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Appendix 8.5 – Vehicle Emissions Modelling

Document approval

	Name	Signature	Position	Date
Prepared by:	Hannah Lederer		Environmental Scientist	12/02/2021
Checked by:	Rosalind Flavell		Senior Consultant	12/02/2021

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1 Introduction

This Appendix contains the detailed methodology and results of the road vehicle modelling assessment to support Chapter 8 - Air Quality, Odour and Human Health for the Environmental Impact Assessment Report (EIAR) to support the planning application of the Proposed Development at Killoch, East Ayrshire.

The IAQM document "Land-Use Planning & Development Control: Planning for Air Quality V1.2" (2017), referred to as the IAQM 2017 Planning Guidance, states that an air quality assessment is required where a development would cause a "significant change" in light duty vehicles (LDVs) or heavy duty vehicles (HDV). The indicative criteria to process to an assessment are:

- A change in LDV flows of:
 - more than 100 Annual Average Daily Traffic (AADT) within or adjacent to an AQMA; or
 - more than 500 AADT elsewhere.
- A change in HDV flows of:
 - more than 25 AADT within or adjacent to an AQMA; or
 - more than 100 AADT elsewhere.

The IAQM guidance does not clearly state the level of assessment which is required. However, if the change in LDV and HDV flows does not exceed the above criteria and there is negligible risk of overlap of emissions with process emissions, the development is not expected to cause a significant change and the significance of effect is deemed to be 'negligible' and further detailed analysis of the impact will not be carried out. If the above criteria are not met detailed modelling of road traffic emissions will be undertaken to determine the impact. It is noted that HDV includes HGVs and buses > 3.5 tonnes.

As stated in Chapter 7 of the EIAR, the anticipated development traffic is for a maximum of 46 LDVs (92 movements) per day and an average of 52 HGVs (103 movements) per day.¹

Although there are no AQMAs within the area, the number of HGV movements exceeds the lower screening criteria. In addition, the routing of vehicles north east along the A70 and through the town of Ochiltree has the potential for vehicle emissions to combine with process emissions. Therefore, it has been considered appropriate to undertake a detailed assessment of the transport emissions in order to calculate the in combination impact with the process emissions.

¹ Note that these values are averages which have been rounded up to the nearest whole vehicle.

2 Methodology

2.1 Model used

All traffic modelling was undertaken using the ADMS-Roads (version 5.1) dispersion modelling package. The ADMS-Roads model is a version of ADMS, which was developed by CERC and is commonly used throughout the UK for environmental assessment purposes. ADMS-Roads is routinely used for modelling of emissions for planning purposes to the satisfaction of local authorities.

2.2 Input data

The model requires input data that details the following parameters:

- Traffic flow data;
- Vehicle emission factors;
- Spatial co-ordinates of emissions;
- Discrete receptor points;
- Meteorological data;
- Roughness length; and,
- Monin-Obukhov length.

2.3 Traffic flow data

24-hour AADT flows and HDV numbers have been provided by Tran Plan World, the transport consultant for the project, for the following scenarios:

- Scenario 1: 2019 Baseline.
- Scenario 2: 2025 do-minimum: including Tempro growth to represent general traffic growth.
- Scenario 3: 2025 do-something: as scenario 2, plus the Proposed Development traffic flows.

The effect of the Proposed Development is defined as the difference between the 'do-something' and 'do-minimum' scenarios, i.e. scenario 3 minus scenario 2.

The assessment has considered any other committed but not yet developed/operational developments in the area. At the time of writing, there are three wind farms. Although these developments will temporarily generate construction traffic, due to the nature of the developments, operational traffic will be minimal and not considered to be of significant impact. It has therefore not been considered necessary to include the committed developments traffic numbers within this assessment.

The year 2019 has been used for the year of the traffic data and meteorological data. The roads included in the model are shown in Figure 1 of Appendix A and the traffic data used in the assessment is presented in Table 1.

Table 1: Traffic Data (AADT)

Road link	Baseline 2019		Do Minimum 2025		Do Something 2025		Development trips	
	LDVs	HDVs	LDVs	HDVs	LDVs	HDVs	LDVs	HDVs
A -Between B730 and Proposed Development	6131	681	6362	707	6391	726	29	19
B – Between proposed Development and Skares Road junction	6201	689	6435	715	6476	771	41	56
C – Between Skares Road junction and Ochiltree	6115	679	6346	705	6387	761	41	56
Note: Figures subject to minor rounding errors								

Note that the AADT values take the week-day vehicle numbers required by the Proposed Development, averaged over a seven day week. Our assessment has factored the same ratio of weekday vehicle numbers for the operating hours on a Saturday between 07:00 -12:00 hrs within the time varying profile. Vehicle speeds

Vehicles have been modelled at 90 kph (~56 mph) for LDVs and 80 kph (~50 mph) for HDVs on most of the A70, where the speed limit is 60 mph. The average speeds used for modelling purposes has been reduced from the speed limit to align with the mean speed of 54 mph measured during data collection by Streetwise Services in 2018.

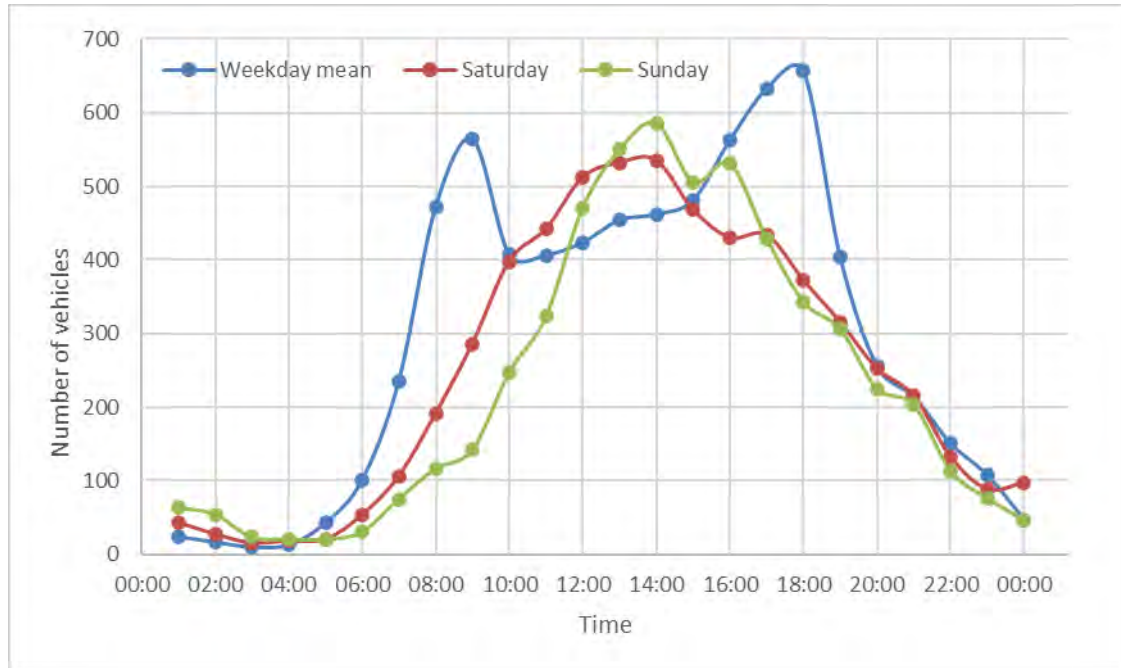
Slower speeds have been used where appropriate as listed below;

