AECOM

Air Quality Assessment for Warrington Local Plan Habitats Regulations Assessment

Further Modelling of Manchester Mosses SAC

Warrington Borough Council

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Quality information

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1. Introduction

1.1 For the submitted Warrington Local Plan (WLP), a Habitats Regulations Assessment (HRA) was produced which among other impacts examined the effects of atmospheric pollution associated with traffic growth from Warrington Local Plan, and other sources such as the Greater Manchester Local Plan, on Manchester Mosses SAC. The dispersion modelling of nitrogen oxides (NOx) and ammonia (NH_3), nitrogen and acid deposition for the Warrington Local Plan Habitats Regulations Assessment was updated in April 2022[1] for the WLP following review of the Greater Manchester Combined Authority (GMCA) modelling of the Manchester Mosses Special Area of Conservation (SAC) [2]. The review identified differences in the methodological approaches between the air quality modelling studies for the two Local Plans and aligned these where appropriate. The results from the two studies were then combined to provide an indication of the specific in-combination effects between these two Local Plans, both going through Examination in late 2022, as requested by Natural England. The in-combination impacts were found to exceed Natural England's screening assessment threshold of an increase of 1% of the critical load or level[3].

1.2 The potential significance of this exceedance has been discussed, within the context of the Council's existing mitigation proposals in the Local Plan HRA and what is understood about the effects of increased nitrogen deposition on bog vegetation. In light of Natural England's request for potential mitigation measures to be identified, the benefits of which can be directly modelled, further dispersion modelling of the same pollutants has also been undertaken in order to further understand and identify potential measures to reduce the in-combination impact of the Warrington and Greater Manchester Local Plans on Holcroft Moss which is part of the Manchester Mosses SAC. Holcroft Moss SAC is adjacent to the M62 and includes a degraded raised bog which is capable of natural regeneration, the closest point of which is 90m from the edge of the M62.

1.3 The pollutant of most concern in the raised bog is nutrient nitrogen but all the pollutants of concern have been assessed. The critical levels and loads for a degraded raised bog are:

- Annual mean NO_x concentration (set for all vegetation) 30 µg/m^3
- Annual mean NH_3 concentrations for lichens and bryophytes 1 µg/m^3 and 3 µg/m^3 for other species
- Nitrogen deposition : 5-10 kgN/ha/yr
- Acid deposition: MinCLMaxN 0.564 MaxCLMaxN 0.58 keq/ha/yr

1.4 The methodology described in this report has been developed in association with Ricardo, who are undertaking air quality modelling on behalf of the GMCA. The dispersion modelling has been carried out using the ADMS-Roads dispersion model as this model enables various mitigation measures to be assessed. The measures considered to reduce impacts include tree belts, solid barriers and changes to traffic speeds on the M62.

1.5 Given that livestock and agriculture are very significant sources of ammonia and atmospheric nitrogen, the impact of animal grazing in the fields adjacent to the SAC has also been modelled in order to compare this with the impacts of the road traffic emissions and to assess whether the effect of increased ammonia and nitrogen emissions from additional traffic could be offset by reducing the emissions from livestock.

1.6 The potential effectiveness of mitigating the impacts from the Warrington and Greater Manchester Local Plans are discussed in this report.

[1] Air Quality Assessment for Warrington Local Plan Habitats Regulations Assessment: Updated Modelling of Manchester Mosses SAC. Warrington Borough Council, April 2022. Minor changes were made to the note, and it was reissued, in July 2022
[2] 'Air Quality Habitat Regulations Assessment (HRA) study for the Greater Manchester "Places for Everyone" Plan', (Ricardo, 2021) and 'Detailed assessment of Manchester Mosses' (Ricardo, 2022).
[3] As set out in Natural England's approach to advising competent authorities on the assessment of road traffic emissions under the Habitats Regulations (NEA001), available at http://publications.naturalengland.org.uk/publication/4720542048845824

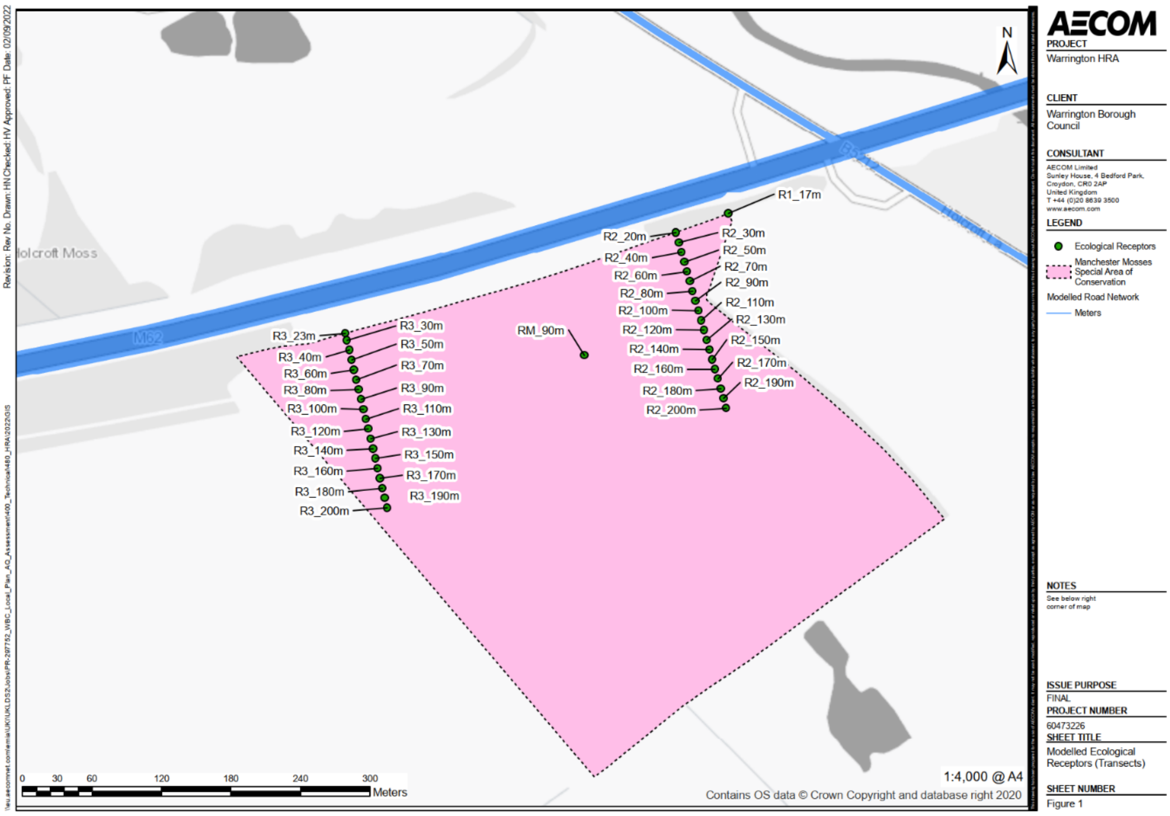
2. Effect of Warrington Local Plan alone

The Model

2.1 The dispersion modelling of traffic emissions has been carried out using the ADMS-Roads dispersion model which allows detailed consideration to be made of the effects of tree belts on concentrations and deposition rates. Tree belts have been represented by porous street canyons. Plume depletion due to dry deposition onto vegetation has been taken into account in the model. The model has been extensively validated and is a useful tool to assess small impacts due to changes in a wide range of parameters. The effects of various measures have been modelled to assess whether these could potentially reduce the impact of the Local Plans on the designated feature.

2.2 Pollutant concentrations at 10m intervals on transects from the northern edge of the SAC on the eastern (transect R2) and western (transect R3) sides of the SAC were modelled. In addition, a receptor (RM_90m) was placed at 90m from the motorway in the middle of the northern edge of the raised bog as some measures may affect one side of the SAC more than the other. The receptor locations are shown on Figure 1.

Figure 1: Receptor Locations



2.3 As set out in the April 2022 report, there are a number of limitations to the modelling. These include a greater level of uncertainty associated with estimating emissions of ammonia and estimating nitrogen deposition rates from ammonia concentrations.

Existing tree belt to the west

2.4 For this report, the air quality modelling carried out in April 2022 was updated to account of the existing tree belt parallel to the M62 to the west of Holcroft Moss SAC which was not included in the April model. The western tree belt was not expected to have a significant effect on the modelled levels / loads but is included for completeness in this study as additional tree belts in other locations are considered as potential mitigation. The existing western tree-belt was added to AECOM's 'Basic + DP + ASC 2-sides'[4] model. The western tree-belt was also added to the model for the Greater Manchester Local Plan to ensure consistency between the two Council's models.

2.5 Aerial photography shows that the tree coverage to the west of the SAC also has the potential to affect the dispersion of pollutants from the motorway traffic. The Advanced Street Canyon module was used to apply a two-sided street canyon on a 470m section of the M62. The parameters applied are presented in Appendix A.

2.6 The extension of the tree belt to the west in the model to reflect reality on the ground has a small impact on the modelling results at transects on the western and eastern edges of the SAC, when compared against Table 11 of the April report. The full set of results with the western tree belt included are provided in Appendix B Table 14. The changes predicted for nitrogen deposition in 2038 with the Warrington Local Plan were +0.05 kgN/ha/yr at R2_90m (eastern transect) and -0.10 kgN/ha/yr at R3_90m (western transect) compared with the results published in April 2022 for the same scenario; this change is due solely to the existing western tree belt being included and it is included in all scenarios in the model.

2.7 With the existing western tree belt included in the model, the updated adverse effect of the Warrington Local Plan alone at 90m from the road is summarised in Tables 1-3. The key figures are the last two columns which show the change due to Warrington Local Plan (i.e. its alone effect) as both pollutant concentrations/deposition rates and as a percentage of the lowest part of the critical load range. So for nitrogen deposition, the contribution of Warrington Local Plan alone is calculated to be 0.03 kgN/ha/yr at 90m from the M62 which is 0.66% of the lower critical load. The full results are provided in Appendix B Table 14 with the results for the closest area of bog, which is 90m from the M62, highlighted orange in these appendices.

Table 1 Modelled Results for transect R2 at 90m from the M62 for Warrington Local Plan Alone

Pollutant (lower critical level/load and units)	Do-Minimum (i.e traffic growth to 2038 but without the WLP)	Traffic growth to 2038 with WLP added	Change in pollutant concentration or deposition rate due to WLP	Change due to WLP expressed as percentage of the critical level or load
NOx (30 µgm^{-3})	19.24	19.29	0.05	0.2
Ammonia (1 µgm^{-3})	2.776	2.782	0.006	0.56
Nitrogen deposition (5 kgN/ha/yr)	24.24	24.27	0.03	0.66
Acid deposition (0.564 keq/ha/yr)	1.731	1.733	0.002	0.42

[4] ADMS Roads model with dry deposition module applied. 2-sided street canyon applied - 40% porosity to south, 70% porosity to north

Table 2 Modelled Results for transect R3 at 90m from the M62 for Warrington Local Plan Alone

Pollutant (lower critical level/load and units)	Do-Minimum (i.e traffic growth to 2038 but without the WLP)	Traffic growth to 2038 with WLP added	Change in pollutant concentration or deposition rate due to WLP	Change due to WLP expressed as percentage of the critical level or load
NOx (30 μgm^{-3})	18.71	18.75	0.04	0.1
Ammonia (1 μgm^{-3})	2.726	2.731	0.005	0.50
Nitrogen deposition (5 kgN/ha/yr)	23.94	23.97	0.03	0.57
Acid deposition (0.564 keq/ha/yr)	1.710	1.712	0.002	0.36

Table 3 Modelled Results for transect RM at 90m from the M62 for Warrington Local Plan Alone

Pollutant (lower critical level/load and units)	Do-Minimum (i.e traffic growth to 2038 but without the WLP)	Traffic growth to 2038 with WLP added	Change in pollutant concentration or deposition rate due to WLP	Change due to WLP expressed as percentage of the critical level or load
NOx (30 μgm^{-3})	18.48	18.52	0.04	0.1
Ammonia (1 μgm^{-3})	2.690	2.695	0.005	0.45
Nitrogen deposition (5 kgN/ha/yr)	23.74	23.76	0.03	0.53
Acid deposition (0.564 keq/ha/yr)	1.696	1.697	0.002	0.33

2.8 The highest pollutant concentrations / loads and largest impacts are predicted to occur on the eastern transect (R2-90m), although the difference is extremely slight.

2.9 The predicted NOx concentrations across the raised bog are well within the critical level of 30 μgm^{-3}. The maximum increase in NOx concentrations due to Warrington Local Plan is less than 1% of the critical level across the raised bog. Predicted ammonia concentrations exceed the critical level set for lichens and bryophytes across the raised bog but are within the 3 μgm^{-3} critical level set for other species. The increase in ammonia due to the Warrington Local Plan is less than 1% of the lower critical level. The predicted nitrogen deposition loads across the raised bog exceed the critical load for raised bogs at 5-10 kgN/ha/yr but is less than 1% of the lower critical load at all locations. Predicted acid deposition rates exceed the lower critical load of 0.56 keq/ha/yr for raised bogs but the increase due to the Warrington Local Plan is less than 1% of the lower critical load. The Warrington Local Plan alone contribution is less than 1% of Natural England's screening threshold for all pollutants.

