uptake of new cars by limiting availability, as well as promoting sales of nearly-new vehicles (i.e. those registered before the WLTP was in force). It may also contribute to a shortage of WLTP-compliant used vehicles in 3-4 years.

The projected decrease in traditional ICE is also sensitive to political decisions, such as central government grants and tariffs, exemplified by the recent termination of the Plug-in Hybrid Electric Vehicles (PHEV) grant scheme. This is compounded by some manufacturers, namely Mercedes-Benz, introducing a new diesel-engine vehicle to complement their existing range of diesel-hybrids.

With regard to buses, Defra projections introduce a complex mixture of alternative fuel types (see Figure 26), including niche technologies such as biogas and Fuel-Cell Electric Vehicles (FCEV) that may not be adopted in many regions due to infrastructure requirements. The Defra projections also re-assign vehicles to niche alternative fuels, which may be misleading where buses are subject to long-term investment, as well as external funding and retrofitting exhaust abatement. Therefore, the uptake of niche alternative technologies may still represent a very small part of the fleet due to uptake through trials, etc, in large urban areas.

There are currently no approved retrofit options for any vehicles except buses, as the technology must be type-approved for every combination of engine, transmission and body type. Where a goods vehicle manufacturer produces numerous combinations and bespoke products, it is currently not feasible to test (and hence type-approve) every combination. A programme of testing is anticipated to be defined to ensure it is workable in the real-world, and there may be an expectation that retrofit technology will be adopted for these vehicles in the future as it is type-approved. This is a specific issue affecting HGVs, as it is expected that retrofit will need to be an option for operators to achieve compliance with a CAZ. It may be reasonable to expect that HGV retrofitted abatement technology may achieve similar levels of emissions reductions as applied to buses (i.e. potentially less effective than Euro VI, subject to the operating profile).

Finally, it is likely that the adoption of CAZ in many cities and urban areas will lead to a regional/national redistribution of non-CAZ compliant HGV fleets, as well as a very significant impact on the private LGV and car owners, who may be compensated through potential scrappage schemes and grants. This means that any regions without a notable CAZ may see an increased number of older (i.e. CAZ non-compliant) vehicles being adopted. This effect has already been recognised in the LCR with the uptake of London black cabs that are no longer permitted to operate in the London ULEZ.

5.3 Traffic Data for Air Quality Modelling

The traffic data used in the model were output from the Maritime Corridor Study, and include data for 2015, 2020 and 2025. This study provided local transport model data for the forecast years, and specifically includes local development trip matrices generated with reference to proposed development allocations, land use types, and scale of each development. The traffic model also includes a 2035 projection, although this was considered too far into the future to generate air quality projections with acceptable confidence.

The model data includes all the major roads in the borough. The transport model takes account of several significant developments near the A5036, including Atlantic Park, Chancery Gate, Senate Business Park, housing on the former St Wilfreds School and industrial uses on Heysham Road. These developments were of specific interest to this air quality study due to the potential effects on the areas of concern around the port access routes and known pollution hotspots, designated as AQMAs.

For modelling purposes, 2015 data was required to determine the baseline conditions for verification. Therefore the baseline 2015 fleet was regressed by normalising the surveyed 2018 fleet against the corresponding years in the EFT. This effectively increased the emissions from the fleet in 2015 compared to 2018Traffic Data for Air Quality Modelling. This adjustment means that the emissions assumptions made in the model are more closely aligned to the local picture in Sefton, where there is a slightly larger proportion of older, more polluting vehicles in circulation compared to England.

In order to increase confidence in the modelled air quality predictions, it is important to ground the study in an excellent understanding of baseline conditions, in terms of the detailed emissions characteristics of the current vehicle fleet. The data provided by the ANPR survey characterises and quantify the current vehicle fleet in the borough.

Understanding the split of vehicles within the study area informed the air quality modelling by feeding into the emission calculations, resulting in more accurate modelling that better reflected the local fleet. A comparison (Section 8.2) was made between the fleet observed by the ANPR survey and the ‘national fleet’ embedded in Defra’s Emission Factor Toolkit to understand the ways in which the local fleet is different from the national average.

6. Existing and Future Baseline - Air Quality Modelling

Detailed dispersion modelling has been undertaken to determine annual mean NO_2 and PM_{10} concentrations at properties near all modelled roads within the context of the national objectives (Section 2). Modelling has been undertaken using ADMS-Roads dispersion modelling software to predict concentrations in 2015, 2020 and 2025 without the CAZ to understand how air quality within Sefton will change in the future. This takes account of anticipated changes to the number, types and polluting potential of vehicles on Sefton's roads to predict air quality in places where people live and spend time. Dispersion modelling reflects the public health rationale that underpins targets and the need to improve air quality.

Detailed dispersion modelling differs from emissions modelling. Emissions modelling predicted the emissions which are released from vehicle exhaust and is important as it provide an indications of the source contribution from different vehicle types. In contrast dispersion modelling predicts actual pollutant concentrations at sensitive receptors which can be compared to national objectives.

The whole Borough was modelled to identify all areas of concern with regard to poor air quality and to identify where the designation of a CAZ may have the greatest benefits or risks, within and outside the designated area. It was not anticipated that a CAZ would be appropriate for the whole Borough, but this extent was used to inform where the greatest benefits or risks from a CAZ may occur.

6.1 Model Years

A base year, and two future years have been considered:

- 2015 baseline for model verification purposes (based on the traffic model validation year);
- 2020 future year; and
- 2025 future year.

6.2 Emission Calculations

The EFT version 8.0.1a (Defra, 2018[8]) was used to calculate the emission rates in g/s for NO_X, PM_{10} and $PM_{2.5}$ for each of the road links in the traffic model (see Section 5.3). The EFT uses drive-cycle data from the European COPERT (EEA, 2018[9]) model for various vehicle types and ages to determine speed / emission relationships. The emission profiles are used in conjunction with the traffic flow data to assign rates to each modelled road link.

6.2.1 Detailed Dispersion Model

The detailed modelling used ADMS-Road version 4.1.1.0 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. The model assigns a complex dispersion algorithm to each source and receptor pathway to determine the total pollutant concentration at each defined location.

The ADMS-Roads model was used to predict the annual mean NO_X, PM_{10} and $PM_{2.5}$ concentrations at the selected receptor locations in each model year.

6.2.2 Conversion of NO_x to NO_2

The proportion of NO_2 in NO_x varies (see health effects discussed in Sectionn11.1) greatly with location and time according to a number of factors including the amount of oxidant available and the distance from the emission source. NO_x concentrations are expected to decline in future years due to falling emissions, therefore NO_2 concentration will not be limited as much by ozone and consequently it is likely that the NO_2/NO_x ratio will in the future increase. In addition, a trend has been noted in recent years whereby roadside NO_2 concentrations have been increasing at certain roadside monitoring sites, despite emissions of NO_x falling. The direct NO_2

[8] https://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html
[9] https://www.eea.europa.eu/themes/air/links/guidance-and-tools/copert4-road-transport-emissions-model

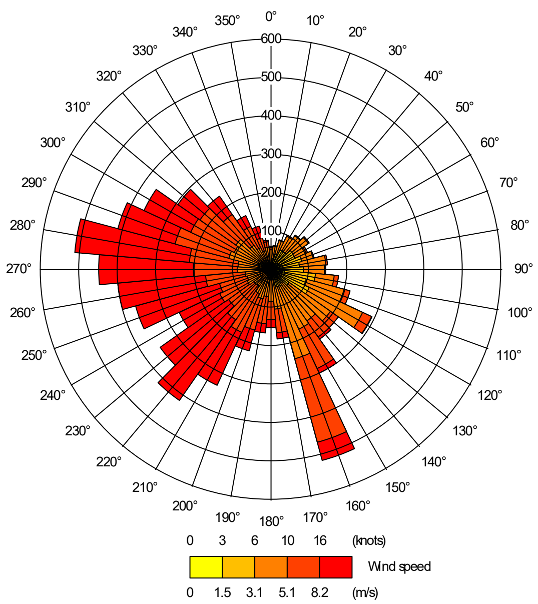
phenomenon is having an increasingly marked effect at many urban locations throughout the UK and must be considered when undertaking modelling studies.

In this study modelled NO_X values were converted to NO_2 using the ‘NO_X to NO_2’ calculator v6.1 (Defra, 2017). The year and region for which the modelling has been undertaken are specified and local factors, such as an appropriate factor of NO_X emitted as NO_2, are used in the calculation.

6.2.3 Meteorological Data

The meteorological dataset used in the assessment was recorded in 2015 at the meteorological station at Crosby. The meteorological site is considered to be representative of regional meteorological conditions and sufficient to satisfy the requirements of this assessment.

Figure 1 Wind Rose Recorded at Crosby in 2015



6.2.4 Receptors

Concentrations have been predicted at every property within 50m of a modelled road link, as the greatest effects will occur within this distance. In addition, the concentration of NO_2 was predicted at NO_2 monitoring locations for the purpose of model verification (see Appendix E).

Kerbside receptor locations were also modelled every 10m on the A5036 port access route and compared to the short-term objective in areas where hourly mean concentrations were predicted to be at risk of exceeding in the future, whereby an annual mean concentration >60 µg/m^3 is considered to indicate a potential exceedance of the hourly objective.

6.2.5 Background Pollutant Concentrations

For any modelling exercise the ideal situation is to estimate emissions from all known sources (road, rail, industry etc). In practice, information will only be available for those sources under the spot light. In this case it’s the road traffic component. Under these circumstances all other sources are collectively considered to be a background element. The concentrations calculated by the model due to vehicle emissions are therefore added to these background concentrations to give the total concentration.

The annual mean background pollutant concentration used in this assessment were modelled estimations provided by Defra[10], who provide values for the centre point of each 1 km by 1 km grid square in the UK, for each year between 2015 and 2030. Estimated average background concentrations for the Ordnance Survey grid square containing each modelled receptor location were downloaded in August 2018.

[10] https://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html

The Defra background concentrations were compared to the Sefton Council background monitoring location recorded in the period 2012 to 2017 and it was determined there was no clear trend, and values were broadly consistent to 2015. Therefore, to ensure that the study is robust, the Defra background concentrations were not projected forward (i.e. decreased) into the future, and the 2015 values were used in all of the modelled years.

6.3 Model Verification

Modelling results are subject to systematic and random error; due to variable factors, such as uncertainty in the traffic data and the composition of the vehicle fleet, and uncertainty in the meteorological dataset. This can be addressed and, if necessary, adjusted for by comparison with monitoring data. The accuracy of the future year modelling results is relative to the accuracy of the base year results, therefore greater confidence can be placed in the future year concentrations if good agreement is found for the base year.

A sensitivity test was undertaken for the baseline verification year whereby the fleet was not regressed, resulting in a higher adjustment factor. Therefore, due to the uncertainties associated with regressing the fleet back to an earlier year, it was considered that the higher verification factor based on a non-regressed fleet would be appropriate to use as a cautious approach, and to ensure the model was robust.

The assessment methodology included a sensitivity test for the baseline verification year:

- 2015 baseline with the fleet profile regressed from 2018 to 2015; which resulted in an adjustment factor of 1.3,
- 2015 baseline using the 2018 fleet profile, which effectively reduced the emissions compared to the above scenario (i.e. the model under-predicted to a greater extent compared to the monitoring data), and resulted in an adjustment factor of 2.3.

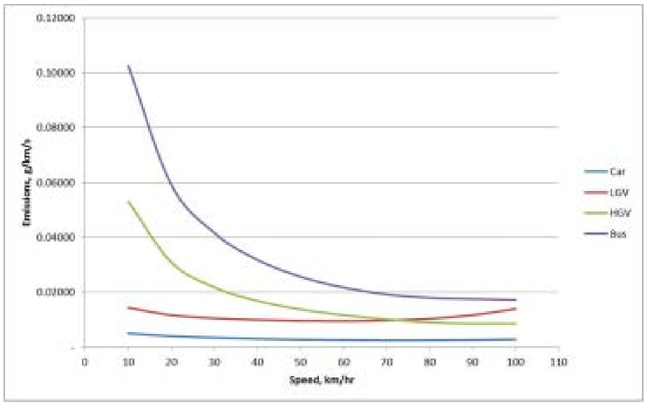
The verification calculations are provided in Appendix E. The RMSE was calculated as 5.0; this value was considered to be acceptable for the purpose of this study.

The Council undertake monitoring for PM_{10} in five locations and $PM_{2.5}$ in one location. The PM_{10} and $PM_{2.5}$ concentrations predicted at the monitoring sites were compared subjectively and the model under-predicted PM_{10}, but over-predicted $PM_{2.5}$, and was broadly consistent with the trend achieved with the NO_X verification at these sites (see Table F15). Therefore, as the NO_2 monitoring network is substantially larger than that for PM, the adjustment factor for NO_X was also applied to PM in order to more effectively represent the larger model extent and benefit from this larger network.

6.4 Queuing and Congestion

The effect of slow moving traffic, queuing and congestion at junctions were considered in the model, whereby lower speeds were applied at links adjacent to junctions. The data in Figure 2 indicate how emissions vary at different speeds. Furthermore, the lowest speeds that can be used in the EFT are 5 km/hr, as below this the engine enters an idling mode when stopped, or an extremely heavy load under acceleration. At this time it is not possible to confidently model speeds <5 km/hr. Queue period data was provided by the Sefton UTMC team. This was used to appraise key junctions on the A5036 and A565 where the dispersion modelling predicted the highest roadside pollutant concentrations. Comparisons with the monitoring data indicate that the model may under-predict emissions lightly in these areas, but the overall fit after verification was considered to be good.

Figure 2 Speed vs emission Profile as g/km/s



7. Predicted Pollutant Concentrations Without a CAZ

The following results project the pollutant concentrations resultant from anticipated improvements to the fleet, increased traffic flows associated with organic growth and development planning, and changes in port haulage. No specific measures to improve local air quality or reduce emissions have been applied to these scenarios.

7.1 Nitrogen Dioxide

7.1.1 Annual Mean

Annual mean concentrations of NO_2, in 2020, were predicted at all relevant receptors within 50m of the modelled road network (Appendix F). The concentrations were predicted to be higher in 2020 than 2025 due to projected improvements to the emissions profile through the uptake of newer vehicles and alternative technologies.

70 properties were predicted to exceed the annual mean NO_2 limit value in 2020; these locations are shown in Appendix F. With regard to the existing AQMAs, the following correlations were predicted, indicating that the majority of the areas of exceedance were outside the designated AQMAs, although they were clustered in similar areas:

- AQMA 2, one exceedance;
- AQMA 3, 13 exceedances;
- AQMA 4, no exceedances; and
- AQMA 5, two exceedances.

The highest concentrations were predicted to occur near the major junctions on the A5036, predominantly due to vehicles slowing and accelerating. The highest concentration predicted in this area was 46 $\mu g/m^3$ at the junction of Kirkstone Road. Exceedances were also predicted to occur at the A565 junction with A5057, and the junction with A5058; the highest value predicted in this area was 53 $\mu g/m^3$, at the junction opposite Millers Bridge.

No other areas of exceedances were identified. However, relatively high roadside concentrations were predicted near junctions on Merton Road and Stanley Road, which were also associated partly with low speeds in this area. To the north of Bootle, relatively high concentrations were predicted in Crosby at the junction of A565 with South Road, and in Maghull at the junction of Westway and Liverpool Road.

7.1.2 Hourly

Annual mean concentrations of NO_2, in 2020, were predicted at kerbside locations along the A5036, where members of the public may be present regularly for short periods whilst commuting, walking to school and waiting at bus stops. These were compared to the annual mean 60 $\mu g/m^3$ threshold, which is indicative of a potential breach of the hourly objective. Breaches of the hourly exceedance targets were predicted at the major traffic light controlled junctions on this route, and although individual periods of exposure may be for less than one hour this index represents the potential effects associated with frequent acute exposure.

The model also predicted concentrations in the central reservation, as pedestrians in the area tend to use the pavements, where numerous bus stops are located, as well as the central reservation where there is no footpath. This indicates that relevant exposure may occur at roadside locations where people spend short periods of time, and so the hourly objective has been used to represent this potential exposure.

7.2 Particulate Matter

Annual mean concentrations of PM_{10} and $PM_{2.5}$ were predicted at all relevant receptors within 50m of the modelled road network.

This is a complex pollutant, as the source apportionment and hence type of ‘matter’ is important to inform the potential health effects. The emissions of PM from road transport are divided into a direct exhaust component, tyre, brake and road abrasion, and resuspension of deposited material. Furthermore, ‘road grime’ consisting of deposited fine particulates can become a significant secondary source of NO_2 when it is exposed to UV light. (Ammar, et. Al.)[11], and so there may be potential cumulative effects of PM.

Suggest add in some background information about relative contribution of PM sources in Sefton, and specifically this area, and perhaps any indication as to whether there are expected to increase or decrease over study period.

7.2.1 PM_{10}

There were no locations where annual or daily mean concentrations were predicted to exceed the respective limit values.

7.2.2 $PM_{2.5}$

There were no modelled sensitive receptor locations where annual mean concentrations were predicted to exceed the annual mean target value of 25 $\mu g/m^3$ There is no short-term objective for $PM_{2.5}$ that may be applicable to a kerbside location.

The UK government has published the Clean Air Strategy 2018[12]which includes a goal to reduce $PM_{2.5}$ levels in order to halve the number of people living in locations where concentrations of particulate matter are above 10 $\mu g/m^3$ by 2025.

Exceedances of the 2025 annual mean objective for PM2.5 were identified in 2020 in area of Bootle. These correlated with areas of exceedance predicted in 2025 as it was predominantly due to the high background contribution (mainly sea-salt, agriculture and industry in the study area), which was based on the 2015 values as a cautious approach (see Section 6.2.5), which was a maximum of 13.2 $\mu g/m^3$. Were the projected 2025 background contribution to be used then the total annual mean $PM_{2.5}$ concentration would be significantly lower, although the maximum road contribution was still predicted to by 15 $\mu g/m^3$ in 2025 near the A565.

A key consideration of the PM projections is also that whilst exhaust emissions may decrease with the adoption of new technology, the emissions from non-exhaust sources (tyre/brake wear and road abrasion) will remain stable. Therefore, there are uncertainties about the potential benefits from the adoption of ‘clean’ fleets in the future, with regard to PM.

7.3 Queuing and Congestion

The percentage of time that vehicles queue is highly variable, with tidal patterns at some locations showing morning and evening peaks. It was not possible to incorporate sub-hour events into the air quality modelling, and the very short-period events that occur at 1-second resolution due to stop-start movement may be specifically significant in terms of emissions in these discrete congested areas, as they occur at predictable intervals during weekday peak periods.

Whilst there may be opportunities to refine the traffic management control system to prioritise air quality at the expense of journey times, it is recognised that it may relocate congestion to adjacent locations. Therefore, it may be viable to consider the creation of designed queuing areas where there are no locations of relevant exposure near the carriageway in order to specifically target the high emissions identified at key junctions.

7.4 Required Reductions

Where the EU limit value was predicted to be exceeded, the total pollutant concentration was analysed to calculate the contribution resultant from road emissions, and the reduction of road emissions that is required. This data is presented in Appendix G, and indicates that significant reductions of half the total emissions are required in several areas near junctions to achieve the annual mean objective for NO_2, by 2020 and which will be even more stringent to achieve the short-term hourly objective to reduce exposure at the roadside.

The required reduction at these locations was compared to the nearby significant road links, and discussed below in Section 9 with regard to the emissions reductions that may be achieved in each CAZ scenario.

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[11] https://onlinelibrary.wiley.com/doi/abs/10.1002/cphc.201000540
[12] https://consult.defra.gov.uk/environmental-quality/clean-air-strategy-consultation/user_uploads/clean-air-strategy-2018-consultation.pdf

8. Existing and Future Baseline - Source Apportionment

Understanding which types of vehicles contribute to pollution and to what degree in different key areas has been undertaken using Automatic Number Plate Recognition (ANPR) data. This is essential when developing CAZ options to understand what types of vehicles need to be targeted.

This section outlines:

- Euro Emission Categories
- Local vs. National Fleet Euro Composition
- Fuel Type Composition and Projections
- Diurnal Flow Profiles
- Emissions by Euro Category
- Emissions on A5036 Port Access from Switch Island

8.1 Euro Emission Categories

The vehicle fleet can be broken down in several ways that are relevant when considering the emissions of the fleet. These include by vehicle type (passenger car, light goods vehicles, heavy goods vehicles, and buses); propulsion type (petrol, diesel, or alternatives such as electric or hybrid-electric vehicles); and by euro engine class.

The most recent European emission standards, dated September 2014, are known as Euro 6/VI (light engines use numbers, and heavy engines use numerals), and vehicles that meet these standards have to meet the most stringent emissions criteria. Older vehicles were manufactured to meet less stringent emissions criteria, and therefore a fleet consisting of older vehicles is more polluting than a fleet consisting of newer vehicles.

The breakdown of Euro emissions classifications for each vehicle type are provided in Figure 3 to Figure 8. Data from each ANPR site is provided to show the variation across the 10 sites. The data is relatively consistent across the 10 sites for cars and LGVs. For HGV and PSV (Public Service Vehicles (i.e. bus and coach)) more variation was observed, in part due to the inherently smaller sample size; Site 4 was noted as an outlier for HGVs likely to be associated with a specific component of the local traffic fleet with a lower Euro rating avoiding the A5036. Buses display a relatively more complex profile due to the route assignments for individual vehicles.

The profiles for LDV are generally biased towards Euro 5, whilst the HGV fleet is generally newer and biased towards Euro VI.

Overall, it was considered that the average composition from all of the sites was representative of the local fleet, and so an average of all of the data was used in the modelling study. This approach was considered acceptable to meet the objectives of the study, but it should be acknowledged that the variations, particularly in the HGV and PSV fleet, may be considered further in future more detailed analyses.

Figure 3 Surveyed Emission Class, Petrol Cars

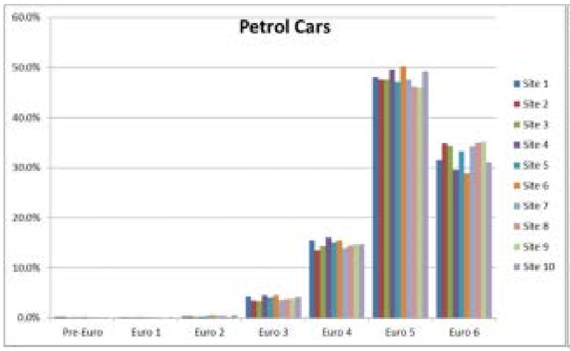


Figure 4 Surveyed Emission Class, Diesel Cars

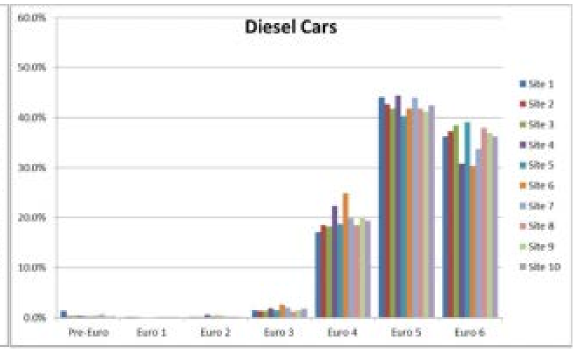


Figure 5 Surveyed Emission Class, LGV

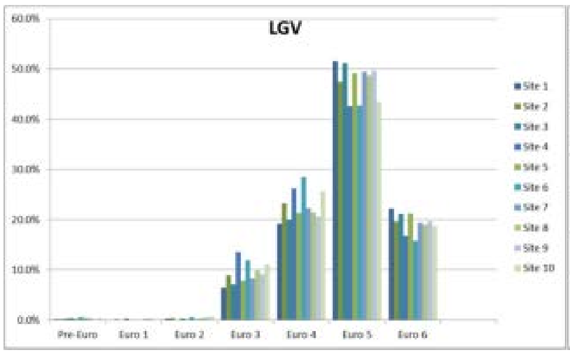


Figure 6 Surveyed Emission Class, Rigid HGV

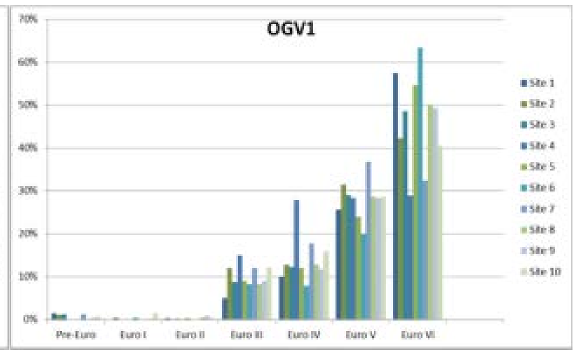


Figure 7 Surveyed Emission Class, Articulated HGV

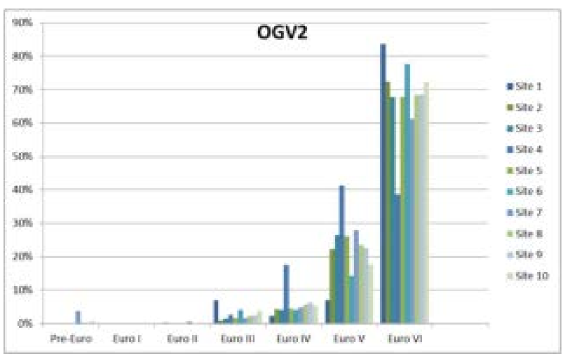
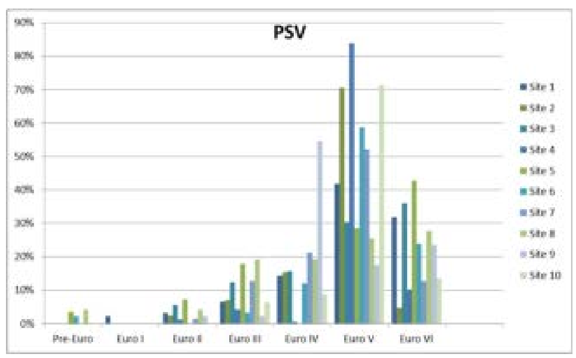


Figure 8 Surveyed Emission Class, PSV (Bus and Coach)



8.2 Local vs. National Fleet Euro Composition

The Euro classifications determined from the ANPR data were compared to the national values published by Defra in the EFT. These data are provided in Figure 9 to Figure 14. The local fleet data generally follow the same trends as national data, but the local fleet is seen to be generally older, with a greater proportion of Euro 5 LDV compared with Euro 6 LDV, and a greater proportion of Euro IV HGV compared Euro VI HGV. The PSV fleet is notably older than the national profile.

This is typical of many urban areas in the UK where similar studies have been undertaken, and highlights the differences on urban roads that are not part of the Strategic Road Network (SRN). The profile for the articulated HGV fleet is closest to the national projection, which may be expected as this type of vehicles tends to use the SRN and inform nation data-sets. However, there is still a 10% difference between the Euro VI local and national fleet, which contributes to a slightly higher proportion of pre-Euro V vehicles.