1. At the run up to the junction of the Proposed Development, where speeds of 20 kph (~12 mph) have been used for LDVs and HDVs;
2. At the run up to the 30 mph speed limit enforcements in Ochiltree, where speeds of 70 kph (~43 mph) for LDVs and 60 kph (~37 mph) for HDVs have been used;
3. Within the 30 mph speed limit within Ochiltree, where speeds of 50 kph (~31 mph) for LDVs and 40 kph (~25 mph) for HDVs have been used;
4. Within the centre of Ochiltree, where the bend in the road and increased numbers of pedestrians and cyclists is expected to slow vehicles, where speeds of 25 kph (~16 mph) have been used for LDVs and HDVs; and
5. The stretch of road after the end oof the 30 mph zone within Ochiltree, where speeds of 80 kph (~50 mph) for LDVs and 70 kph (~43 mph) for HDVs have been used.

2.4 Daily profile of traffic volume

It is important that the model reflects the variability of the traffic flow during the day. To account for this, a time varying emission profile has been included in the model. This has used the data as collected in the Streetwise Services in 2018. The time varying profile for the Do Something scenario has also considered additional traffic associated with the Proposed Development and so has separate profiles for each of the three road links accordingly.

Graph 1: Baseline Traffic Diurnal Profile



2.5 Vehicle emissions factor

Emission factors for NO_x, PM₁₀ and PM_{2.5} have been determined for each scenario using the traffic data and the Emissions Factors Toolkit (EFT) v 10.1 (2VC) database of road traffic emission factors within ADMS Roads. All roads were classified as “Scotland (rural)”. Emissions for each link have been calculated using the EFT within the ADMS model.

It is possible to account for the effect of road gradients on vehicle emissions using the EFT, although this only affects emissions from HDVs, and the effects are capped at a gradient of 6%. This option has been used where the gradient is expected to significantly influence emissions from HDVs. Some sections of road have been modelled to include a gradient, most notably a gradient of 4.5% has been modelled for the first section of link A from the B730.

The EFT predicts that emissions from road vehicles will reduce in future years as newer cleaner vehicles enter the fleet. However, evidence has shown that the rate of this reduction may not be occurring in the real world as the vehicle fleet turnover rate has reduced. Within this assessment, we have conservatively adopted a worse -case scenario, which assumes no change to the fleet composition on local networks between 2019 and the opening year of 2025. The assessment also conservatively applies 2019 background concentrations to the future scenarios – i.e. assumes no reduction in background concentration.

If the results exceed the screening criteria or cannot be screened out as negligible, the conservative scenario will be assessed and a further best-case scenario accommodating expected fleet changes will be considered.

2.6 Spatial co-ordinates of vehicle emissions

Street locations and widths were estimated from a desk-top mapping study and referenced to UK National Grid Reference (NGR) co-ordinates.

2.7 Discrete receptor points

The Design Manual for Roads and Bridges (DMRB) considers any receptor within 200 m of a road source to be potentially affected by that operation. The AQALs only apply at locations where the public may be exposed to pollution for a sufficient period for there to be any measurable health effect. However, as the purpose of the assessment is to assess road vehicle emissions in combination with the process emissions, the assessment has used the same receptor points as the human receptor points used within the process emissions modelling. All the human receptors are listed in Table 2, with those receptors which are within 200 m of the road marked with an asterisk. There are no ecological receptors within 200 m of the roads modelled.

Table 2: Human sensitive receptors

ID	Description	X (m)	Y (m)	Height (m)
R1	Pennymore	248884	621862	1.5
R2	Findlayston	250156	620463	1.5
R3	Holehouse	249570	619960	1.5
R4	Bardarroch Farm	247095	618531	1.5
R5	Hunterston	246279	621583	1.5
R6	Creoch House	247623	620969	1.5
R7	Ardmhor	247622	621096	1.5
R8	The Bungalow	248878	621553	1.5
R9	Knowe View	249895	620966	1.5
R10	Gallowlee Avenue	250241	620991	1.5
R11	Torview	248903	620814	1.5
R12	Mote Toll*	249057	620619	1.5
R13	Netherton*	250498	620708	1.5
R14	North Palmerston	250712	620043	1.5
R15	The Bungalow	250697	619775	1.5
R16	Hilltop	249337	619489	1.5
R17	Auchness Cottage	248554	619646	1.5
R18	Lessnessock Bungalows	248306	619658	1.5
R19	Provost Mount	247711	619866	1.5
R20	Clydenoch	247290	619272	1.5
R21	Oakmount	246933	618100	1.5
R22	The Cottage*	246426	619844	1.5
R23	Shield*	245279	619923	1.5
R24	Briardene Cottage	245108	621159	1.5
R25	Alpbach	245396	621344	1.5
R26	House Fox Hollow	246050	621589	1.5
R27	Gowanpark House	247977	622321	1.5
R28	Gargowan	247489	622329	1.5

ID	Description	X (m)	Y (m)	Height (m)
R29	Steelpark	248503	622454	1.5
R30	Corselet	248450	621650	1.5
R31	Cawhillan	249237	621552	1.5
R32	Slatehole	249078	623077	1.5
R33	Barturk	249516	622088	1.5
R34	Low Carston	249945	621752	1.5
R35	Hill of Ochiltree	250016	621331	1.5
R36	High Tarbeg*	248610	620713	1.5
R37	Back o'Hill	250217	619821	1.5
R38	South Palmerston	250786	619544	1.5
R39	Glenconner	249470	619350	1.5
R40	Barquharrie	250259	619079	1.5
R41	Burnockstone	250123	618685	1.5
R42	Lessnessock	248181	619633	1.5
R43	Barlosh Court	248066	618199	1.5
R44	High Plyde	248906	617702	1.5
R45	Burnton	249367	617985	1.5
R46	Bardarroch	247373	618715	1.5
R47	Killochside*	247386	620184	1.5
R48	Treesmax	246082	618570	1.5
R49	East Tarelgin*	246665	619857	1.5
R50	Macquittiston	246068	619250	1.5
R51	Lochmark Farm	245065	619639	1.5
R52	West Tarelgin	246137	620014	1.5
R53	Chipperlaigan	245629	620735	1.5
R54	Hoodston	245937	620972	1.5
R55	Speirston	246330	621261	1.5
R56	Braehead	246828	621708	1.5
R57	Trabbochburn	246676	621872	1.5
R58	Laigh Tarbeg*	248730	620437	1.5
R59	Tarelgin Smokehouse*	246115	619720	1.5
R60	Gemmell's Garden Centre	245656	621496	1.5
R61	Ochiltree Primary School*	250523	621047	1.5
R62	Watson	249647	621013	1.5
R63	Ochiltree Corner - Ayr Road*	250682	621117	1.5
R64	Ochiltree Corner - Main Street 1*	250727.5	621184	1.5
R65	Ochiltree Corner - Main Street 2*	250744	621172.7	1.5
R66	Ochiltree Corner - Main Street 3*	250768	621191	1.5
R67	Ochiltree Corner - Main Street 4*	250795	621180	1.5

ID	Description	X (m)	Y (m)	Height (m)
R68	Ochiltree Corner - Mill Street*	250797.5	621197.5	1.5
R69	Ochiltree Corner - Burnock Street 1*	250829	621179	1.5
R70	Ochiltree Corner - Burnock Street 2*	250839	621151	1.5

2.8 Meteorological data

To calculate pollutant concentrations at identified receptor locations, the model uses sequential hourly meteorological data, including wind direction, wind speed, temperature, cloud cover and stability, which exert significant influence over atmospheric dispersion.