2.10 Nitrogen deposition is considered to be the pollutant of most concern in the raised bog and the one for which there is the clearest evidence of adverse effects. Traffic across the UK makes a contribution to nitrogen and acid deposition through emissions of nitrogen oxides and ammonia. Therefore, addressing nitrogen deposition will also address ammonia and acid deposition. The increase in nitrogen deposition due to the Warrington Plan alone is 0.03 kgN/ha/yr. This is a very small increase and is an increase of 0.1% of the predicted Do-Minimum dose in the same year. The deposition rate in 2038 with the WLP is 10% less than the predicted dose in the base year of 2018 due to the deposition rate decreasing year to year. To put this into context, the nitrogen deposition rate is predicted to decrease by 0.13 kgN/ha/yr each year between the base year of 2018 and assessment year of 2038 at R2_90m purely due to the reduction in NOx emissions from traffic as a result of improved technology. The increase due to the Warrington Local Plan is therefore a small fraction of the annual decrease predicted and would not be noticeable for this reason and also as the year to year changes due to factors such as weather, natural fluctuations in traffic flows and wet deposition of nitrogen from other sources would be much greater than this..

3. In-combination Effect of Warrington and Greater Manchester Local Plans

3.1 The impacts from the Greater Manchester Local Plan and potential mitigation measures are being assessed in a separate study being undertaken by Ricardo on behalf of GMCA. That study is still underway at the time of writing since GMCA is working to a longer examination timetable, but there has been close collaboration between AECOM and Ricardo and the initial results from the GMCA work have been provided to inform this study. As with the impacts from the Warrington Local Plan alone, the impacts from the Greater Manchester Local Plan alone were predicted to be less than 1% of the critical levels and loads for all pollutants within the raised bog. NOx concentrations were well within the critical level within the raised bog and so are not considered further in this section.

3.2 Maximum impacts from the Warrington Local Plan were predicted to occur at the R2_90m receptor which is on the north-eastern corner of the raised bog. The maximum impacts from the Greater Manchester Local Plan alone, which also occur at R2_90m, are reported in Table 4 . The Warrington Local Plan alone results for the R2_90m receptor are shown in Table 5 for comparison. The results have been combined from the two Local Plans to give the in-combination impacts and are reported in Table 6 . Impacts due to the two Local Plans at other receptors within the raised bog are less than this reported worst case.

Table 4 Maximum Impacts from Greater Manchester Local Plan Alone

Pollutant (lower critical level/load)	Maximum
Ammonia (1 µgm^{-3})	0.007 µgm^{-3} or 0.66% of the critical level
Nitrogen deposition (5 kgN/ha/yr)	0.04 kgN/ha/yr or 0.81**%** of the critical load
Acid deposition (0.564 keq/ha/yr)	0.003 keq/ha/yr or 0.51% of the critical load

Table 5 Maximum Impacts from Warrington Local Plan Alone

Pollutant (lower critical level/load)	Maximum
Ammonia (1 µgm^{-3})	0.006 µgm^{-3} or 0.56% of the critical level
Nitrogen deposition (5 kgN/ha/yr)	0.03 kgN/ha/yr or 0.66% of the critical load
Acid deposition (0.564 keq/ha/yr)	0.002 keq/ha/yr or 0.42% of the critical load

Table 6 Maximum Impacts from Warrington and Greater Manchester Local Plans In-Combination

Pollutant (lower critical level/load)	Maximum
Ammonia (1 µgm^{-3})	0.012 µgm^{-3} or **1.22% of the critical level**
Nitrogen deposition (5 kgN/ha/yr)	0.07 kgN/ha/yr or **1.48 % of the critical load**
Acid deposition (0.564 keq/ha/yr)	0.005 keq/ha/yr or 0.94% of the critical load

3.3 The maximum in-combination impact exceeds 1% of the lower critical load for nitrogen deposition and 1% of the critical level for ammonia for lichens and bryophytes. It should be noted that the maximum change predicted (0.07 kgN/ha/year) is so small that it would not be discernible from the year to year decrease due to improved vehicle emission technologies. A decrease of 0.133 kgN/ha/yr is predicted each year between 2018 and 2038 at this location as the vehicle fleet become cleaner. The predicted nitrogen deposition rate in 2018 at this location is 26.91 kgN/ha/yr and by 2038, it is predicted to have decreased to 24.24 kgN/ha/yr as shown in Appendix B Table 14. Even with the WLP, the nitrogen deposition rate would be 24.27 kgN/ha/yr, considerably less than in the base year of 2018 with 26.91 kgN/ha/yr. Nitrogen deposition rates within the bog are gradually decreasing and will continue to decrease into the future as air quality improves. The potential marginal increase in nitrogen deposition rates due to the two Local Plans being implemented over the next 20 years, must be set against this backdrop of improving air quality. The improvement in air quality will outweigh the impact from the two Local Plans year on year.

3.4 Increases due to the two Local Plans to the in-combination nitrogen deposition rates would need to decrease by at least 0.48% of the critical load at the R2_90m receptor in order to be within the 1% screening threshold. Increases to the in-combination ammonia concentrations would need to decrease by at least 0.22% of the critical level at R2_90m to be within the 1% screening threshold. The pollutant of most concern in the raised bog is nutrient nitrogen as it exceeds the screening threshold by the largest amount.

3.5 The in-combination impacts from the two Local Plans at the R2_90m receptor (in the centre of the northern edge of the bog) were calculated to be 1.2% of the lower critical load for nitrogen deposition and so deposition rates would need to decrease by at least 0.2% at this location to be within the screening threshold. Ammonia concentrations were within the 1% screening threshold with 0.99% and acid deposition rates were also within the 1% threshold with 0.76% of the lower critical load.

3.6 The raised bog on the western side of the SAC is located further than 90m back from the M62, at approximately 130m from the motorway. The in-combination impact for nitrogen deposition may marginally exceed the 1% screening threshold at this location.

3.7 The in-combination impact of Warrington and Greater Manchester Local Plans have been estimated and are shown in Figure 2. Approximately 10% of the area of the raised bog exceeds 1% of the lower nitrogen deposition critical load (5 kgN/ha/year) when the two plans are considered together. It should be noted that an increase of more than 1% does not necessarily indicate that a significant effect will occur, it simply means that the change in concentration or deposition requires further consideration.

3.8 The worst case in-combination impacts are pessimistic as it assumes that both Local Plans are fully built out and it does not take account of vehicle emission reductions beyond 2035. Section 5 of this report considers the effectiveness of various additional mitigation measures in addressing the contribution of the Warrington Local Plan. This is because if the contribution of Warrington Local Plan were entirely addressed or offset it would reduce the ‘in combination’ contribution from both Local Plans to below 1% of the critical level/load since the contribution of Greater Manchester Local Plan alone is below 1% of the critical level/load as per Table 4.

Figure 2: Area predicted to Exceed the Screening Threshold for the In-Combination Contribution to Nutrient Nitrogen

4. Ecological effect of nitrogen deposition on bogs and Warrington Local Plan current mitigation approach

Introduction to Manchester Mosses SAC

4.1 Before the urbanisation of Manchester, the River Mersey had an extensive flood plain that supported a variety of bog habitats and species. However, post 20th century extreme changes in flooding behaviour of the river were brought about due to river and runoff modifications[5]. As a result, much of the specialist bog habitats and species have been lost either due to drainage for agriculture and development. Manchester Mosses SAC hold some of the largest remaining raised bog within Greater Manchester, Merseyside and southern Lancashire. There are three components of this SAC within and around Warrington: Risley Moss, Holcroft Moss (both within the borough) and Astley & Bedford Mosses (600m north-east of the borough).

4.2 The Manchester Mosses SAC qualities for its Annex I habitats. These are:

- Degraded raised bogs still capable of natural regeneration.

4.3 Species of interest that can be found at the SAC include:

- Purple moor grass *Molinia cearulea;*
- Common cotton grass *Eriophorum angustiflolia;*
- Hare's cotton grass *Eriophorum vaginaum;* and
- Bog mosses *Shagnum sp.*

4.4 The Conservation Objectives of the SAC are '*Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring;*

- *The extent and distribution of qualifying natural habitats;*
- *The structure and function (including typical species) of qualifying natural habitats; and*
- *The supporting processes on which qualifying natural habitats rely*.'[6]

4.5 As previously mentioned, parts of the Manchester Mosses SAC were drained in the past and subject to habitat degradation. This has led to the dominance of vegetation types such as purple moor grass, bracken *Pterdium aquilinum* and birch *Betula sp* but the 1980s. To date, these bogs have been subject to habitat management and involve the re-wetting of the bogs to allow colonisation of bog specialists such as *Sphagnum* mosses with the remaining areas at slightly higher elevations supporting wet woodland and fen habitat.

Test of Likely Significant Effects

4.6 Traffic and air quality modelling were undertaken for this HRA and the analysis below follows the steps contained in the Natural England document 'Natural England's approach to advising competent authorities on the assessment of road traffic emissions under the Habitats Regulations. Version: June 2018'. There are four stages to HRA screening using this methodology. These are set out below.

[5] https://www.mangeogsoc.org.uk/egm/5_1.pdf [Accessed: 07/11/2018]
[6] http://publications.naturalengland.org.uk/publication/5283870555504640 [Accessed: 07/11/2018]

Screening Steps	Analysis
Step 1: Does the proposal give rise to emissions which are likely to reach a European site?	Growth in Warrington will result in an increase in traffic and Holcroft Moss lies within 200m of a significant route (M62) likely to be used by traffic originating in Warrington Borough. Therefore, the answer to step one is 'yes'.
Step 2: Are the qualifying features of sites within 200m of a road sensitive to air pollution?	According to aerial photography and mapping provided by Natural England the nearest area of bog within the SAC is 90m from the M62, so the answer to step 2 is also 'yes'.
Step 3: Could the sensitive qualifying features of the site be exposed to emissions?	While the area most affected by emissions is the belt of dense woodland closest to the M62, and while the presence of dense woodland between the M62 and the nearest area of bog may reduce the amount of pollution reaching that bog (since dense woodland intercepts a greater amount of nitrogen than other habitats due to its large surface area), it would not prevent pollution from reaching the bog. Therefore, the answer to step 3 is 'yes'.
Step 4a: Application of screening thresholds alone (see Section 3, Table 5)	There are two screening thresholds that are available: one is based on traffic flows (namely, whether or not the change in flows will fall below 1000 Annual Average Daily Traffic (AADT)) and the other is based on changes in pollutant concentrations (particularly whether or not the change in pollutant concentrations or deposition rates will fall below 1% of the critical load for the most sensitive habitat). Since the lowest part of the critical load range for bog is 5 kgN/ha/yr and the critical level for NOx is 30 μgm^{-3}, in this case that means whether the change will be less than 0.05 kgN/ha/yr for nitrogen or 0.3 μgm^{-3} for NOx. The change in flows due to the Warrington Local Plan alone have been modelled to be 2,431 AADT. This exceeds the 1,000 AADT threshold. However, Table 5 shows that the change in NOx, ammonia and nitrogen deposition at the closest area of bog due to the Warrington Local Plan alone is **below** 1% of the critical level. The UK Air Pollution Information System (APIS) website[7] notes that it is likely that the strongest effect of emissions of nitrogen oxides on vegetation is through their contribution to nitrogen deposition[8]. Therefore, the Warrington Local Plan will not have a likely significant effect on Manchester Mosses SAC when considered alone.
Step 4b: Application of the screening thresholds 'in combination' (see Section 3, Table 6)	It can be seen from Table 6 that the change in nitrogen deposition and ammonia when the impacts of both Warrington Local Plan and Greater Manchester Local Plan are considered together exceeds 1% of the critical level for ammonia and 1% of the critical load for nitrogen deposition, being a maximum of 1.48% of the critical load for nitrogen deposition. Moreover, these two Local Plans will not be the only sources of traffic growth between 2018 and 2038.

[7] http://www.apis.ac.uk/overview/pollutants/overview_NOx.htm

[8] APIS identifies that direct effects of gaseous nitrogen oxides can also be important, but that negative effects of NO_2 in atmosphere (as distinct from its role in nitrogen deposition) are most likely to arise in the presence of equivalent concentrations of sulphur dioxide (SO_2). Vehicle exhausts do not emit SO_2 and APIS indicates that background SO_2 concentrations at the SAC are very low (a maximum of 2.6 μgm^{-3}) compared to critical levels for SO_2 of 10-20 μgm^{-3} and 2016 baseline NOx concentrations of 62 μgm^{-3} at c. 60m from the road. Since the SO_2 concentrations are so low no synergistic effect with NOx is expected.

Therefore, a likely significant effect from Warrington and Greater Manchester Local Plans 'in combination' cannot be dismissed and appropriate assessment is required.

4.7 Given the modelling in Section 3 of this report, a likely significant effect from Warrington and Greater Manchester Local Plans 'in combination' cannot be dismissed and appropriate assessment is required.