Figure **9** Petrol Car Euro Class NO_X Emissions

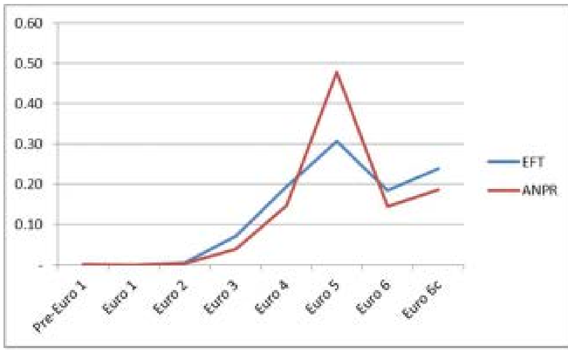


Figure **10** Diesel Car Euro Class NO_X Emissions

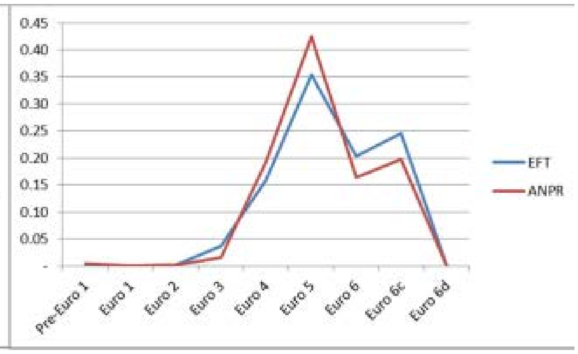


Figure 11 Diesel LGV Euro Class NO_X Emissions

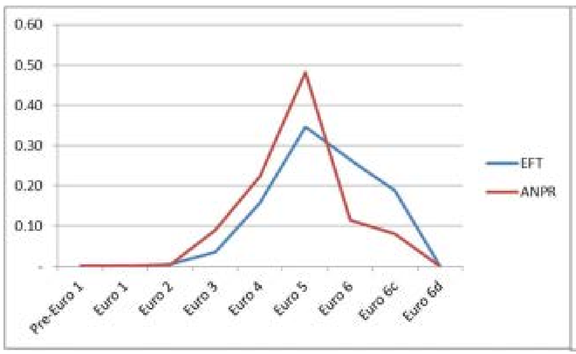


Figure 12 Rigid HGV Euro Class NO_X Emissions

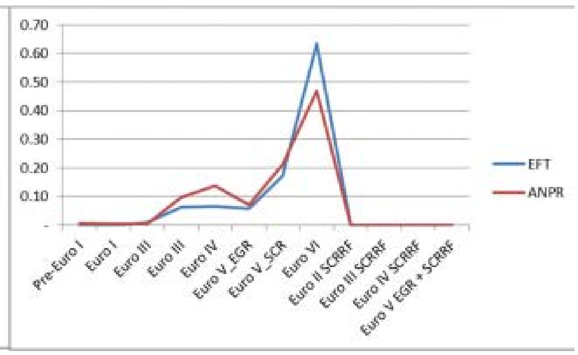


Figure 13 Artic HGV Euro Class NO_X Emissions

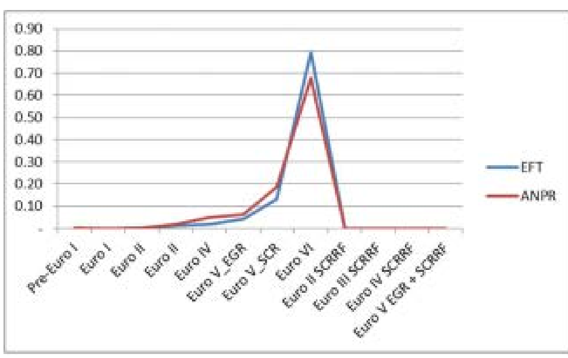
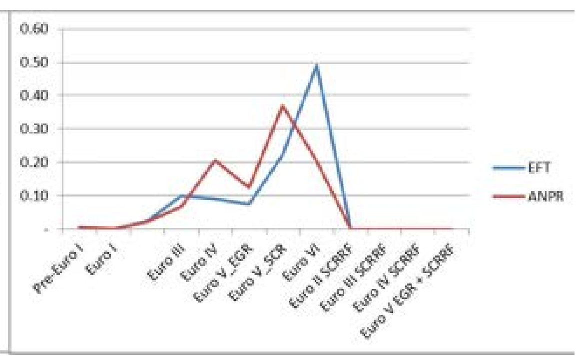


Figure 14 Bus Euro Class NO_X Emissions



8.3 Fuel Type Composition and Projections

The fuel-type within each traffic component was calculated using a normalised projection of the ANPR data using the fleet breakdowns published in the EFT for each modelled year, which used the local data along with an appropriate national projection.

The break-down of fleet compositions recorded in 2018 are shown in Figure 15 to Figure 18, and indicate that the car fleet is split approximately equally between petrol and diesel, almost all (>99.5%) LGV and HGV are diesel, and the majority of buses are diesel.

The projected fuel type splits in 2020 and 2025, are shown in Figure **19** to Figure **26**. These show how alternative fuel types are expected to become a more important part of the fleet, mainly at the expense of diesel. It should be recognised that the projections are based on the best available information and extant technologies, and so some caution should be used to interpret these as they cannot incorporate some factors, such as political support or funding that may prioritise or limit adoption of specific technologies.

Figure 15 2018 Car Fleet Fuel Type

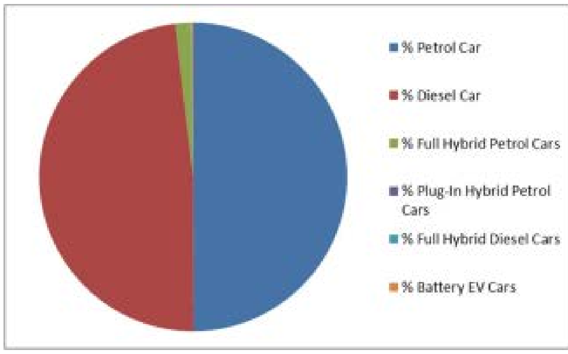


Figure 16 2018 LGV Fleet Fuel Type

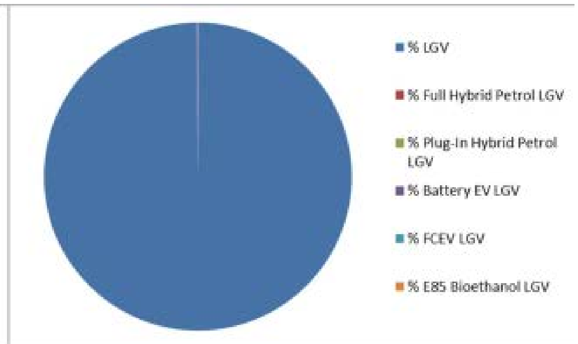


Figure 17 2018 HGV Fleet Fuel Type *

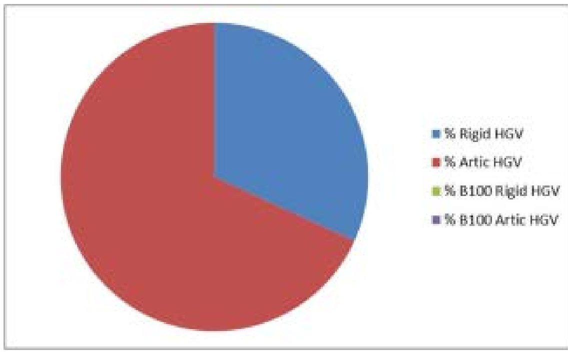


Figure 18 2018 PSV Fleet Fuel Type *

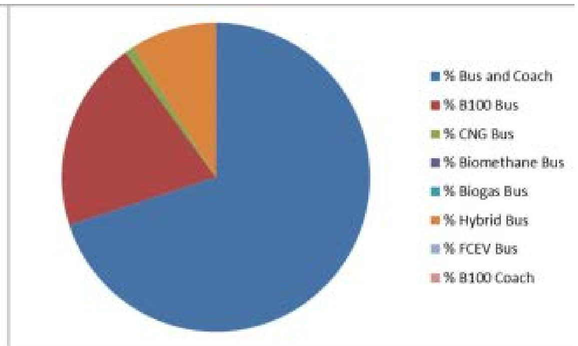


Figure 19 2020 Car Fleet Fuel Type

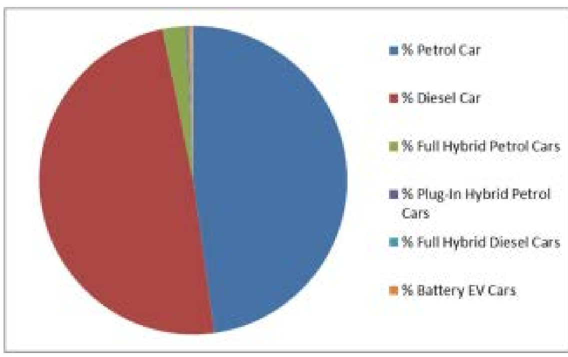


Figure 20 2020 LGV Fleet Fuel Type

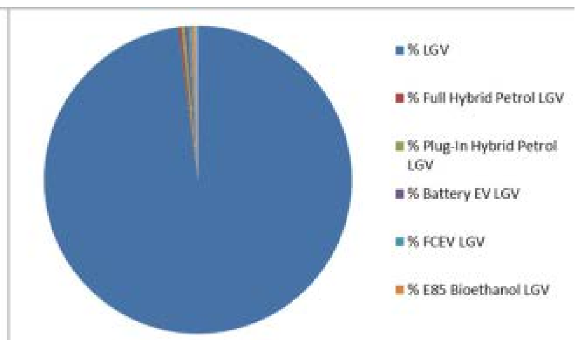


Figure 21 2020 HGV Fleet Fuel Type *

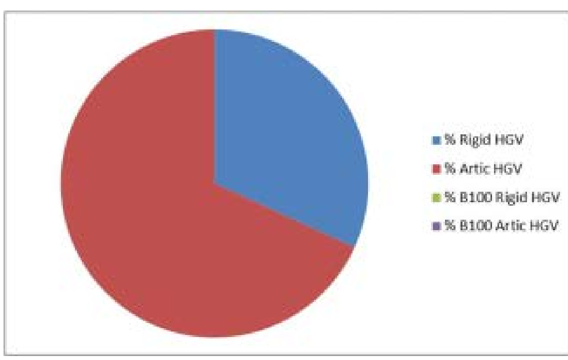


Figure 22 2020 PSV Fleet Fuel Type *

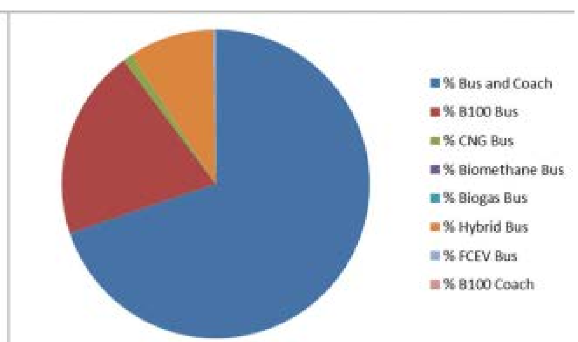


Figure 23 2025 Car Fleet Fuel Type

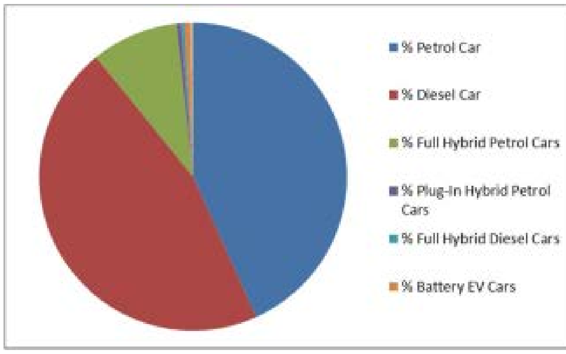


Figure 24 2025 LGV Fleet Fuel Type

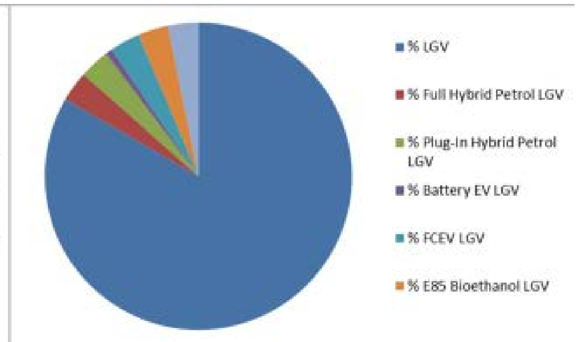


Figure 25 2025 HGV Fleet Fuel Type *

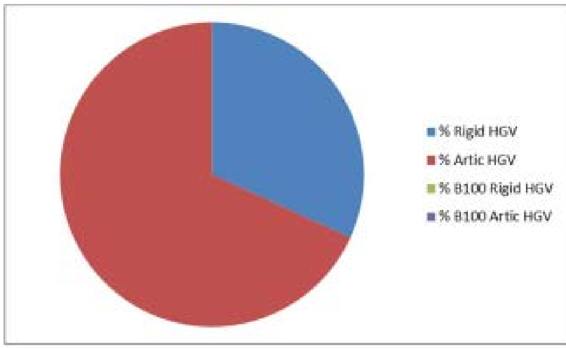
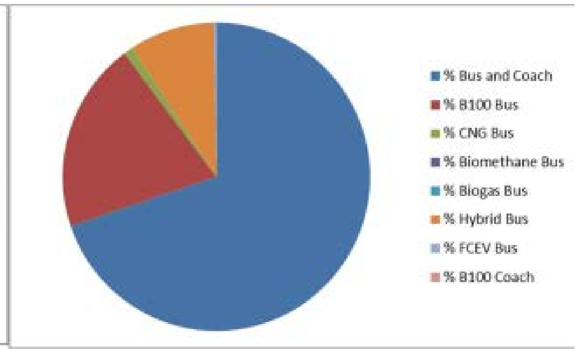


Figure 26 2025 PSV Fleet Fuel Type *



Note: *Data for LGV and HDV are diesel unless otherwise stated. B100 is bio-fuel. CNG is compressed natural gas. FCEV is fuel-cell EV

8.4 Diurnal Flow Profiles

There was a clear diurnal 'tidal' flow of cars at the majority of survey locations, with a distinct morning and evening peak. HGVs tended to be more stable throughout the day with no clear peak at any times. This was specifically notable on the port access routes, as HGV delivery / collection is dependent on ship timing and tides. This is indicated by the data recorded during the ANPR survey site 5, on the A5036 east of the port access in Figure **27** and Figure **28**.

The A685 south of the port access recorded flows on 2-lanes northbound and southbound, and indicated that vehicles tended to use the left lane in preference to the right lane, which may be due to vehicles turning right or queuing into the single-carriageway sections.

Figure **27** AM Flow Profile at ANPR Site 5, A5036 East of Port

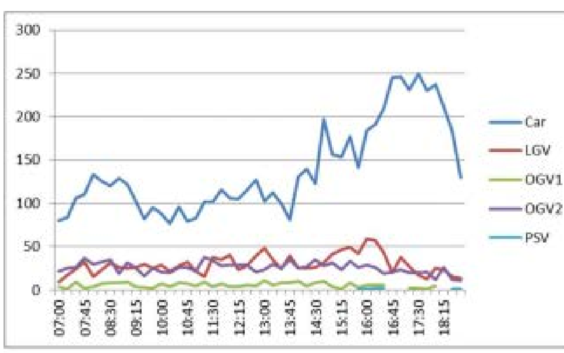
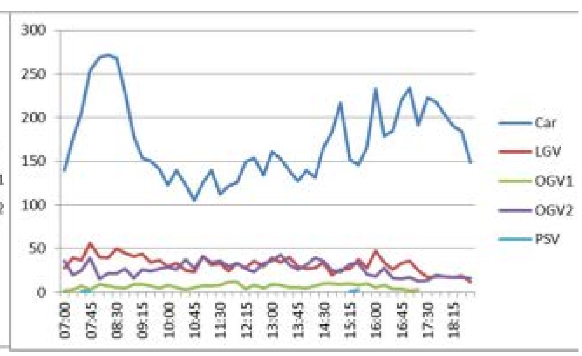


Figure **28** PM Flow Profile at ANPR Site 5, A5036 East of Port



8.5 Emissions by Euro Category

The data in Figure **29** and Figure **30** are examples that show the proportion of emissions from different vehicle Euro classes, based on a speed of 48 km/hr, and the local fleet breakdown. 48km/hr was chosen as a reasonable approximation of urban speeds.

Most emissions from LDV (cars and LGVs) are from Euro 5, 6 and 6C vehicles, whereas HDV emissions are predominantly from Euro V vehicles, with significant contributions from Euro III and IV buses and Rigid HGVs, and from Euro VI articulated HGVs.

This information is significant where interventions are targeted based on the Euro emissions classification, it is important to understand what components of the fleet may be affected, and the resultant effects that may be achieved.

Figure **29** Emissions per Euro Classification at 48km/hr, Whole Sefton LDV Fleet

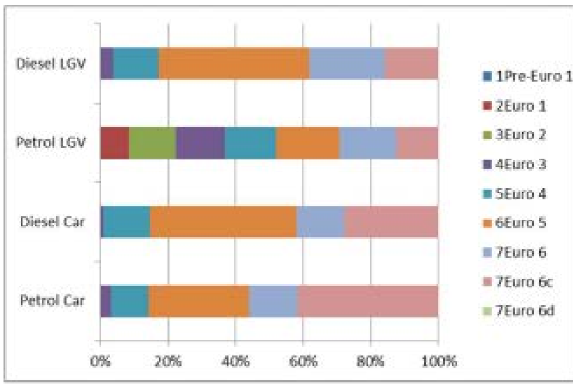


Figure **30** Emissions per Euro Classification at 48km/hr, Whole Sefton HDV Fleet

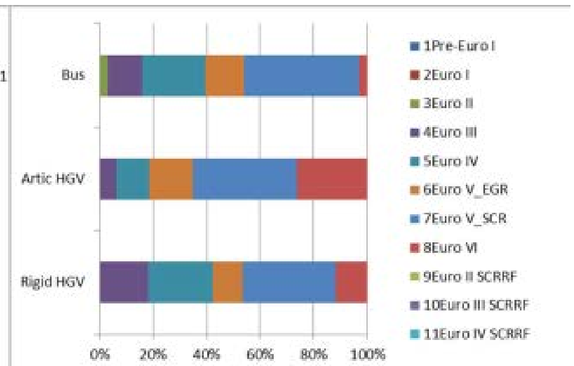


Figure **31** and Figure **32** are examples indicating how emissions vary with speed, using the local fleet profiles shown above. Emissions from diesel cars are predominantly from Euro 5 (as shown above), and they remain constant up to 60 km/hr. However, with HGVs a significant reduction in emissions occurs at and above approximately 32-36 km/hr where the exhaust abatement controls become operational. Below this speed Euro VI articulated HGVs are more polluting than older models (Euro III to V).

This indicates how speed management may be used to achieve changes of emissions by focusing on different Euro categories with regard to the speed of the affected links. This should be taken into consideration in the design of mitigation controls to ensure that the most significant emission sources on the targeted links are encouraged to operate in the most efficient way.

Figure **31** Example of Diesel Car NO_X Emissions vs Speed per Euro Category

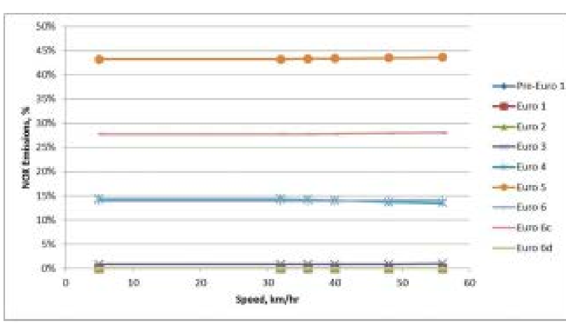
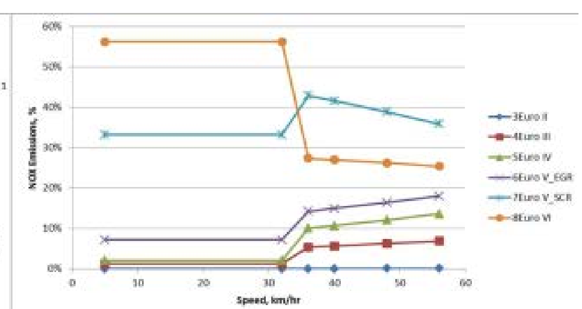


Figure **32** Example of Artic HGV NO_X Emissions vs Speed per Euro Category



8.6 Emissions on A5036 Port Access from Switch Island

NO_X Emissions from vehicles on the A5036 between the port and the Switch Island junction with the M57 and M58 were explicitly considered to extract the emissions associated with the port HGV traffic. Emissions from the A5036 attributed to port traffic were extrapolated from eastbound / westbound HGV movements at the port entrance. These flows were modelled on key links of the A5036 to determine the emissions contribution, and it was assumed that all port traffic heading eastbound and westbound travels along the whole of the A5036, and so these vehicles contribute an average of 36% of total road emissions.

For each vehicle type, the Euro category is indicated in Figure 33, and the breakdown of vehicle emissions on this route indicates that approximately 35% are from diesel cars, with proportions of 15-20% each from LGVs, rigid HGVs and artic HGVs. It should be noted that whilst petrol cars are a relatively large proportion of the fleet, emissions are only 4%.

Diesel car and LDV emissions are predominantly from Euro 4, 5, and 6 vehicles. HGVs are split more evenly, but include a relatively large Euro III component, and a predominant Euro V component. It is also noted there are no retrofitted HGVs in the mix, as there are currently no type-approved technologies currently available. Furthermore, there is uncertainty about the projections for HGV emissions technologies, as manufacturers and fleet operators are cautious about adopting new technology[13].

These data indicate that a large component of the LDV emissions will be linked to Euro 5 vehicles, whereas the emissions from the HDV fleet is far more complex. With reference to Figure **12** and Figure **13**, this indicates the disproportionate significance of total emissions from pre-Euro V HGVs on the port access route. Emissions from cars are predominantly from Euro 5 and 6c, but with significant component of Euro 4 and 6.

Therefore, this indicates that where a CAZ includes HGVs, it may achieve a significant benefit by reducing emissions from Pre-Euro VI vehicles accessing the port. This is demonstrated through the CAZ-B appraisal scenario.

[13] https://www.transportenvironment.org/press/eu-truckmakers-hide-polluting-diesel-trucks-behind-fa%C3%A7ade-electrification?utm_source=Email+alerts+-+Transport+%26+Environment&utm_campaign=230817944b-EMAIL_CAMPAIGN_2018_10_16_10_30&utm_medium=email&utm_term=0_50e72c3d00-230817944b-119846089&mc_cid=230817944b&mc_eid=59c1a21434

Figure 33 NO_X Emissions Source Apportionment, A5036, 2020

8.7 Summary of Emissions

The breakdown of the fleet data indicates the local fleet generally follow the same trends as national data, but the local fleet is generally older than the national profile. The car fleet is split approximately equally between petrol and diesel, almost all (>99.5%) LGV and HGV are diesel, and the majority of buses are diesel.

The most significant emissions from LDV (cars and LGVs) are from relatively newer (Euro 5, 6 and 6C) vehicles, whereas HDV emissions are predominantly from Euro V vehicles; there are significant contributions from Euro III and IV buses and Rigid HGVs, and from Euro VI articulated HGVs.

The relationship between speed and emissions means that all vehicle types have a peak efficiency that may be achieved by controlling speed, where vehicles using exhaust control technology may also be specifically engineered to achieve lower emissions under certain conditions. Emissions from vehicles on the A5036 between the port and the Switch Island junction with the M57 and M58 were explicitly considered to extract the emissions associated with the port HGV traffic. This data indicates that where a CAZ includes HGVs, it may achieve a significant benefit by reducing emissions from Pre-Euro VI vehicles accessing the port.

9. CAZ Emissions Assessment

9.1 Clean Air Zones

A Clean Air Zone (CAZ), can have two forms, non-charging or charging, and can be defined as either, (a) a geographical extent for action to improve air quality, or (b) people are required to pay a charge to enter or to move within the zone if they are driving a vehicle that does not meet the particular standard for their vehicle type in that zone. The latter type of CAZ may also be considered a Low Emissions Zone (LEZ).

The objective of a charging (or penalty) CAZ is therefore to, (a) reduce overall emissions from vehicles operating within the zone, (b) encourage vehicle operators to consider switching to compliant vehicle types and thus leading to accelerated fleet turnover, and (c) encourage the uptake of alternative modes of travel to transfer people and goods.

The establishment of a CAZ has been recognised as a possible tool for improving local air quality, but one which will require careful research to identify the economic, social and environmental impacts (positive and negative).

9.1.1 Extent of Model

For the purpose of this study, scenarios have been appraised that encompass the whole borough in order to determine the potential effects of implementing a CAZ. This approach was used to determine the locations where the greatest magnitude of effects may occur, and to inform how a smaller, discrete, extent may be applied. The extent considered only roads with Sefton, although it is recognised that cumulative effects may affect roads with neighbouring districts.

9.1.2 CAZ Classifications

The Defra Plan for implementing a CAZ has defined four 'types' of CAZ The Plan also defines the equivalent Euro classification that should be applied as the minimum standard within the CAZ, whereby petrol engines should achieve Euro 4/IV and diesel engines Euro 6/VI, as shown Table 5.

The classification groups of CAZ are defined according to the following types of vehicles:

- Type A – Buses, coaches and taxis only
- Type B – Buses, coaches, taxis and heavy goods vehicles (HGVs)
- Type C – Buses, coaches, taxis, HGVs and light goods vehicles (LGVs)
- Type D – Buses, coaches, taxis, HGVs, LGVs and cars

Table 5. CAZ Vehicle Classification Standards

Vehicle Type	Fuel	Equivalent Euro Classification
Cars	Petrol	Euro 4
	Diesel	Euro 6
LGV (Light Goods Vehicle, <3.5t)	Petrol	Euro 4
	Diesel	Euro 6
HGVs (Heavy Goods Vehicle > 3.5t,)	Diesel	Euro VI
Buses	Diesel	Euro VI

The CAZ scenarios are consistent with those defined by DEFRA and are intended to reduce NO_X emissions, although there will be some benefits to PM emissions.

9.2 CAZ Model Scenarios

The CAZ scenario models the change in emissions that may be achieved based on the operation of a Type A, B, C, or D CAZ. It was assumed that all affected vehicles were compliant in each.

The non-compliant vehicles in the HDV fleet were also split into two further scenarios, whereby they were replaced with new vehicles, or retrofitted. This approach was used due to uncertainties about the real-world emissions reductions that may be achieved with retrofit technology, as the EFT emission rates indicate that it may not be as effective in reducing emission as engines designed to achieve lower emissions without retrofit.

There are currently no emission rates for retrofitted HGVs, and so there is no scenario considering this option. This is considered to be appropriate for the 2020 scenario, although by 2025 it is expected that approved retrofit technology will exist and may represent a more real-world viable option.

Table 6. CAZ Scenarios

CAZ Type	Vehicles Affected	HDV Fleet Assignment	Year	Figure Reference
Type A	Buses	Retrofit buses	2020	Figure H56
			2025	-
		Replace buses	2020	Figure H60
			2025	-
Type B	Buses and HGVs	Retrofit buses and replace HGVs	2020	Figure H57
			2025	-
		Replace buses and HGVs	2020	Figure H61
			2025	-
Type C	Buses, HGVs and LGVs	Retrofit buses and replace HGVs	2020	Figure H58
			2025	-
		Replace buses and HGVs	2020	Figure H62
			2025	-
Type D	Buses, HGVs, LGVs and cars	Retrofit buses and replace HGVs	2020	Figure H59
			2025	-
		Replace buses and HGVs	2020	Figure H63
			2025	-

9.3 CAZ Scenario Results

The outcomes from the CAZ model scenarios are broadly consistent with the emissions source apportionment, where the emissions reductions that may be achieved are linked to the affected fleet component; e.g. on road links where buses are a major emissions source, a CAZ type A would achieve more notable benefits.

In each scenario, the effects in 2025 are less than in 2020 as the CAZ is affecting a smaller proportion of the fleet due to organic improvement during this time, and an increasingly large proportion of the fleet with be compliant with the relevant CAZ scenario.

9.3.1 CAZ-A

The effects of improving the bus fleet in terms of emissions reduction are greatest where buses comprise a large proportion of total traffic, for example:

- Stanley Road, Bootle (access only for buses and taxis);
- Kingsway, Crosby; and
- Coronation Road, Crosby

Pollutant concentrations were not predicted to be very high in the areas where the greatest change in bus emissions would be achieved. Therefore, this intervention was not predicted to significantly improve air quality in the locations where it is of greatest concern.

This scenario specifically included two versions based on replacing, or retrofitting, the non-compliant proportion of the bus fleet to achieve a higher emission standard. As it is expected that retrofit will not be as effective as replacing the engine with a new Euro VI compliant unit, retrofitting achieved relatively smaller benefits.

9.3.2 CAZ-B

The CAZ B scenario will achieve cumulative effects that include those from the CAZ A scenario.

This scenario has not separated rigid and articulated HGVs, although the Euro breakdowns indicate that these fleets are very different in terms of emissions. Therefore, the greatest effects will be associated with improvements to the rigid-HGV fleet, as this is relatively older than the articulated fleet. It may also be assumed that rigid HGVs undertake more local journeys, as the ANPR surveys indicate the proportion of articulated vehicles on the regional motorway network is larger than rigid.