Sequential 1-hour meteorological data to be used in this assessment were taken from Prestwick meteorological station for 2019. As stated within Appendix 8.4 of the EIAR, Prestwick is considered to be the most representative meteorological station available.

Typically, road assessments use one-year of meteorological data. The traffic baseline data and meteorological data are all for the year 2019. A wind rose of the 2019 meteorological data is provided in Figure 4 of Appendix 8.4 to the EIAR Chapter 8.

The surface roughness and Monin-Obukov lengths used within the roads modelling for the site location and meteorological site location are the same as those used for the process emissions modelling as presented in Appendix 8.4 of the EIAR.

Table 3: Meteorological parameters summary

Parameter	Dispersion site	Meteorological site
Minimum Monin-Obukhov length	1 m	10 m
Surface roughness	0.3 m	0.3 m

2.9 Background data

For the purpose of this analysis the mapped background concentrations for each receptor point have been extracted from the most recent Scottish Air Quality Database (SAQD) mapped background 2018 dataset for nitrogen dioxide and PM₁₀. The SAQD does not include PM_{2.5}. Therefore, in line with the recommendation from SAQD the latest version of the DEFRA dataset has been used (2018). This data is presented in Table 3. There is considerable uncertainty as to how background pollutant concentrations will change in the future, so as a conservative measure the 2018 background pollutant concentrations have been applied to the future year (2019 and 2025) scenarios – i.e. assuming no reduction in background pollutant concentrations.

Table 4: Mapped Background Data

Grid square	Annual mean concentration (µg/m ³)		
	Nitrogen dioxide	PM ₁₀	PM _{2.5}
Annual mean AQAL	40	18	10
247500,621500	3.80	5.49	9.63
249500,620500	4.07	5.72	10.55
250500,620500	4.00	5.41	9.20

Grid square	Annual mean concentration ($\mu\text{g}/\text{m}^3$)		
	Nitrogen dioxide	PM ₁₀	PM _{2.5}
247500,619500	3.78	5.42	9.15
247500,622500	3.83	5.41	9.32
248500,622500	3.74	5.61	10.13
248500,621500	3.77	5.61	10.09
249500,623500	3.70	5.81	10.90
249500,622500	3.68	5.76	10.68
249500,619500	3.53	5.23	8.42
250500,619500	3.47	5.22	8.41
250500,618500	3.32	5.19	8.28
248500,619500	3.61	5.31	8.75
248500,618500	3.41	5.26	8.57
248500,617500	3.33	5.40	9.12
249500,617500	3.30	5.22	8.39
247500,618500	3.47	5.56	9.78
247500,620500	4.03	5.52	9.66
246500,618500	3.60	5.44	9.33
245500,619500	4.26	5.61	9.67
246500,620500	3.80	5.23	8.61
245500,620500	3.83	5.47	9.53
246500,621500	3.85	5.21	8.52
248500,620500	4.09	5.81	11.08
246500,619500	4.12	5.74	10.25
245500,621500	3.86	5.21	8.54
249500,621500	3.77	5.58	9.95
250500,621500	3.98	5.53	9.56

Source: SAQD and DEFRA 2018 mapped background datasets

As shown the mapped background concentrations are well below the AQAL for nitrogen dioxide and PM₁₀, but are close to and slightly exceed the AQAL for PM_{2.5} in some areas.

2.10 Post modelling conversion from NO_x to nitrogen dioxide (NO₂)

The modelled road-NO_x and the mapped background concentrations have been used as inputs in DEFRA's NO_x to NO₂ calculator (V8.1) to convert modelled NO_x to NO₂ in accordance with the methodology outlined in LAQM.(TG16).

When converting from NO_x to NO₂ the following inputs have been used:

- The year has been taken as the same as the emissions data, i.e. 2019 for the worst case scenario;
- The local authority has been selected as "East Ayrshire"; and
- The traffic mix has been selected as "All non-urban UK traffic".

2.11 Verification

The ADMS Roads model has been validated against real world monitoring. However LAQM.TG(16) recommends that the model output is verified. The verification process should involve the comparison between predicted and measured concentrations at one or more suitable local sites and forms an essential component of a detailed assessment for road traffic models. Part of the verification process involves improvements to the base model to provide a better representation of the monitored data. This includes checks on:

- • Traffic data;
- • Road widths;
- • Distance between sources and monitoring locations;
- • Speed estimates;
- • Street canyons;
- • Background concentrations; and
- • Monitoring data.

All of these have been reviewed and the model refined to increase the accuracy as much as possible.

As there are no local monitoring points along the roads modelled in the assessment, it is not possible to further verify the model outputs. In lieu of this consideration has been made to the results in line with the national modelling carried out to support the UK's annual compliance assessment as reported to the Commission each year. This data is accessible via the DEFRA UK-AIR website. Although the road through Ochiltree is not included in the results, the A70 on a stretch through neighbouring Cumnock is. The modelled annual mean nitrogen dioxide concentration along this part of the A70 compares well to that predicted in Ochiltree. Therefore, despite any local monitoring to verify the modelling against, we are confident that the model is performing well.

2.12 Analysis

The analysis considers the worst case emissions scenario, in which there is no change to the fleet composition on local networks between 2019 and 2025 and using the 2019 background concentrations to the future scenarios. This is a conservative approach as there will be some changeover of the fleet with newer cleaner vehicles.

3 Results

3.1 Impact of Proposed Development

The Design Manual for Roads and Bridges (DMRB) considers any receptor within 200 m of a road source to be potentially affected by that operation. The AQALs only apply at locations where the public may be exposed to pollution for a sufficient period for there to be any measurable health effect. For the purpose of this assessment, the impact at each of the human receptors identified in the EIAR within 200 m of the road route of operation vehicles has been assessed. Those receptors more than 200m from the road have nil road contributions but are displayed as to show the combined impact from the stack.

There are no ecological receptors within 200 m of the routes. Therefore, the impact at ecological receptors has not been necessary.

Full details of the model and inputs, including receptor locations, derivation of traffic flows used in the assessment, and the model verification procedure, are provided in Section 2.

Detailed results tables can be found in Annex A.

3.2 Nitrogen dioxide

As shown in Table 5, for the worst-case scenario, which assumes that the vehicle fleet does not change from the existing mix, the maximum predicted annual mean nitrogen dioxide concentration associated with the traffic from the Proposed Development at modelled receptors is $0.33 \mu\text{g}/\text{m}^3$ (or 0.83% of the AQAL). When the contribution from process emissions from the Proposed Development is added to the road contribution the maximum annual mean nitrogen dioxide impact is $0.39 \mu\text{g}/\text{m}^3$ (or 0.97% of the AQAL).