Appropriate Assessment

4.8 Intense combustion of fossil fuels within the north-west has caused significant emissions of NOx into the atmosphere resulting in air pollution and changes in rainfall chemistry. The deposition of these pollutants has resulted in the acidification of soils and waters throughout the north-west.

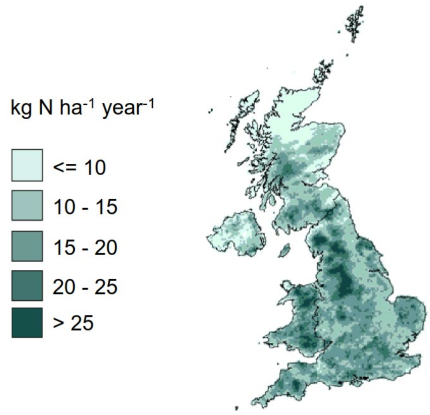


Figure 3: The nitrogen deposition measured between 2003-2005.

4.9 Monitoring programs such as the Countryside survey and the New Plant Atlas[9] of the UK revealed shifts in species composition that favour nutrient-tolerant species[10]. N deposition within the north-west is strongly associated with the large amounts of precipitation experienced there. Experimental evidence suggests that hummock forming *Sphagnum* species may be lost from bogs that are experiencing high deposition rates. Based upon research constructed from the Main Valley Bogs SAC, which are located in Northern Ireland, the critical load for bogs is described at 5-10 kgN/ha/yr compared to current deposition rates of 36 kgN/ha/yr at the closest area of SAC bog to the M62. Therefore, Holcroft Moss is already subject to a deposition rate far above its critical load. However, it is important to note that:

- Paragraph 5.26 of Natural England guidance[11] states that '*An exceedance* [of the critical level or load] *alone is insufficient to determine the acceptability (or otherwise) of a project'.* So, the fact that the critical level for NOx or critical load for nitrogen are already exceeded is not a legitimate basis to conclude that any further NOx or nitrogen (no matter how small) will result in an adverse effect;
- Paragraph 4.25 of the same NE guidance states '*…1% of critical load/level are considered by Natural England's air quality specialists (and by industry, regulators and other statutory nature conservation bodies) to be suitably precautionary, as any emissions below this level are widely considered to be imperceptible…There can therefore be a high degree of confidence in its application to screen for risks of an effect'.*

4.10 Moreover, the exceedance of the 1% of the critical level or load thresholds does not itself mean that adverse effects on integrity would automatically arise. Consideration of the likely effect of the exceedance, the physical extent of the exceedance and other factors that might modify the site's response to nitrogen deposition are also relevant.

4.11 Before discussing the impact of such a forecast change in nitrogen deposition, it is also important to note that the general long-term trend for NOx concentrations in the UK has been one of improvement (particularly

[9] Preston, C.D., Pearman, D.A. & Dines, T.D. (eds), 2002. New Atlas of the British and Irish Flora. ISBN: 0198510675
[10] Haines-Young, R., et al., 2003. Changing landscapes, habitats and vegetation diversity across Great Britain. Journal of Environmental Management, 67, 267-281.
[11] 'Natural England's approach to advising competent authorities on the assessment of road traffic emissions under the Habitats Regulations. Version: June 2018'. http://publications.naturalengland.org.uk/publication/4720542048845824

since 1990) despite an increase in vehicles on the roads[12]. Total nitrogen deposition[13] in the UK decreased by 13% between 1988 and 2008, while NOx concentrations decreased by 50% over the same time period[14]. According to Plantlife, '*There is an overall decreasing trend in the percentage of UK habitats affected by nitrogen deposition, with levels exceeding critical loads dropping from 75% of UK sensitive habitats in 1996, to 62.5% in 2011-2013'*[15]. The trend has also been observed and documented by the European Union and has been recently used by them to develop a tool to monetise the biodiversity benefit of such improvements[16].

4.12 This improving trend can be expected to continue, and indeed steepen, as drivers continue to replace older cars with newer vehicles and as further improvements in vehicle emissions technology are introduced, progressing towards the government's target of ending the sale of all new petrol and diesel cars and vans by 2030 (eight years before the end of the plan period). For example, the latest and most stringent (Euro6/VI) emissions standard only became mandatory in 2014 (for heavy duty vehicles) and 2015 (for cars). The effects of these changes in standards will not be visible in the data available from APIS because relatively few people will have been driving vehicles compliant with that standard as early as 2016. In contrast, far more drivers can be expected to be using Euro6 compliant vehicles or better by the end of the Local Plan period (2038) since vehicles that are not compliant with Euro6 ceased manufacture in 2015.

4.13 By 2038, a large number of vehicles will be electric. Moreover, uptake of electric vehicles is a fast moving subject, with ongoing rapid take up of fully electric vehicles in response to technical improvements, increasing fuel costs and changing social attitudes. During 2021 there was a 10% reduction in petrol cars registered and a 36% decrease in diesel cars registered compared to 2020. Eleven percent of cars registered in 2021 were battery electric vehicles, a 76% increase compared to 2020 and a 1,726% increase compared to 2016[17]; the trend is expected to continue on a rapid upward trajectory. Given the expected changes in the vehicle fleet it is entirely possible that the model overestimates emissions for 2038, the year for which the 'in combination' effect is forecast and eight years after the total ban on the sale of new petrol and diesel cars and vans is implemented.

4.14 In addition, the modelling tool AECOM has used for ammonia (CREAM), while one of the few sources of data currently available , is considered by some air quality scientists to be conservative. It must be stressed that there is very little information available on ammonia emissions and so is subject to a much higher level of uncertainty than NOx emissions. For example, the EMEP/EEA air pollutant emission inventory guidebook forecasts lower ammonia emissions from the same volume of traffic and ammonia is a very significant contributor to nitrogen deposition. If the CREAM tool does overestimate ammonia emissions, it would have a significant effect on overestimating the deposition rates in the AECOM model.

4.15 In order to understand the potential ecological effect of the forecast 'in combination' change in nitrogen deposition reported in Section 3 it is important to consider what the botanical effect of a 'dose' of 0.07 kgN/ha/yr (the combined nitrogen dose due to Warrington and Greater Manchester Local Plans at the nearest area of bog) would be on bog habitats. Section 3 of this report identifies that the area exceeding 1% of the critical load for nitrogen deposition due to Warrington Local Plan and Greater Manchester Local Plan in combination is c. 10% of Holcroft Moss (the relevant part of Manchester Mosses SAC).

4.16 Natural England Commissioned Report 210[18] examines the ecological effect of a given nitrogen dose on various habitats including bog. Table 21 of the report identifies that at high background rates of nitrogen deposition (such as is experienced at Manchester Mosses SAC) a typical additional dose of 3.3 kgN/ha/yr is required to reduce species richness by the equivalent of 1 species; this is 47 times the deposition forecast

[12] Emissions of nitrogen oxides fell by 72% between 1970 and 2017. Source: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/778483/Emissions_of_air_pollutants_1990_2017.pdf [accessed 30/08/19]

[13] Oxidised nitrogen derives from combustion, such as vehicle exhausts, while reduced nitrogen results from ammonia primarily from agriculture. Total nitrogen deposition is both oxidised and reduced nitrogen combined.

[14] Rowe EC, Jones L, Stevens CJ, Vieno M, Dore AJ, Hall J, Sutton M, Mills G, Evans CD, Helliwell RC, Britton AJ, Mitchell RJ, Caporn SJ, Dise NB, Field C & Emmett BA (2014) Measures to evaluate benefits to UK semi-natural habitats of reductions in nitrogen deposition. Final report on REBEND project (Defra AQ0823; CEH NEC04307)

[15] https://www.plantlife.org.uk/application/files/1614/9086/5868/We_need_to_talk_Nitrogen_webpdf2.pdf

[16]Jones, L., Milne, A., Hall, J., Mills, G., Provins, A. and Christie, M. (2018). Valuing Improvements in Biodiversity Due to Controls on Atmospheric Nitrogen Pollution. Ecological Economics, 152: 358-366. http://ec.europa.eu/environment/integration/research/newsalert/pdf/monetising_biodiversity_benefit_of_reducing_nitrogen_pollution_in_air_522na2_en.pdf

[17] Vehicle licensing statistics: 2021 - GOV.UK (www.gov.uk)

[18] Caporn, S., Field, C., Payne, R., Dise, N., Britton, A., Emmett, B., Jones, L., Phoenix, G., S Power, S., Sheppard, L. & Stevens, C. 2016. Assessing the effects of small increments of atmospheric nitrogen deposition (above the critical load) on semi-natural habitats of conservation importance. Natural England Commissioned Reports, Number 210.

due to the Warrington and Greater Manchester Local Plans in combination. **This demonstrates that the nitrogen dose due to the Warrington and Greater Manchester Local Plans will not affect the species richness of the bog.** The limited species richness effect on bog even when a large nitrogen dose is applied is probably due to the hydrological regime limiting further species responses to deposition once the critical load is exceeded[19]. **This then indicates that the hydrological regime is more important in determining species richness than nitrogen deposition.**

4.17 As discussed earlier, no direct effect of NOx as a pollutant (other than as a source of nitrogen, already considered above) is anticipated following APIS guidelines. The other relevant pollutant exceeding 1% of the critical level from Warrington and Greater Manchester Local Plans in combination is ammonia. Ammonia as a source of nitrogen has already been factored into the nitrogen deposition calculations. However, ammonia in atmosphere can also be directly toxic to lower plants (lichens and bryophytes), which are characteristic of good condition bogs, at concentrations above 1 μgm^{-3}. Total ammonia at Holcroft Moss exceeds this threshold under all current and future scenarios, being just under 3 μgm^{-3} at the closest part of the bog to the road. This is relatively typical of much of the UK due primarily to agriculture.

4.18 The total in combination change in ammonia from both the Warrington and Greater Manchester Local Plans is a worst-case 0.012 $\mu g/m^3$ or 1.2% of the critical level and therefore exceeds the 1% screening threshold.. However, scrutiny of ammonia data from the UKEAP national ammonia monitoring network for a range of sites covering 2010-2019 shows that the normal variation in ammonia concentrations throughout a year can be as high as 3-4 $\mu g/m^3$, and even at rural sites concentrations generally fluctuate by more than 1 $\mu g/m^3$ (100% of the critical level) throughout the year. In other words, the forecast ammonia dose falls well within the expected variance in existing ammonia concentrations and is unlikely to be statistically significant. It is, however, the case that the forecast traffic growth due to the Plans is forecast to make the existing situation marginally worse without mitigation.

4.19 The worst-case 'in combination' effect at the closest area of bog to the M62 is thus likely to be very botanically subtle (if observed at all it is most likely restricted to some possible impact on lichen diversity, with some possible impact on higher plant species richness when other sources of traffic growth are also considered) and may never actually arise even without mitigation. Moreover, this would only apply to 10% of the bog with the remaining 90% falling below the 1% threshold due to the two plans. Furthermore, even the worst-case effect could be negated by changes in management or hydrological regime and the botanical effect that is forecast may prove to be even more subtle than identified in this report if the full improvement in vehicle emissions that Defra expect to arise by 2030 and beyond does occur.

4.20 Nonetheless, the site has a restore objective and in discussions over the Local Plan HRAs for both Warrington and Greater Manchester Natural England shared data for the site which indicated that although hydrology had been restored across the entire site, vegetation recovery was notably less in the eastern part of the SAC than in the western part of the SAC. It was suggested that this difference in recovery could be attributable to exposure of the eastern part of the SAC to the M62 motorway, although it was acknowledged that there could be other causes.

4.21 Taking the restore objective and the difference in vegetation recovery following hydrological restoration into account, and to confidently draw a conclusion of no adverse effect on integrity the HRA of the Warrington Local Plan took a precautionary approach and considered that some measures to reduce the (very small) contribution of Warrington to the overall subtle effect is required for purposes of good stewardship and to reinforce the conclusion of no adverse effect on integrity. This conclusion will be further underlined as vehicle purchasers react to the 2030 ban on the sale of new diesel and petrol cars and vans in the later part of the Local Plan period.

Mitigation proposed in the Warrington Local Plan

4.22 While it is preferable to consider whether an impact can be avoided before considering mitigation, case law is clear that within the context of appropriate assessment the courts draw no distinction between avoidance and mitigation (their only interest being effectiveness) and do not privilege one over the other. In practice, it would not be possible to deliver housing and employment growth in Warrington Borough without an increase in traffic on the M62 and it would not be possible to meet the housing and employment objectives of the

[19] NECR210, pages 56 and 72. Page 72 also notes that the relationships expressed in the report for bog habitats should be regarded as conservative.

Local Plan if quanta were reduced to such an extent that the effect of Warrington Local Plan on Manchester Mosses SAC was no longer perceptible in modelling.