Where rigid HGVs undertake more local journeys, it is likely there will be more repeat journeys (i.e. vehicles undertaking the same journey more than once each day), and so there will be a better return from investment in individual vehicles. At this time it is not possible to make a comment on the origin-destination for journeys by specific vehicle types.

The following links are prominent in the scenario due to the high proportion of HGV emissions, and so would experience the greatest benefits:

- A5036 port access from Switch Island;
- A5058 Balliol Road; and
- A565 Derby Road and Millers Bridge.

These are areas of concern with regard to high pollutant concentrations, and so the effects of reducing emissions from HGVs would be highly beneficial in reducing the highest levels of exposure.

9.3.3 CAZ-C

The effect of CAZ type C is fairly dispersed and will achieve a benefit on most roads. However, as LGVs are not a dominant emission source it does not lead to benefits in any specific area, compared to a CAZ type B. Therefore, the designation of a CAZ that includes LGVs would likely achieve a discrete effect within the controlled area (i.e. the CAZ boundary), but may lead to detrimental effects due to non-compliant vehicles distributing onto other roads throughout the borough rather than following major routes intended to complete a well-defined journey linked to a major origin-destination.

The effects of the CAZ type C are not localised around discrete roads as these vehicles are not constrained to major routes, and so it is reasonable to quantify the average NO_X emissions reduction of approximately 5% that may be achieved in 2020 solely due to reducing LGV emissions (i.e. excluding the effects of the HGV and bus improvements).

This scenario would have benefits in all areas with a borough-wide CAZ, including the main areas of concern on A5036 and A565, but would likely lead to dispersed detrimental effects where a smaller CAZ is designated. Therefore, the benefits and detriments from this type of CAZ would likely be proportional to the size of the designated area.

9.3.4 CAZ-D

All roads will be affected by this option as (predominantly diesel) cars are a major emission source throughout the borough, and emissions were predicted to be significantly reduced on all roads included within a designated CAZ.

The charging model would be specifically important to determine the behavioural response of drivers, as non-compliant vehicles may be charged for time within the CAZ, or based only on crossing the boundary. Where residents are included with a CAZ it may require a defined level of dispensation, grant funding or reduced charges to ensure these residents are not unfairly penalised.

The percentage change is relative to the proportion of diesel cars, so the overall effect is less distinct on roads such as the A5036 where HGVs are a major emission source, although there would still be quantifiable benefits in the range of 10-20% in addition the affects from CAZ-B of reducing HGV emissions.

As with the CAZ C, the effects are distributed across all roads, and so it is reasonable to state the average emissions reduction of approximately 8.4% attributed to this scenario in 2020 solely due to reducing car emissions.

This scenario would have benefits in all areas, including the main areas of concern on A5036 and A565.

9.4 Summary

The NO_X emissions reduction achieved by targeting buses (CAZ A) and HGVs (CAZ B) mainly affect specific road links where these vehicles types are a dominant emission source, such the A5036. However, the CAZ C and D scenarios have a more dispersed effect and will achieve benefits across the whole borough.

With regard to the location where specifically high annual mean NO_2 concentrations were predicted, the CAZ B option would achieve mostly localised benefits in areas with large HGV flows. Whilst the emissions from diesel cars are similar to HGVs (both rigid and artic) on the A5036, the HGV fleet (and especially the rigid component) is generally older, and achieving Euro VI emission standards would have a greater benefit.

The data in Table 7 show that none of the CAZ options were predicted to achieve compliance in all locations, with two properties remaining above the limit value in all scenarios in 2020. The baseline modelling forecasts that all locations will be compliant by 2025. However, with regard to the confidence limits of the model, the number of properties close to the limit value (i.e. within 10%) was also predicted to be fairly significant. It should be noted that this highlights a risk that exceedences may exist even with a CAZ, and so further complementary measures may be required to achieve further emissions reductions.

It was noted that the number of properties in exceedence decreased significantly between a CAZ-A and CAZ-B, with relatively marginal gains in CAZ-C and D. This is likely due to the clusters of exceedances locations on the A5036, where HGVs are a major emission source and so improvements to this fleet will have a disproportionate benefit.

Table 7. Summary of Effects of CAZ Scenarios, in terms of Number of Properties, Based on CAZ Designation of the Whole Borough

Annual Mean NO_2	Baseline	CAZ Scenario 2020							
		CAZ-A		CAZ-B		CAZ-C		CAZ-D	
	2020	Retrofit	Replace	Retrofit	Replace	Retrofit	Replace	Retrofit	Replace
>40 $\mu g/m^3$	70	65	66	9	9	4	5	2	2
>36 $\mu g/m^3$	165	126	132	40	42	37	38	32	33
>32 $\mu g/m^3$	575	469	497	123	143	105	118	85	100

9.4.1 Redistribution Effects of CAZ

The modelled scenarios were applied to the whole borough and did not consider the effects of the redistribution of non-compliance vehicles. As discussed earlier , a CAZ applies to a defined geographical area, and so non-compliant vehicles may be reassigned to other routes and contribute to increased emissions in these areas. The appraisal of this effect would require a journey-destination transport model that is outside the scope of this current study, which focusses on the potential effects that may be achieved within a CAZ, and it is recommended this is undertaken as a subsequent study to inform the decision whether to implement a CAZ, and what type may be achieve the greatest benefits in the areas of concern while minimising detrimental effects elsewhere..

Experience in other regions indicates that where the exclusions of non-compliant vehicles reduced demand, this is effectively brought back up to the original levels by vehicles being encouraged to divert from other areas to utilise released road capacity (i.e. less congestion), and so the total traffic flow may remain fairly consistent whilst the emission profile changes to decrease emissions within the zone, and increase emissions in other areas.

Figure F53 identified the locations where the predicted annual mean concentration of NO_2 is within 20% of the limit value without any measures in-place. If these locations are excluded from a CAZ, it is expected they may be most at-risk of detrimental effects resultant from non-compliant vehicles diverting to avoid a CAZ.

This plot indicates that the main area of concern is around Bootle, to the south of the A5036, although there are a number of other discrete area in Crosby and Maghull.

10. Implementation of CAZ options

The effects of a CAZ on emissions are appraised in Section 9. However, the implementation phases, enforcement and resultant journey effects will be determined by the level of charge to both promote change and to cover operational costs of the scheme, as well as what exemptions would be allowed (e.g. benefits claimants or blue-badge holders). The different types of CAZ are discussed below.

A CAZ is intended to reduce the number of non-compliant emissions within a defined zone by altering behaviour. Therefore, whilst a CAZ will have demonstrable benefits for local air quality within the prescribed zone, there are significant commercial, economic and financial risks as vehicle are displaced into other areas. This may lead to changes in regional air quality hotspots, or reduced accessibility for the most vulnerable groups of society; e.g. barriers to accessing local services and amenities, with the greatest disadvantage falling on those least able to afford to pay a charge or upgrade their vehicle, and difficulties for smaller employers to participate in the local economy, and making this a less attractive area for small-scale inward investors. A mitigation a support package is, therefore, essential to enable a CAZ to be practically implemented.

There are a number of travel behaviour responses we could expect from this including:

- Re-routing of vehicle trips (where the effects are mare pronounced with some vehicles types more than others);
- Re-distribution of vehicle trips;
- Increase in car sharing / lifts;
- Suppression of vehicle trips;
- Mode shift primarily to public transport and taxi; and
- Changing / upgrading of vehicles.

There may be a short-term detrimental effect due to diverted traffic and limited access for parts of the fleet that are non-compliant. This will increase operating costs and penalise those operators who may be least able to pay, although it may be mitigated with local and centrally funded subsidies for retrofitting and replacement; these may include scrappage, low cost loans for taxi and van operators to upgrade vehicles, and trial schemes for electric vehicles in partnership with suppliers.

Long-term effects of designating a CAZ may be beneficial, by encouraging adoption of new technology and skills to align with the local and regional infrastructure, such as electric charge points, hydrogen refuelling station, or service and maintenance skills that vary significantly from traditional vehicle mechanics.

Therefore, the effects of a CAZ occur will be related to the charging model, and the designation of a route or destination will then determine the affected population. The immediate and long-term funding allocation is a core consideration needed to support a CAZ without entailing unacceptable socio-economic detriments based on further study. This may be aligned with the damage cost calculations to inform the evidence base and to indicate the magnitude of costs and benefits that may be achieved.

10.1.1 National and Regional Alignment

The resultant routing behaviour for the affected component of the fleet outside and around the CAZ will be a significant concern, including effects within:

- Existing AQMAs;
- Individual boroughs; and
- The regional metropolitan areas, such as Cheshire and Warrington.

Also, Transport for Greater Manchester (TfGM) has undertaken a CAZ appraisal, and Liverpool City Council has been mandated (as of October 2018) to undertake an assessment based on a CAZ-D appraisal threshold. Elsewhere, a number of other cities and regions have undertaken, or are undertaking similar studies.

Therefore, it is essential that any implementation in Sefton should align with the regional and national frameworks so that fleet operators and private buyers can confidently invest in compliant vehicles.

10.1.2 CAZ Charging

CAZ charging models are discussed by Defra (ref), and highlight the behavioural responses associated with the different charging / penalty models, whereby the economic cost will determine the behavioural response:

- The penalty model will effectively ban non-compliant vehicles from accessing the CAZ, with a fixed penalty fine applicable to any breaches.
- The charging model will apply a fixed or sliding scale fee to all vehicles entering the zone. This option may be more flexible in terms of socio-economic effects, but may be more complex to manage.
- Quality partnerships may be used as a proxy for a CAZ, where a known and regulated fleet, such as buses, can be managed to ensure that a minimum standard is achieved and any non-compliant vehicles are retrofitted, removed from the fleet, or operated only on defined routes.

Where a penalty or charging model is applied, the financial cost effectively defines the response of vehicle operators. For example, where a penalty is too low it may be accepted as an operational cost and not achieve the emissions targets, whereas a charging model that is too high it can have detrimental socio-economic effects and push impacts into different areas.

Also, the charging must be carefully balanced with the alternative travel modes, such as park and ride for car drivers. The cost of modal shift must not be onerous, or profit overtly from the situation, and so it may be necessary to subsidise bus or rail travel to specially ensure that those who are least able to pay are not adversely affected.

The charge programme and thresholds should also align with the national and regional framework. Defra have published guidance thresholds based on Euro 4 petrol and Euro 6/VI diesel emission standards, but have not defined an appropriate charging framework. No UK cities outside London have yet declared a CAZ, although when this occurs it is likely to inform the standard charging approach.

A dedicated study may be undertaken to model the effects of charging thresholds and determine how they will alter traffic flow.

10.1.3 Types of CAZ

The way in which the CAZ is implemented will affect behavioural responses, as there are two primary models:

- ‘Corridor’ approach, based on banning non-compliant vehicles from a defined route, and then either rerouting non-compliant vehicles to the destination, or wholly preventing access.
- ‘Cordon’ approach, where vehicles could not re-route since their origin/destination would be within the CAZ. This would make a proportion of these trips ‘non- available’ to the affected fleet and use the existing proportions to allocate journeys to alternative modes. Therefore, it is important to ensure an alternative mode is available, and to consider the effects on residents/businesses within the cordon and are unable to divert.

The air quality study has indicated that the high pollutant concentrations are at junctions on the key routes through the region. If a corridor CAZ were to be defined to encompass these junctions, it would likely lead to redistribution of traffic onto unsuitable roads and resultant congestion and local air quality effects.

Based on the outcome from the air quality modelling for the whole borough, a cordon model may be appropriate in Sefton, based on existing knowledge of destinations for the affected vehicles types; e.g. the port access or major employment areas.

10.2 Recommendations

The model results indicated that the number of properties exposed to high pollutant concentrations decreased significantly between a CAZ-A and CAZ-B scenario, with relatively marginal additional gains in CAZ-C and D scenario. The appraisal considered the whole borough, although the largest changes were predicted to occur on the A5036, and routes with the highest proportion of HGV movements.

Merseytravel is working with bus operators to reduce emissions from buses through a programme of exhaust abatement retrofitting and replacing older vehicles. Together with other regional initiatives, it is likely that an emission standard similar to the modelled CAZ-A scenario may be achieved in the region without further intervention from Sefton.

Therefore, a CAZ that targets HGVs to specifically ensure compliance with Euro VI or greater on the roads with highest HGV proportions would achieve potentially significant benefits in terms of reducing the number of properties exposed to high pollutant concentrations.

The most effective options to implement a CAZ may be:

- Several discrete CAZ incorporating the AQMAs and other hotspots identified in the model; near the major junctions on the A5036; the A565 junction with A5056; and the junction of A565 with the A5058 near Millers Bridge;
- A single large CAZ incorporating all areas of concern; or,
- A discrete CAZ targeting part of a route to target a sub-set of vehicles, whilst having an effect on a whole route, and minimising redistribution effects on local traffic.

Of these options, a CAZ that includes the junction of Princess Way and Crosby Road would potentially achieve the most significant benefits in areas that comprise routes for HGVs, whilst minimising the likelihood of redistribution effects onto local roads. Whilst this would not encompass all areas of concern, to improve these other areas would require additional measures or a larger CAZ including additional vehicle types, which may not be feasible.

To validate the potential effects of this approach it is recommended that the ANPR survey and transport model data be interrogated to understand the number of individual HGVs that operate in this area, and what other areas they also travel through. This information may be used to inform an implementation programme to achieve significant uptake of low-emission vehicles.

The charging model should also be reviewed to determine how operators will respond (see Section 11.6.2).

11. Health and Socio-Economic Effects

As discussed in Section 2.1, poor air quality can contribute, and in some circumstances, cause direct health effects. The study has focussed on areas where the air quality limit values are exceeded, although there are no 'safe' levels for exposure to atmospheric pollutants, and health effects can occur within compliant limits.

Statistical exposure and health impact studies of particulate exposure have shown that short-term pollution events have direct correlation with increased hospital admissions, as well as increased mortality[14]. Therefore, there is a tangible health and economic benefit to reducing both long, and short-term exposure to atmospheric pollution.

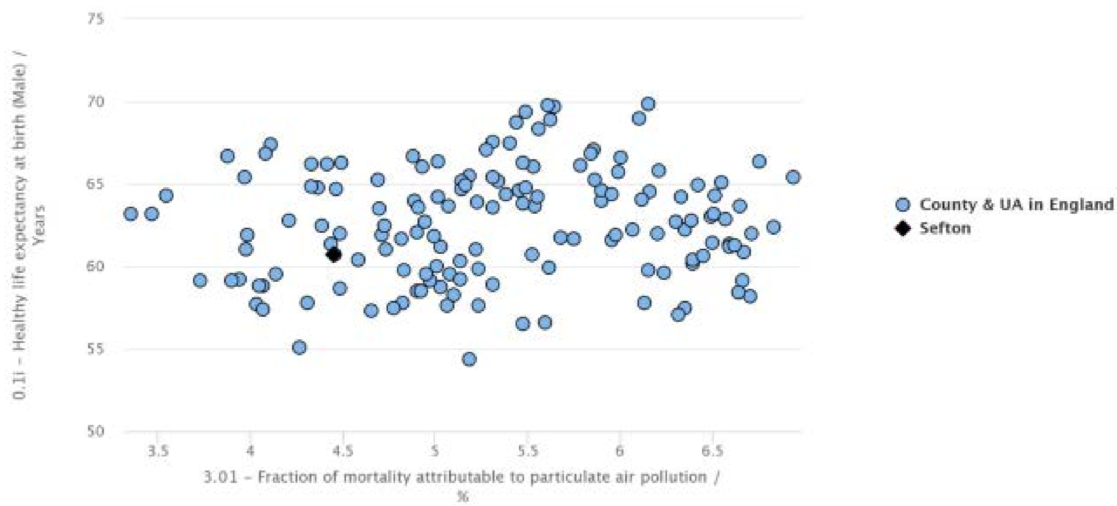
This section outlines the potential socio-economic and health effects in a local context.

11.1 Public Health

The Public health outcomes[15] indicates that Sefton is near the centre of the range of life expectancy in the UK, and near the lower end of the fraction of mortality attributed air pollution, using $PM_{2.5}$ exposure as an indicator.

Therefore, whilst Sefton has not been identified as atypical of the national perspective, there are opportunities to improve the effects on mortality and morbidity due to air quality. Also, as this data is representative for the whole borough, there may be specific opportunities to achieve improvements in specific sensitive areas at a ward level. The data in Figure 34 indicate where Sefton ranks compared to the rest of the UK.

Figure 34 Life Expectancy and Fraction Attributable to Air Pollution



11.1.1 Nitrogen Dioxide

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.

Exposure to NO_2 understood to be linked with decreased lung function, growth, increases in respiratory symptoms, asthma prevalence and incidence, cancer incidence, adverse birth outcomes and mortality. However, whilst evidence indicates direct health effects, it is also understood that cumulative effects may occur from

[14] Macintyre et.al. (2016) Mortality and emergency hospitalizations associated with atmospheric particulate matter episodes across the UK in spring 2014

[15] https://fingertips.phe.org.uk/profile/public-health-outcomes-framework/

exposure to associated pollutants, such as combustion products[16]. Therefore, whilst NO_2 is used as an indicator pollutant, the direct health effects associated with exposure to this pollutant are very complex.

11.1.2 Particulate Matter

Particulate matter is composed of a wide range of materials arising from a variety of sources, and is typically assessed as total suspended particulates or as a mass size fraction. Potential background and regional sources include sea-salt, agricultural emissions (e.g. dust from exposure fields), industrial sites, and domestic wood stoves, whilst transport sources are due to combustion products from exhausts, tyre/brake wear, and re-suspended dust from road surfaces. The background contribution of PM represents a large proportion of the total concentration, and this is important to recognise as it will affect the overall shape and chemical composition of the material, and the resultant health effects.

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 micrograms (µm) in diameter 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.

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 (COMEAP)[17] 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.

11.2 Index of Multiple Deprivation

The IMD 2015 is the official measure of relative deprivation for small areas (or neighbourhoods) in England[18]. The IMD ranks every small area in England from 1 (most deprived area) to 32,844 (least deprived area). Deprivation deciles are calculated by ranking the 32,844 small areas in England from most deprived to least deprived and dividing them into 10 equal groups. The index is based on scores for:

- Income;
- Employment;
- Education;
- Health;
- Crime;
- Barriers to housing & services; and
- Living Environment.

The index is used in this study to indicate the potential health effects of changes in air quality, where it is broadly understood that individuals living in deprived areas may be disproportionally sensitive to the cumulative effects of poor air quality. The index has also been used to help indicate the ability of a population to adapt to potential interventions, where accessibility or economic impacts may occur.

The IMD was used to objectively consider the sensitivity of the modelled receptor locations, representing properties within 50m of the modelled roads. There is a significant variation of IMD scores across the borough,

[16] Committee On The Medical Effects Of Air Pollutants Statement On The Evidence For The Effects Of Nitrogen Dioxide On Health https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/411756/COMEAP_The_evidence_for_the_effects_of_nitrogen_dioxide.pdf

[17] Associations of long-term average concentrations of nitrogen dioxide with mortality A report by the Committee on the Medical Effects of Air Pollutants, Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/734799/COMEAP_NO2_Report.pdf

[18] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/464430/English_Index_of_Multiple_Deprivation_2015_-_Guidance.pdf

with lower scores in the lowest band clustered around Bootle, Litherland and Netherton, and higher scores in Maghull, Corby and Southport.

11.2.1 Sensitivity to Effects

As discussed in Section 9.2, there are a number of areas that may be at risk of significant effects due to vehicles diverting to avoid a CAZ. Many of the locations in Bootle are designated with an IMD score of 1, which is the lowest index and suggests they would be both highly sensitive to changes in air quality, and least prepared to accommodate any socio-economic effects of a CAZ being implemented. Therefore, the implementation of a CAZ would need to consider how it can be effective in reducing air pollution without limiting access to participation in work for those who are most affected but may be least able to respond.

Where high concentrations are significant associated with short periods of exposure, such as walking near a busy road, this may specifically contribute to acute effects. The traffic profiles discussed in Section 5 indicate the locations and patterns of these events and may be used to infer how members of the public may be exposed.

11.3 Public Health Costs

Public Health England have published a tool[19] to test the long-term health and cost impacts of air pollution at a local authority level, whereby the model scales all the aggregated individual disease costs according to the relative disease prevalence in years after the start year.

The data in Figure **35**, and Figure **36** show the age / exposure profile in the baseline scenario, whereby the cost are higher where a demographic is exposed to high pollutant concentrations for a longer duration. This effect is significant in Sefton as the proportion of children and people of working age exposed to air pollution is higher than for people in older age groups.

The costs presented in Table 8 are estimated to be £13.4M per 100,000 people in 2017, which is equivalent to a total of £36.7M based on Sefton's population of approximately 273,700 people in 2015.

The exposure profiles below are based on a nominal exposure profile, which predicts a notable proportion of the residents exposed to a 'high' level of pollution. The air quality modelling presented in this report does not predict a large number of residential properties are likely to be exposed to high pollutant concentrations, but this does not take into account other potential exposure pathways or lifestyle. Therefore, the magnitude of costs projected by the PHE tool may subjectively represent a cautious projection.

Figure **35** Males, Age Profile Exposure to NO_2

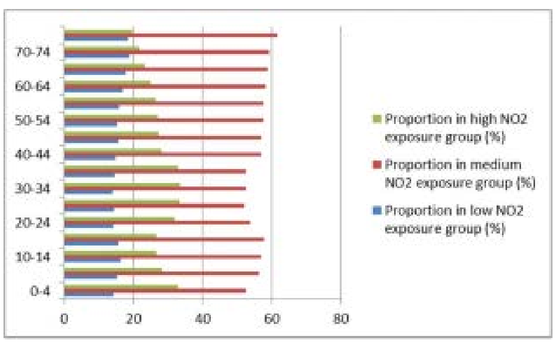
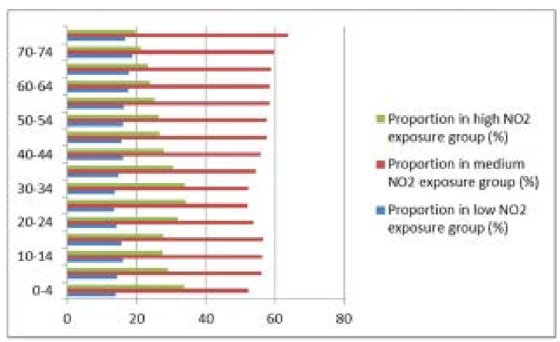


Figure **36** Females, Age Profile Exposure to NO_2



[19] PHE (2018) A tool to test the long term health and cost impacts of air pollution at a local authority level https://www.gov.uk/government/publications/air-pollution-a-tool-to-estimate-healthcare-costs

Table 8. Estimated Direct Public Health Costs (M£/100,000 people)

	Year										
	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Primary Care Costs	£2.70	£2.89	£3.06	£3.22	£3.38	£3.52	£3.67	£3.81	£3.93	£4.04	£4.17
Secondary Care Costs	£3.90	£4.15	£4.39	£4.63	£4.85	£5.06	£5.27	£5.47	£5.64	£5.80	£5.99
Medication Costs	£2.90	£3.04	£3.16	£3.28	£3.40	£3.51	£3.61	£3.72	£3.80	£3.89	£3.97
Social Care Costs	£3.92	£4.21	£4.48	£4.75	£5.00	£5.23	£5.46	£5.68	£5.88	£6.06	£6.27
Combined Costs	£13.42	£14.28	£15.09	£15.88	£16.62	£17.32	£18.01	£18.68	£19.25	£19.79	£20.39

11.4 Damage Costs

Guidance to calculate damage costs is published by Defra based on the impact on an average population affected by changes in air quality (Defra, https://www.gov.uk/air-quality-economic-analysis). These costs represent the direct and indirect effects on health, and include factors for productivity, lost work time and direct health care.

The guidance stipulates that the damage cost should help determine the amount (value) of mitigation that is expected to be spent on measures to reduce the impacts, although in the context of this study it is used to indicate the effect that may be achieved. The calculation requires the use of the most recent Defra Emissions Factor Toolkit (v8.0.1a) to estimate the annual pollutant emissions across the modelled network, whilst the Inter Government Department on Costs and Benefits (IGCB) Air Quality Damage Costs (Defra, 2015) were used calculate the resultant damage costs for the specific pollutant of interest.

It should be noted that the calculation methodology is not contained within any National air quality planning guidance. The IGCB guidance rather, was prepared for use by Government to assess the impact of changes to existing policy with regards to potential air quality impacts. The following statement is provided on Defra's website (http://archive.defra.gov.uk/environment/quality/air/airquality/panels/igcb/qanda.htm) qualifying its intended use:

> *'Due to the limitations of the damage costs approach their use is only recommended for central government departments, or consultants conducting work on their behalf. This would include project appraisals and regulatory impact assessments where policies have ancillary air quality benefits and for more general 'scoping analysis' of policy options. Damage costs are not appropriate to use at a local or regional (such as by local authorities) as the values do not take into account local or regional effects or variations. It is also stressed that the values are not proposed for full air quality appraisal – either of air quality policy (at a national level) or of air quality measures (inc. local schemes).'*

Therefore, in the context of this study it is used to indicate the potential effects that may be achieved, and to provide an indicative framework for the economic effects.

The resultant annual damage costs in 2015 are provided in Table **9**, and suggest that approximately £300M of costs is attributable to air pollution in Sefton. With reference to the outputs from the PHE tool presented above, this includes approximately £270M of indirect costs (i.e. less the values from the PHE tool) based on 2015 values and emissions.

Table 9. Annual Damage Costs, based on modelled roads in Sefton 2015

Pollutant	Emissions, t/yr	Cost per t	Annual Cost
NO_X	7304.0	£30,514	£222,875,077
PM_{10}	540.5	£84,283	£45,557,769
$PM_{2.5}$	337.8	£84,283	£28,470,611
		Total Cost	£296,903,458

The damage costs attributed to each scenario are presented in Table **10** for 2020, based on 2015 value for damage costs. The resultant change compared to the baseline projection reflect how the change in emissions is reflected across the whole network, as the CAZ-A was predicted to achieve significant changes in key locations (i.e. road links with large bus flows), but would have minimal effect across the borough, whereas the other scenarios would achieve increasingly dispersed, effects on local air quality across the wider borough.

Table 10. Change in NO_X Damage Cost Results from each CAZ Scenario in 2020

Scenario	Annual NO_X Emissions, t/yr	Annual Cost	Damage Cost Saving	
Baseline (no CAZ)	4893.2	£149,312,442		
Result CAZ A (Replace buses)	4759.6	£145,235,390	£4,077,052	2.8%
Result CAZ A (Retrofit buses)	4818.3	£147,025,215	£2,287,227	1.6%
Result CAZ B (Replace buses)	3865.7	£117,959,315	£31,353,127	26.6%
Result CAZ B (Retrofit buses)	3924.4	£119,749,140	£29,563,302	24.7%
Result CAZ C (Replace buses)	3665.3	£111,843,957	£37,468,485	33.5%
Result CAZ C (Retrofit buses)	3724.0	£113,633,782	£35,678,660	31.4%
Result CAZ D (Replace buses)	3348.8	£102,184,641	£47,127,801	46.1%
Result CAZ D (Retrofit buses)	3407.4	£103,974,451	£45,337,991	43.6%

These are considerable sums, and so may be used to indicate the potential benefits of emissions reductions that may seem relatively small, as well as highlighting the potential benefits of reductions even in areas where compliance has already been achieved (e.g. annual mean NO_2 concentrations <40$\mu g/m^3$). However, it must be recognised that the outcomes presented here assume the CAZ is borough wide and achieves 100% compliance as a hypothetical scenario, and a real-world scenario would not recover damage cost on this scale.

11.5 Impact Pathway Costs

The Impact Pathway model (Defra, 2013[20]) is a more complex approach than Damage Cost, and may be appropriate where the impacts exceed £50m, as it considers the location of the exposure rather than the strategic effects. It therefore, becomes more significant in densely populated urban areas.

With reference to the data in Table 10, the predicted effects on Damage Cost that may be achieved with a borough-wide CAZ exceed £50m in the CAZ-C and CAZ-D scenarios. However, were a CAZ to be applied to only part of the borough, the magnitude of effects would likely be smaller.

The key component of the Impact Pathway approach is to assign a concentration-response to the impacts, such as health, and to assign an appropriate monetary valuation. The complex stage is the assignment of a suitable response function, which potentially entails a significant amount of information to fully complete an assessment.