Additional analysis has been carried out for short term impacts. DEFRA's Local Air Quality Management Technical Guidance Note 16 (LAQM.(TG16)) states that if annual mean nitrogen dioxide concentrations are above $60 \mu\text{g}/\text{m}^3$ (i.e. 150% of the AQAL), there is the potential for exceedences of the 1-hour AQAL. Even in the worst-case scenario that the fleet mix does not change from current levels the maximum predicted concentration is well below $60 \mu\text{g}/\text{m}^3$. Therefore, there is no potential for exceedences of the 1-hour nitrogen dioxide AQAL.

It should be noted that due to the lack of monitoring in the area it was not possible to verify the model with monitored results. Therefore, a degree of uncertainty should be given when interpreting the results. As shown in the UK's annual compliance assessment baseline concentrations in the local area are low. In this case the impact of the Proposed Development would need to exceed 5.5% of the AQAL in order to be considered a slight adverse impact (rather than negligible), this is a 5 fold increase in the impact predicted. Even considering any uncertainty in the modelling, there is very little risk predicted impacts would be so much greater.

3.3 Particulate matter

As shown in Table 6, for the worst-case scenario which assumes that the vehicle fleet does not change from the existing mix, the maximum predicted annual mean particulate matter concentration (as PM_{10} or $\text{PM}_{2.5}$) associated with the vehicles from the Proposed Development is $0.032 \mu\text{g}/\text{m}^3$ (0.18% of the AQAL), and $0.21 \mu\text{g}/\text{m}^3$ (0.002% of the AQAL) respectively. When the contribution from process emissions from the Facility is added to the road contribution the

maximum annual mean particulate matter concentration (as PM₁₀ or PM_{2.5}) impact is 0.035 µg/m³ (or 0.19% of the AQAL) and 0.023 µg/m³ (or 0.002% of the AQAL).

Annexes

A Vehicle emissions detailed results tables

Table 5: Annual Mean Nitrogen Dioxide – Worst Case

Receptor	Do-Minimum		Proposed Development		Do-Something		Impact		
	µg/m ³	% AQAL	PC	Road contribution	µg/m ³	% AQAL	µg/m ³	% AQAL	Magnitude of change descriptor
			µg/m ³	µg/m ³					
R1	3.88	9.70%	0.12	<0.01	4.00	9.99%	0.12	0.29%	Negligible*
R2	4.63	11.58%	0.07	0.01	4.71	11.77%	0.08	0.19%	Negligible*
R3	3.82	9.55%	0.09	0.01	3.92	9.80%	0.10	0.25%	Negligible*
R4	3.61	9.03%	0.02	<0.01	3.63	9.09%	0.02	0.06%	Negligible*
R5	3.95	9.88%	0.04	0.01	4.00	10.00%	0.05	0.13%	Negligible*
R6	4.27	10.68%	0.16	<0.01	4.43	11.08%	0.16	0.41%	Negligible*
R7	4.00	10.00%	0.17	0.01	4.18	10.45%	0.18	0.45%	Negligible*
R8	3.92	9.80%	0.15	0.01	4.08	10.19%	0.16	0.39%	Negligible*
R9	4.63	11.58%	0.10	0.02	4.75	11.86%	0.12	0.29%	Negligible*
R10	4.73	11.83%	0.08	0.02	4.83	12.07%	0.10	0.24%	Negligible*
R11	4.68	11.70%	0.22	0.01	4.91	12.26%	0.23	0.56%	Negligible
R12	6.3	15.75%	0.18	0.05	6.53	16.32%	0.23	0.57%	Negligible
R13	5.12	12.80%	0.06	0.03	5.21	13.02%	0.09	0.22%	Negligible*
R14	4.22	10.55%	0.05	<0.01	4.27	10.66%	0.05	0.11%	Negligible*
R15	3.64	9.10%	0.05	0.01	3.70	9.24%	0.06	0.14%	Negligible*
R16	3.72	9.30%	0.09	<0.01	3.81	9.52%	0.09	0.22%	Negligible*

Receptor	Do-Minimum		Proposed Development		Do-Something		Impact		
	µg/m ³	% AQAL	PC	Road contribution	µg/m ³	% AQAL	µg/m ³	% AQAL	Magnitude of change descriptor
			µg/m ³	µg/m ³					
R17	3.88	9.70%	0.10	0.01	3.99	9.98%	0.11	0.28%	Negligible*
R18	3.92	9.80%	0.07	0.01	4.00	9.99%	0.08	0.19%	Negligible*
R19	4.39	10.98%	0.03	<0.01	4.42	11.04%	0.03	0.07%	Negligible*
R20	4.05	10.13%	0.04	<0.01	4.09	10.23%	0.04	0.11%	Negligible*
R21	3.7	9.25%	0.02	<0.01	3.72	9.30%	0.02	0.05%	Negligible*
R22	6	15.00%	0.07	0.02	6.09	15.21%	0.09	0.21%	Negligible*
R23	5.29	13.23%	0.04	0.01	5.34	13.36%	0.05	0.14%	Negligible*
R24	3.97	9.93%	0.04	<0.01	4.01	10.03%	0.04	0.11%	Negligible*
R25	3.96	9.90%	0.04	<0.01	4.00	10.01%	0.04	0.11%	Negligible*
R26	3.95	9.88%	0.04	<0.01	3.99	9.98%	0.04	0.10%	Negligible*
R27	3.9	9.75%	0.08	<0.01	3.98	9.96%	0.08	0.21%	Negligible*
R28	3.9	9.75%	0.09	<0.01	3.99	9.97%	0.09	0.22%	Negligible*
R29	3.81	9.53%	0.07	0.01	3.89	9.72%	0.08	0.19%	Negligible*
R30	3.9	9.75%	0.13	<0.01	4.03	10.07%	0.13	0.32%	Negligible*
R31	3.94	9.85%	0.13	<0.01	4.07	10.17%	0.13	0.32%	Negligible*
R32	3.74	9.35%	0.05	<0.01	3.79	9.47%	0.05	0.12%	Negligible*
R33	3.77	9.43%	0.09	<0.01	3.86	9.65%	0.09	0.23%	Negligible*
R34	3.92	9.80%	0.09	<0.01	4.01	10.02%	0.09	0.22%	Negligible*
R35	4.27	10.68%	0.09	0.01	4.37	10.93%	0.10	0.25%	Negligible*