4.23 Following discussion between AECOM and Warrington Borough Council a three-tier approach to achieving positive air quality for Warrington and Manchester Mosses SAC has been agreed, as follows, the framework for which is provided by the Local Plan policies INF1 (Parts 1-4 and 7) and ENV8 (Parts 3/4):

- Tier One: Warrington Council will deliver a programme of borough-wide initiatives to reduce reliance on the private car and promoting and delivering improved public transport and low emission vehicles, such as requiring a certain percentage of new developments having electric vehicle charging points and working with the transport authorities to improve non-road connectivity between Warrington and Greater Manchester, producing materials to promote use of low-emission transport and/or deliver improved bus services with less polluting buses. These strategic initiatives would to some degree address the contribution of all new housing and employment in Warrington even on small sites. Warrington Council considers that the appropriate forum for this would be the revised Local Transport Plan (LTP4) that has just been out for consultation. This can be accessed via the following link: https://www.warrington.gov.uk/info/201080/streets-and-transport/2383/local-transport-plan.

- Tier-Two: Warrington Council will require the larger developments (MD1 to MD6) and those which line the M62 corridor (OS1, OS2, OS6) to each devise a scheme-specific range of measures to reduce reliance on cars, reduce trip generation and promote ultra-low emission vehicles. These 9 sites are responsible for a large proportion of Warrington Local Plan's new housing and the vast majority of its new employment such that applying this requirement would actually capture a lot of the planned development. It is noted that the updated policies for the main sites now require these developments '*to mitigate air quality impacts on the Manchester Mosses SAC in accordance with Policy ENV8…*' The kind of measures the applicants would be expected to introduce could include, but not be limited to, the following:

  a. Electric vehicle charging points at parking spaces. The government has committed to ceasing the sale of all new petrol and diesel cars and vans from 2035. In the latter part of the plan period therefore people can be expected to show particular interest in electric vehicles;

  b. Provision of a communal minibus (particularly if electric), and car club space. This will be effective for housing developments but particularly for employment developments;

  c. Cycle parking and shower facilities for staff;

  d. On-site services (e.g. GP surgery's and shops) to reduce need for off-site movements;

  e. Personalised Journey Planning services for residents. If employment premises the company could provide incentives for car-sharing and minimising car journeys for work;

  f. Production of sustainable travel information for residents e.g. accurate and easily understandable bus timetables;

  g. Implementation of a Staff Management Plan to place restrictions on car use by Staff;

  h. For vehicles generating HGV movements, restrictions to keep movements below 200 HDV per day, or a commitment to ensuring all HGVs used will be Euro6 compliant.

- Tier Three: Warrington Council will require all other developments that would exceed Warrington Council's thresholds for Transport Assessments to also devise a scheme-specific range of measures to reduce reliance on cars, reduce trip generation and promote ultra-low emission vehicles. This would avoid placing an undue burden on small sites and convey benefits to the SAC as well as air quality more broadly.

4.24 It is not possible to precisely forecast the effect of this strategy on emissions of nitrogen oxides (NO_x), or nitrogen deposition rates. However, retrospective data regarding the measured effectiveness of a broadly comparable package of measures elsewhere gives a reasonable broad indication of likely minimum effectiveness. A report published by the DfT in 2004[20] reviewed the evidence for the impact of various 'soft'

[20] DfT, 2004. Smarter Choices - Changing the Way We Travel https://www.gov.uk/government/publications/smarter-choices-main-report-about-changing-the-way-we-travel

measures[21] such as workplace and school travel plans, personalised travel planning, travel awareness campaigns, public transport information and marketing, car clubs and car sharing schemes, teleworking, teleconferencing and home shopping on resident behaviour. The authors of the report concluded that a package of 'low intensity' interventions[22] could be expected to reduce traffic by 2-3%, whilst a package of 'high intensity' interventions[23] could be expected to lead to an 11% reduction.

4.25 The conclusions of the 2004 DfT report were used to inform large-scale Smarter Choice Programmes that were carried out in three designated Sustainable Travel Towns: Darlington, Peterborough and Worcester. This project involved implementing a limited package of soft measures in each town: workplace travel planning, school travel planning, personal travel planning, public transport information and marketing, cycling and walking promotion and travel awareness raising. Post-project appraisal of these schemes[24] confirmed an average 9% reduction in car-based trips by residents. This compared very well with a fall of approximately 1% in medium-sized urban areas that did not have such a package of measures.

4.26 AECOM's modelling indicates that Warrington Local Plan would increase traffic (in terms of AADT i.e. daily trips) on the M62 by 2.1% compared to the baseline situation as shown in Table 7.

Table 7 Increase in Traffic Flows due to WLP

2016 Baseline AADT on M62 past Manchester Mosses SAC	Additional AADT on M62 past Manchester Mosses SAC due to full implementation of Warrington Local Plan in 2038	Growth in traffic due to Warrington Local Plan as a percentage of the 2016 baseline
116,214	2,431	2.1%

4.27 Therefore, a *reduction* of 2.1% in M62 trips, vehicle kilometres travelled, or emissions (due to an increased proportion of vehicles with less polluting engines) compared to the situation without such measures, would entirely address the forecast contribution of Warrington Local Plan. The recorded trip reductions of 2% to 9% from implementation of soft measures in Peterborough, Darlington and Worcester compare very well with the 2.1% reduction that would be the target for Warrington. This is particularly the case since:

a) the three-tier approach for Warrington would be much more fine-scale than the approach implemented at Peterborough, Darlington and Worcester, in that one element is to require a bespoke package of measures to be devised for specific new developments; and

b) a number of the measures identified in the three-tier strategy, notably working with the transport authorities to improve non-road connectivity between Warrington and Greater Manchester and/or delivering improved bus services with less polluting buses, go beyond the 'soft measures' that were implemented at those other settlements.

4.28 The available evidence that exists regarding the effectiveness of local authorities implementing Smarter Choice Programmes, even without the additional measures set out in (a) and (b) above, indicates that it is reasonable to expect a reduction of at least 2% in traffic flows on the M62 by 2038 (compared to the 2016 baseline), as a result of the implementation of the three-tier strategy for Warrington. The UK government's policy to end the sale of new petrol and diesel cars and vans from 2030 can be expected to considerably accelerate this reduction beyond the scale forecast above during the latter part of the plan period. As such the duration of the negative impact is such that it is likely to fall below the 1% threshold even in combination with other plans and projects after 2040 as by that time it will have been impossible to purchase a new petrol or diesel car or van for a decade meaning relatively few cars and vans still on the network are likely to be emitting NOx or ammonia.

4.29 As such, with the aforementioned three-tier strategy in place it was considered in the HRA of the submitted Local Plan that a conclusion of no adverse effect on integrity could be reached with

[21] Soft transport policy measures seek to give better information and opportunities, aimed at helping people to choose to reduce their car use while enhancing the attractiveness of alternatives.
[22] The 'low intensity' scenario was broadly defined as a simple projection of the 2003-4 levels of local and national activity on soft measures.
[23] The 'high intensity' scenario identified the potential provided by a significant expansion of activity to a much more widespread implementation of present good practice, albeit to a realistic level which still recognised the constraints of money and other resources, and variation in the suitability and effectiveness of soft factors according to local circumstances.
[24] DfT, 2010. The Effects of Smarter Choice Programmes https://www.gov.uk/government/publications/the-effects-of-smarter-choice-programmes-in-the-sustainable-travel-towns-full-report

confidence and that remains the position of Warrington Borough Council given the precautionary nature of the conclusions drawn and modelling undertaken.

4.30 However, in discussions over the Local Plan and its HRA, during 2022 Natural England expressed some concerns over the proposed mitigation in the submitted HRA. It is understood that the concern was not that soft measures that depend on people changing their habitat could not be effective in addressing any issue, but that to provide additional confidence that mitigation could be achieved if required, options for 'hard' measures (i.e. those whose effectiveness can be directly modelled) should also be explored. That is the purpose of Section 5 of this report.

4.31 Before embarking on Section 5 it is also worth considering the value of 'resilience' measures. These are measures that can be implemented on a site to improve its general health and thus make it less vulnerable to the adverse effects of (in this case) increased nitrogen deposition. While the benefit of such measures cannot be mathematically modelled there is no question that improving the health of a site would further minimise any likelihood of negative effects from increased nitrogen deposition, particularly since numerous factors such as management and hydrology have a much greater effect on habitat quality and species richness than do nitrogen deposition. It is for this reason that mitigation strategies for other sites (such as the air quality mitigation strategy prepared by AECOM and Epping Forest District Council for Epping Forest SAC) have included a mixture of soft measures (i.e. measures to influence uptake of electric vehicles), resilience measures (in the case of Epping Forest this includes proposals for mulching around veteran trees as recommended by Natural England) and, where required, hard measures whose benefit can be directly modelled. It is worth noting that at Epping Forest SAC the forecast effect of Epping Forest Local Plan is far greater than that forecast for Warrington Local Plan on Manchester Mosses SAC. It must also be remembered that air quality at the SAC will continue to improve in the future due to improvements in vehicle emission technologies which should assist with the restorative aim of the SAC and these improvements will be considerably greater than the marginal change due to the two Local Plans.

4.32 In meetings to discuss the Warrington and Greater Manchester Local Plans Natural England officers familiar with the site mentioned hydrological improvements to improve drainage on land adjacent to the moss that would make the site more resilient to nitrogen deposition. Legal advice received by Warrington Council had confirmed such measures would constitute mitigation. Therefore, in addition to the soft measures already proposed, Warrington Borough Council is content to continue to liaise with Natural England over any benefits of providing measures to improve the general health of Holcroft Moss.

5. Effect of Various Further Mitigation Measures

5.1 Taking account of Natural England's request to identify mitigation measures as precautionary mitigation that can be more directly modelled than the 'soft measures' already proposed by Warrington Council, various measures have been assessed that could potentially reduce the impact from the Local Plans. These measures include extending the existing tree belts, reducing the speed limit on the M62, building solid barriers between the M62 and the raised bog and reducing the ammonia emissions from nearby grazing animals.

5.2 These measures have been assessed to provide an indication of the change that could occur and identify a suite of measures that could in principle address the impact of Warrington Local Plan and Greater Manchester Local Plan, in the event they ever were actually needed. Practicality has not been considered at this stage since there will be no actual need for the measures to be introduced (if ever) until at least after the first five-year Local Plan Review and probably later, providing ample time to continue to explore the deliverability of all measures and consider additional measures that may emerge between now and the time any implementation is required. Results for NOx, ammonia and nitrogen deposition are reported in this section as the latter two pollutants exceed the screening threshold and NOx (and ammonia) concentrations affect the nitrogen deposition rates.

5.3 If the contribution of the Warrington Local Plan (for example, or alternatively the Greater Manchester Plan) were entirely addressed or offset it would reduce the 'in combination' contribution from both Local Plans to below 1% of the critical level/load. However, the reduction required to be within the 1% screening threshold is less than this.

Extended tree belt to the east

5.4 The Advanced Street Canyon module was used to apply a one-sided street canyon on a 112m section of the M62 adjacent to the area between Holcroft Moss and Holcroft Lane. This was intended to simulate the effect of extending the existing tree belt between the M62 and the bog further east. The parameters applied are presented in Appendix A. The results are provided in Appendix B Table 15.

5.5 The results are summarised in Table 8 for the receptors closest to the motorway. It presents the results as the difference between the Warrington Local Plan plus the extended tree belt, and the Do Minimum scenario (i.e. the 2038 reference case). A negative number means that a net improvement is forecast compared to the reference case and therefore the mitigation has more than addressed the WLP impact. A positive number means that pollution would continue to exceed the reference case to some degree, indicating the mitigation has not addressed 100% of the WLP impact. The extension of the tree belt to the east reduced concentrations and deposition rates on the eastern transect (R2) to below the Do-Minimum values but did not appreciably affect the increase due to the Warrington Local Plan at the western (R3) transect. This is because the R3 transect is situated further west from the proposed additional tree belt (over 300m). The greatest projected benefits are therefore experienced on the eastern side of the SAC. Since this is where the condition of the habitat is poorer as identified by Natural England, this may be a desirable option to consider further notwithstanding that its effect is restricted to the eastern side of the bog. The tree belt slightly reduced the impact of the Warrington Local Plan at the centre of the bog (R2_90m).

Table 8 Change between DM and WLP plus mitigation of extended eastern tree belt

Pollutant (lower critical level/load)	R2_90m	R3_90m	RM_90m
NOx ($30\ \mu gm^{-3}$)	$-0.12\ \mu gm^{-3}$ -0.4% of the critical level	$0.04\ \mu gm^{-3}$ 0.1% of the critical level	$0.01\ \mu gm^{-3}$ 0.1% of the critical level
Ammonia ($1\ \mu gm^{-3}$)	$-0.007\ \mu gm^{-3}$ -0.71% of the critical level	$0.006\ \mu gm^{-3}$ 0.60% of the critical level	$0.004\ \mu gm^{-3}$ 0.38% of the critical level
Nitrogen deposition (5 kgN/ha/yr)	-0.05 kgN/ha/yr -0.92% of the critical load	0.03 kgN/ha/yr 0.68% of the critical load	0.02 kgN/ha/yr 0.42% of the critical load

5.6 The eastern tree belt is effective at removing the increases due to the Warrington Local Plan on the eastern side of the bog and partially reduces it at the centre of the bog. It is not effective on the western side but that may not be a consideration given it is the eastern side that is identified to be in poorer ecological condition with the western side having recovered as a result of activities to improve the site hydrology.