The method applies a coefficient as a fractional percentage per 10 μgm^3 increase in exposure, based on an associated health outcome of mortality and hospital admissions. The outcome of this coefficient is subsequently attributed a monetary value in terms of health (e.g. cost of a hospital visit, and value of lost productivity).

In this way, the results of the Impact Pathway model are more targeted than the Damage Cost approach, although it must recognise the potential uncertainties in the valuations. Therefore, this method has not been used in this study, but may be undertaken using the model outputs and accurate local health information if it is determined to be necessary.

11.6 Summary

The significant difference between the damage cost approach and the PHE is the level of exposure attributed to the emissions. However, regardless of the indices, it is clear that poor air quality has a very significant economic impact.

[20] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/197900/pb13913-impact-pathway-guidance.pdf

11.6.1 Cost - Benefit

The cost to implement a CAZ in terms of assessment, consultation and business case, leading onto the implementation and capital costs will likely be in the region of >£10m based on similar studies elsewhere in the UK, plus long-term operational costs less an income from the charging/penalty model that will decrease in the future.

The damage-cost approach indicates the annual benefits that could be achieved if the CAZ included the whole borough, and depending upon the type of CAZ. There are numerous caveats with this value, as outlined in Section 11.5, related to the concentration-response profiles used.

Therefore, a CAZ is likely to be economically beneficial in the long-term, subject to the type and extent of the designation, due to improved outcomes for social care cost savings, fewer days off work, and incentivising new industry and technological skills.

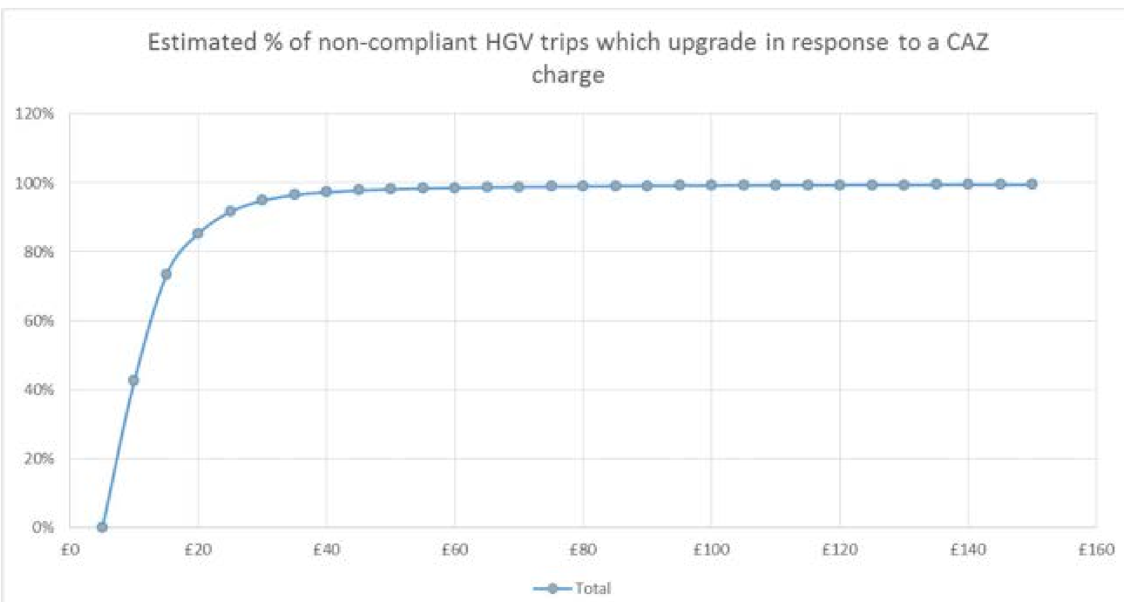
11.6.2 HGV charge analysis

An HGV charge analysis tool has been developed on behalf of JAQU as an example of an innovative approach to estimating HGV responses.

This tool aims to estimate how HGVs might respond to a CAZ charge by comparing the cost of upgrading to the cost of paying the charge depending on the frequency of travel and based on the local ANPR fleet analysis.

The plot in Figure 37 indicates that a charge of approximately £60 per day would achieve 99% compliance with the CAZ emission standards – i.e. the charge would be sufficient enough that users will avoid the zone or upgrade the vehicle rather than pay a fee / fine. The charge may change in future, as the presence of the CAZ encourages the uptake of compliant vehicles, so the level of compliance increases and the revenue decreases, which would need to be balanced against the cost of operating the scheme.

Figure 37 HGV Charge Analysis



12. Conclusions

A detailed emissions and dispersion modelling study was undertaken to determine the concentrations of NO_2, PM_{10} and $PM_{2.5}$ near major roads in the Borough of Sefton.

The study included collection and analysis of ANPR data to determine the age profile of the regional fleet and to assign an emissions profile, which was then projected into the future years using tools published by Defra. A source apportionment study was undertaken to determine the major emission sources on the major routes.

Several modelling scenarios were used to predict effects of implementing a Clean Air Zone in the Borough, and the results appraised with regard to the predicted pollutant concentrations at sensitive locations. The study specifically considered the conditions on the A5036 route between the port and the Switch island motorway junction.

The whole Borough was modelled to identify all areas of concern, with regard to poor air quality, and where the designation of a potential CAZ may have the greatest benefits or risks, within and outside the designated area. It was not anticipated that a CAZ would be appropriate for the whole Borough, but this extent was used to inform where the greatest benefits or risks from a CAZ may occur.

12.1 Summary

12.1.1 Baseline

SMBC undertakes passive and automatic air quality monitoring for NO_2. The monitoring was used to inform and verify the detailed modelling to identify a number of locations where the annual mean concentration of NO_2 is persistently higher than the EU limit value, although the majority of locations are below this threshold. The high concentrations are mainly near major road junctions where there is regular queuing and congestion.

The baseline projection was also used to identify those areas most ‘at risk’ to increased pollutant concentrations that may occur due to any redistribution of non-compliant vehicles on roads outside of a CAZ.

12.1.2 Fleet Breakdown

The Euro classifications determined from the ANPR data were compared to the national values published by Defra in the EFT.

The local fleet derived from the ANPR data generally follows the same trends, but is slightly older than the national projections. This is typical of many urban areas in the UK where similar studies have been undertaken, and highlights the differences on local roads that are not part of the Strategic Road Network (SRN).

The majority of HGVs and buses are diesel, almost all LGV are diesel, and the car fleet is split approximately 50/50 between petrol and diesel.

12.1.3 Emissions Breakdown

The main emissions components from LDVs (cars and vans) are Euro 5 and 6C, whereas HDVs are predominantly comprised of Euro IV with significant emissions from Euro IV buses and Rigid HGVs, and from Euro VI articulated HGVs. It is noted that HDVs (HGVs and Buses) generally have higher emissions than LDVs (cars or vans), and so can represent a disproportionally significant emission source.

The emissions on the A5036 between the port and the Switch Island junction with the M57 and M58 were explicitly considered in terms of sources for all traffic, and to extract the emissions associated with the port HGV traffic.

- The breakdown of vehicles emissions on this route indicates that 31% are due to diesel cars, with similar proportions of approximately15-20% each due to LGVs, rigid HGVs and artic HGVs.
- Within each category of vehicle type, the Euro category is shown, where diesel car emissions are predominantly Euro 4 and 6. LGVS are also predominantly Euro 4, with equal splits in Euro 5 and 6.

12.1.4 Pollutant Exposure

The annual mean concentration of NO_2 was predicted at all relevant receptors within 50m of the modelled road network. The concentrations were predicted to be higher in 2020 than 2025 due to projected improvements to the emissions profile through the uptake of newer vehicles and alternative technologies.

The highest concentrations were predicted to occur near the major junctions on the A5036 and the junction of Millers Bridge and Derby Road, predominantly due to lower speeds of vehicles slowing and accelerating and relatively high proportions of HGVs.

Relatively high roadside concentrations below the NAQS, but also potential exceedances were predicted near junctions on Merton Road and Stanley Road, which were also associated with low speeds.

To the north of Bootle, high concentrations were predicted in Crosby at the junction of A565 with South Road, and in Maghull at the junction of Westway and Liverpool Road.

There were no locations where the annual mean concentrations were predicted to exceed the annual mean limit value for PM_{10} or $PM_{2.5}$ in any modelled scenario.

12.1.5 Socio-economic Costs

The direct public health costs were estimated to be equivalent to £36.7M based on the population of approximately 273,700 people in 2015, with total socio-economic damage cost of approximately £300M attributable to air pollution in the borough.

12.1.6 CAZ

The model results indicated that the number of properties exposed to high pollutant concentrations decreased significantly between a CAZ-A and CAZ-B scenario, with relatively marginal additional gains in CAZ-C and D scenario. The appraisal considered the whole borough, although the largest changes were predicted to occur on the A5036, and routes with the highest proportion of HGV movements.

Merseytravel is working with bus operators to reduce emissions from buses through a programme of exhaust abatement retrofitting and replacing older vehicles. This is supported by ongoing work by Liverpool City Council on a Local Air Quality Plan in response to a mandate from JAQU, and so it is likely that an emission standard similar to the modelled CAZ-A scenario may be achieved in the region without further intervention from Sefton.

A CAZ that targets HGVs, including the junction of Princess Way and Crosby Road, would potentially achieve the most significant benefits, whilst minimising the likelihood of redistribution effects onto local roads. Whilst this would not encompass all areas of concern, to improve these other areas would require additional measures or a larger CAZ including additional vehicle types, which may not be feasible.

The model also predicted there may be residual areas of high pollution concentrations in a CAZ-B scenario. Further emissions reductions may be achieved with a more stringent CAZ, such as a type D (all vehicles) implemented in these areas. However, even with a CAZ-D implemented across the borough, there will be some residual areas of high concentrations. Any CAZ option may be complemented with proven measures, such as targeted driver training or screening / barriers in discrete areas where persistent high concentrations occur.

12.2 Further Actions and Recommendations

The implementation of a CAZ would achieve reduced emissions within the defined zone, although there will be potential detrimental effects due to non-compliance or journey redistribution outside the zone. Therefore, it is recommended that an improved understanding of journey origin-destination should be developed, and this may be used in conjunction with a behavioural demand model to understand how different vehicle types will respond, and to ensure that unacceptable detrimental effects do not occur. This information should be used to inform the detailed design of a CAZ.

To validate the potential effects of this approach it is recommended that the ANPR survey and transport model data be interrogated to understand the number of individual HGVs that operate in this area, and what other areas they also travel through. This information may be used to inform an implementation programme to achieve significant uptake of low-emission vehicles.

13. Appendices

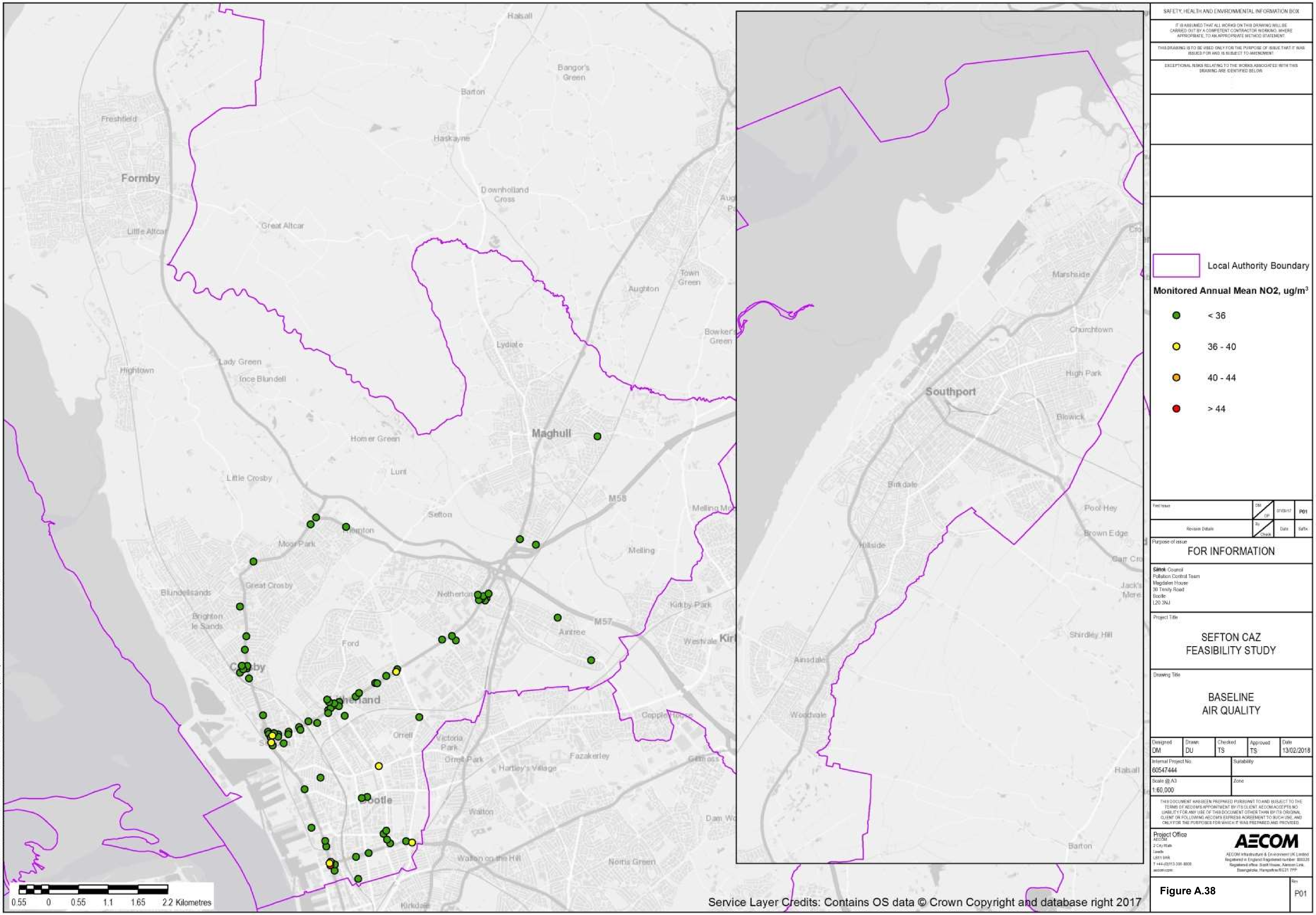
Appendix A Local Air Quality Monitoring

Table 11. Passive Air Quality Monitoring

			Coordinates		Annual Mean NO_2, $\mu g/m^3$					
ID	Location	Type	X	Y	2012	2013	2014	2015	2016	2017
NW	Gladstone Road/Gordon Road, Seaforth	Roadside	332978	397021	36.0	33.0	33.0	30.0	31.0	32.0
NAG	Lydiate Lane, Thornton	Roadside	334039	400808	24.0	21.0	21.0	18.0	17.0	
NAN	Strand Road, Bootle	Kerbside	333399	395251	34.0	34.0	33.0	30.0	31.0	34.0
NAW	Balliol House, Bootle	Roadside	334459	394781	37.0	37.0	35.0	33.0	30.0	33.0
NBB	Eaton Avenue, Seaforth	Roadside	333510	397184	34.0	33.0	31.0	28.0	29.0	28.0
NBL	Litherland Road/Marsh Lane, Bootle	Kerbside	334432	395820	33.0	31.0	29.0	29.0	29.0	33.0
NBM	Millers Bridge, Bootle	Roadside	333785	394594	**45.0**	**45.0**	**44.0**	**41.0**	**41.0**	**47.0**
NBO	Douglas Place, Bootle	Roadside	333828	394457	34.0	32.0	30.0	29.0	30.0	32.0
NBQ	Douglas Place/Millers Bridge, Bootle	Roadside	333834	394570	35.0	33.0	32.0	30.0	32.0	36.0
NBR	Derby Road, Bootle	Roadside	333751	394553	**58.0**	**56.0**	**54.0**	**53.0**	**46.0**	**61.0**
NBS	Derby Road, Bootle	Roadside	333757	394622	**48.0**	**43.0**	40.0	39.0	39.0	40.0
NBU	Hougoumont Avenue/South Road, Waterloo	Kerbside	332083	398113	31.0	29.0	26.0	25.0	26.0	25.0
NBV	Quarry Road, Thornton	Roadside	333386	400851	37.0	35.0	33.0	31.0	33.0	31.0
NBW	Crosby Road South/Riversdale Road, Seaforth	Kerbside	332599	397021	36.0	34.0	33.0	31.0	30.0	33.0
NCI	Hawthorne Road, Bootle	Roadside	333821	397512	**48.0**	**42.0**	**42.0**	37.0	38.0	**42.0**
NCJ	South Road, Waterloo	Roadside	332204	398230	**46.0**	**42.0**	**41.0**	38.0	38.0	**41.0**
NCR	Parker Avenue, Seaforth	Roadside	332507	397330	36.0	33.0	33.0	30.0	29.0	31.0
NCS	Willoughby Road, Waterloo	Kerbside	332142	398186	25.0	24.0	24.0	20.0	22.0	23.0
NCU	Sefton Street, Litherland	Roadside	333711	397422	35.0	35.0	33.0	26.0	25.0	
NCV	South Road Waterloo	Roadside	332188	398218	31.0	26.0	28.0	22.0	22.0	24.0
NCY	Lytton Grove, Seaforth	Roadside	332976	396977	31.0	32.0	31.0	26.0	28.0	30.0
NCZ	Pleasant Street, Bootle	Kerbside	333674	394904	37.0	37.0	38.0	34.0	32.0	**43.0**
NDC	Marsh Lane, Bootle	Kerbside	334328	395797	38.0	38.0	36.0	33.0	33.0	40.0
NDD	Hawthorne Road, Litherland	Roadside	333773	397535	**42.0**	**43.0**	**44.0**	38.0	38.0	**47.0**
NDE	Wilson's Lane, Litherland	Roadside	333913	397574	30.0	30.0	29.0	26.0	28.0	29.0
NDF	Church Road flats. Litherland	Roadside	333909	397497	34.0	31.0	30.0	27.0	28.0	31.0
NDG	Marina Avenue, Litherland	Roadside	333759	397460	31.0	27.0	30.0	24.0	24.0	26.0
NDH	South Road, Waterloo	Roadside	332191	398194	39.0	35.0	36.0	32.0	31.0	34.0
NDI	Crosby Road North, Waterloo	Roadside	332205	398190	**44.0**	**41.0**	**41.0**	34.0	33.0	39.0
NDM	Chapel Terrace, Bootle	Roadside	333656	395005	31.0	33.0	35.0	31.0	30.0	33.0
NDN	Queens Road, Bootle	Roadside	334225	394710	32.0	32.0	34.0	29.0	29.0	33.0
NDO	Hawthorne Road/ Linacre Lane, Bootle	Kerbside	334647	396388	**42.0**	**44.0**	**47.0**	38.0	40.0	**47.0**

			Coordinates		Annual Mean NO_2, $\mu g/m^3$					
ID	**Location**	**Type**	**X**	**Y**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
NDP	Gordon Road/ Rawson Road, Bootle	Kerbside	332786	396975	39.0	35.0	39.0	33.0	33.0	36.0
NDQ	Rawson Road, Bootle	Roadside	332788	396932	38.0	36.0	34.0	30.0	32.0	34.0
NDR	Crosby Road North, Waterloo	Roadside	332216	398236	**41.0**	**40.0**	39.0	35.0	34.0	**44.0**
NDS	South Road, Waterloo	Kerbside	332142	398176	36.0	34.0	35.0	30.0	29.0	32.0
NDT	Glendower Road, Waterloo	Kerbside	332115	398241	23.0	23.0	22.0	20.0	20.0	21.0
NDU	Liverpool Road/ Kingsway, Waterloo	Roadside	332196	398788	39.0	38.0	38.0	33.0	33.0	34.0
NDV	Moor Lane, Crosby	Kerbside	332327	400168	**44.0**	**43.0**	38.0	36.0	36.0	39.0
NDW	Church Road/ Kirkstone Road North	Roadside	334577	397923	37.0	37.0	39.0	31.0	33.0	34.0
NDX	Merton Road, Bootle	Roadside	334734	395138	35.0	37.0	36.0	33.0	33.0	36.0
NDY	Hougoumont Avenue/Crosby Road North	Kerbside	332248	398008	28.0	26.0	28.0	22.0	23.0	28.0
NDZ	Bailey Drive, Bootle	Roadside	335394	397291	36.0	39.0	36.0	30.0	33.0	35.0
NEA	Copy Lane, Netherton	Roadside	336635	399491	29.0	28.0	29.0	29.0	28.0	30.0
NEB	Copy Lane, Netherton	Kerbside	336607	399446	39.0	39.0	35.0	34.0	31.0	37.0
NEC	Copy Lane/ Dunningsbridge Road	Roadside	336539	399477	**43.0**	40.0	39.0	32.0	32.0	35.0
NED	Cumberland Gate, Netherton	Urban bknd	336492	399455	25.0	26.0	25.0	21.0	21.0	23.0
NEE	Copy Lane Police Station, Netherton	Roadside	336574	399525	**41.0**	**41.0**	39.0	34.0	36.0	36.0
NEF	Copy Lane/ Northern Perimeter Road	Roadside	336476	399553	36.0	32.0	32.0	27.0	28.0	28.0
NEG	Dooley Drive, Netherton	Roadside	336672	399574	33.0	30.0	29.0	26.0	26.0	30.0
NEK	Hawthorne Road, Bootle	Kerbside	334781	395193		33.0	33.0	30.0	32.0	34.0
NEL	Breeze Hill, Bootle	Kerbside	335259	394977		**43.0**	39.0	38.0	40.0	**42.0**
NEM	Millers Bridge Industrial Estate, Bootle	Roadside	333735	394594		**41.0**	40.0	37.0	**41.0**	**43.0**
NEN	Hawthorne Road, Litherland	Roadside	333725	397573		34.0	34.0	31.0	32.0	33.0
NEO	Hatton Hill Road, Litherland	Kerbside	333690	397615		38.0	36.0	32.0	35.0	36.0
NEP	Ash Road, Seaforth	Roadside	333343	397217		28.0	31.0	27.0	30.0	30.0
NEQ	Crosby Road South, Seaforth	Kerbside	332612	396982		35.0	35.0	33.0	32.0	33.0
NER	Green Lane, Seaforth	Kerbside	333174	397112		29.0	29.0	27.0	24.0	27.0
NES	Chatham Close, Seaforth	Kerbside	332712	397000		30.0	30.0	27.0	29.0	30.0
NET	Moorhey Road, Maghull	Roadside	337547	400475		21.0	22.0	20.0	22.0	24.0
NEU	Moorhey Road, Maghull	Roadside	337250	400580		24.0	25.0	22.0	24.0	26.0
NEV	Princess Way, Seaforth	Roadside	332650	396919			39.0	36.0	37.0	**41.0**
NEW	Crosby Road South, Seaforth	Roadside	332662	396824			38.0	37.0	35.0	39.0
NEX	Elm Drive, Seaforth	Kerbside	332725	396840			33.0		31.0	32.0
NEY	Lathom Avenue, Seaforth	Kerbside	332682	396952			**41.0**	38.0	37.0	36.0
NEZ	Hicks Road, Seaforth	Kerbside	333199	397058			28.0	25.0	26.0	26.0
NFA	Bridge Road, Seaforth	Kerbside	333711	397368			33.0	29.0	26.0	33.0
NFB	Hawthorne Road, Litherland	Roadside	334017	397317			38.0	32.0	32.0	39.0

			Coordinates		Annual Mean NO_2, $\mu g/m^3$					
ID	Location	Type	X	Y	2012	2013	2014	2015	2016	2017
NFC	St Phillips Avenue, Litherand	Roadside	334218	397673			29.0	27.0	27.0	30.0
NFD	Church Road, Litherland	Roadside	334280	397737			30.0	26.0	26.0	29.0
NFE	Church Road, Litherland	Roadside	334617	397917			33.0	31.0	32.0	36.0
NFF	Boundary Road, Litherland	Kerbside	334984	398177			39.0	32.0	35.0	38.0
NFG	Sandiways Avenue, Netherton	Roadside	335997	398790			28.0	26.0	27.0	30.0
NFH	Church Road, Netherton	Kerbside	334963	398131			**45.0**	37.0	39.0	**44.0**
NFI	Hemans Street, Bootle	Roadside	333273	395963			36.0	34.0	35.0	**42.0**
NFJ	Dunningsbridge Road, Netherton	Roadside	335815	398723			25.0	23.0	24.0	25.0
NC10	Sandfield Road. Bootle	Roadside	334855	394959	24.0	25.0	24.0	21.0	23.0	26.0
NC11	Sandfield Road. Bootle	Roadside	334796	395034		24.0	25.0	22.0	22.0	
NC14	Viola Street, Bootle	Roadside	334262	394305	27.0	23.0	22.0	20.0	21.0	22.0
NC28	Marina Avenue, Litherland	Roadside	333823	397545	29.0	26.0	26.0	23.0	24.0	24.0
NC47	Coronation Drive, Crosby	Roadside	332080	399336	20.0	19.0	18.0	15.0	17.0	8.0
NC51	Apollo Way, Netherton	Roadside	335928	399882	19.0	15.0	14.0	14.0	14.0	16.0
NC52	Green Lane, Thornton	Roadside	333489	400980	31.0	28.0	25.0	22.0	21.0	22.0
NC74	Deyes Lane, Maghull	Roadside	338682	402476	24.0	21.0	20.0	20.0	21.0	19.0
NC82	Fernhill Way, Bootle	Roadside	335147	395002	32.0	31.0	31.0	28.0	21.0	30.0
NC83	Sandiways Avenue, Netherton	Roadside	336067	398710	24.0	22.0	23.0	20.0	19.0	22.0
NC86	Crosby Road South, Seaforth	Roadside	332685	396768	35.0	34.0	33.0	31.0	29.0	34.0
NC107	Norton Street, Bootle	Roadside	333571	396173	28.0	25.0	23.0	23.0	21.0	25.0
NC108	Wango Lane, Aintree	Roadside	338567	398342	21.0	21.0	20.0	18.0	18.0	20.0
NC112	Poplar Grove, Seaforth	Roadside	332889	396811	28.0	27.0	25.0	24.0	21.0	23.0
UK2	Church Road, Litherland	Roadside	334781	398054	33.0	32.0	30.0	27.0	28.0	29.0
UK4	Crosby Road North, Waterloo	Roadside	332170	398538	39.0	38.0	35.0	32.0	31.0	36.0
NC124	Bartons Close , Southport	Roadside	337593	420294						19.0
NFL	Hawthorne Road Bootle	Roadside	333687	397578						35.0



Plot Date: 13 February 2018 20:09:10
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EXCEPTIONAL RISKS RELATING TO THE WORKS ASSOCIATED WITH THIS DRAWING ARE IDENTIFIED BELOW

First Issue	DM / DP	07/09/17	P01
Revision Details	By / Check	Date	Suffix

Purpose of issue

FOR INFORMATION

Sefton Council
Pollution Control Team
Magdalen House
30 Trinity Road
Bootle
L20 3NJ