Receptor	Do-Minimum		Proposed Development		Do-Something		Impact		
	µg/m ³	% AQAL	PC	Road contribution	µg/m ³	% AQAL	µg/m ³	% AQAL	Magnitude of change descriptor
			µg/m ³	µg/m ³					
R36	4.83	12.08%	0.29	0.02	5.14	12.86%	0.31	0.78%	Negligible
R37	3.69	9.23%	0.06	<0.01	3.75	9.37%	0.06	0.15%	Negligible*
R38	3.61	9.03%	0.04	<0.01	3.65	9.14%	0.04	0.11%	Negligible*
R39	3.69	9.23%	0.08	0.01	3.78	9.44%	0.09	0.21%	Negligible*
R40	3.59	8.98%	0.05	<0.01	3.64	9.10%	0.05	0.13%	Negligible*
R41	3.41	8.53%	0.04	<0.01	3.45	8.62%	0.04	0.10%	Negligible*
R42	3.93	9.83%	0.04	0.01	3.98	9.96%	0.05	0.13%	Negligible*
R43	3.51	8.78%	0.01	<0.01	3.52	8.81%	0.01	0.03%	Negligible*
R44	3.4	8.50%	0.01	<0.01	3.41	8.52%	0.01	0.02%	Negligible*
R45	3.37	8.43%	0.01	0.01	3.39	8.48%	0.02	0.06%	Negligible*
R46	3.63	9.08%	0.02	<0.01	3.65	9.14%	0.02	0.06%	Negligible*
R47	5.21	13.03%	0.07	0.02	5.30	13.24%	0.09	0.22%	Negligible*
R48	3.75	9.38%	0.04	<0.01	3.79	9.48%	0.04	0.10%	Negligible*
R49	6.64	16.60%	0.08	0.02	6.74	16.84%	0.10	0.24%	Negligible*
R50	4.46	11.15%	0.05	0.01	4.52	11.30%	0.06	0.15%	Negligible*
R51	5	12.50%	0.04	0.01	5.05	12.62%	0.05	0.12%	Negligible*
R52	4.4	11.00%	0.06	0.01	4.47	11.18%	0.07	0.18%	Negligible*
R53	3.99	9.98%	0.06	<0.01	4.05	10.11%	0.06	0.14%	Negligible*
R54	3.97	9.93%	0.06	<0.01	4.03	10.07%	0.06	0.14%	Negligible*

Receptor	Do-Minimum		Proposed Development		Do-Something		Impact		
	$\mu\text{g}/\text{m}^3$	% AQAL	PC	Road contribution	$\mu\text{g}/\text{m}^3$	% AQAL	$\mu\text{g}/\text{m}^3$	% AQAL	Magnitude of change descriptor
			$\mu\text{g}/\text{m}^3$	$\mu\text{g}/\text{m}^3$					
R55	3.98	9.95%	0.05	<0.01	4.03	10.08%	0.05	0.13%	Negligible*
R56	3.96	9.90%	0.05	<0.01	4.01	10.03%	0.05	0.13%	Negligible*
R57	3.94	9.85%	0.04	<0.01	3.98	9.96%	0.04	0.11%	Negligible*
R58	5.37	13.43%	0.23	0.03	5.63	14.07%	0.26	0.64%	Negligible
R59	6.73	16.83%	0.06	0.02	6.81	17.02%	0.08	0.19%	Negligible*
R60	3.96	9.90%	0.04	<0.01	4.00	10.00%	0.04	0.10%	Negligible*
R61	5.24	13.10%	0.07	0.04	5.35	13.37%	0.11	0.27%	Negligible*
R62	4.2	10.50%	0.12	0.02	4.34	10.84%	0.14	0.34%	Negligible*
R63	10.45	26.13%	0.06	0.23	10.74	26.86%	0.29	0.73%	Negligible
R64	11.62	29.05%	0.06	0.29	11.97	29.93%	0.35	0.88%	Negligible
R65	12.61	31.53%	0.06	0.32	12.99	32.48%	0.38	0.95%	Negligible
R66	12.37	30.93%	0.06	0.32	12.75	31.88%	0.38	0.95%	Negligible
R67	12.76	31.90%	0.06	0.33	13.15	32.87%	0.39	0.97%	Negligible
R68	9.91	24.78%	0.06	0.22	10.19	25.47%	0.28	0.70%	Negligible
R69	10.76	26.90%	0.06	0.25	11.07	27.67%	0.31	0.77%	Negligible
R70	11.01	27.53%	0.06	0.25	11.32	28.29%	0.31	0.77%	Negligible

Note:

*Negligible irrespective of the total concentration.

Assumes 70% conversion of NO_x to NO₂ for process emissions

Road traffic NO_x converted to NO₂ using the LAQM calculator

Table 6: Annual Mean Particulate Matter as PM₁₀ – Worst Case

Receptor	Do-Minimum		Proposed Development		Do-Something		Impact		
	µg/m ³	% AQAL	PC	Road contribution	µg/m ³	% AQAL	µg/m ³	% AQAL	Magnitude of change descriptor
			µg/m ³	µg/m ³					
R1	10.11	56.17%	<0.01	<0.01	10.12	56.19%	0.01	0.03%	Negligible*
R2	9.28	51.58%	<0.01	<0.01	9.29	51.61%	0.01	0.03%	Negligible*
R3	8.46	46.99%	<0.01	<0.01	8.46	47.02%	<0.01	0.03%	Negligible*
R4	9.80	54.45%	<0.01	<0.01	9.80	54.46%	<0.01	0.01%	Negligible*
R5	8.53	47.41%	<0.01	<0.01	8.54	47.42%	<0.01	0.01%	Negligible*
R6	9.69	53.85%	0.01	<0.01	9.70	53.89%	0.01	0.04%	Negligible*
R7	9.66	53.65%	0.01	<0.01	9.67	53.70%	0.01	0.04%	Negligible*
R8	10.12	56.20%	0.01	<0.01	10.12	56.23%	0.01	0.04%	Negligible*
R9	10.63	59.04%	<0.01	<0.01	10.63	59.07%	0.01	0.04%	Negligible*
R10	9.30	51.64%	<0.01	<0.01	9.30	51.68%	0.01	0.04%	Negligible*
R11	11.16	62.01%	0.01	<0.01	11.17	62.07%	0.01	0.06%	Negligible*
R12	10.86	60.34%	0.01	0.01	10.88	60.43%	0.02	0.09%	Negligible*
R13	9.35	51.94%	<0.01	0.01	9.36	51.98%	0.01	0.04%	Negligible*
R14	9.23	51.27%	<0.01	<0.01	9.23	51.29%	<0.01	0.02%	Negligible*
R15	8.43	46.84%	<0.01	<0.01	8.43	46.85%	<0.01	0.01%	Negligible*
R16	8.44	46.91%	<0.01	<0.01	8.45	46.94%	<0.01	0.02%	Negligible*
R17	8.79	48.81%	<0.01	<0.01	8.79	48.83%	0.01	0.03%	Negligible*
R18	8.79	48.83%	<0.01	<0.01	8.79	48.85%	<0.01	0.02%	Negligible*