Eastern tree belt extension coupled with a speed limit reduction

5.7 The effects of reducing the speed limit on the M62 was also explored. The average modelled speed on the M62 was 93 kph (57 mph). As potential mitigation, a reduction to 80 kph (50 mph) was modelled in addition to the eastern tree belt. Reducing the speed limit will reduce emissions of nitrogen oxides,

5.8 The effect of the Warrington Local Plan at 90m from the road with an eastern extension to the tree belt and a reduced speed limit on the M62 is summarised in Table 9 . It presents the results as the difference between the Warrington Local Plan plus the extended tree belt and a speed limit reduction, and the Do Minimum scenario (i.e. the 2038 reference case). A negative number means that a net improvement is forecast compared to the reference case and therefore the mitigation has more than addressed the WLP impact. A positive number means that pollution would continue to exceed the reference case to some degree, indicating the mitigation has not addressed 100% of the WLP impact. The full model results are in Appendix B Table 15. The results at 90m from the motorway are highlighted orange in these appendices.

Table 9 Change between DM and WLP plus eastern tree belt and speed limit reduction

Pollutant (lower critical level/load)	R2_90m	R3_90m	RM_90m
NOx (30 µgm^{-3})	-0.29 µgm^{-3} -1.0% of the critical level	-0.12 µgm^{-3} -0.4% of the critical level	-0.01 µgm^{-3} 0.5% of the critical level
Ammonia (1 µgm^{-3})	-0.006 µgm^{-3} -0.59% of the critical level	0.007 µgm^{-3} 0.72% of the critical level	0.005 µgm^{-3} 0.46% of the critical level
Nitrogen deposition (5 kgN/ha/yr)	-0.05 kgN/ha/yr -1.04**%** of the critical load	0.03 kgN/ha/yr 0.55**%** of the critical load	0.01 kgN/ha/yr 0.28% of the critical load

5.9 Whilst concentrations of NOx decrease due to the reduction in speed limit, a very small increase in ammonia concentrations is seen when compared to the model run with the eastern tree belt. This is because the CREAM calculation method used to derive emissions of ammonia is not currently dependent upon speed, but the slight increase in ammonia is due to reduced dispersion of the pollutants as a result of the reduced speed.

5.10 The speed limit reduction is not effective at reducing ammonia concentrations relative to the eastern tree belt alone and has a negligible effect on nitrogen deposition rates compared to the eastern tree belt extension alone. **Therefore, there appears to be little point in exploring speed limit reductions further.**

Solid barriers

5.11 The effects of additional solid barriers between the M62 and Holcroft Moss as mitigation was investigated.

5.12 The Advanced Street Canyon module was used to apply a two-sided street canyon on a 503m section of the M62 (i.e. portion of M62 sits parallel to the length of the SAC). The porosity of the canyon was reduced to take account of the solid barrier during the months when the plant canopy is greater (April to October inclusive). The height of the canyon during the winter months (November to March inclusive) was taken to be equal to the height of the barrier being assessed with a porosity of 0% as the trees were not considered to contribute to the canyon when not in leaf. The canyon parameters are provided in Appendix A.

5.13 The effect of a 6m barrier positioned in two different locations in the SAC was assessed to determine which location was most effective. The first location was close to the treeline near the M62 (at 18m from the road on the north edge of SAC) and the second was close to the northern edge of the raised bog within the SAC (i.e. the opposite side of the tree belt from the M62). The results for both alternatives are provided in Appendix B Table 16. The barrier located close to the M62 was marginally more effective at reducing nitrogen deposition rates within the raised bog (by 0.01 kgN/ha/yr at R2-90m) than the barrier located close to the bog, although the differences are small. The barriers are most effective at reducing pollutant concentrations close to the leeward side of the barrier, resulting in changes of -1.6% of the lower nitrogen critical load at R2-90m with the Warrington Local Plan compared with the Do-Minimum scenario (i.e. a net improvement thus entirely addressing the contribution of WLP). At greater distances from the barrier, the relative decrease in ammonia concentrations is less than for NOx; this is likely to be due to less dry deposition of ammonia occurring as the barrier reduces contact with the vegetation. This has the effect of increasing nitrogen deposition by 2.2% of the critical load with the Warrington Local Plan compared with the Do-Minimum scenario at R2_200m..

5.14 The effect of various heights of barrier at the edge of the SAC were modelled. The heights assessed were 4m, 6m, 8m and 10m. The barriers were represented within the Advanced Street Canyon module by changing the porosity of the canyon to represent the proportion of the height of the street canyon filled by a solid barrier. The results are provided in Appendix B Table 17.

5.15 The 10m barrier was found to be the most effective. This changed the nitrogen deposition rate by -7.2% of the critical load at R2-90m which is the most sensitive area and by +0.6% of the critical load at R2-200m with the Warrington Local Plan compared with the Do-Minimum scenario. Across the raised bog, the 10m barrier was predicted to reduce deposition rates overall with the Warrington Local Plan to below the Do-Minimum scenario (i.e. to entirely address the contribution of WLP), based on the sum of the changes at each receptor on the transect.

5.16 This illustrates that a solid barrier could provide effective mitigation. Further work would be needed to assist with the design and location of the barrier and to explore the practical aspects of erecting a barrier.

Grazing Animals

5.17 Information was provided by Natural England regarding the Management Prescriptions of the land adjacent to Holcroft Moss SAC:

5.18 This information combined with emission factors from the National Atmospheric Emissions Inventory (NAEI), have been used to estimate the release of ammonia due to the grazing animals, and to quantify the concentration of ammonia and subsequent nitrogen deposition within the boundaries of the SAC.

Emissions and Modelling

5.19 There is a maximum stocking density permitted of 1.02 Livestock Units per hectare (LU/Ha). Whilst sheep should be the only stock in November to February, any other stock can graze from March to October, however they cannot exceed 1.02 LU/Ha.

5.20 Assuming that the Livestock Units are medium weight ewes (0.08 LU[25]), 12.75 ewes are permitted per hectare.

5.21 The field to the west covers an area of 3.3 ha, and the field to the east is 6.3 ha – thereby allowing for a maximum of 42 ewes in the western field, and 82 ewes in the eastern field at any one time.

5.22 The NAEI provides a database[26] of average emission factors compiled from data and applied in the annual update of the inventory. The data are provided according to pollutant, emissions sector, source and fuel, and are presented in the format of mass of pollutant per activity unit.

5.23 Agricultural emissions of ammonia (NH_3) are included in the annual update of the inventory[27], meaning that associated agricultural emission rates / factors are readily available. Examples of sources of such emissions include grazing, housing, storage and manure spread. Examples of ‘fuels’ of such emissions include cattle, dairy cows, poultry, pigs, sheep, goats, deer and agricultural horses.

5.24 The 2020 inventory emission rate for grazing sheep (ewe) is 3.3×10^{-4} kilotonnes NH_3 per thousand head, which is equivalent to 0.33 kg NH_3 per ewe per year (kg NH_3/ewe/yr).

[25] https://www.accidentalsmallholder.net/smallholding/grassland-management/livestock-units/
[26] Emission factors detailed by source and fuel - NAEI, UK (beis.gov.uk)
[27] Inventory of Ammonia Emission from (defra.gov.uk)

5.25 By combining this information, it is calculated that 13.9 kg NH_3 can be emitted per year from grazing sheep within the western field, and 26.5 kg NH_3 within the eastern field.

5.26 The detailed dispersion model, ADMS, was used to model the emissions from grazing sheep. The emissions were treated as area sources at ground level, with minimal velocity due to the nature of the diffuse source. Emissions were distributed evenly across the fields in units of g $NH_3/s/m^2$. Two polygons were created to represent the two respective fields either side of the SAC for modelled ammonia emissions associated with sheep.

5.27 One year (2018) of hourly sequential observation data from Rostherne meteorological station was used in the assessment, consistent with the road source modelling. Concentrations of NH_3 and the subsequent nitrogen deposition were calculated at the same receptor / transect locations as modelled for the road sources.

5.28 The 'Baseline' model run includes plume depletion to grassland by using the 'dry deposition' module was applied in ADMS Roads. In order to simulate the effect of a proposed tree belt to the east of the SAC and west of the eastern field, and thus to quantify the potential impacts of this mitigation measure, plume depletion to forest was applied – the same approach as applied in the updated air quality modelling (April 2022). The NH_3 deposition rates used were the same as used for the roads modelling. All of the transects have been modelled and analysed as heathland / grassland due to the designation of the habitat.

Results

Baseline

5.29 The closest area of open bog to the M62, as identified on mapping provided by Natural England, is 90m from the M62, or 70m into the SAC, past a dense block of woodland. Transect point R2_90m and R3_90m is situated 90m from the roadside, with the two transects located respectively 70m and 10m into the SAC, at the eastern and western side of the Holcroft Moss SAC. RM-90m is located at the centre of the northern edge of the bog.

5.30 The annual mean ammonia concentrations at 90m from the M62, from the grazing sheep emissions alone, and its contribution to nitrogen deposition, are shown in Table 10. In this table, the contribution to ammonia and nitrogen from the livestock grazing the fields either side of the SAC is shown in the first two rows. The second two rows then show the contribution to ammonia and nitrogen deposition from Warrington Local Plan for comparison.

5.31 The largest contribution is at R2_90m with a contribution of 1.6% of the critical level for ammonia and 1.7% of the lower critical load for nitrogen deposition. To put this into context, this is much larger than the WLP contribution at the edges of the bog (R2_90m and R3_90m) and similar to the contribution at the centre of the northern edge of the bog (RM_90m).

Table 10 Contribution from grazing sheep and comparison with increase due to WLP

Pollutant (lower critical level/load)	R2_90m	R3_90m	RM_90m
Ammonia from sheep ($1\ \mu gm^{-3}$)	$0.016\ \mu gm^{-3}$ 1.6% of the critical level	$0.010\ \mu gm^{-3}$ 1.0% of the critical level	$0.004 \mu gm^{-3}$ 0.4% of the critical level
Nitrogen deposition from sheep (5 kgN/ha/yr)	0.084 kgN/ha/yr 1.67% of the critical load	0.052 kgN/ha/yr 1.04% of the critical load	0.022 kgN/ha/yr 0.44% of the critical load
Ammonia from WLP for comparison with that from sheep	0.56% of the critical level	0.50% of the critical level	0.45% of the critical level
Nitrogen from WLP for comparison with that from sheep	0.66% of the critical load	0.57% of the critical load	0.53% of the critical load

Reducing Stocking Densities

5.32 Reducing stocking densities, such as through an amended stewardship agreement with the farmer, would reduce the contribution to nutrient nitrogen from the grazing animals. Reducing the stocking densities by half could reduce the contribution from the grazing animals by the same proportion which would offset much of the potential increases in nitrogen deposition due to the Warrington Local Plan. For example, a 50% reduction in stocking density would more than offset the increase due to the Warrington Local Plan at R2_90m (the eastern transect), almost entirely offset it at R3_90m (the western transect) and reduce it by around half in the centre of the northern edge of the bog (RM-90m). Since reducing stocking density is effective at offsetting the increases due to the Warrington Local Plan on the eastern side of the bog (where the impact of the Plan is greatest) and partially offsetting it at the centre and western side of the bog this could be a sufficiently effective mitigation measure since it is the eastern side of the bog that is identified to be in poorer ecological condition with the western side having recovered as a result of activities to improve the site hydrology.

Increasing tree belts

5.33 Additional trees could be planted around the bog to deplete ammonia and this has been considered as another measure. The maximum effect of increasing the tree belts between the eastern and western field sources and the SAC as mitigation to reduce the ammonia contribution from sheep to the SAC is presented in Table 11. In the table below, the ammonia and nitrogen from sheep when the tree belts are added is presented in the first two rows. The reduction (compared to a situation without any trees) is then presented as a percentage of the critical level/load in rows 3 and 4. For reference, the contribution of Warrington Local Plan is shown in rows 5 and 6 of the table. So, for example, at 90m along transect R2 (the closest part of the bog on that eastern transect where the impact of the Local Plan is greatest) tree planting along the eastern and western boundaries of the bog could reduce nitrogen deposition to the bog from the sheep by 0.37% of the critical load. This alone would offset more than half the contribution of the Local Plan (0.66% of the critical load as shown in row 6 of the table).

5.34 Naturally the offsetting effect is least in the centre of the bog since this is furthest from the grazing animals. However, the effect of the Local Plan is worst at the eastern side of the bog and it is understood from Natural England that it is the eastern side of the bog that has not recovered to the same extent as the rest of the site following hydrological restoration works. Any tree planting along the eastern and western boundaries would need to be undertaken in such a way that it did not affect bog hydrology.