Project Title

SEFTON CAZ
FEASIBILITY STUDY

Drawing Title

BASELINE
AIR QUALITY

Designed	Drawn	Checked	Approved	Date
DM	DU	TS	TS	13/02/2018

Internal Project No. 60547444	Suitability
Scale @ A3 1:60,000	Zone

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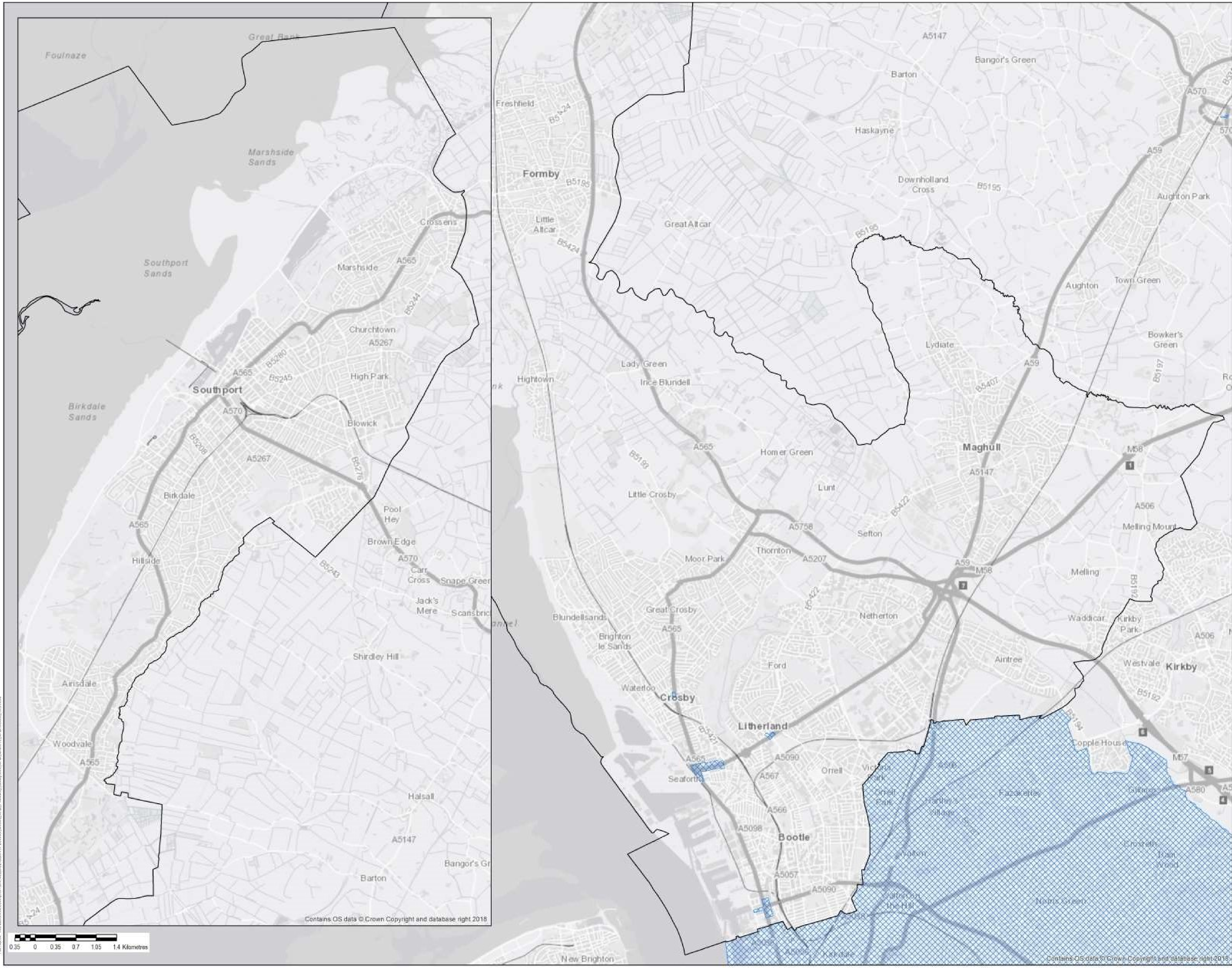
Figure A.38

Rev
P01



N
W E
S

Local Authority Boundary

FOR INFORMATION

SEFTON CAZ
FEASIBILITY STUDY

AIR QUALITY
MANAGEMENT AREAS

Designed DM | Drawn DU | Checked TS | Approved TS | Date 14/12/2018

Scale @ A3 1:40,000

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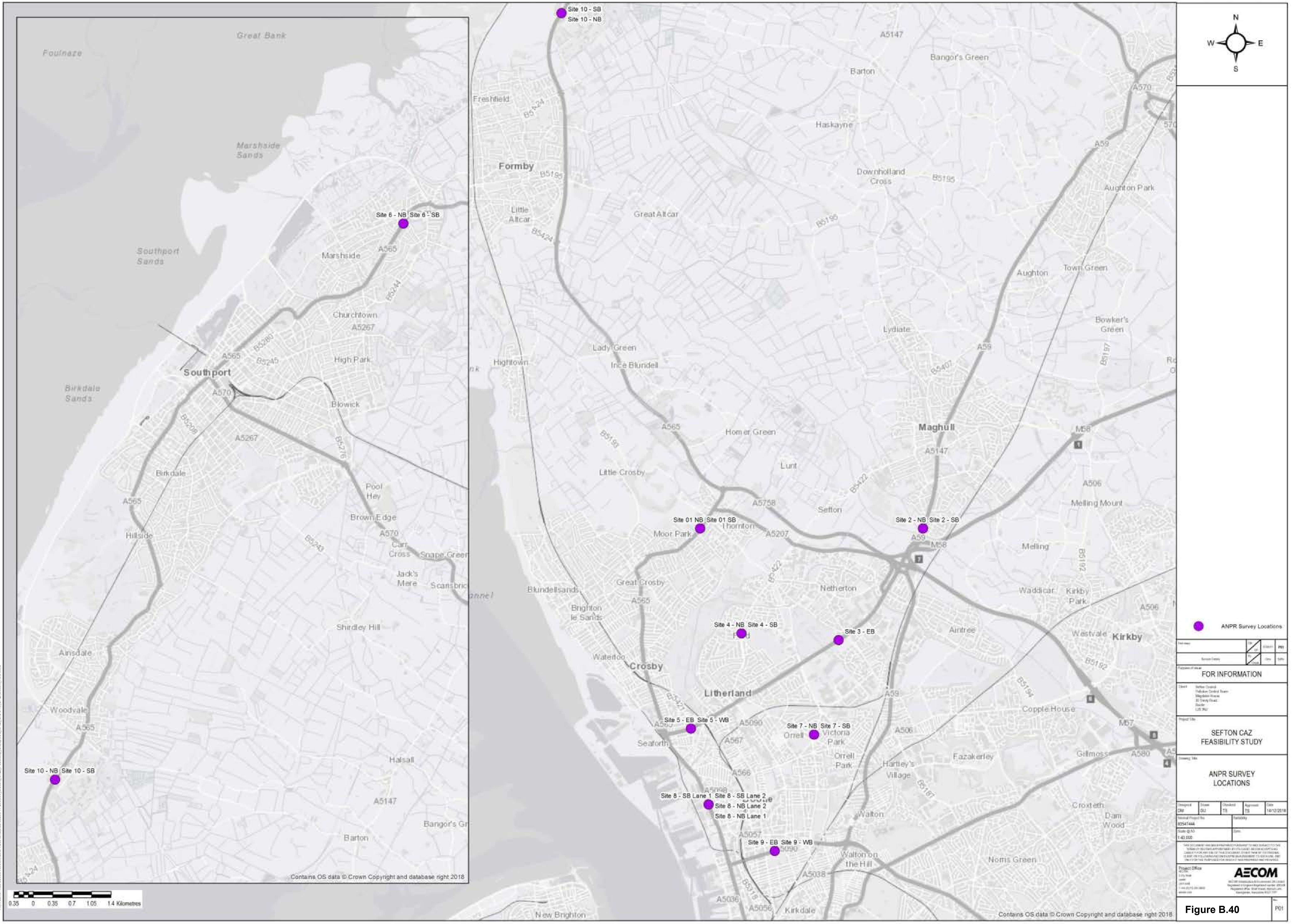
Figure A.39

P01

Appendix B ANPR Survey Locations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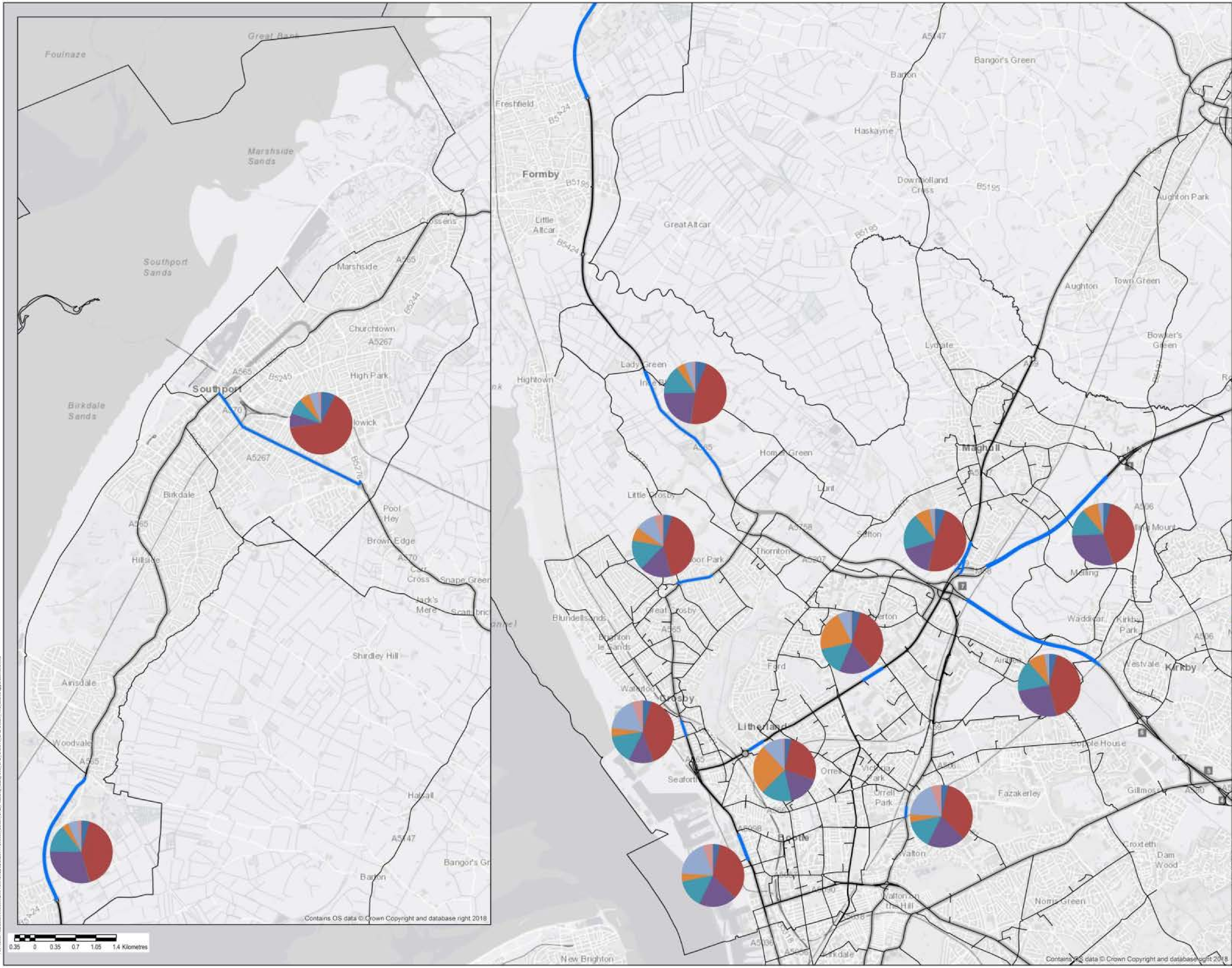
Site 10 - NB
Site 6 - NB
Site 6 - SB
Site 10 - NB
Site 10 - SB
Site 01 NB
Site 01 SB
Site 2 - NB
Site 2 - SB
Site 4 - NB
Site 4 - SB
Site 3 - EB
Site 5 - EB
Site 5 - WB
Site 7 - NB
Site 7 - SB
Site 8 - SB Lane 1
Site 8 - SB Lane 2
Site 8 - NB Lane 2
Site 8 - NB Lane 1
Site 9 - EB
Site 9 - WB
Southport
Formby
Maghull
Crosby
Litherland
Kirkby
Contains OS data © Crown Copyright and database right 2018
0.35 0 0.35 0.7 1.05 1.4 Kilometres
N
W
E
S
ANPR Survey Locations
FOR INFORMATION
SEFTON CAZ FEASIBILITY STUDY
ANPR SURVEY LOCATIONS
AECOM
Figure B.40
P01

Appendix C EFT Fleet Vehicle Composition

Table 12. Modelled Fuel Compositions

2018	Cars	**Petrol**	**Diesel**	**Full Hybrid Petrol**	**Plug-In Hybrid Petrol**	**Full Hybrid Diesel**	**Battery EV**	**FCEV**	**E85 Bioethanol**	**LPG**
		49.9%	48.2%	1.7%	0.0%	0.1%	0.1%	0.0%	0.0%	0.0%
	LGV	**Diesel**	**Full Hybrid Petrol**	**Plug-In Hybrid Petrol**	**Battery EV**	**FCEV**	**E85 Bioethanol**	**LPG**		
		100%	0%	0.0%	0.1%	0.0%	0.0%	0%		
	HGV	**Rigid**	**Artic**	**B100 Rigid**	**B100 Artic**					
		32%	68%	0%	0%					
	PSV	**Diesel**	**B100**	**CNG**	**Biomethane**	**Biogas**	**Hybrid**	**FCEV**	**B100 Coach**	
		70%	20%	1%	0%	0%	9%	0%	0%	
2020	Cars	**Petrol**	**Diesel**	**Full Hybrid Petrol**	**Plug-In Hybrid Petrol**	**Full Hybrid Diesel**	**Battery EV**	**FCEV**	**E85 Bioethanol**	**% LPG**
		47.8%	49.0%	2.5%	0.1%	0.1%	0.2%	0.0%	0.1%	0.1%
	LGV	**Diesel**	**Full Hybrid Petrol**	**Plug-In Hybrid Petrol**	**Battery EV**	**FCEV**	**E85 Bioethanol**	**LPG**		
		98%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%		
	HGV	**Rigid**	**Artic**	**B100 Rigid**	**B100 Artic**					
		32%	68%	0.0%	0.0%					
	PSV	**Diesel**	**B100**	**CNG**	**Biomethane**	**Biogas**	**Hybrid**	**FCEV**	**B100 Coach**	
		70%	20%	1%	0%	0%	9%	0%	0%	
2025	Cars	**Petrol**	**Diesel**	**Full Hybrid Petrol**	**Plug-In Hybrid Petrol**	**Full Hybrid Diesel**	**Battery EV**	**FCEV**	**E85 Bioethanol**	**LPG**
		43.3%	45.9%	9.1%	0.5%	0.4%	0.6%	0.0%	0.1%	0.1%
	LGV	**Diesel**	**Full Hybrid Petrol**	**Plug-In Hybrid Petrol**	**Battery EV**	**FCEV**	**E85 Bioethanol**	**LPG**		
		83%	3.2%	3.2%	0.7%	3.2%	3.2%	3.2%		
	HGV	**Rigid**	**Artic**	**B100 Rigid**	**B100 Artic**					
		32%	68%	0.0%	0.0%					
	PSV	**Diesel**	**B100**	**CNG**	**Biomethane**	**Biogas**	**Hybrid**	**FCEV**	**B100 Coach**	
		70%	20%	1%	0%	0%	9%	0%	0%	

Appendix D Source Apportionment



- % Petrol Car
- % Diesel Car
- % Alt
- % LGV
- % Rigid HGV
- % Artic HGV
- % Bus and Coach

Source Road

Modelled Network

Local Authority Boundary

Purpose of Issue: FOR INFORMATION

Client: Sefton Council, Pollution Control Team, Magdalen House, 30 Trinity Road, Bootle, L20 3NJ

Project Title: SEFTON CAZ FEASIBILITY STUDY

Drawing Title: NOx EMISSIONS SOURCE APPORTIONMENT 2020

Designed	Drawn	Checked	Approved	Date
DM	DU	TS	TS	15/10/2018

Internal Project No. 60547444

Scale @ A3 1:40,000

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Figure D.41

Rev P01

N
W E
S

Petrol Car % NO_x Emissions, 2020

- <5%
- 5 - 10%
- 10 - 15%
- 15 - 20%
- 20 - 25%
- 25 - 30%
- 30 - 35%
- 35 - 40%
- 40 - 45%
- 45 - 50%
- 50 - 55%
- 55 - 60%
- 60 - 65%
- 65 - 70%
- 70 - 75%
- 75 - 80%
- Local Authority Boundary

Purpose of Issue: FOR INFORMATION

Client: Sefton Council, Pollution Control Team, Magdalen House, 30 Trinity Road, Bootle, L20 3NJ

Project Title: SEFTON CAZ FEASIBILITY STUDY

Drawing Title: NO_x EMISSIONS, 2020 PETROL CAR % CONTRIBUTION

Designed	Drawn	Checked	Approved	Date
DM	DU	TS	TS	25/07/2018

Internal Project No.: 60547444

Scale @ A3: 1:40,000

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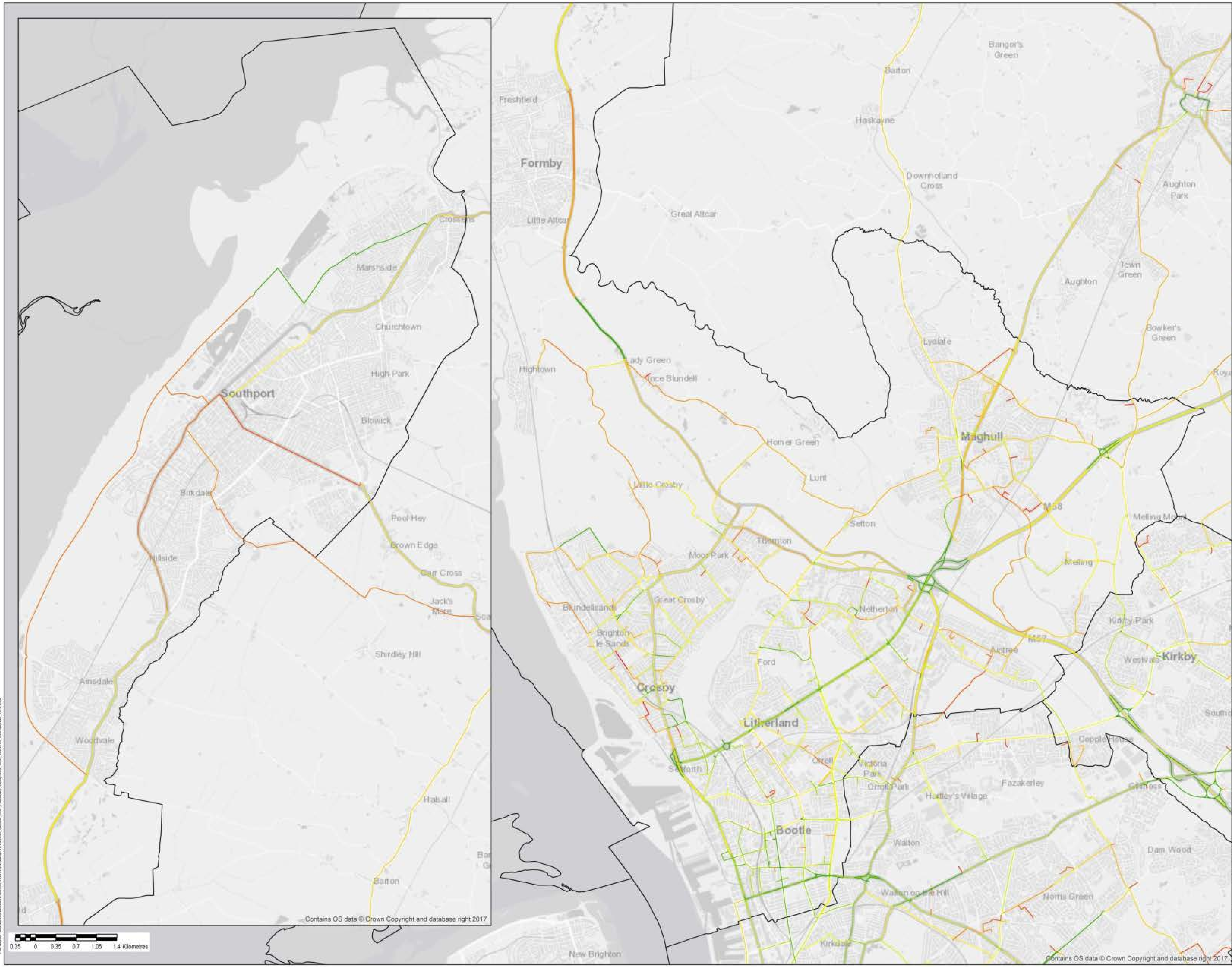
Figure D.42

Rev: P01



Purpose of issue: FOR INFORMATION

Client: Sefton Council, Pollution Control Team, Magdalen House, 30 Trinity Road, Bootle, L20 3NJ

Project Title: SEFTON CAZ FEASIBILITY STUDY

Drawing Title: NOx EMISSIONS, 2020 DIESEL CAR % CONTRIBUTION

Designed	Drawn	Checked	Approved	Date
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Internal Project No: 60547444

Scale @ A3: 1:40,000

AECOM

Figure D.43

Rev: P01

Purpose of Issue: FOR INFORMATION

Client: Sefton Council, Pollution Control Team, Magdalen House, 30 Trinity Road, Bootle, L20 3NJ

Project Title

SEFTON CAZ FEASIBILITY STUDY

Drawing Title

NOx EMISSIONS, 2020 LGV % CONTRIBUTION

Designed	Drawn	Checked	Approved	Date
DM	DU	TS	TS	25/07/2018

Internal Project No. 60547444

Scale @ A3 1:40,000

AECOM

Figure D.44

P01

Rigid HGV % NOx Emissions, 2020
<5%
5 - 10%
10 - 15%
15 - 20%
20 - 25%
25 - 30%
30 - 35%
35 - 40%
40 - 45%
45 - 50%
50 - 55%
55 - 60%
60 - 65%
65 - 70%
70 - 75%
75 - 80%
Local Authority Boundary
Southport
Crossens
Marshside
Churchtown
High Park
Blowick
Birkdale
Pool Hey
Brown Edge
Hillside
Ainsdale
Woodvale
Shirdley Hill
Halsall
Barton
Formby
Freshfield
Little Altcar
Great Altcar
Haskayne
Downholland Cross
Bangor's Green
Aughton Park
Aughton
Town Green
Bowker's Green
Lydiate
Hightown
Lady Green
Ince Blundell
Homer Green
Lunt
Little Crosby
Maghull
M58
Sefton
Thornton
Moor Park
Melling Mount
Melling
Great Crosby
Blundellsands
Brighton-le-Sands
Netherton
Kirkby Park
Aintree
M57
Westvale
Kirkby
Ford
Crosby
Litherland
Seaforth
Orrell
Victoria Park
Orrell Park
Hartley's Village
Fazakerley
Bootle
Walton
Walton on the Hill
Dam Wood
Norris Green
New Brighton
Kirkdale
0.35 0 0.35 0.7 1.05 1.4 Kilometres
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Purpose of issue
FOR INFORMATION
Client
Sefton Council
Pollution Control Team
Magdalen House
30 Trinity Road
Bootle
L20 3NJ
Project Title
SEFTON CAZ
FEASIBILITY STUDY
Drawing Title
NOx EMISSIONS, 2020
RIGID HGV % CONTRIBUTION
Scale @ A3
1:40,000
AECOM
Figure D.45
P01

Purpose of issue: FOR INFORMATION

Client: Sefton Council, Pollution Control Team, Magdalen House, 30 Trinity Road, Bootle, L20 3NJ

Project Title: SEFTON CAZ FEASIBILITY STUDY

Drawing Title: NO_x EMISSIONS, 2020 ARTIC.HGV % CONTRIBUTION

Designed	Drawn	Checked	Approved	Date
DM	DU	TS	TS	25/07/2018

Internal Project No. 60547444

Scale @ A1: 1:40,000

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AECOM

Figure D.46

Rev: P01

Purpose of Issue: FOR INFORMATION

Client: Sefton Council, Pollution Control Team, Magdalen House, 30 Trinity Road, Bootle, L20 3NJ

Project Title: SEFTON CAZ FEASIBILITY STUDY

Drawing Title: NOx EMISSIONS, 2020 BUS % CONTRIBUTION

Designed	Drawn	Checked	Approved	Date
DM	DU	TS	TS	25/07/2018

Internal Project No.: 60547444

Scale @ A3: 1:60,000

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Figure D.47

Rev: P01

Appendix E Dispersion Model Verification

The model under-estimated concentrations when compared to the monitoring data and so the modelled results for NO_2 and PM_{10} were adjusted in accordance with the procedure detailed in technical guidance LAQM.TG(16).

Table F13. Comparison of Modelled and Monitored NO_2 Concentrations, 2015

Monitoring Site	Monitor Type	Background NO_2	Monitored Total NO_X	Modelled Total NO_2	% Difference	Type
102	passive	15.1	30	18.5	-38%	Roadside
103	passive	11.2	18	12.2	-32%	Roadside
104	passive	21.9	30	30.6	2%	Kerbside (intermediate)
105	passive	19.8	33	24.4	-26%	Roadside
106	passive	15.5	28	18.8	-33%	Roadside
107	passive	21.7	29.0	26.3	-9%	Kerbside
108	passive	22.0	41.0	27.7	-33%	Roadside
109	passive	22.0	29.0	24.0	-17%	Roadside
110	passive	22.0	30.0	24.5	-18%	Roadside
111	passive	22.0	53.0	33.2	-37%	Roadside
112	passive	22.0	39.0	31.1	-20%	Roadside
113	passive	13.1	25.0	17.0	-32%	Kerbside
114	passive	11.3	31.0	19.1	-38%	Roadside
115	passive	15.1	31.0	18.8	-39%	Kerbside
116	passive	15.5	37.0	24.5	-34%	Roadside
117	passive	13.1	38.0	20.0	-48%	Roadside
118	passive	15.1	30	18.0	-40%	Roadside
119	passive	13.1	20	16.3	-18%	Kerbside
120	passive	15.5	26	21.0	-19%	Roadside
121	passive	13.1	22	19.2	-13%	Roadside
122	passive	17.8	26	21.0	-19%	Roadside
123	passive	22.0	34	27.0	-21%	Kerbside
124	passive	21.7	33	25.7	-22%	Kerbside
125	passive	15.5	38	24.6	-35%	Roadside
126	passive	15.5	26	19.1	-27%	Roadside
127	passive	15.5	27	20.5	-24%	Roadside
128	passive	15.5	24	20.7	-14%	Roadside
129	passive	13.1	32	21.4	-33%	Roadside
130	passive	13.1	34	20.7	-39%	Roadside
131	passive	21.9	31	25.3	-18%	Roadside
132	passive	19.8	29	23.7	-18%	Roadside
133	passive	17.7	38	23.2	-39%	Kerbside
134	passive	17.8	33	21.3	-35%	Kerbside
135	passive	17.8	30	21.0	-30%	Roadside
136	passive	13.1	35	24.0	-31%	Roadside
137	passive	13.1	30	17.2	-43%	Kerbside

Monitoring Site	Monitor Type	Background NO_2	Monitored Total NO_X	Modelled Total NO_2	% Difference	Type
138	passive	13.1	20	14.9	-26%	Kerbside
139	passive	13.1	33	17.0	-48%	Roadside
140	passive	10.6	36	15.4	-57%	Kerbside
141	passive	15.9	31	29.5	-5%	Roadside
142	passive	21.7	33	28.6	-13%	Roadside
143	passive	13.1	22	17.6	-20%	Kerbside
144	passive	16.3	30	21.2	-29%	Roadside
145	passive	14.2	29	17.7	-39%	Roadside / UB
146	passive	14.2	34	19.6	-42%	Kerbside
147	passive	14.2	32	25.0	-22%	Roadside
148	passive	14.2	21	-	-	Urban background
149	passive	14.2	34	23.2	-32%	Roadside
150	passive	14.2	27	18.4	-32%	Roadside
151	passive	14.2	26	17.8	-32%	Roadside
152	passive	21.7	30	27.6	-8%	Kerbside
153	passive	18.7	38	53.0	39%	Kerbside
154	passive	22.0	37	29.5	-20%	Roadside
155	passive	15.5	31	22.2	-28%	Roadside
156	passive	15.5	32	20.9	-35%	Kerbside
157	passive	15.5	27	20.7	-23%	Roadside
158	passive	17.8	33	21.8	-34%	Kerbside
159	passive	15.5	27	19.6	-27%	Kerbside
160	passive	15.1	27	17.3	-36%	Kerbside
161	passive	12.9	20	14.0	-30%	Roadside
162	passive	12.9	22	15.5	-30%	Roadside
163	passive	17.8	36	32.1	-11%	Roadside
164	passive	17.8	37	22.4	-40%	Roadside
165	passive	17.8	37	19.7	-47%	Kerbside / UB
166	passive	17.8	38	22.1	-42%	Kerbside
167	passive	15.5	25	18.1	-28%	Kerbside
168	passive	15.5	29	18.9	-35%	Kerbside
169	passive	15.9	32	19.0	-41%	Roadside
170	passive	15.9	27	21.0	-22%	Roadside
171	passive	15.9	26	19.9	-23%	Roadside
172	passive	15.9	31	31.9	3%	Roadside
173	passive	14.0	32	23.5	-26%	Kerbside
174	passive	14.3	26	19.2	-26%	Roadside
175	passive	14.0	37	19.9	-46%	Kerbside
176	passive	21.9	34	27.5	-19%	Roadside
177	passive	14.3	23	23.7	3%	Roadside
178	passive	19.8	21	22.2	6%	Roadside / UB
179	passive	21.7	22	24.8	13%	Roadside / UB
180	passive	19.8	20	20.5	2%	Roadside / UB

Monitoring Site	Monitor Type	Background NO_2	Monitored Total NO_X	Modelled Total NO_2	% Difference	Type
181	passive	15.5	23	19.8	-14%	Roadside
182	passive	12.2	15	13.2	-12%	Roadside
183	passive	13.5	14	14.3	2%	Roadside / UB
184	passive	11.3	22	18.9	-14%	Roadside
185	passive	11.8	20	12.9	-36%	Roadside
186	passive	18.7	28	25.4	-9%	Roadside
187	passive	15.5	20	17.1	-15%	Roadside
188	passive	17.8	31	21.9	-29%	Roadside
189	passive	18.3	23	19.1	-17%	Roadside
190	passive	14.9	18	16.8	-6%	Roadside
191	passive	17.8	24	19.0	-21%	Roadside
192	passive	14.0	27	18.6	-31%	Roadside
193	passive	13.1	32	18.2	-43%	Roadside
264	auto	13.1	30.6	17.3	-44%	Roadside
265	auto	22.0	34.8	28.4	-18%	Roadside
266	auto	17.8	40.6	23.9	-41%	Roadside
267	auto	15.5	36.9	24.5	-34%	Roadside
268	auto	17.8	34.6	20.3	-41%	Urban background

An adjustment factors were calculated as follows:

$NO_{X\ [monitored,\ traffic\ contribution]} = NO_{X\ [monitored]} – NO_{X\ [background]}$

$NO_{X\ [modelled,\ traffic\ contribution]} = NO_{X\ [modelled]} – NO_{X\ [background]}$

Adjustment Factor = $NO_{X\ [monitored,\ traffic\ contribution]}$ / $NO_{X\ [modelled,\ traffic\ contribution}$

An adjustment factor of **2.5886** was calculated for the majority of locations.