Receptor	Do-Minimum		Proposed Development		Do-Something		Impact		
	µg/m ³	% AQAL	PC	Road contribution	µg/m ³	% AQAL	µg/m ³	% AQAL	Magnitude of change descriptor
			µg/m ³	µg/m ³					
R19	9.23	51.28%	<0.01	<0.01	9.23	51.29%	<0.01	0.01%	Negligible*
R20	9.18	51.03%	<0.01	<0.01	9.19	51.04%	<0.01	0.01%	Negligible*
R21	9.34	51.91%	<0.01	<0.01	9.34	51.91%	<0.01	0.01%	Negligible*
R22	10.50	58.35%	<0.01	<0.01	10.51	58.38%	<0.01	0.03%	Negligible*
R23	9.81	54.48%	<0.01	<0.01	9.81	54.50%	<0.01	0.02%	Negligible*
R24	8.56	47.53%	<0.01	<0.01	8.56	47.54%	<0.01	0.01%	Negligible*
R25	8.55	47.52%	<0.01	<0.01	8.56	47.53%	<0.01	0.01%	Negligible*
R26	8.53	47.41%	<0.01	<0.01	8.54	47.42%	<0.01	0.01%	Negligible*
R27	9.33	51.81%	<0.01	<0.01	9.33	51.83%	<0.01	0.02%	Negligible*
R28	9.33	51.81%	<0.01	<0.01	9.33	51.83%	<0.01	0.02%	Negligible*
R29	10.14	56.32%	<0.01	<0.01	10.14	56.34%	<0.01	0.02%	Negligible*
R30	10.11	56.18%	0.01	<0.01	10.12	56.21%	<0.01	0.03%	Negligible*
R31	9.98	55.43%	0.01	<0.01	9.98	55.46%	<0.01	0.03%	Negligible*
R32	10.91	60.61%	<0.01	<0.01	10.91	60.62%	<0.01	0.01%	Negligible*
R33	10.70	59.42%	<0.01	<0.01	10.70	59.44%	<0.01	0.02%	Negligible*
R34	9.97	55.41%	<0.01	<0.01	9.98	55.43%	<0.01	0.02%	Negligible*
R35	9.60	53.34%	<0.01	<0.01	9.61	53.37%	<0.01	0.03%	Negligible*
R36	11.18	62.14%	0.01	<0.01	11.20	62.22%	<0.01	0.08%	Negligible*
R37	8.44	46.88%	<0.01	<0.01	8.44	46.89%	<0.01	0.02%	Negligible*

Receptor	Do-Minimum		Proposed Development		Do-Something		Impact		
	µg/m ³	% AQAL	PC	Road contribution	µg/m ³	% AQAL	µg/m ³	% AQAL	Magnitude of change descriptor
			µg/m ³	µg/m ³					
R38	8.43	46.81%	<0.01	<0.01	8.43	46.83%	<0.01	0.01%	Negligible*
R39	8.44	46.90%	<0.01	<0.01	8.45	46.92%	<0.01	0.02%	Negligible*
R40	8.42	46.80%	<0.01	<0.01	8.43	46.82%	<0.01	0.01%	Negligible*
R41	8.30	46.08%	<0.01	<0.01	8.30	46.10%	<0.01	0.01%	Negligible*
R42	8.79	48.84%	<0.01	<0.01	8.79	48.85%	<0.01	0.01%	Negligible*
R43	8.59	47.70%	<0.01	<0.01	8.59	47.70%	<0.01	0.00%	Negligible*
R44	9.13	50.72%	<0.01	<0.01	9.13	50.72%	<0.01	0.00%	Negligible*
R45	8.40	46.67%	<0.01	<0.01	8.40	46.67%	<0.01	0.00%	Negligible*
R46	9.80	54.46%	<0.01	<0.01	9.80	54.47%	<0.01	0.01%	Negligible*
R47	9.83	54.59%	<0.01	<0.01	9.83	54.62%	<0.01	0.03%	Negligible*
R48	9.35	51.94%	<0.01	<0.01	9.35	51.95%	<0.01	0.01%	Negligible*
R49	10.59	58.85%	<0.01	<0.01	10.60	58.89%	<0.01	0.04%	Negligible*
R50	10.30	57.19%	<0.01	<0.01	10.30	57.21%	<0.01	0.02%	Negligible*
R51	9.77	54.26%	<0.01	<0.01	9.77	54.28%	<0.01	0.02%	Negligible*
R52	8.69	48.29%	<0.01	<0.01	8.70	48.31%	<0.01	0.02%	Negligible*
R53	9.56	53.09%	<0.01	<0.01	9.56	53.10%	<0.01	0.01%	Negligible*
R54	9.55	53.07%	<0.01	<0.01	9.56	53.08%	<0.01	0.02%	Negligible*
R55	8.54	47.43%	<0.01	<0.01	8.54	47.44%	<0.01	0.01%	Negligible*
R56	8.53	47.41%	<0.01	<0.01	8.54	47.43%	<0.01	0.01%	Negligible*

Receptor	Do-Minimum		Proposed Development		Do-Something		Impact		
	$\mu\text{g}/\text{m}^3$	% AQAL	PC	Road contribution	$\mu\text{g}/\text{m}^3$	% AQAL	$\mu\text{g}/\text{m}^3$	% AQAL	Magnitude of change descriptor
			$\mu\text{g}/\text{m}^3$	$\mu\text{g}/\text{m}^3$					
R57	8.53	47.40%	<0.01	<0.01	8.53	47.42%	<0.01	0.01%	Negligible*
R58	11.26	62.56%	0.01	<0.01	11.28	62.64%	0.01	0.08%	Negligible*
R59	10.60	58.90%	<0.01	<0.01	10.61	58.94%	0.01	0.03%	Negligible*
R60	8.55	47.52%	<0.01	<0.01	8.56	47.53%	<0.01	0.01%	Negligible*
R61	9.72	54.02%	<0.01	0.01	9.73	54.07%	0.01	0.05%	Negligible*
R62	10.01	55.62%	<0.01	<0.01	10.02	55.66%	0.01	0.04%	Negligible*
R63	10.32	57.33%	<0.01	0.03	10.35	57.50%	0.03	0.16%	Negligible*
R64	10.36	57.57%	<0.01	0.03	10.39	57.74%	0.03	0.17%	Negligible*
R65	10.47	58.15%	<0.01	0.03	10.50	58.35%	0.03	0.19%	Negligible*
R66	10.44	58.00%	<0.01	0.03	10.47	58.19%	0.03	0.19%	Negligible*
R67	10.48	58.24%	<0.01	0.03	10.52	58.44%	0.03	0.19%	Negligible*
R68	10.18	56.57%	<0.01	0.02	10.21	56.71%	0.02	0.14%	Negligible*
R69	10.28	57.09%	<0.01	0.03	10.30	57.25%	0.03	0.16%	Negligible*
R70	10.32	57.31%	<0.01	0.03	10.34	57.47%	0.03	0.16%	Negligible*

Note:

*Negligible irrespective of the total concentration.