Table 11 Contribution from grazing sheep with mitigation of increased tree belts

Pollutant (lower critical level/load)	**R2_90m**	**R3_90m**	**RM_90m**
Ammonia from sheep with additional tree belts (1 μgm^{-3})	0.012 μgm^{-3} 1.2% of the critical level	0.008 μgm^{-3} 1.0% of the critical level	0.003μgm^{-3} 0.3% of the critical level
Nitrogen deposition from sheep with additional tree belts (5 kgN/ha/yr)	0.065 kgN/ha/yr 1.30**%** of the critical load	0.041 kgN/ha/yr 0.082**%** of the critical load	0.017 kgN/ha/yr 0.34% of the critical load
Reduction in ammonia from livestock due to tree belt	-0.4% of the critical level	-0.2% of the critical level	-0.1% of the critical level
Reduction in nitrogen deposition from livestock due to tree belt	-0.37% of the critical load	-0.22% of the critical load	-0.10% of the critical load
WLP contribution to ammonia for comparison	0.56% of the critical level	0.50% of the critical level	0.45% of the critical level
WLP contrition to nitrogen deposition for comparison	0.66% of the critical load	0.57% of the critical load	0.53% of the critical load

5.35 Increasing tree belts on both sides of the SAC is therefore predicted to reduce the contribution from the sheep to nitrogen deposition. As an upper estimate, this could offset more than half of the contribution from the WLP at R2_90m, just under half at R3_90m and only have a very slight effect at the centre of the northern edge of the bog (RM-90m). In practice, the change would be less than this and reducing the grazing density would be more effective or would be needed in addition to tree planting.

6. Summary

6.1 The receptors within the raised bog predicted to have the largest impacts from the Warrington Local Plan are located at the northern edge of the bog, approximately 90m from the M62. The maximum increase due to the Warrington Local Plan was predicted to be 0.2% of the critical level for NO_X, 0.56% of the lower critical level for ammonia, 0.66% of the lower critical load for nitrogen deposition and 0.42% of the lower critical load for acid deposition. The contribution from the Warrington Local Plan alone is less than the 1% screening threshold.

6.2 The contribution from the Greater Manchester Local Plan was assessed in a separate study. This was also found to contribute less than 1% of the critical load and level for all pollutants. The contribution from the Greater Manchester Local Plan alone is therefore also less than the 1% screening threshold.

6.3 The contributions from the two Local Plans were combined to give an in-combination contribution. This is worst case as it assumes that both Local Plans are fully implemented by 2038 and that vehicle emissions do not decrease beyond 2035. Nitrogen deposition and ammonia were found to exceed the 1% screening threshold and so warranted further investigation. The north-eastern corner of the raised bog was found to be most affected by the M62 and by the Warrington Local Plan.

6.4 The pollutant predicted to have the largest impact from the Warrington Local Plan in relation to a percentage change compared with its critical load or level, is nitrogen deposition. The ecological effect of a given nitrogen dose on various habitats including bog has been assessed and it was found that at high background rates of nitrogen deposition (such as is experienced at Manchester Mosses SAC) a typical additional dose of 3.3 kgN/ha/yr is required to reduce species richness by the equivalent of 1 species; this is 47 times the deposition forecast due to the Warrington and Greater Manchester Local Plans in combination. This demonstrates that the dose due to the Warrington and Greater Manchester Local Plans will not affect the species richness of the bog and that the mitigation proposed in the submitted Warrington Local Plan HRA is suitably precautionary. The limited species richness effect on bog even when a large nitrogen dose is applied is probably due to the hydrological regime limiting further species responses to deposition once the critical load is exceeded. This then indicates that the hydrological regime is often more important in determining species richness than nitrogen deposition.

6.5 Despite there being a lack of evidence for any adverse effects on the bog due to the very small additional contribution from the two Plans, which must also be set against a backdrop of year on year decreasing deposition rates due to cleaner vehicles, the effects of various potential ‘hard’ mitigation measures that could reduce nitrogen deposition have also been explored, beyond those that would occur through the “soft” measures.

6.6 Grazing animals on the land adjacent to the west and east of the SAC, were found to contribute to the ammonia concentrations and nitrogen deposition rates within the SAC. Reducing the stocking densities and possibly increasing the tree belts between the animals and the SAC could reduce this impact and contribute towards offsetting the increase due the Warrington Local Plan.

6.7 Extending the tree belt near the M62 to the east of the SAC could more than remove the increase due to the Warrington Local Plan along the eastern side of the raised bog and reduce it at the centre of the bog. This is relevant because the eastern side of the bog is the area considered by Natural England to be in a poorer state of restoration than the western side, which would thus make it potentially more vulnerable to increased nitrogen deposition.

6.8 A solid barrier located between the M62 and the raised bog could remove or reduce the increases due to the Warrington Local Plan. A taller barrier was found to be more effective than a shorter barrier. A 10m tall barrier could reduce the overall total amount of nitrogen deposition across the site with the Warrington Local Plan to below that with the Do-Minimum scenario thus entirely offsetting the impact of the Local Plan.

6.9 Further work would be needed to explore these mitigation options further should the predicted impacts be considered to have a significant adverse impact upon the sensitive habitats within the SAC. The practicality and acceptability of implementing these measures would need to be considered in addition to further work on the detailed design of and locations for such measures over the years before the mitigation would actually be needed in the second half of the plan period.

6.10 If any of these measures were to be required, it is probable in practice that a combination of measures would need to be brought forward. For example, while a 10m high barrier would more than address the entire impact of Warrington Local Plan by itself, an alternative option to addressing the impact could be a smaller barrier coupled with extending tree planting along the motorway, while a third could be extending tree planting along the motorway coupled with a reduction in the density of grazing livestock, and a fourth could be reducing livestock density and undertaking tree planting along the western and eastern field boundaries of Holcroft Moss, without any barrier or tree planting along the motorway at all. It must also be borne in mind that while the soft measures already included in the Warrington Local Plan mitigation proposals for Manchester Mosses SAC cannot be directly modelled, they are very likely to be effective to a degree and therefore the entire mitigation burden would not rest on the additional measures explored in this report.

6.11 In practice it is entirely possible none of the additional mitigation measures modelled in section 5 of this report would ever be required, and any firm decision over their need would not be required until after the first five year Local Plan Review, by which time additional measures may have been identified. Moreover, by that time a clarified picture of the shift from petrol cars to electric vehicles will be available given the ban on sale of new diesel and petrol cars and vans that will be in force from 2030, and this will itself significantly affect emissions. In the long-term, vehicle-related pollution effects on vegetation is a time-limited impact and is very likely to cease to be an issue from c. 2050, barely 10 years after the end of the Warrington Local Plan period. That must be borne in mind when deciding on necessary mitigation measures, particularly at this early date in the Local Plan period, as it makes air pollution a distinctly different issue from (for example) recreational pressure, which will only get worse as the national population rises.

6.12 Notwithstanding those points, it is clear from the modelling undertaken that, if such measures were needed, there are numerous potential mitigation measures that are capable of being directly modelled and that could be implemented alone or as a package to reduce the in-combination contribution from the Warrington and Greater Manchester Local Plans to less than the screening assessment threshold of 1% of the critical loads and levels, should significant adverse impacts on sensitive habitats within the SAC be expected.

Appendix A :Model Set-Up

Table 12 ADMS Roads Advanced Street Canyon parameters for 2-sided street canyon – west of SAC

Parameter	Value
Length of road (m)	470
Width (m) – south	18
Average height (m) – south	12
Minimum height (m) – south	9
Maximum height (m) – south	16
Building length (m) – south	282
Porosity (%) – south	40
Width (m) – north	22
Average height (m) – north	12
Minimum height (m) – north	9
Maximum height (m) – north	16
Building length (m) – north	141
Porosity (%) – north	70

Table 13 ADMS Roads Advanced Street Canyon parameters for 1-sided street canyon – east of SAC

Parameter	Value
Length of road (m)	112
Width (m) – south	18
Average height (m) – south	12
Minimum height (m) – south	9
Maximum height (m) – south	16
Building length (m) – south	67
Porosity (%) – south	40

Table 14 ADMS Roads Advanced Street Canyon parameters for 2-sided street canyon – adjacent to SAC and M62

Parameter	Value (Winter months*)
Length of road (m)	503
Width (m) – south	18
Average height (m) – south	12 (height of barrier or if not present 0)
Minimum height (m) – south	9 (height of barrier or if not present 0)
Maximum height (m) – south	16 ((height of barrier or if not present 0)
Building length (m) – south	403 (503)
Porosity (%) – south	40 (0) with no barrier; 27 (0) with 4m barrier; 20 (0) with 6m barrier; 13 (0) with 8m barrier ; 7 (0) with 10m barrier
Width (m) – north	18 (0)
Average height (m) – north	12 (0)
Minimum height (m) – north	9 (0)
Maximum height (m) – north	16 (0)
Building length (m) – north	144 (0)
Porosity (%) – north	40 (0)

Notes:
* where values are provided in brackets, the parameter has been changed for the winter months to represent the winter impacts

Appendix B : Modelled Results

Table 15 Modelled Results including Western Tree belt

	NOx (μgm^{-3})				Ammonia (μgm^{-3})				Nitrogen deposition (kgN/ha/yr)				Acid deposition (Keq/ha/yr)			
Road Link	2018	2038 FB	2038 DM	2038 DS	2018	2038 FB	2038 DM	2038 DS	2018	2038 FB	2038 FB	2038 DS	2018	2038 FB	2038 DM	2038 DS
R1_17m	76.46	26.14	29.65	29.82	3.86	4.05	4.35	4.38	35.42	31.38	33.18	33.32	2.53	2.24	2.37	2.38
R2_20m	62.52	22.95	25.45	25.57	3.36	3.49	3.69	3.71	31.95	28.22	29.45	29.54	2.28	2.02	2.10	2.11
R2_30m	55.44	21.33	23.33	23.42	3.10	3.20	3.36	3.37	30.16	26.60	27.55	27.63	2.15	1.90	1.97	1.97
R2_40m	51.07	20.33	22.03	22.11	2.95	3.03	3.16	3.17	29.09	25.66	26.45	26.51	2.08	1.83	1.89	1.89
R2_50m	48.05	19.64	21.13	21.20	2.86	2.92	3.03	3.04	28.38	25.03	25.72	25.77	2.03	1.79	1.84	1.84
R2_60m	45.87	19.14	20.49	20.55	2.79	2.85	2.94	2.95	27.86	24.59	25.20	25.25	1.99	1.76	1.80	1.80
R2_70m	44.18	18.76	19.99	20.04	2.73	2.79	2.88	2.88	27.48	24.26	24.81	24.85	1.96	1.73	1.77	1.77
R2_80m	42.81	18.44	19.58	19.63	2.69	2.74	2.82	2.83	27.16	23.99	24.50	24.53	1.94	1.71	1.75	1.75
R2_90m	41.67	18.18	19.24	19.29	2.66	2.70	2.78	2.78	26.91	23.77	24.24	24.27	1.92	1.70	1.73	1.73
R2_100m	40.71	17.96	18.95	19.00	2.63	2.67	2.74	2.74	26.69	23.59	24.03	24.06	1.91	1.69	1.72	1.72
R2_110m	39.89	17.77	18.71	18.75	2.61	2.64	2.71	2.71	26.52	23.44	23.85	23.88	1.89	1.67	1.70	1.71
R2_120m	39.18	17.61	18.50	18.54	2.59	2.62	2.68	2.69	26.36	23.31	23.69	23.72	1.88	1.67	1.69	1.69
R2_130m	38.57	17.47	18.31	18.35	2.57	2.60	2.66	2.66	26.23	23.20	23.56	23.58	1.87	1.66	1.68	1.68
R2_140m	38.01	17.34	18.15	18.18	2.56	2.58	2.64	2.64	26.11	23.10	23.44	23.47	1.86	1.65	1.67	1.68
R2_150m	37.52	17.23	18.00	18.03	2.54	2.57	2.62	2.62	26.00	23.02	23.34	23.36	1.86	1.64	1.67	1.67
R2_160m	37.08	17.13	17.87	17.90	2.53	2.56	2.60	2.61	25.91	22.94	23.25	23.27	1.85	1.64	1.66	1.66
R2_170m	36.68	17.04	17.74	17.78	2.52	2.54	2.59	2.59	25.83	22.87	23.16	23.18	1.84	1.63	1.65	1.66
R2_180m	36.31	16.95	17.63	17.67	2.51	2.53	2.58	2.58	25.75	22.81	23.09	23.11	1.84	1.63	1.65	1.65
R2_190m	35.97	16.88	17.53	17.56	2.50	2.52	2.57	2.57	25.68	22.75	23.02	23.04	1.83	1.63	1.64	1.65
R2_200m	35.67	16.81	17.44	17.47	2.49	2.51	2.56	2.56	25.62	22.70	22.96	22.97	1.83	1.62	1.64	1.64
R3_23m	55.25	21.28	23.26	23.36	3.12	3.22	3.38	3.39	30.23	26.70	27.66	27.73	2.16	1.91	1.98	1.98
R3_30m	51.70	20.47	22.21	22.29	3.00	3.08	3.22	3.23	29.35	25.92	26.75	26.81	2.10	1.85	1.91	1.91
R3_40m	48.10	19.65	21.14	21.21	2.88	2.95	3.06	3.07	28.49	25.15	25.86	25.91	2.03	1.80	1.85	1.85
R3_50m	45.55	19.07	20.38	20.44	2.79	2.85	2.95	2.96	27.88	24.63	25.24	25.28	1.99	1.76	1.80	1.81
R3_60m	43.64	18.63	19.81	19.87	2.73	2.79	2.87	2.88	27.43	24.24	24.79	24.83	1.96	1.73	1.77	1.77
R3_70m	42.15	18.29	19.37	19.42	2.69	2.73	2.81	2.82	27.09	23.95	24.44	24.47	1.94	1.71	1.75	1.75
R3_80m	40.94	18.01	19.01	19.06	2.65	2.69	2.76	2.77	26.82	23.72	24.16	24.19	1.92	1.69	1.73	1.73
R3_90m	39.94	17.78	18.71	18.75	2.62	2.66	2.73	2.73	26.59	23.53	23.94	23.97	1.90	1.68	1.71	1.71
R3_100m	39.10	17.59	18.46	18.50	2.60	2.63	2.69	2.70	26.41	23.37	23.75	23.78	1.89	1.67	1.70	1.70
R3_110m	38.40	17.43	18.25	18.29	2.58	2.61	2.67	2.67	26.25	23.24	23.60	23.62	1.88	1.66	1.69	1.69
R3_120m	37.80	17.29	18.07	18.11	2.56	2.59	2.64	2.65	26.12	23.13	23.47	23.49	1.87	1.65	1.68	1.68
R3_130m	37.28	17.18	17.91	17.95	2.55	2.57	2.63	2.63	26.01	23.04	23.36	23.38	1.86	1.65	1.67	1.67
R3_140m	36.82	17.07	17.78	17.81	2.53	2.56	2.61	2.61	25.91	22.96	23.26	23.28	1.85	1.64	1.66	1.66
R3_150m	36.41	16.98	17.65	17.68	2.52	2.55	2.59	2.60	25.82	22.88	23.17	23.19	1.84	1.63	1.66	1.66
R3_160m	36.04	16.89	17.54	17.57	2.51	2.54	2.58	2.58	25.74	22.82	23.09	23.11	1.84	1.63	1.65	1.65
R3_170m	35.71	16.82	17.44	17.47	2.50	2.53	2.57	2.57	25.67	22.76	23.02	23.04	1.83	1.63	1.64	1.65
R3_180m	35.40	16.75	17.35	17.37	2.50	2.52	2.56	2.56	25.61	22.71	22.96	22.98	1.83	1.62	1.64	1.64
R3_190m	35.12	16.68	17.26	17.29	2.49	2.51	2.55	2.55	25.55	22.66	22.90	22.92	1.83	1.62	1.64	1.64
R3_200m	34.87	16.62	17.18	17.21	2.48	2.50	2.54	2.54	25.50	22.62	22.85	22.86	1.82	1.62	1.63	1.63
RM_90m	39.16	17.60	18.48	18.52	2.60	2.63	2.69	2.69	26.40	23.36	23.74	23.76	1.89	1.67	1.70	1.70