The adjustment factors were subsequently applied to the modelled NO_X concentrations, and background NO_X added to give the adjusted NO_X concentrations (NO_X [model adjusted]) (Table 30):

$NO_{X\ [model\ adjusted,\ traffic\ contribution]} = NO_{X\ [modelled,\ traffic\ contribution]}$ x Adjustment Factor

$NO_{X\ [model\ adjusted]} = NO_{X\ [model\ adjusted,\ traffic\ contribution]} + NO_{X\ [background]}$

The adjusted NO_X concentrations were then converted to NO_2. using version 6.1 of the 'NO_2 to NO_X' calculator provided by the Air Quality Archive and in accordance with the technical guidance, LAQM.TG(16).

In the absence of suitable PM_{10} data for verification, the road-NO_X adjustment factor was also applied to the modelled road-PM_{10}. This is in accordance with LAQM.TG(16).

Four sites were not used as they were outliers and could not be verified accurately, which were likely due to localised conditions. Seven sites were not used as they were considered to be representative of background conditions.

Table F14. Determination of Modelled and Monitored Rd NO2 and Modelled Rd NOX

ID	Monitored Total NO2	Monitored Road NOX	Background NO2	Monitored Road Contribution NO2 (total-background)	Monitored Road Contribution NOX (total-background)	Modelled Road Contribution NOX (excluding background)
102	30.0	29.9	15.1	14.9	29.9	6.5
103	18.0	13.0	11.2	6.8	13.0	2.0
105	33.0	27.0	19.8	13.2	27.0	9.0

ID	Monitored Total NO2	Monitored Road NOX	Background NO2	Monitored Road Contribution NO2 (total-background)	Monitored Road Contribution NOX (total-background)	Modelled Road Contribution NOX (excluding background)
106	28.0	24.8	15.5	12.5	24.8	6.2
107	29.0	14.6	21.7	7.3	14.6	9.1
108	41.0	40.3	22.0	19.0	40.3	11.2
109	29.0	14.0	22.0	7.0	14.0	3.8
110	30.0	16.0	22.0	8.0	16.0	4.8
111	53.0	70.2	22.0	31.0	70.2	22.8
112	39.0	35.7	22.0	17.0	35.7	18.4
113	25.0	23.4	13.1	11.9	23.4	7.4
114	31.0	39.9	11.3	19.7	39.9	14.9
115	31.0	32.1	15.1	15.9	32.1	7.0
116	37.0	44.7	15.5	21.5	44.7	17.6
117	38.0	52.2	13.1	24.9	52.2	13.2
118	30.0	29.9	15.1	14.9	29.9	5.5
119	20.0	13.3	13.1	6.9	13.3	6.1
120	26.0	20.7	15.5	10.5	20.7	10.6
121	22.0	17.3	13.1	8.9	17.3	11.7
122	26.0	16.1	17.8	8.2	16.1	6.1
123	34.0	24.6	22.0	12.0	24.6	9.9
124	33.0	23.0	21.7	11.3	23.0	7.8
125	38.0	47.1	15.5	22.5	47.1	17.7
126	26.0	20.7	15.5	10.5	20.7	6.8
127	27.0	22.7	15.5	11.5	22.7	9.6
128	24.0	16.6	15.5	8.5	16.6	10.0
129	32.0	38.4	13.1	18.9	38.4	16.1
130	34.0	42.9	13.1	20.9	42.9	14.7
131	31.0	18.4	21.9	9.1	18.4	6.6
132	29.0	18.5	19.8	9.2	18.5	7.6
133	38.0	42.4	17.7	20.3	42.4	10.7
134	33.0	31.0	17.8	15.2	31.0	6.7
135	30.0	24.5	17.8	12.2	24.5	6.2
136	35.0	45.2	13.1	21.9	45.2	21.4
137	30.0	34.0	13.1	16.9	34.0	7.7
138	20.0	13.3	13.1	6.9	13.3	3.4
139	33.0	40.7	13.1	19.9	40.7	7.5
140	36.0	52.6	10.6	25.4	52.6	8.9
142	33.0	23.0	21.7	11.3	23.0	13.8
143	22.0	17.3	13.1	8.9	17.3	8.5
144	30.0	27.5	16.3	13.7	27.5	9.4
145	29.0	29.5	14.2	14.8	29.5	6.6
146	34.0	40.5	14.2	19.8	40.5	10.2
147	32.0	36.0	14.2	17.8	36.0	21.0

ID	Monitored Total NO2	Monitored Road NOX	Background NO2	Monitored Road Contribution NO2 (total-background)	Monitored Road Contribution NOX (total-background)	Modelled Road Contribution NOX (excluding background)
148	21.0	13.0	14.2	6.8	13.0	9.7
149	34.0	40.5	14.2	19.8	40.5	17.3
150	27.0	25.2	14.2	12.8	25.2	8.0
151	26.0	23.1	14.2	11.8	23.1	6.7
152	30.0	16.6	21.7	8.3	16.6	11.6
154	37.0	31.2	22.0	15.0	31.2	15.0
155	31.0	31.3	15.5	15.5	31.3	13.0
156	32.0	33.5	15.5	16.5	33.5	10.3
157	27.0	22.7	15.5	11.5	22.7	10.1
158	33.0	31.0	17.8	15.2	31.0	7.7
159	27.0	22.7	15.5	11.5	22.7	7.9
160	27.0	23.5	15.1	11.9	23.5	4.1
161	20.0	13.6	12.9	7.1	13.6	2.2
162	22.0	17.6	12.9	9.1	17.6	4.8
163	36.0	37.7	17.8	18.2	37.7	28.9
164	37.0	39.9	17.8	19.2	39.9	8.8
165	37.0	39.9	17.8	19.2	39.9	3.7
166	38.0	42.2	17.8	20.2	42.2	8.3
167	25.0	18.6	15.5	9.5	18.6	4.9
168	29.0	27.0	15.5	13.5	27.0	6.6
169	32.0	32.6	15.9	16.1	32.6	5.9
170	27.0	21.9	15.9	11.1	21.9	9.7
171	26.0	19.8	15.9	10.1	19.8	7.6
173	32.0	36.5	14.0	18.0	36.5	18.6
174	26.0	23.0	14.3	11.7	23.0	9.4
175	37.0	47.9	14.0	23.0	47.9	11.3
176	34.0	24.8	21.9	12.1	24.8	11.2
181	23.0	14.6	15.5	7.5	14.6	8.2
182	15.0	5.3	12.2	2.8	5.3	1.9
184	22.0	20.7	11.3	10.7	20.7	14.5
185	20.0	15.8	11.8	8.2	15.8	2.1
186	28.0	18.5	18.7	9.3	18.5	13.2
187	20.0	8.6	15.5	4.5	8.6	3.0
188	31.0	26.6	17.8	13.2	26.6	7.9
189	23.0	9.2	18.3	4.7	9.2	1.6
190	18.0	5.8	14.9	3.1	5.8	3.6
191	24.0	12.1	17.8	6.2	12.1	2.3
192	27.0	25.7	14.0	13.0	25.7	8.8
193	32.0	38.4	13.1	18.9	38.4	9.8
264	30.6	35.3	13.1	17.5	35.3	8.0
265	34.8	26.3	22.0	12.8	26.3	12.7

ID	Monitored Total NO2	Monitored Road NOX	Background NO2	Monitored Road Contribution NO2 (total-background)	Monitored Road Contribution NOX (total-background)	Modelled Road Contribution NOX (excluding background)
266	40.6	48.3	17.8	22.8	48.3	12.0
267	36.9	44.5	15.5	21.4	44.5	17.6

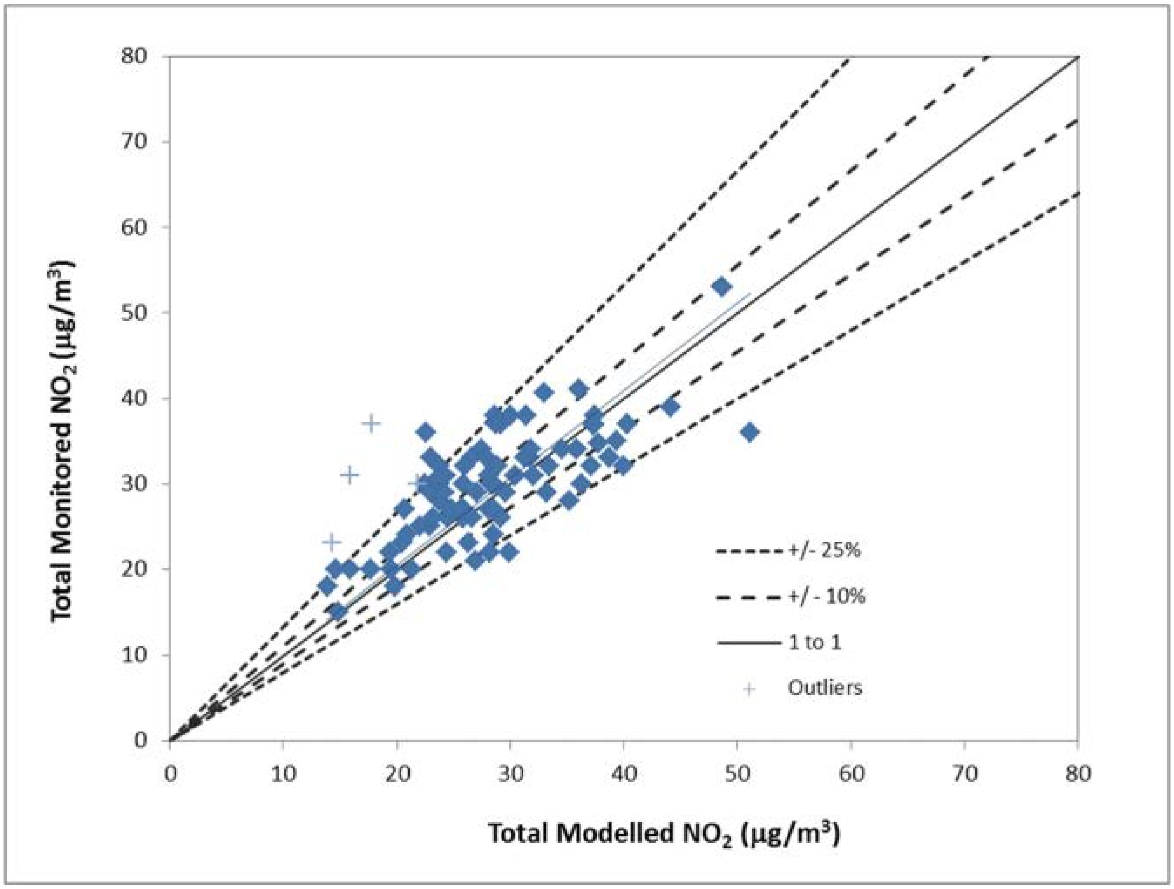
Table F15. Determination of the Adjustment Factor and Total Adjusted NO2

ID	Adjusted Modelled Road Contribution NOX	Adjusted Modelled Total NO2	Monitored Total NO2	% Difference [(mod-mon)/mon]
102	16.8	23.7	30.0	-21%
103	5.1	13.9	18.0	-23%
105	23.2	31.3	33.0	-5%
106	16.1	23.8	28.0	-15%
107	23.4	33.2	29.0	14%
108	29.0	36.1	41.0	-12%
109	9.9	27.0	29.0	-7%
110	12.5	28.3	30.0	-6%
111	59.1	48.7	53.0	-8%
112	47.7	44.1	39.0	13%
113	19.2	23.0	25.0	-8%
114	38.6	30.5	31.0	-2%
115	18.0	24.3	31.0	-22%
116	45.5	37.3	37.0	1%
117	34.1	30.0	38.0	-21%
118	14.3	22.5	30.0	-25%
119	15.9	21.3	20.0	7%
120	27.3	29.2	26.0	12%
121	30.3	28.3	22.0	28%
122	15.7	25.8	26.0	-1%
123	25.7	34.5	34.0	2%
124	20.3	31.7	33.0	-4%
125	45.8	37.5	38.0	-1%
126	17.5	24.5	26.0	-6%
127	25.0	28.1	27.0	4%
128	25.9	28.5	24.0	19%
129	41.6	33.4	32.0	4%
130	38.0	31.8	34.0	-6%
131	17.2	30.4	31.0	-2%
132	19.7	29.6	29.0	2%
133	27.7	31.4	38.0	-17%
134	17.5	26.7	33.0	-19%
135	15.9	25.9	30.0	-14%
136	55.4	39.3	35.0	12%
137	20.0	23.4	30.0	-22%

ID	Adjusted Modelled Road Contribution NOX	Adjusted Modelled Total NO2	Monitored Total NO2	% Difference [(mod-mon)/mon]
138	8.9	17.8	20.0	-11%
139	19.4	23.0	33.0	-30%
140	23.1	22.6	36.0	-37%
142	35.8	38.8	33.0	17%
143	22.1	24.4	22.0	11%
144	24.4	28.6	30.0	-5%
145	17.0	23.0	29.0	-21%
146	26.3	27.5	34.0	-19%
147	54.4	40.0	32.0	25%
148	25.0	26.9	21.0	
149	44.7	35.9	34.0	5%
150	20.6	24.8	27.0	-8%
151	17.4	23.2	26.0	-11%
152	30.1	36.3	30.0	21%
154	38.7	40.3	37.0	9%
155	33.6	32.1	31.0	3%
156	26.7	28.9	32.0	-10%
157	26.0	28.6	27.0	6%
158	20.0	27.9	33.0	-16%
159	20.5	25.9	27.0	-4%
160	10.6	20.7	27.0	-24%
161	5.6	15.9	20.0	-21%
162	12.5	19.5	22.0	-12%
163	74.9	51.2	36.0	42%
164	22.8	29.2	37.0	-21%
166	21.5	28.6	38.0	-25%
167	12.6	22.0	25.0	-12%
168	17.0	24.2	29.0	-17%
169	15.2	23.7	32.0	-26%
170	25.0	28.5	27.0	5%
171	19.6	25.9	26.0	0%
173	48.1	37.1	32.0	16%
174	24.3	26.6	26.0	2%
175	29.4	28.7	37.0	-22%
176	28.9	35.9	34.0	6%
181	21.2	26.3	23.0	14%
182	5.0	14.8	15.0	-1%
184	37.5	29.9	22.0	36%
185	5.4	14.7	20.0	-27%
186	34.1	35.3	28.0	26%
187	7.6	19.5	20.0	-2%
188	20.5	28.1	31.0	-9%
189	4.3	20.5	23.0	-11%

ID	Adjusted Modelled Road Contribution NOX	Adjusted Modelled Total NO2	Monitored Total NO2	% Difference [(mod-mon)/mon]
190	9.4	19.8	18.0	10%
191	6.0	20.9	24.0	-13%
192	22.9	25.6	27.0	-5%
193	25.4	26.0	32.0	-19%
264	20.7	23.7	30.6	-23%
265	32.8	37.7	34.8	8%
266	31.0	33.0	40.6	-19%
267	45.5	37.3	36.9	1%

Figure E.48: Adjusted Modelled Versus Monitored Concentrations

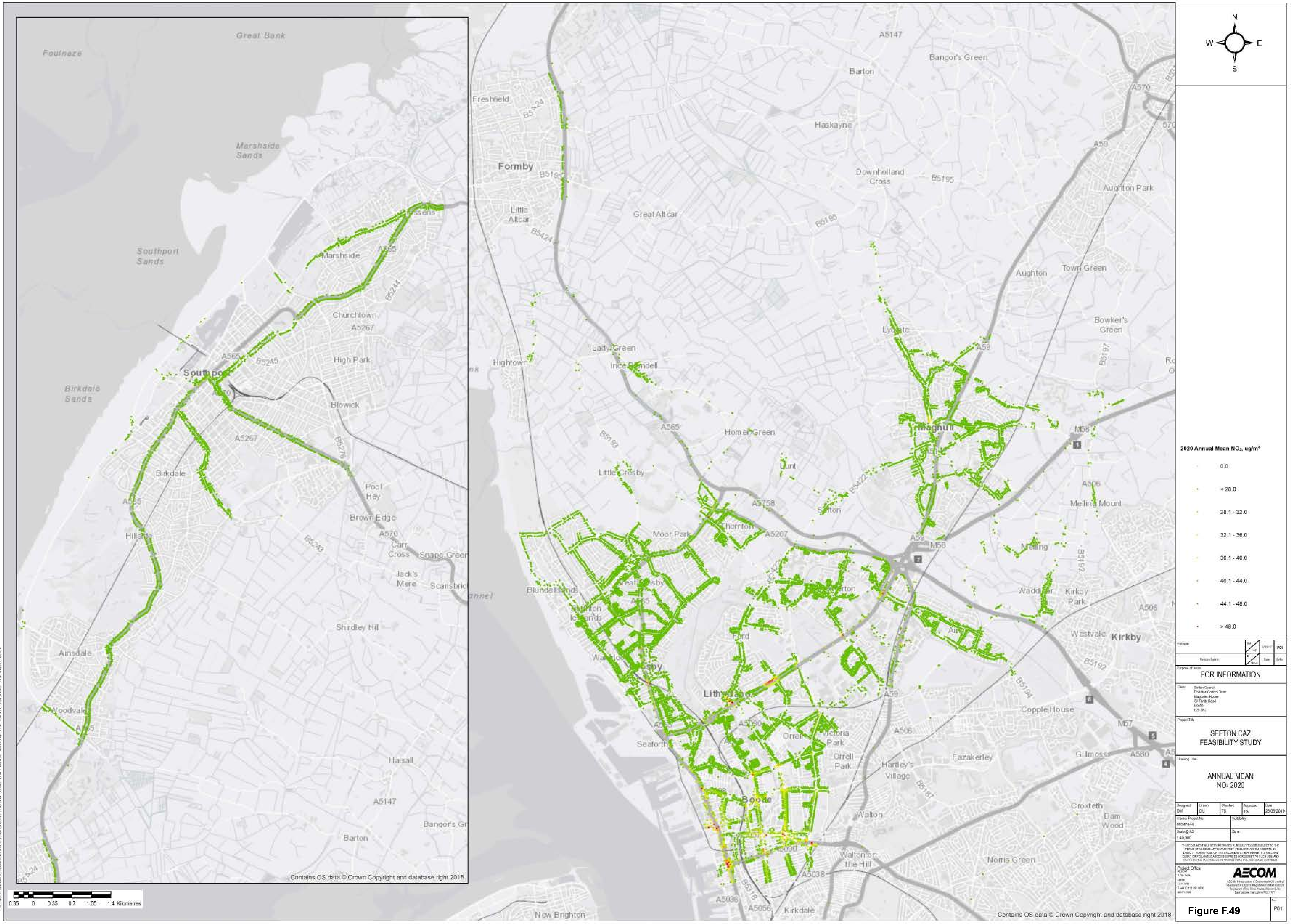


The data in Table 11: Statistical Confidence indicate the statistical confidence attributed to the model. The data show that the verification significantly improves the accuracy of the model, with a resultant RMSE of +/- 5.03 µg/m³.

Table E16. Statistical Confidence

	Ideal Value	Unadjusted	Adjusted
Correlation coefficient	1	0.71	0.74
RMSE	0	9.70	5.03
fractional bias	1	0.34	0.04

Appendix F Projected Pollutant Concentrations



Purpose of Issue
FOR INFORMATION

Client
Sefton Council
Pollution Control Team
Magdalen House
30 Trinity Road
Bootle
L20 3NJ

Project Title
SEFTON CAZ
FEASIBILITY STUDY

Drawing Title
ANNUAL MEAN
NO_2 2020

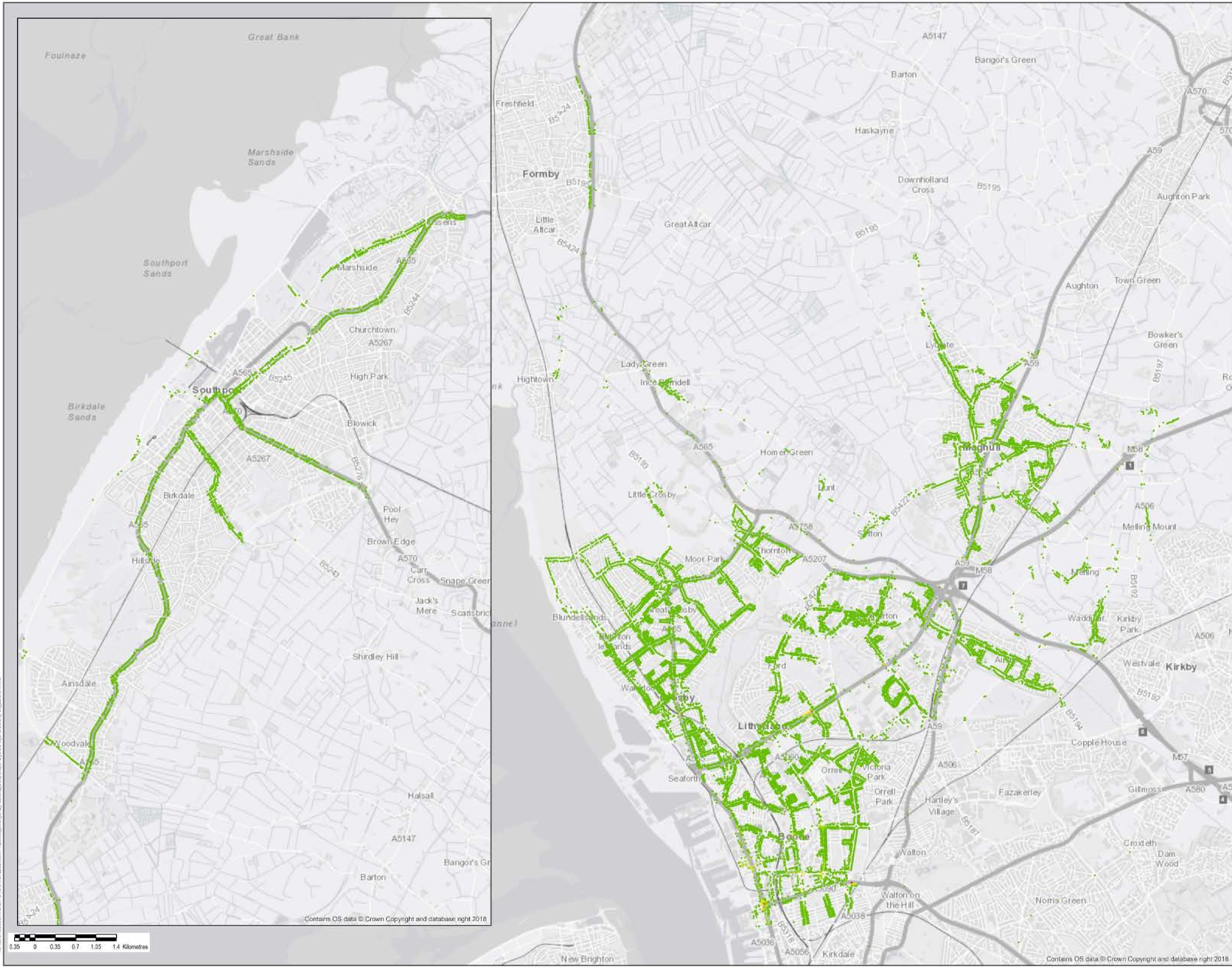
Designed	Drawn	Checked	Approved	Date
DM	DU	TS	TS	28/06/2019

AECOM Project No: 60567444
Scale @ A3: 1:40,000

AECOM

Figure F.49

Rev: P01



2025 Annual Mean NO_2, ug/m^3

- 0.0
- < 28.0
- 28.1 - 32.0
- 32.1 - 36.0
- 36.1 - 40.0
- 40.1 - 44.0
- 44.1 - 48.0
- > 48.0

Purpose of Issue: FOR INFORMATION

Client: Sefton Council, Pollution Control Team, Magdalen House, 30 Trinity Road, Bootle, L20 3NJ

Project Title: SEFTON CAZ FEASIBILITY STUDY

Drawing Title: ANNUAL MEAN NO_2 2025

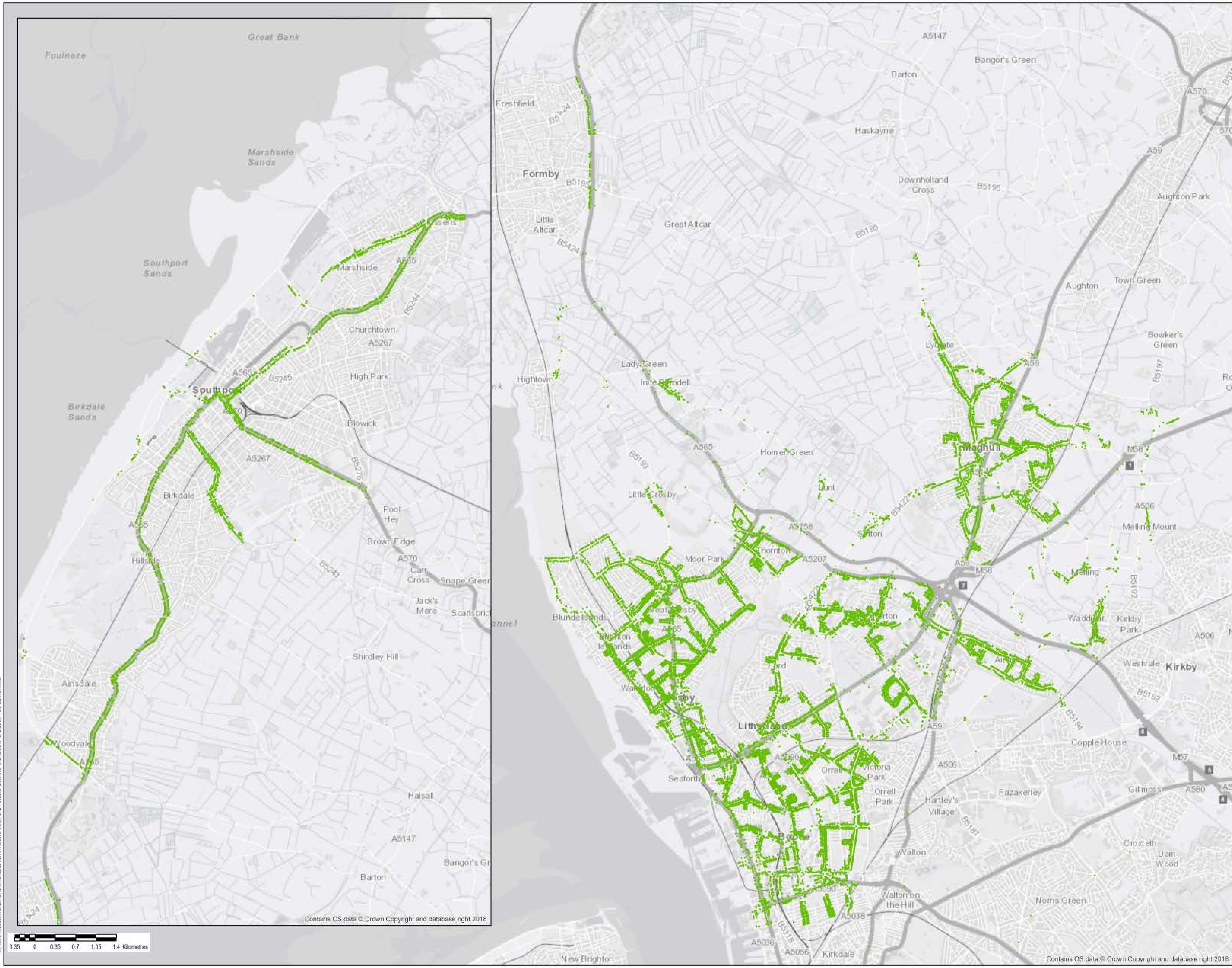
Designed	Drawn	Checked	Approved	Date
DM	DU	TS	TS	28/06/2019