Assumes 70% conversion of NO_x to NO₂ for process emissions

Road traffic NO_x converted to NO₂ using the LAQM calculator

Table 7: Annual Mean Particulate Matter as PM_{2.5} – Worst Case

Receptor	Do-Minimum		Proposed Development		Do-Something		Impact		
	µg/m ³	% AQAL	PC	Road contribution	µg/m ³	% AQAL	µg/m ³	% AQAL	Magnitude of change descriptor
			µg/m ³	µg/m ³					
R1	5.62	56.17%	<0.01	<0.01	5.62	56.22%	0.01	0.05%	Negligible*
R2	5.46	54.61%	<0.01	<0.01	5.47	54.66%	<0.01	0.05%	Negligible*
R3	5.25	52.51%	<0.01	<0.01	5.26	52.56%	<0.01	0.04%	Negligible*
R4	5.57	55.67%	<0.01	<0.01	5.57	55.68%	<0.01	0.01%	Negligible*
R5	5.22	52.17%	<0.01	<0.01	5.22	52.19%	<0.01	0.02%	Negligible*
R6	5.54	55.39%	0.01	<0.01	5.55	55.46%	0.01	0.07%	Negligible*
R7	5.51	55.05%	0.01	<0.01	5.51	55.13%	0.01	0.07%	Negligible*
R8	5.62	56.20%	0.01	<0.01	5.63	56.27%	0.01	0.07%	Negligible*
R9	5.77	57.69%	<0.01	<0.01	5.77	57.75%	0.01	0.06%	Negligible*
R10	5.47	54.69%	<0.01	<0.01	5.47	54.74%	0.01	0.05%	Negligible*
R11	5.86	58.58%	0.01	<0.01	5.87	58.68%	0.01	0.10%	Negligible*
R12	5.91	59.13%	0.01	0.01	5.93	59.26%	0.01	0.13%	Negligible*
R13	5.50	55.02%	<0.01	<0.01	5.51	55.07%	0.01	0.06%	Negligible*
R14	5.43	54.28%	<0.01	<0.01	5.43	54.30%	<0.01	0.02%	Negligible*
R15	5.23	52.32%	<0.01	<0.01	5.23	52.35%	<0.01	0.02%	Negligible*
R16	5.24	52.43%	<0.01	<0.01	5.25	52.47%	<0.01	0.04%	Negligible*
R17	5.33	53.30%	<0.01	<0.01	5.33	53.35%	<0.01	0.05%	Negligible*
R18	5.33	53.33%	<0.01	<0.01	5.34	53.36%	<0.01	0.03%	Negligible*

Receptor	Do-Minimum		Proposed Development		Do-Something		Impact		
	µg/m ³	% AQAL	PC	Road contribution	µg/m ³	% AQAL	µg/m ³	% AQAL	Magnitude of change descriptor
			µg/m ³	µg/m ³					
R19	5.47	54.70%	<0.01	<0.01	5.47	54.72%	<0.01	0.02%	Negligible*
R20	5.44	54.42%	<0.01	<0.01	5.44	54.44%	<0.01	0.02%	Negligible*
R21	5.45	54.50%	<0.01	<0.01	5.45	54.51%	<0.01	0.01%	Negligible*
R22	5.90	59.01%	<0.01	<0.01	5.91	59.06%	<0.01	0.04%	Negligible*
R23	5.70	57.00%	<0.01	<0.01	5.70	57.03%	<0.01	0.03%	Negligible*
R24	5.22	52.22%	<0.01	<0.01	5.22	52.24%	<0.01	0.02%	Negligible*
R25	5.22	52.21%	<0.01	<0.01	5.22	52.23%	<0.01	0.02%	Negligible*
R26	5.22	52.17%	<0.01	<0.01	5.22	52.19%	<0.01	0.02%	Negligible*
R27	5.42	54.21%	<0.01	<0.01	5.42	54.24%	<0.01	0.04%	Negligible*
R28	5.42	54.20%	<0.01	<0.01	5.42	54.24%	<0.01	0.04%	Negligible*
R29	5.62	56.20%	<0.01	<0.01	5.62	56.23%	<0.01	0.03%	Negligible*
R30	5.62	56.19%	<0.01	<0.01	5.62	56.24%	0.01	0.06%	Negligible*
R31	5.59	55.93%	<0.01	<0.01	5.60	55.99%	0.01	0.06%	Negligible*
R32	5.81	58.14%	<0.01	<0.01	5.82	58.16%	<0.01	0.02%	Negligible*
R33	5.76	57.64%	<0.01	<0.01	5.77	57.68%	<0.01	0.04%	Negligible*
R34	5.59	55.92%	<0.01	<0.01	5.60	55.96%	<0.01	0.04%	Negligible*
R35	5.56	55.55%	<0.01	<0.01	5.56	55.60%	<0.01	0.05%	Negligible*
R36	5.87	58.72%	<0.01	<0.01	5.89	58.86%	0.01	0.14%	Negligible*
R37	5.24	52.36%	<0.01	<0.01	5.24	52.39%	<0.01	0.03%	Negligible*

Receptor	Do-Minimum		Proposed Development		Do-Something		Impact		
	µg/m ³	% AQAL	PC	Road contribution	µg/m ³	% AQAL	µg/m ³	% AQAL	Magnitude of change descriptor
			µg/m ³	µg/m ³					
R38	5.23	52.29%	<0.01	<0.01	5.23	52.32%	<0.01	0.02%	Negligible*
R39	5.24	52.41%	<0.01	<0.01	5.24	52.44%	<0.01	0.04%	Negligible*
R40	5.23	52.28%	<0.01	<0.01	5.23	52.30%	<0.01	0.02%	Negligible*
R41	5.20	51.95%	<0.01	<0.01	5.20	51.97%	<0.01	0.02%	Negligible*
R42	5.33	53.34%	<0.01	<0.01	5.34	53.36%	<0.01	0.02%	Negligible*
R43	5.26	52.65%	<0.01	<0.01	5.27	52.66%	<0.01	0.01%	Negligible*
R44	5.40	54.01%	<0.01	<0.01	5.40	54.02%	<0.01	0.01%	Negligible*
R45	5.22	52.22%	<0.01	<0.01	5.22	52.22%	<0.01	0.01%	Negligible*
R46	5.57	55.69%	<0.01	<0.01	5.57	55.70%	<0.01	0.01%	Negligible*
R47	5.62	56.21%	<0.01	<0.01	5.63	56.25%	<0.01	0.04%	Negligible*
R48	5.45	54.54%	<0.01	<0.01	5.46	54.56%	<0.01	0.02%	Negligible*
R49	5.96	59.57%	<0.01	<0.01	5.96	59.62%	0.01	0.06%	Negligible*
R50	5.77	57.73%	<0.01	<0.01	5.78	57.76%	<0.01	0.03%	Negligible*
R51	5.68	56.76%	<0.01	<0.01	5.68	56.78%	<0.01	0.02%	Negligible*
R52	5.28	52.81%	<0.01	<0.01	5.28	52.84%	<0.01	0.03%	Negligible*
R53	5.48	54.80%	<0.01	<0.01	5.48	54.83%	<0.01	0.03%	Negligible*
R54	5.48	54.78%	<0.01	<0.01	5.48	54.81%	<0.01	0.03%	Negligible*
R55	5.22	52.20%	<0.01	<0.01	5.22	52.22%	<0.01	0.02%	Negligible*
R56	5.22	52.18%	<0.01	<0.01	5.22	52.20%	<0.01	0.02%	Negligible*

Receptor	Do-Minimum		Proposed Development		Do-Something		Impact		
	$\mu\text{g}/\text{m}^3$	% AQAL	PC	Road contribution	$\mu\text{g}/\text{m}^3$	% AQAL	$\mu\text{g}/\text{m}^3$	% AQAL	Magnitude of change descriptor
			$\mu\text{g}/\text{m}^3$	$\mu\text{g}/\text{m}^3$					
R57	5.22	52.16%	<0.01	<0.01	5.22	52.18%	<0.01	0.02%	Negligible*
R58	5.92	59.19%	0.01	<0.01	5.93	59.31%	0.01	0.12%	Negligible*
R59	5.96	59.62%	<0.01	<0.01	5.97	59.67%	<0.01	0.05%	Negligible*
R60	5.22	52.21%	<0.01	<0.01	5.22	52.23%	<0.01	0.02%	Negligible*
R61	5.63	56.31%	<0.01	<0.01	5.64	56.37%	0.01	0.06%	Negligible*
R62	5.62	56.16%	<0.01	<0.01	5.62	56.22%	0.01	0.06%	Negligible*
R63	6.01	60.06%	<0.01	0.02	6.03	60.26%	0.02	0.20%	Negligible*
R64	6.04	60.40%	<0.01	0.02	6.06	60.61%	0.02	0.21%	Negligible*
R65	6.11	61.07%	<0.01	0.02	6.13	61.30%	0.02	0.23%	Negligible*
R66	6.09	60.90%	<0.01	0.02	6.11	61.13%	0.02	0.23%	Negligible*
R67	6.12	61.18%	<0.01	0.02	6.14	61.41%	0.02	0.23%	Negligible*
R68	5.93	59.26%	<0.01	0.01	5.94	59.43%	0.02	0.17%	Negligible*
R69	5.98	59.85%	<0.01	0.02	6.00	60.04%	0.02	0.19%	Negligible*
R70	6.01	60.09%	<0.01	0.02	6.03	60.28%	0.02	0.19%	Negligible*