Table 16 Modelled Results for Additional Tree-belt to East and Traffic Speed Limit Changes

	NOx (µgm^{-3})				Ammonia (µgm^{-3})				Nitrogen deposition (kgN/ha/yr)				Acid deposition (Keq/ha/yr)			
Road Link	2038 DM	2038 DS	2038 DS + trees	2038 DS + trees + speed	2038 DM	2038 DS	2038 DS + trees	2038 DS + trees + speed	2038 DM	2038 DS	2038 DS + trees	2038 DS + trees + speed	2038 DM	2038 DS	2038 DS + trees	2038 DS + trees + speed
R1_17m	29.65	29.82	27.83	27.36	4.35	4.38	4.08	4.10	33.18	33.32	31.64	31.70	2.37	2.38	2.26	2.26
R2_20m	25.45	25.57	25.40	25.03	3.69	3.71	3.69	3.71	29.45	29.54	29.46	29.50	2.10	2.11	2.10	2.11
R2_30m	23.33	23.42	23.24	22.94	3.36	3.37	3.35	3.36	27.55	27.63	27.53	27.55	1.97	1.97	1.97	1.97
R2_40m	22.03	22.11	21.92	21.66	3.16	3.17	3.16	3.16	26.45	26.51	26.41	26.42	1.89	1.89	1.89	1.89
R2_50m	21.13	21.20	21.02	20.79	3.03	3.04	3.03	3.03	25.72	25.77	25.67	25.68	1.84	1.84	1.83	1.83
R2_60m	20.49	20.55	20.36	20.15	2.94	2.95	2.94	2.94	25.20	25.25	25.15	25.15	1.80	1.80	1.80	1.80
R2_70m	19.99	20.04	19.86	19.67	2.88	2.88	2.87	2.87	24.81	24.85	24.76	24.75	1.77	1.77	1.77	1.77
R2_80m	19.58	19.63	19.46	19.28	2.82	2.83	2.81	2.81	24.50	24.53	24.45	24.44	1.75	1.75	1.75	1.75
R2_90m	19.24	19.29	19.12	18.95	2.78	2.78	2.77	2.77	24.24	24.27	24.19	24.19	1.73	1.73	1.73	1.73
R2_100m	18.95	19.00	18.84	18.68	2.74	2.74	2.73	2.73	24.03	24.06	23.99	23.98	1.72	1.72	1.71	1.71
R2_110m	18.71	18.75	18.61	18.46	2.71	2.71	2.70	2.70	23.85	23.88	23.81	23.80	1.70	1.71	1.70	1.70
R2_120m	18.50	18.54	18.41	18.26	2.68	2.69	2.68	2.68	23.69	23.72	23.66	23.65	1.69	1.69	1.69	1.69
R2_130m	18.31	18.35	18.23	18.09	2.66	2.66	2.65	2.66	23.56	23.58	23.53	23.52	1.68	1.68	1.68	1.68
R2_140m	18.15	18.18	18.07	17.93	2.64	2.64	2.64	2.64	23.44	23.47	23.42	23.41	1.67	1.68	1.67	1.67
R2_150m	18.00	18.03	17.93	17.80	2.62	2.62	2.62	2.62	23.34	23.36	23.32	23.31	1.67	1.67	1.67	1.67
R2_160m	17.87	17.90	17.80	17.67	2.60	2.61	2.60	2.60	23.25	23.27	23.23	23.22	1.66	1.66	1.66	1.66
R2_170m	17.74	17.78	17.68	17.56	2.59	2.59	2.59	2.59	23.16	23.18	23.15	23.14	1.65	1.66	1.65	1.65
R2_180m	17.63	17.67	17.58	17.46	2.58	2.58	2.58	2.58	23.09	23.11	23.08	23.07	1.65	1.65	1.65	1.65
R2_190m	17.53	17.56	17.48	17.37	2.57	2.57	2.57	2.56	23.02	23.04	23.01	23.00	1.64	1.65	1.64	1.64
R2_200m	17.44	17.47	17.39	17.28	2.56	2.56	2.55	2.55	22.96	22.97	22.95	22.94	1.64	1.64	1.64	1.64
R3_23m	23.26	23.36	23.36	23.06	3.38	3.39	3.39	3.40	27.66	27.73	27.75	27.78	1.98	1.98	1.98	1.98
R3_30m	22.21	22.29	22.29	22.02	3.22	3.23	3.23	3.24	26.75	26.81	26.82	26.84	1.91	1.91	1.92	1.92
R3_40m	21.14	21.21	21.21	20.98	3.06	3.07	3.07	3.08	25.86	25.91	25.92	25.93	1.85	1.85	1.85	1.85
R3_50m	20.38	20.44	20.44	20.23	2.95	2.96	2.96	2.97	25.24	25.28	25.29	25.30	1.80	1.81	1.81	1.81
R3_60m	19.81	19.87	19.87	19.68	2.87	2.88	2.88	2.88	24.79	24.83	24.83	24.83	1.77	1.77	1.77	1.77
R3_70m	19.37	19.42	19.42	19.24	2.81	2.82	2.82	2.82	24.44	24.47	24.48	24.48	1.75	1.75	1.75	1.75
R3_80m	19.01	19.06	19.06	18.89	2.76	2.77	2.77	2.77	24.16	24.19	24.20	24.20	1.73	1.73	1.73	1.73
R3_90m	18.71	18.75	18.75	18.60	2.73	2.73	2.73	2.73	23.94	23.97	23.97	23.97	1.71	1.71	1.71	1.71
R3_100m	18.46	18.50	18.50	18.35	2.69	2.70	2.70	2.70	23.75	23.78	23.78	23.78	1.70	1.70	1.70	1.70
R3_110m	18.25	18.29	18.28	18.14	2.67	2.67	2.67	2.67	23.60	23.62	23.63	23.62	1.69	1.69	1.69	1.69
R3_120m	18.07	18.11	18.10	17.97	2.64	2.65	2.65	2.65	23.47	23.49	23.50	23.49	1.68	1.68	1.68	1.68
R3_130m	17.91	17.95	17.95	17.82	2.63	2.63	2.63	2.63	23.36	23.38	23.38	23.37	1.67	1.67	1.67	1.67
R3_140m	17.78	17.81	17.81	17.68	2.61	2.61	2.61	2.61	23.26	23.28	23.28	23.27	1.66	1.66	1.66	1.66
R3_150m	17.65	17.68	17.68	17.56	2.59	2.60	2.60	2.60	23.17	23.19	23.19	23.18	1.66	1.66	1.66	1.66
R3_160m	17.54	17.57	17.57	17.45	2.58	2.58	2.58	2.58	23.09	23.11	23.11	23.11	1.65	1.65	1.65	1.65
R3_170m	17.44	17.47	17.46	17.35	2.57	2.57	2.57	2.57	23.02	23.04	23.04	23.03	1.64	1.65	1.65	1.65
R3_180m	17.35	17.37	17.37	17.26	2.56	2.56	2.56	2.56	22.96	22.98	22.98	22.97	1.64	1.64	1.64	1.64
R3_190m	17.26	17.29	17.28	17.18	2.55	2.55	2.55	2.55	22.90	22.92	22.92	22.91	1.64	1.64	1.64	1.64
R3_200m	17.18	17.21	17.21	17.10	2.54	2.54	2.54	2.54	22.85	22.86	22.87	22.86	1.63	1.63	1.63	1.63
RM_90m	18.48	18.52	18.49	18.34	2.69	2.69	2.69	2.69	23.74	23.76	23.76	23.75	1.70	1.70	1.70	1.70