Internal Project No: 60547444

Scale @ A3: 1:40,000

AECOM

Rev: P01



2020 Annual Mean PM_{10}, ug/m³

- 0.0
- < 28.0
- 28.1 - 32.0
- 32.1 - 36.0
- 36.1 - 40.0
- 40.1 - 44.0
- 44.1 - 48.0
- > 48.0

Purpose of issue: FOR INFORMATION

Client: Sefton Council

Project Title: SEFTON CAZ FEASIBILITY STUDY

Drawing Title: ANNUAL MEAN PM_{10} 2020

Designed	Drawn	Checked	Approved	Date
DM	DU	TS	TS	28/06/2019

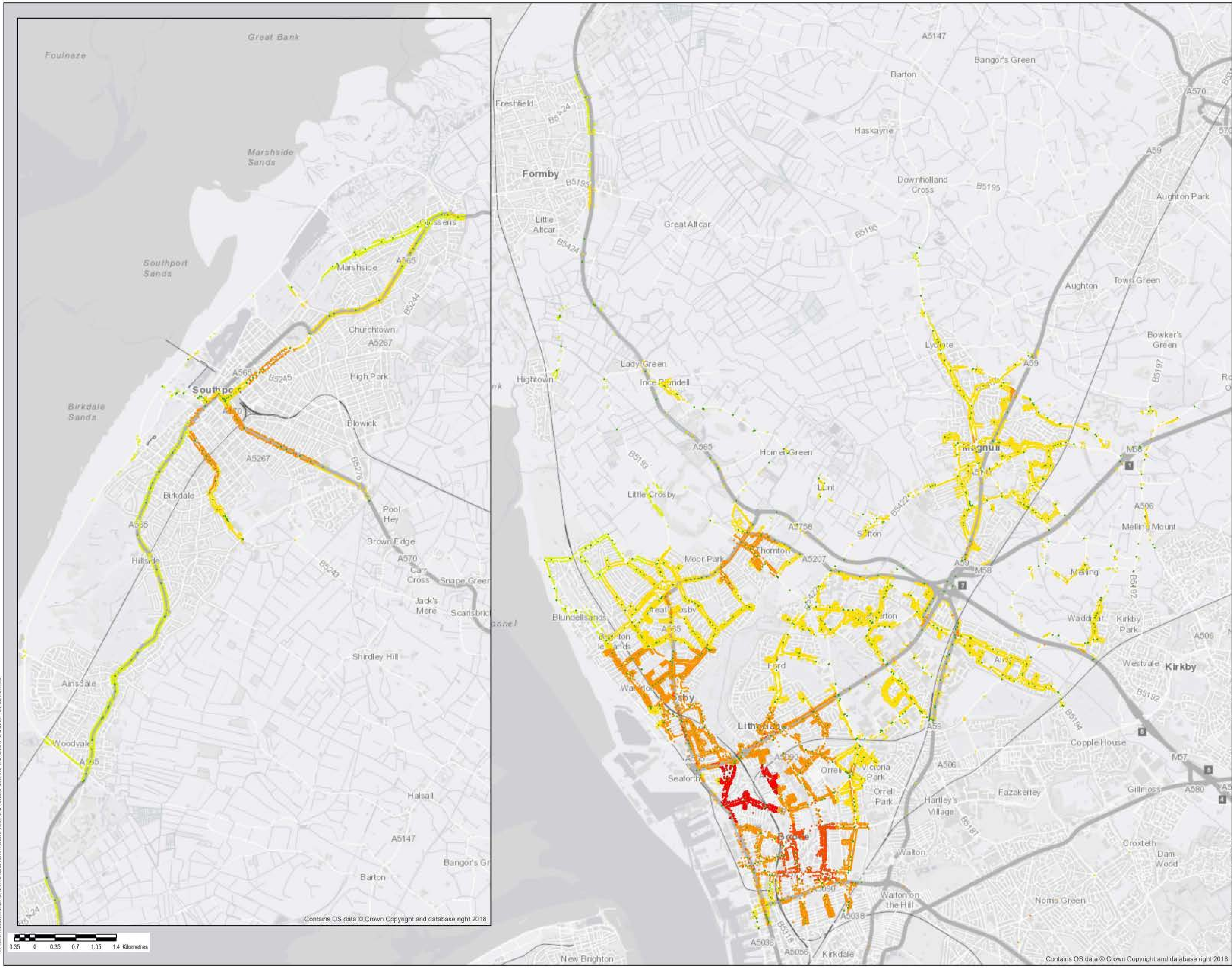
Internal Project No.: 60547444

Scale @ A3: 1:40,000

AECOM

Figure F.51

Rev: P01



2025 Annual Mean $PM_{2.5}$, ug/m^3

- 0.0
- 0.1 - 4.0
- 4.1 - 6.0
- 6.1 - 8.0
- 8.1 - 10.0
- 10.1 - 12.0
- 12.1 - 14.0
- 14.1 - 20.0

Purpose of Issue: FOR INFORMATION

Client: Sefton Council, Pollution Control Team, Magdalen House, 30 Trinity Road, Bootle, L20 3NJ

Project Title: SEFTON CAZ FEASIBILITY STUDY

Drawing Title: ANNUAL MEAN $PM_{2.5}$ 2025

Designed	Drawn	Checked	Approved	Date
DM	DU	TS	TS	28/06/2019

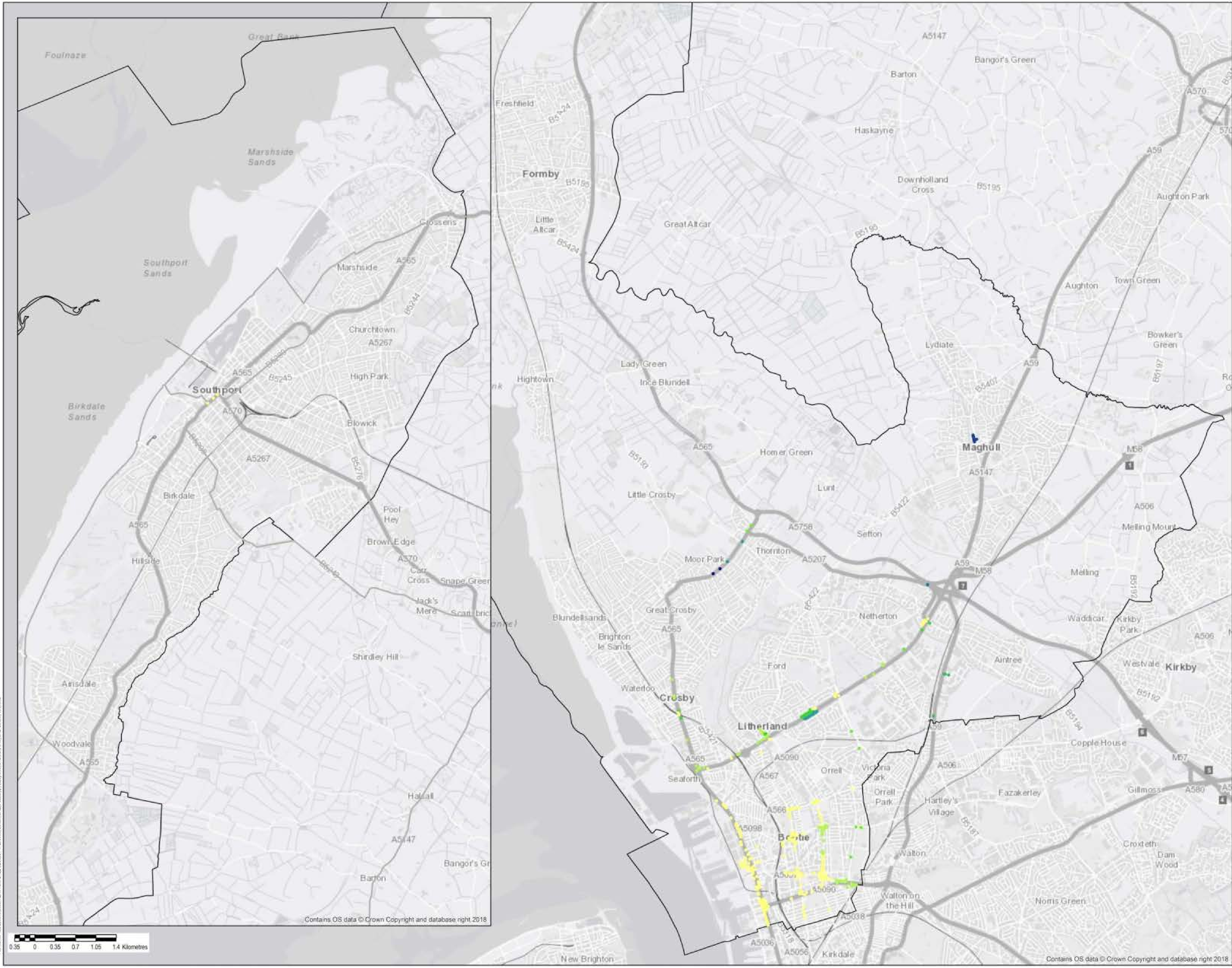
Internal Project No: 60547444

Scale @ A3: 1:40,000

AECOM

Figure F.52

Rev: P01



FOR INFORMATION

Client: Sefton Council, Pollution Control Team, Magdalen House, 30 Trinity Road, Bootle, L20 3NJ

Project Title

SEFTON CAZ FEASIBILITY STUDY

Drawing Title

AREAS AT RISK DUE TO CAZ VEHICLE REDISTRIBUTION EFFECTS, 2020

Designed	Drawn	Checked	Approved	Date
DM	DU	TS	TS	21/11/2018

Internal Project No.	Suitability
60547444	
Scale @ A3	Zone
1:40,000	

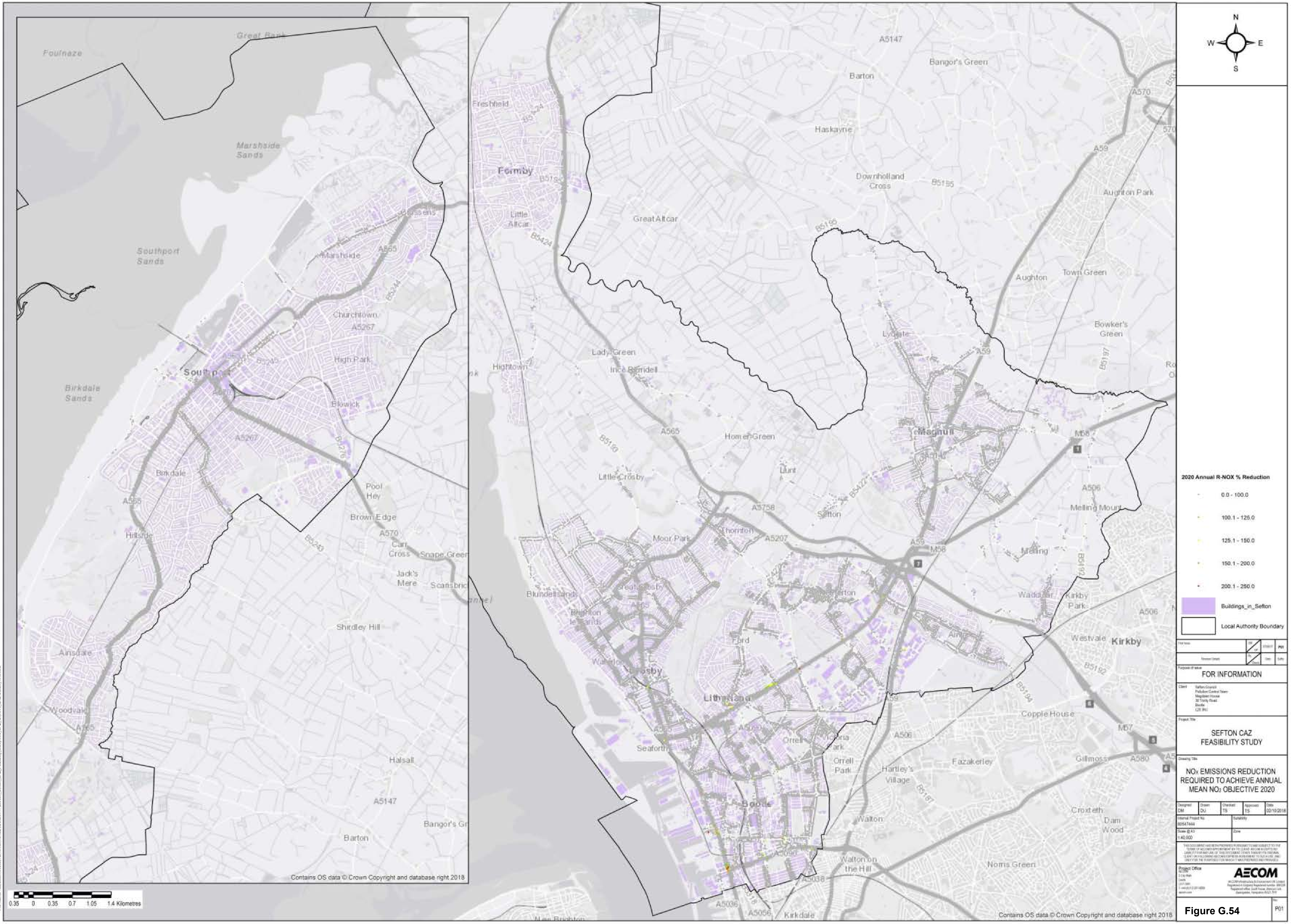
AECOM

Figure F.53

P01

Plot Date: 21 November 2018 12:05:00

Appendix G Required Reductions



Purpose of issue: FOR INFORMATION

Client: Sefton Council, Pollution Control Team, Magdalen House, 30 Trinity Road, Bootle, L20 3NJ

Project Title: SEFTON CAZ FEASIBILITY STUDY

Drawing Title: NO_x EMISSIONS REDUCTION REQUIRED TO ACHIEVE ANNUAL MEAN NO_2 OBJECTIVE 2020

Designed	Drawn	Checked	Approved	Date
DM	DU	TS	TS	02/10/2018

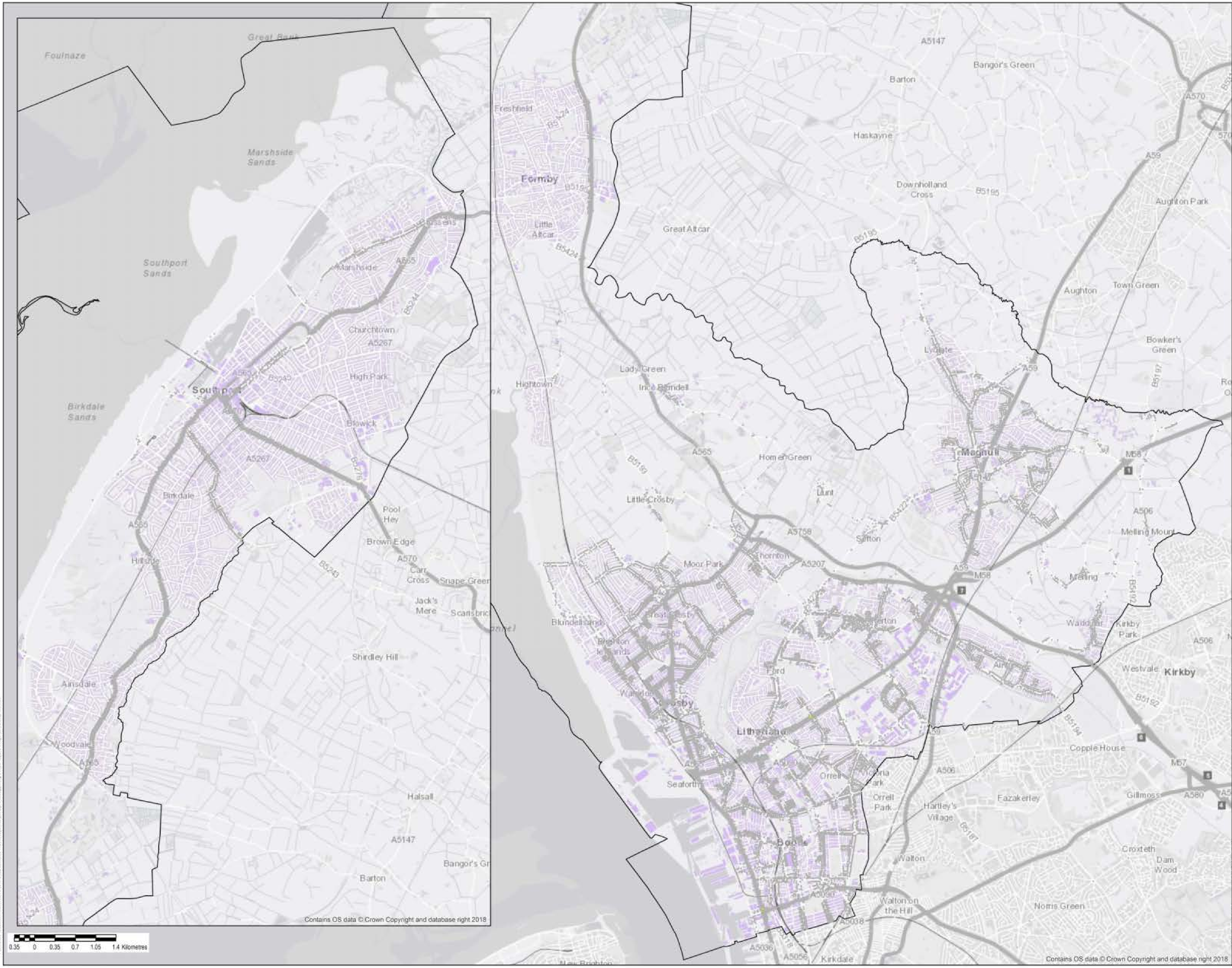
Internal Project No: 60547444

Scale @ A3: 1:40,000

AECOM

Figure G.54

Rev: P01



2025 Annual R-NOX % Reduction

- 0.0 - 100.0
- 100.1 - 125.0
- 125.1 - 150.0
- 150.1 - 200.0
- 200.1 - 250.0
- Buildings_in_Sefton
- Local Authority Boundary

Purpose of issue: FOR INFORMATION

Client: Sefton Council, Pollution Control Team, Magdalen House, 30 Trinity Road, Bootle, L20 3NJ

Project Title: SEFTON CAZ FEASIBILITY STUDY

Drawing Title: NO_x EMISSIONS REDUCTION REQUIRED TO ACHIEVE ANNUAL MEAN NO_2 OBJECTIVE 2025

Designed	Drawn	Checked	Approved	Date
DM	DU	TS	TS	02/10/2018

Internal Project No.: 60547444

Scale @ A3: 1:40,000

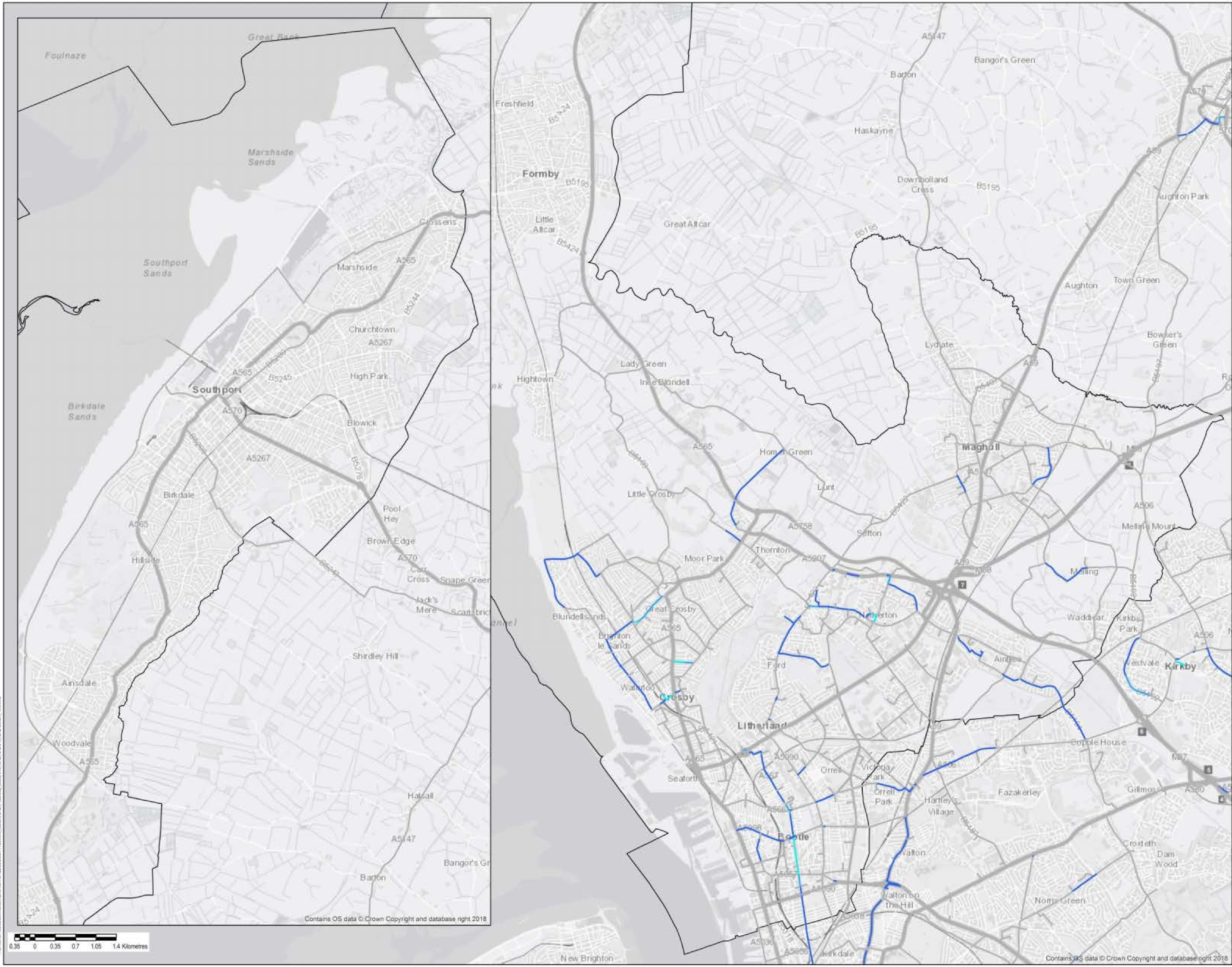
AECOM

Figure G.55

Rev: P01

Appendix H CAZ Emissions Scenarios

.