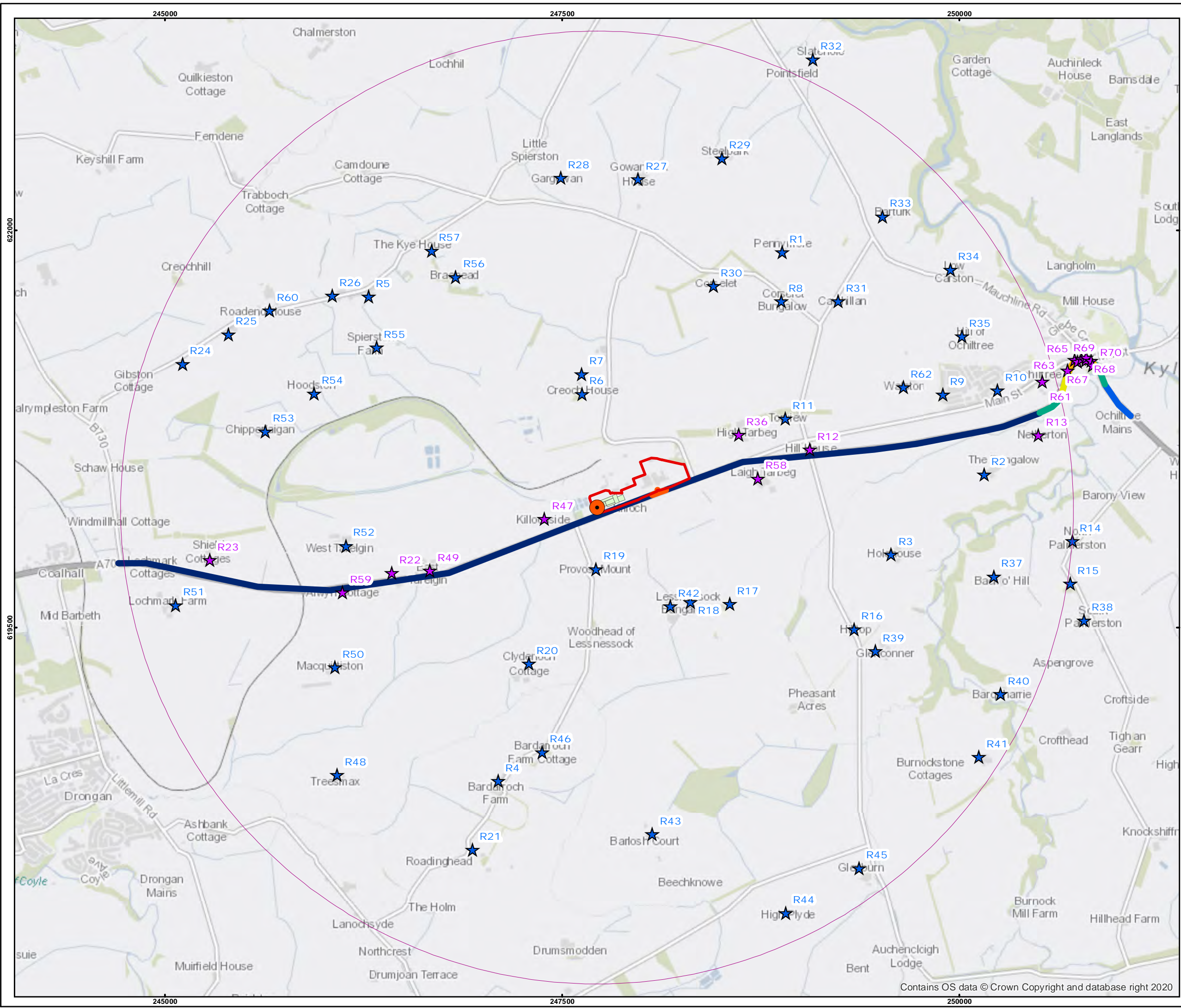
Note:

*Negligible irrespective of the total concentration.

Assumes 70% conversion of NO_x to NO₂ for process emissions

Road traffic NO_x converted to NO₂ using the LAQM calculator

B Figures



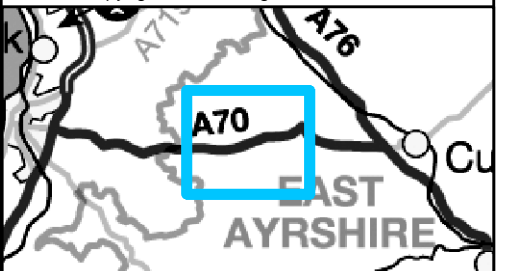
Legend

- Stack
- Site boundary
- Buildings
- 3 km from stack
- Human receptors
- Human receptors within 200 m of road
- 20 kph
- 25 kph
- 50/40 kph LDVs/HDVs
- 70/60 kph LDVs/HDVs
- 80/70 kph LDVs/HDVs
- 90/80 kph LDVs/HDVs

Client:	Barr Environmental Ltd
Site:	Killoch
Project:	3179
Title:	

Figure 1 - Roads modelled

Drawn by: HKL	Date: 16/02/2021
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FICHTNER
Consulting Engineers Limited
Kingsgate, Wellington Road North,
Stockport, Cheshire, SK4 1LW
Tel: 0161 476 0032
Fax: 0161 474 0618



- Legend**
- 3 km from stack
 - ★ Human receptors within 200 m of road
 - 25 kph
 - 50/40 kph LDVs/HDVs
 - 70/60 kph LDVs/HDVs
 - 80/70 kph LDVs/HDVs
 - 90/80 kph LDVs/HDVs

Client:	Barr Environmental Ltd
Site:	Killoch
Project:	3179
Title:	

Figure 1a - Roads modelled -
Zoom in on Ochiltree

Drawn by: HKL	Date: 16/02/2021
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FICHTNER
Consulting Engineers Limited

Kingsgate, Wellington Road North,
Stockport, Cheshire, SK4 1LW
Tel: 0161 476 0032
Fax: 0161 474 0618

ENGINEERING  CONSULTING

FICHTNER

Consulting Engineers Limited

Kingsgate (Floor 3), Wellington Road North,
Stockport, Cheshire, SK4 1LW,
United Kingdom

t: +44 (0)161 476 0032

f: +44 (0)161 474 0618

www.fichtner.co.uk