Table 17 Modelled Results for 6m Solid Barriers at Two Locations

	NOx (μgm^{-3})				Ammonia (μgm^{-3})				Nitrogen deposition (kgN/ha/yr)				Acid deposition (Keq/ha/yr)			
Road Link	2038 DM	2038 DS	2038 DS + south barrier	2038 DS + north barrier	2038 DM	2038 DS	2038 DS + south barrier	2038 DS + north barrier	2038 DM	2038 DS	2038 DS + south barrier	2038 DS + north barrier	2038 DM	2038 DS	2038 DS + south barrier	2038 DS + north barrier
R1_17m	29.65	29.82	29.11	27.74	4.35	4.38	4.31	4.13	33.18	33.32	32.92	31.90	2.37	2.38	2.35	2.28
R2_20m	25.45	25.57	38.09	22.08	3.69	3.71	6.96	3.27	29.45	29.54	47.31	27.02	2.10	2.11	3.38	1.93
R2_30m	23.33	23.42	33.36	21.03	3.36	3.37	5.95	3.11	27.55	27.63	41.77	26.09	1.97	1.97	2.98	1.86
R2_40m	22.03	22.11	30.40	20.36	3.16	3.17	5.33	3.01	26.45	26.51	38.34	25.52	1.89	1.89	2.74	1.82
R2_50m	21.13	21.20	28.36	19.87	3.03	3.04	4.91	2.94	25.72	25.77	35.99	25.12	1.84	1.84	2.57	1.79
R2_60m	20.49	20.55	26.88	19.50	2.94	2.95	4.60	2.88	25.20	25.25	34.29	24.81	1.80	1.80	2.45	1.77
R2_70m	19.99	20.04	25.75	19.20	2.88	2.88	4.37	2.84	24.81	24.85	33.00	24.56	1.77	1.77	2.36	1.75
R2_80m	19.58	19.63	19.05	18.94	2.82	2.83	2.80	2.80	24.50	24.53	24.34	24.35	1.75	1.75	1.74	1.74
R2_90m	19.24	19.29	18.82	18.71	2.78	2.78	2.77	2.77	24.24	24.27	24.17	24.16	1.73	1.73	1.73	1.73
R2_100m	18.95	19.00	18.63	18.51	2.74	2.74	2.74	2.74	24.03	24.06	24.03	24.00	1.72	1.72	1.72	1.71
R2_110m	18.71	18.75	18.46	18.33	2.71	2.71	2.72	2.72	23.85	23.88	23.91	23.86	1.70	1.71	1.71	1.70
R2_120m	18.50	18.54	18.30	18.18	2.68	2.69	2.70	2.69	23.69	23.72	23.79	23.73	1.69	1.69	1.70	1.70
R2_130m	18.31	18.35	18.16	18.04	2.66	2.66	2.68	2.67	23.56	23.58	23.68	23.62	1.68	1.68	1.69	1.69
R2_140m	18.15	18.18	18.02	17.91	2.64	2.64	2.67	2.66	23.44	23.47	23.58	23.52	1.67	1.68	1.68	1.68
R2_150m	18.00	18.03	17.90	17.79	2.62	2.62	2.65	2.64	23.34	23.36	23.49	23.43	1.67	1.67	1.68	1.67
R2_160m	17.87	17.90	17.79	17.68	2.60	2.61	2.63	2.63	23.25	23.27	23.40	23.34	1.66	1.66	1.67	1.67
R2_170m	17.74	17.78	17.68	17.58	2.59	2.59	2.62	2.61	23.16	23.18	23.32	23.26	1.65	1.66	1.67	1.66
R2_180m	17.63	17.67	17.59	17.49	2.58	2.58	2.61	2.60	23.09	23.11	23.25	23.19	1.65	1.65	1.66	1.66
R2_190m	17.53	17.56	17.50	17.41	2.57	2.57	2.60	2.59	23.02	23.04	23.18	23.13	1.64	1.65	1.66	1.65
R2_200m	17.44	17.47	17.41	17.33	2.56	2.56	2.59	2.58	22.96	22.97	23.11	23.07	1.64	1.64	1.65	1.65
R3_23m	23.26	23.36	34.57	20.47	3.38	3.39	6.27	3.06	27.66	27.73	43.51	25.81	1.98	1.98	3.11	1.84
R3_30m	22.21	22.29	32.17	19.98	3.22	3.23	5.76	2.98	26.75	26.81	40.71	25.37	1.91	1.91	2.91	1.81
R3_40m	21.14	21.21	29.72	19.47	3.06	3.07	5.25	2.91	25.86	25.91	37.87	24.94	1.85	1.85	2.70	1.78
R3_50m	20.38	20.44	27.98	19.10	2.95	2.96	4.89	2.85	25.24	25.28	35.87	24.63	1.80	1.81	2.56	1.76
R3_60m	19.81	19.87	26.68	18.81	2.87	2.88	4.62	2.81	24.79	24.83	34.39	24.38	1.77	1.77	2.46	1.74
R3_70m	19.37	19.42	25.69	18.57	2.81	2.82	4.42	2.77	24.44	24.47	33.26	24.18	1.75	1.75	2.38	1.73
R3_80m	19.01	19.06	18.52	18.36	2.76	2.77	2.75	2.74	24.16	24.19	24.06	24.00	1.73	1.73	1.72	1.71
R3_90m	18.71	18.75	18.34	18.18	2.73	2.73	2.73	2.72	23.94	23.97	23.92	23.85	1.71	1.71	1.71	1.70
R3_100m	18.46	18.50	18.18	18.02	2.69	2.70	2.71	2.69	23.75	23.78	23.81	23.72	1.70	1.70	1.70	1.69
R3_110m	18.25	18.29	18.04	17.88	2.67	2.67	2.69	2.67	23.60	23.62	23.70	23.61	1.69	1.69	1.69	1.69
R3_120m	18.07	18.11	17.92	17.76	2.64	2.65	2.67	2.66	23.47	23.49	23.60	23.50	1.68	1.68	1.69	1.68
R3_130m	17.91	17.95	17.80	17.64	2.63	2.63	2.66	2.64	23.36	23.38	23.51	23.41	1.67	1.67	1.68	1.67
R3_140m	17.78	17.81	17.69	17.54	2.61	2.61	2.64	2.62	23.26	23.28	23.42	23.32	1.66	1.66	1.67	1.67
R3_150m	17.65	17.68	17.58	17.44	2.59	2.60	2.63	2.61	23.17	23.19	23.34	23.24	1.66	1.66	1.67	1.66
R3_160m	17.54	17.57	17.49	17.36	2.58	2.58	2.61	2.60	23.09	23.11	23.26	23.17	1.65	1.65	1.66	1.65
R3_170m	17.44	17.47	17.40	17.27	2.57	2.57	2.60	2.59	23.02	23.04	23.19	23.10	1.64	1.65	1.66	1.65
R3_180m	17.35	17.37	17.32	17.20	2.56	2.56	2.59	2.57	22.96	22.98	23.12	23.04	1.64	1.64	1.65	1.65
R3_190m	17.26	17.29	17.24	17.13	2.55	2.55	2.58	2.56	22.90	22.92	23.06	22.98	1.64	1.64	1.65	1.64
R3_200m	17.18	17.21	17.17	17.06	2.54	2.54	2.57	2.56	22.85	22.86	23.00	22.93	1.63	1.63	1.64	1.64
RM_90m	18.48	18.52	18.14	17.98	2.69	2.69	2.70	2.69	23.74	23.76	23.78	23.71	1.70	1.70	1.70	1.69

Table 18 Modelled Results for Four Heights of Solid Barrier next to M62

	NOx (μgm^{-3})						Ammonia (μgm^{-3})						Nitrogen deposition (kgN/ha/yr)					
Road Link	2038 DM	2038 DS	2038 DS + 4m b	2038 DS + 6m b	2038 DS + 8m b	2038 DS + 10m b	2038 DM	2038 DS	2038 DS + 4m b	2038 DS + 6m b	2038 DS + 8m b	2038 DS + 10m b	2038 DM	2038 DS	2038 DS + 4m b	2038 DS + 6m b	2038 DS + 8m b	2038 DS + 10m b
R1_17m	29.65	29.82	28.30	27.74	27.34	27.10	4.35	4.38	4.22	4.13	4.07	4.04	33.18	33.32	32.39	31.90	31.58	31.38
R2_20m	25.45	25.57	23.01	22.08	21.49	21.10	3.69	3.71	3.42	3.27	3.18	3.13	29.45	29.54	27.85	27.02	26.52	26.19
R2_30m	23.33	23.42	21.78	21.03	20.55	20.25	3.36	3.37	3.22	3.11	3.04	2.99	27.55	27.63	26.74	26.09	25.69	25.45
R2_40m	22.03	22.11	20.97	20.36	19.96	19.70	3.16	3.17	3.10	3.01	2.95	2.91	26.45	26.51	26.04	25.52	25.19	24.99
R2_50m	21.13	21.20	20.38	19.87	19.52	19.30	3.03	3.04	3.01	2.94	2.89	2.86	25.72	25.77	25.53	25.12	24.83	24.66
R2_60m	20.49	20.55	19.93	19.50	19.19	19.00	2.94	2.95	2.94	2.88	2.84	2.81	25.20	25.25	25.14	24.81	24.57	24.41
R2_70m	19.99	20.04	19.56	19.20	18.93	18.75	2.88	2.88	2.88	2.84	2.80	2.78	24.81	24.85	24.82	24.56	24.35	24.21
R2_80m	19.58	19.63	19.25	18.94	18.70	18.54	2.82	2.83	2.84	2.80	2.77	2.75	24.50	24.53	24.55	24.35	24.16	24.04
R2_90m	19.24	19.29	18.97	18.71	18.50	18.35	2.78	2.78	2.80	2.77	2.74	2.72	24.24	24.27	24.33	24.16	24.00	23.88
R2_100m	18.95	19.00	18.74	18.51	18.32	18.18	2.74	2.74	2.76	2.74	2.72	2.70	24.03	24.06	24.13	24.00	23.86	23.75
R2_110m	18.71	18.75	18.53	18.33	18.16	18.03	2.71	2.71	2.73	2.72	2.69	2.68	23.85	23.88	23.96	23.86	23.74	23.64
R2_120m	18.50	18.54	18.35	18.18	18.02	17.90	2.68	2.69	2.71	2.69	2.68	2.66	23.69	23.72	23.81	23.73	23.63	23.54
R2_130m	18.31	18.35	18.19	18.04	17.90	17.78	2.66	2.66	2.68	2.67	2.66	2.64	23.56	23.58	23.68	23.62	23.53	23.45
R2_140m	18.15	18.18	18.05	17.91	17.78	17.68	2.64	2.64	2.66	2.66	2.64	2.63	23.44	23.47	23.57	23.52	23.44	23.36
R2_150m	18.00	18.03	17.91	17.79	17.67	17.58	2.62	2.62	2.65	2.64	2.63	2.62	23.34	23.36	23.46	23.43	23.36	23.29
R2_160m	17.87	17.90	17.79	17.68	17.58	17.49	2.60	2.61	2.63	2.63	2.62	2.61	23.25	23.27	23.37	23.34	23.28	23.22
R2_170m	17.74	17.78	17.68	17.58	17.49	17.40	2.59	2.59	2.61	2.61	2.60	2.59	23.16	23.18	23.29	23.26	23.21	23.16
R2_180m	17.63	17.67	17.58	17.49	17.40	17.33	2.58	2.58	2.60	2.60	2.59	2.58	23.09	23.11	23.21	23.19	23.15	23.10
R2_190m	17.53	17.56	17.49	17.41	17.32	17.25	2.57	2.57	2.59	2.59	2.58	2.57	23.02	23.04	23.14	23.13	23.09	23.05
R2_200m	17.44	17.47	17.40	17.33	17.25	17.18	2.56	2.56	2.58	2.58	2.57	2.57	22.96	22.97	23.07	23.07	23.04	22.99
R3_23m	23.26	23.36	21.31	20.47	19.94	19.59	3.38	3.39	3.19	3.06	2.98	2.93	27.66	27.73	26.54	25.81	25.35	25.06
R3_30m	22.21	22.29	20.71	19.98	19.51	19.20	3.22	3.23	3.09	2.98	2.91	2.87	26.75	26.81	26.00	25.37	24.98	24.73
R3_40m	21.14	21.21	20.08	19.47	19.06	18.81	3.06	3.07	3.00	2.91	2.85	2.81	25.86	25.91	25.44	24.94	24.60	24.39
R3_50m	20.38	20.44	19.61	19.10	18.74	18.52	2.95	2.96	2.92	2.85	2.80	2.77	25.24	25.28	25.03	24.63	24.33	24.15
R3_60m	19.81	19.87	19.24	18.81	18.49	18.29	2.87	2.88	2.86	2.81	2.76	2.74	24.79	24.83	24.70	24.38	24.12	23.96
R3_70m	19.37	19.42	18.93	18.57	18.29	18.10	2.81	2.82	2.82	2.77	2.73	2.71	24.44	24.47	24.43	24.18	23.95	23.80
R3_80m	19.01	19.06	18.67	18.36	18.11	17.94	2.76	2.77	2.78	2.74	2.71	2.69	24.16	24.19	24.21	24.00	23.81	23.67
R3_90m	18.71	18.75	18.45	18.18	17.96	17.80	2.73	2.73	2.74	2.72	2.69	2.67	23.94	23.97	24.02	23.85	23.69	23.56
R3_100m	18.46	18.50	18.25	18.02	17.83	17.68	2.69	2.70	2.72	2.69	2.67	2.65	23.75	23.78	23.85	23.72	23.57	23.46
R3_110m	18.25	18.29	18.08	17.88	17.71	17.57	2.67	2.67	2.69	2.67	2.65	2.63	23.60	23.62	23.71	23.61	23.48	23.37
R3_120m	18.07	18.11	17.93	17.76	17.60	17.48	2.64	2.65	2.67	2.66	2.64	2.62	23.47	23.49	23.58	23.50	23.39	23.30
R3_130m	17.91	17.95	17.80	17.64	17.50	17.39	2.63	2.63	2.65	2.64	2.62	2.61	23.36	23.38	23.47	23.41	23.31	23.22
R3_140m	17.78	17.81	17.68	17.54	17.41	17.31	2.61	2.61	2.63	2.62	2.61	2.60	23.26	23.28	23.38	23.32	23.24	23.16
R3_150m	17.65	17.68	17.57	17.44	17.33	17.23	2.59	2.60	2.62	2.61	2.60	2.59	23.17	23.19	23.28	23.24	23.17	23.10
R3_160m	17.54	17.57	17.47	17.36	17.25	17.16	2.58	2.58	2.60	2.60	2.59	2.58	23.09	23.11	23.20	23.17	23.11	23.04
R3_170m	17.44	17.47	17.37	17.27	17.18	17.09	2.57	2.57	2.59	2.59	2.58	2.57	23.02	23.04	23.13	23.10	23.05	22.99
R3_180m	17.35	17.37	17.29	17.20	17.11	17.03	2.56	2.56	2.58	2.57	2.57	2.56	22.96	22.98	23.06	23.04	22.99	22.94
R3_190m	17.26	17.29	17.21	17.13	17.04	16.97	2.55	2.55	2.57	2.56	2.56	2.55	22.90	22.92	23.00	22.98	22.94	22.89
R3_200m	17.18	17.21	17.13	17.06	16.99	16.92	2.54	2.54	2.56	2.56	2.55	2.54	22.85	22.86	22.94	22.93	22.89	22.85
RM_90m	18.48	18.52	18.22	17.98	17.77	17.61	2.69	2.69	2.71	2.69	2.67	2.65	23.74	23.76	23.83	23.71	23.56	23.44

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