CAZ-A Retrofit, 2020 Residual NO_x

- 0 - 40%
- 41 - 50%
- 51 - 60%
- 61 - 70%
- 71 - 80%
- 81 - 90%
- 91 - 100%
- Local Authority Boundary

Purpose of issue: FOR INFORMATION

Client: Sefton Council

Project Title: SEFTON CAZ FEASIBILITY STUDY

Drawing Title: RESIDUAL NO_x EMISSIONS CAZ A, VEHICLE RETROFIT 2020

Designed	Drawn	Checked	Approved	Date
DM	DU	TS	TS	18/10/2018

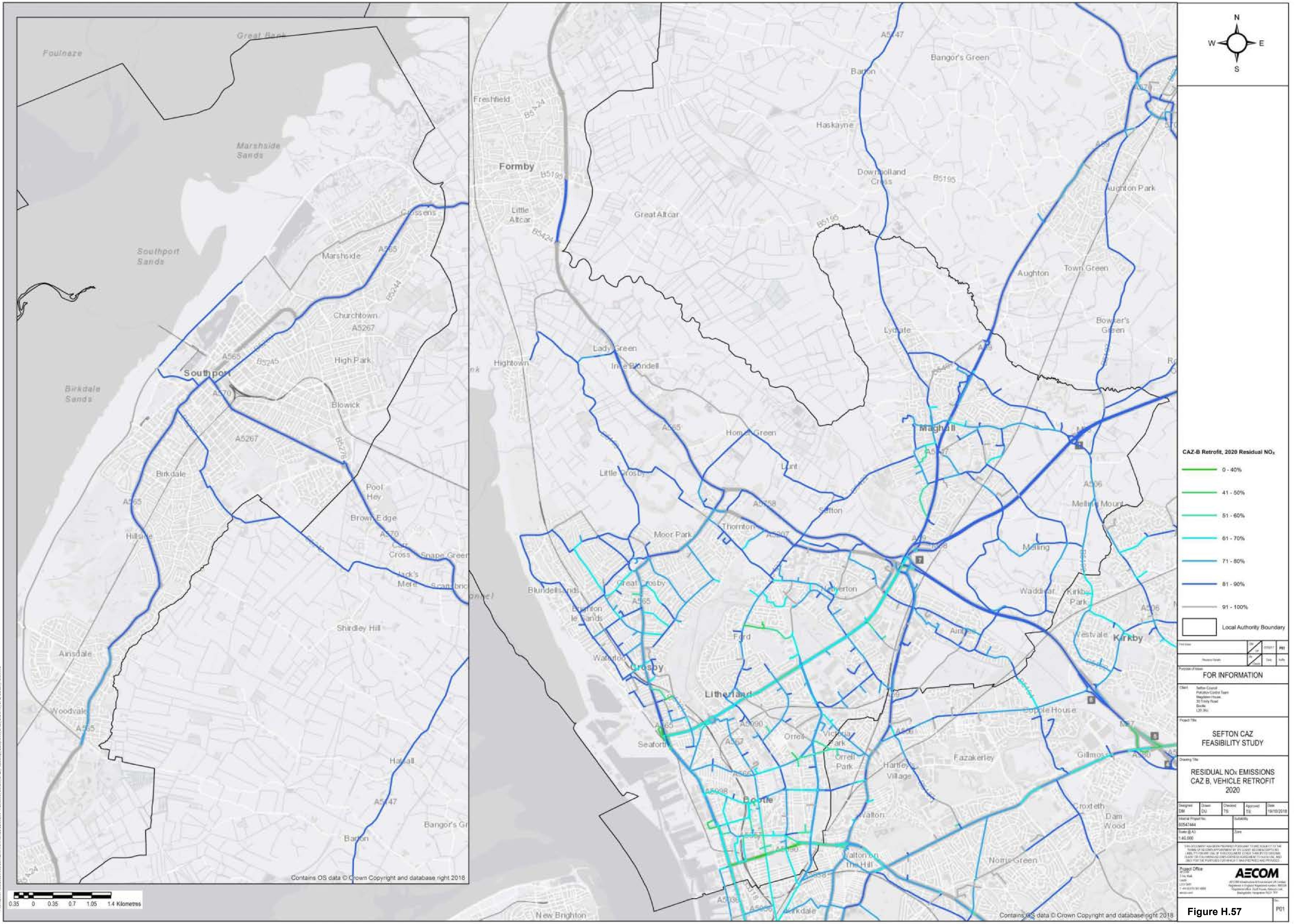
Internal Project No: 60547444

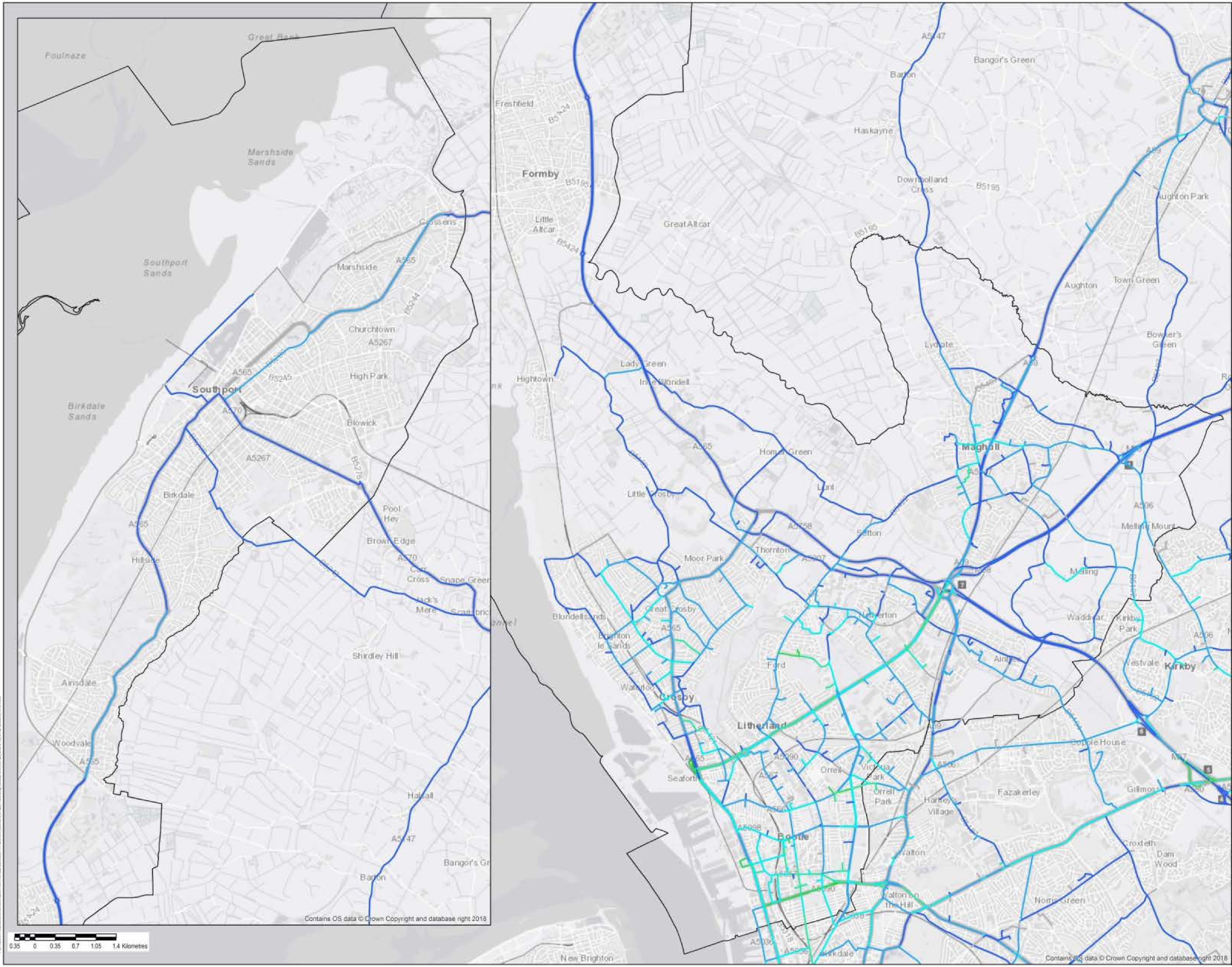
Scale @ A3: 1:40,000

AECOM

Figure H.56

P01


N
W
E
S
CAZ-B Retrofit, 2020 Residual NOx
0 - 40%
41 - 50%
51 - 60%
61 - 70%
71 - 80%
81 - 90%
91 - 100%
Local Authority Boundary
FOR INFORMATION
SEFTON CAZ
FEASIBILITY STUDY
RESIDUAL NOx EMISSIONS
CAZ B, VEHICLE RETROFIT
2020
AECOM
Figure H.57
P01
Contains OS data © Crown Copyright and database right 2018
0.35 0 0.35 0.7 1.05 1.4 Kilometres
Southport
Formby
Maghull
Crosby
Litherland
Bootle
Kirkby
Birkdale
Ainsdale
Woodvale
Churchtown
Marshside
Crossens
High Park
Blowick
Hillside
Freshfield
Hightown
Great Altcar
Haskayne
Bangor's Green
Aughton
Aughton Park
Town Green
Lydiate
Sefton
Thornton
Netherton
Seaforth
Waterloo
Blundellsands
Orrell Park
Walton
Fazakerley
Croxteth
Gillmoss
Melling
Melling Mount
Waddicar
Kirkby Park
Westvale
Aintree
Moor Park
Great Crosby
Little Crosby
Lunt
Ford
Southport Sands
Marshside Sands
Birkdale Sands
Great Bank
Foulnaze
Shirdley Hill
Halsall
Barton
New Brighton



Purpose of Issue: FOR INFORMATION

Project Title: SEFTON CAZ FEASIBILITY STUDY

Drawing Title: RESIDUAL NO_x EMISSIONS CAZ C, VEHICLE RETROFIT 2020

Designed	Drawn	Checked	Approved	Date
DM	DU	TS	TS	19/10/2018

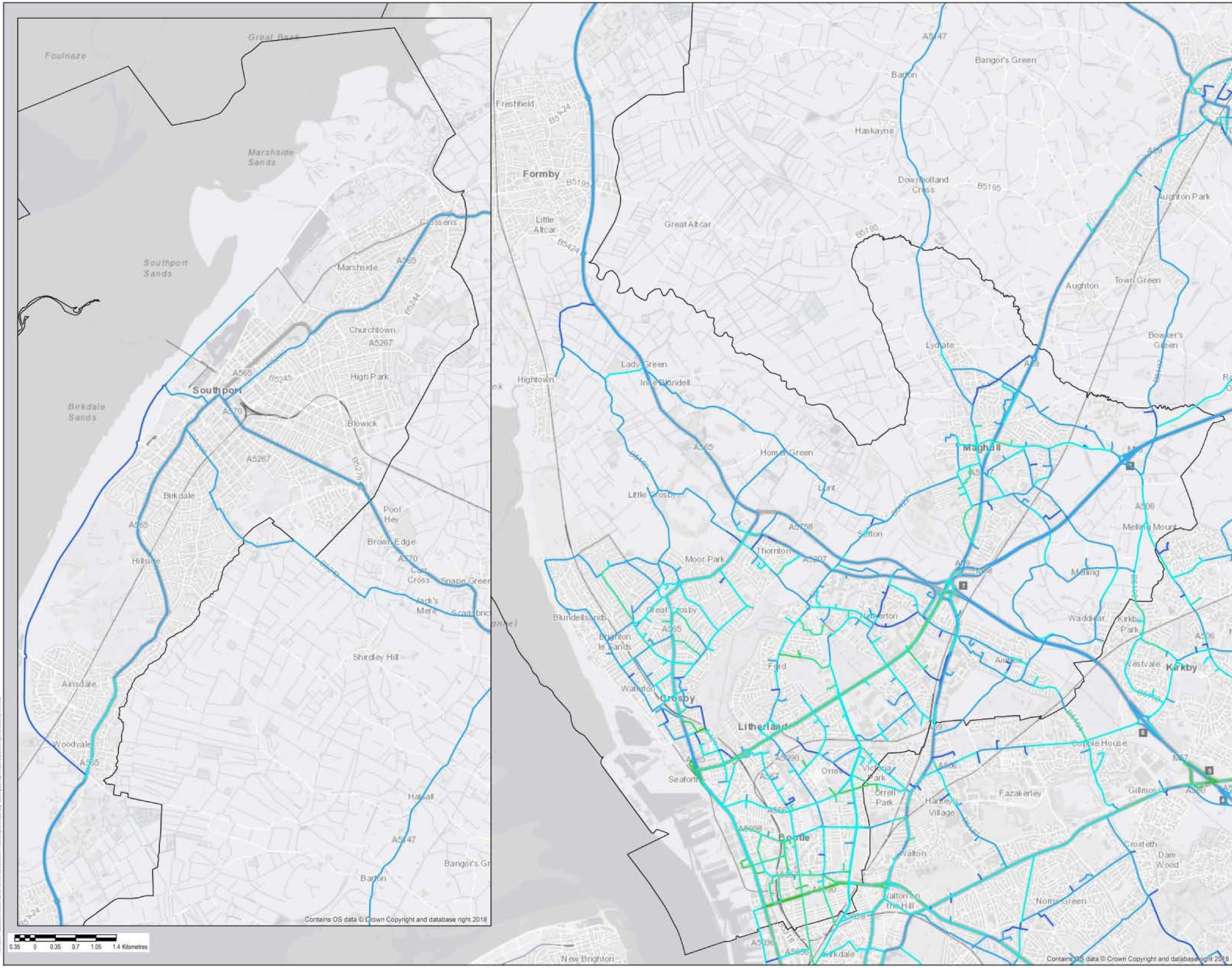
Internal Project No. 60547444

Scale @ A3 1:40,000

AECOM

Figure H.58

Rev. P01



CAZ-D Retrofit, 2020 Residual NO_x

0 - 40%	
41 - 50%	
51 - 60%	
61 - 70%	
71 - 80%	
81 - 90%	
91 - 100%	
Local Authority Boundary	

Purpose of Issue: FOR INFORMATION

Client: Sefton Council
Pollution Control Team
Magdalen House
30 Trinity Road
Bootle
L20 3NJ

Project Title: SEFTON CAZ FEASIBILITY STUDY

Drawing Title: RESIDUAL NOx EMISSIONS CAZ D, VEHICLE RETROFIT 2020

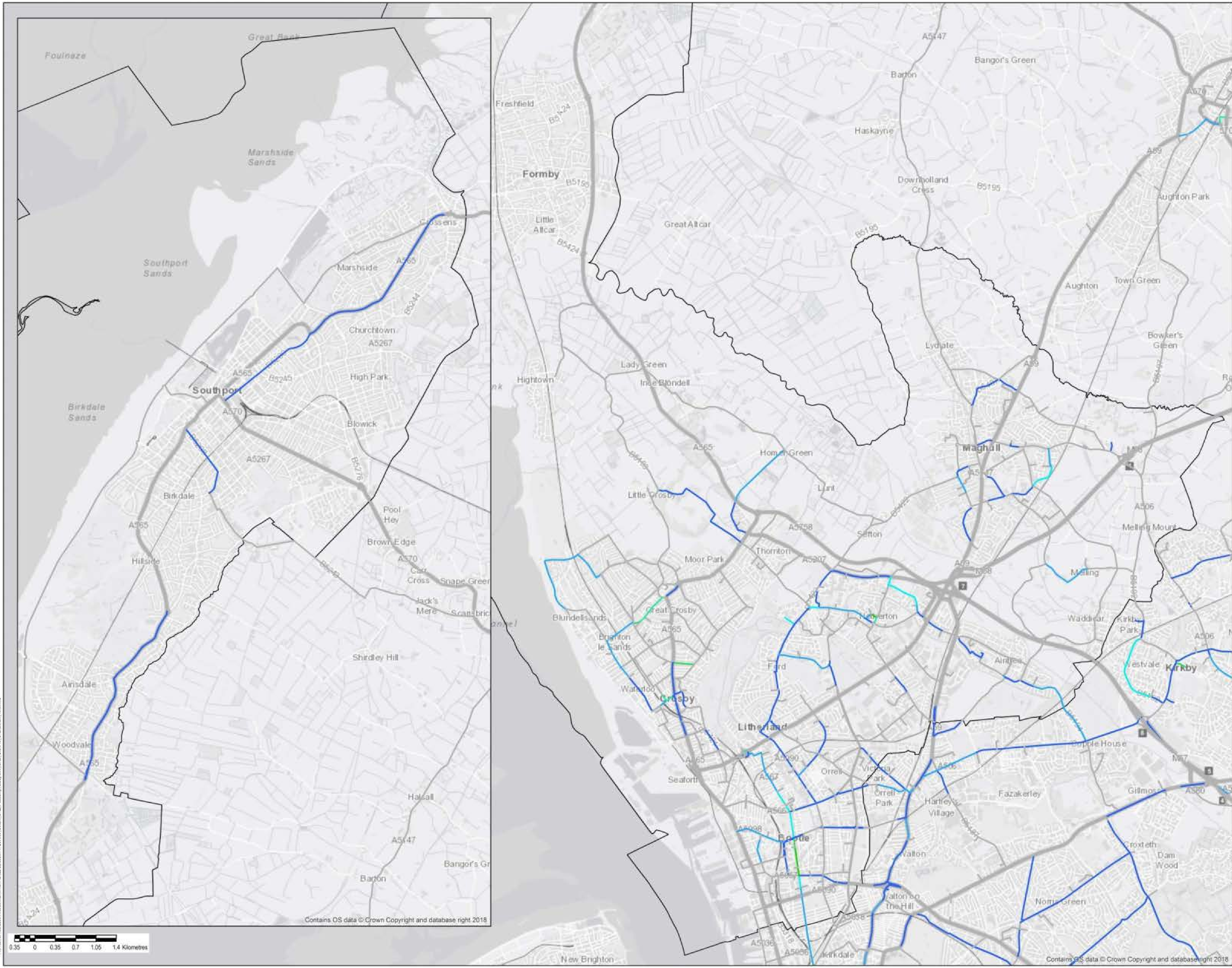
Designed	Drawn	Checked	Approved	Date
DM	DU	TS	TS	19/10/2018

Internal Project No.	Suitability
60547444	
Scale @ A3	Zone
1:40,000	

AECOM

Figure H.59

Rev: P01



CAZ-A Replacement, 2020 Residual NOx

- 0 - 40%
- 41 - 50%
- 51 - 60%
- 61 - 70%
- 71 - 80%
- 81 - 90%
- 91 - 100%
- Local Authority Boundary

Purpose of issue: FOR INFORMATION

Client: Sefton Council, Pollution Control Team, Magdalen House, 30 Trinity Road, Bootle, L20 3NJ

Project Title: SEFTON CAZ FEASIBILITY STUDY

Drawing Title: RESIDUAL NOx EMISSIONS CAZ A, VEHICLE REPLACEMENT 2020

Designed	Drawn	Checked	Approved	Date
DM	DU	TS	TS	18/10/2018

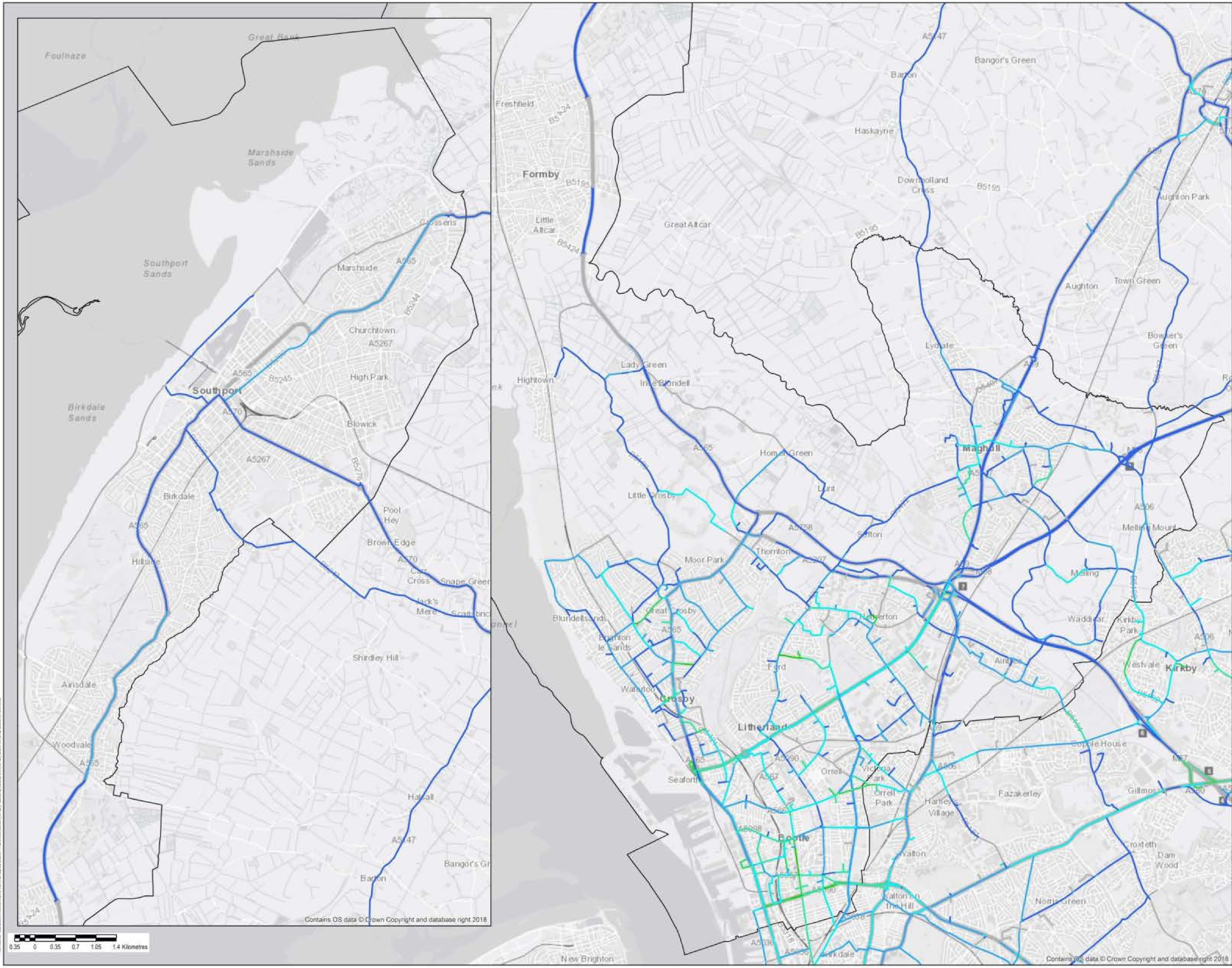
Internal Project No. 60547444

Scale @ A3: 1:40,000

AECOM

Figure H.60

Rev: P01



CAZ-B Replacement, 2020 Residual NOx

- 0 - 40%
- 41 - 50%
- 51 - 60%
- 61 - 70%
- 71 - 80%
- 81 - 90%
- 91 - 100%
- Local Authority Boundary

Purpose of Issue: FOR INFORMATION

Client: Sefton Council, Pollution Control Team, Magdalen House, 30 Trinity Road, Bootle, L20 3NJ

Project Title: SEFTON CAZ FEASIBILITY STUDY

Drawing Title: RESIDUAL NOx EMISSIONS CAZ B, VEHICLE REPLACEMENT 2020

Designed	Drawn	Checked	Approved	Date
DM	DU	TS	TS	19/10/2018

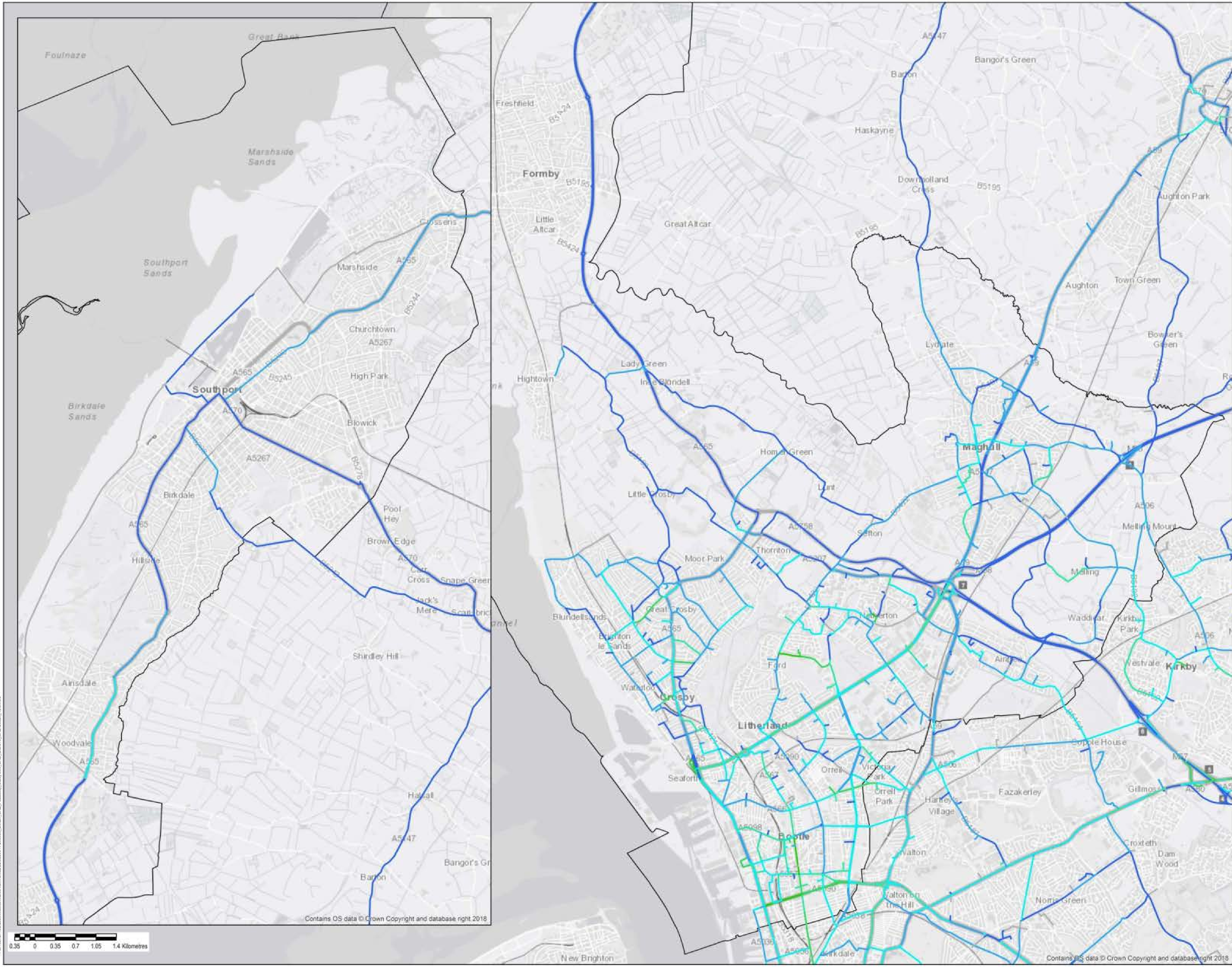
Internal Project No.: 60547444

Scale @ A3: 1:40,000

AECOM

Figure H.61

P01



Purpose of Issue: FOR INFORMATION

Client: Sefton Council, Pollution Control Team, Magdalen House, 30 Trinity Road, Bootle, L20 3NJ

Project Title: SEFTON CAZ FEASIBILITY STUDY

Drawing Title: RESIDUAL NOx EMISSIONS CAZ C, VEHICLE REPLACEMENT 2020

Designed	Drawn	Checked	Approved	Date
DM	DU	TS	TS	19/10/2018

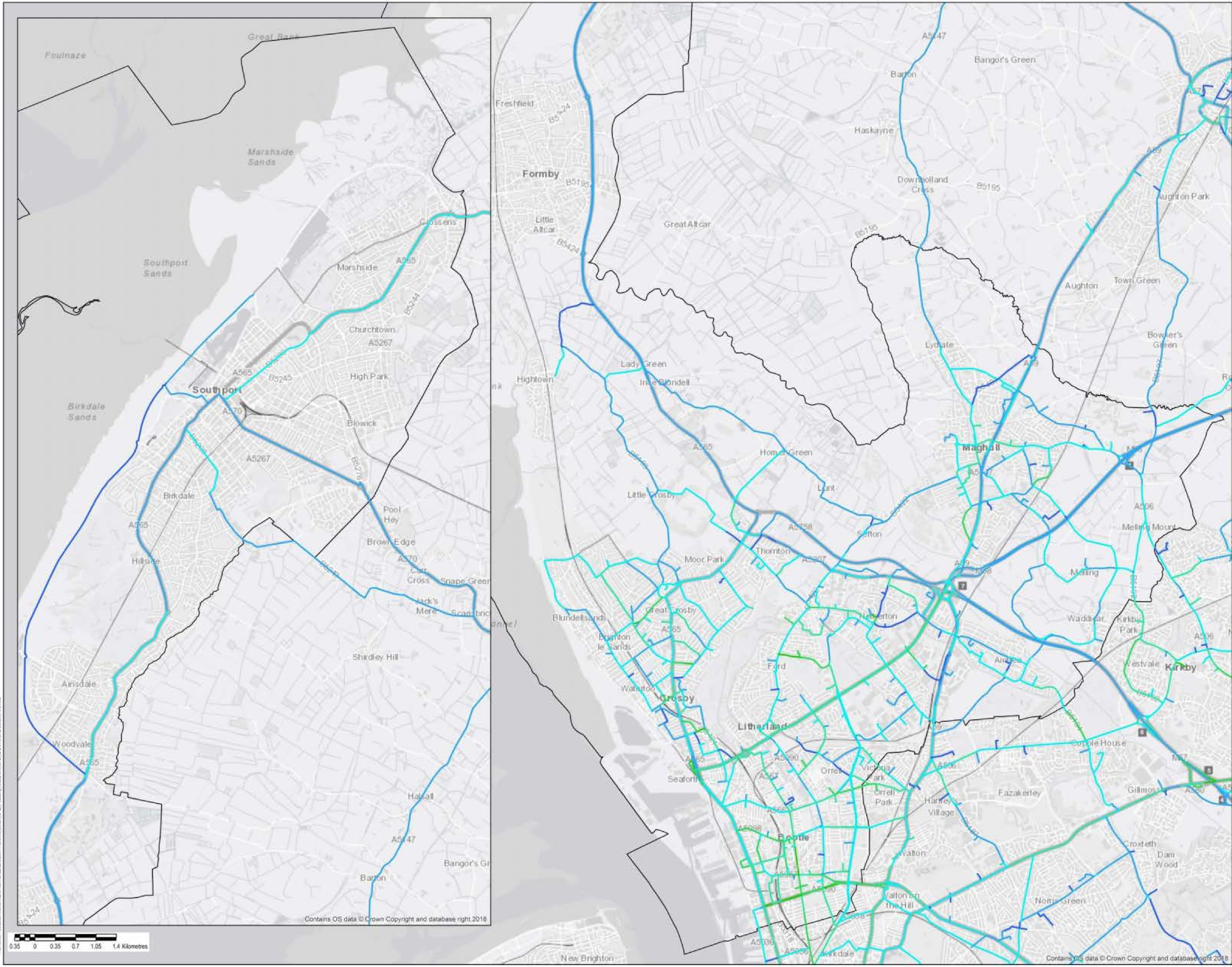
Internal Project No: 60547444

Scale @ A3: 1:40,000

AECOM

Figure H.62

P01



CAZ-D Replacement, 2020 Residual NOx

- 0 - 40%
- 41 - 50%
- 51 - 60%
- 61 - 70%
- 71 - 80%
- 81 - 90%
- 91 - 100%
- Local Authority Boundary

Purpose of issue: FOR INFORMATION

Client: Sefton Council, Pollution Control Team, Magdalen House, 30 Trinity Road, Bootle, L20 3NJ

Project Title: SEFTON CAZ FEASIBILITY STUDY

Drawing Title: RESIDUAL NOx EMISSIONS CAZ D, VEHICLE REPLACEMENT 2020

Designed	Drawn	Checked	Approved	Date
DM	DU	TS	TS	19/10/2018

Internal Project No. 60547444

Scale @ A3: 1:40,000

Project Office

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Figure H.63

Rev. P01