THE PLANNING ACT 2008

M4 (JUNCTIONS 3 TO 12) (SMART MOTORWAY) DEVELOPMENT CONSENT ORDER APPLICATION

TR010019

Issue Specific Hearing - Environment - Air Quality

Appendix D - Speed Banding Risk View Technical Note

Deadline VII - 17 February 2016

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Summary

1. The M3M4 traffic model was satisfactorily validated to Design Manual for Roads and Bridges ("DMRB") criteria based on traffic flows and journey times. However, speeds on individual links required better representation in the model. Several key routes where the required level of validation was not achieved in all time periods are noted in the Local Modal Validation Report (Local Model Validation Report – SATURN model; M3M4 Managed Motorways Highway Assignment Model, May 2013 ("LMVR")).

2. Whilst the model performance is entirely sufficient to support the economic assessment of the M4 junctions 3 to 12 smart motorway scheme (the "Scheme"), it is preferable to have finer detail for the environmental assessments that rely on data at individual link level to assess effects at the individual property or façade level.

3. The publication of Interim Advice Note ("IAN") 185/15 "Updated traffic, air quality and noise advice on the assessment of link speeds and generation of vehicle data into 'speed bands' for users of DMRB Volume 11, Section 3, Part 1 'Air Quality' and Volume 11, Section 3, Part 7 'Noise'" sought to improve the approach hitherto used under DMRB by introducing two methods for adjusting vehicle speeds from the traffic model for inclusion in air quality and noise assessments for highways schemes:
    a. First, vehicle speeds are aggregated into three or four speed 'bands'; and

b. Secondly, model forecasts are used to calculate the ‘change’ in traffic speed relative to the observed value, rather than actual model speeds.

4. This Note presents the findings of a quantitative risk review into the application of the IAN 185/15 principles to the environmental assessments for air quality and noise undertaken for the Scheme. In particular, the reviews considered whether the implementation of the speed banding approach (see above) would result in a different determination of significance of air quality and noise effects from that presented in the Scheme’s Environmental Statement (“ES”). This quantitative review builds upon a qualitative risk review for air quality undertaken in July 2015 (Highways England document number 514451-MUH-00-ZZ-TN-EN-400096), which concluded that there is a possibility that an assessment carried out in accordance with IAN 185/15 could identify a significant effect in terms of air quality along the Scheme. Similarly, for the noise assessment, the implications for the changed approach on the findings of the assessment and the need for mitigation have been considered.

5. Following completion of the traffic dataset for speed banding, the noise model for the Scheme was also revised to incorporate the speed band data for all links in the study area. The model was run to calculate façade noise levels to all sensitive receptors and noise level contours in the study area.

6. The assessment found that the employment of the speed band data results in a slight improvement in the noise level changes, with fewer receptors experiencing noise increases.

7. It is therefore concluded that there is no requirement for the provision of additional noise mitigation (beyond that specified in the Environmental Statement) as a consequence of employing the speed band data in the noise assessment for the Scheme.

8. Similarly, for air quality the quantitative review also suggests that the use of the IAN 185/15 approach does not result in a significant air quality effect.

Introduction

9. Historically, traffic models have been developed with a focus on providing information to inform a scheme's economic assessment. Whilst traffic flows have been used to inform environmental assessments and scheme design, the increased risks around air quality in particular, have required more careful consideration in relation to accuracy and suitability of traffic data required at the link level, as opposed to more strategic flows.

10. Whilst there are validation criteria routinely employed for modelled traffic flows at the link level, the criterion for journey time validation is based on discrete journeys through the model area and not at the individual link level. A review of journey times undertaken as part of scheme assessments has shown that the accuracy of journey times does not always correlate well to speeds on individual links.

11. IAN 185/15 (Updated traffic, air quality and noise advice) is intended as a procedure for improving the modelling of noise and air quality at the individual link level. This is achieved through adjustment of individual link speed forecasts better to reflect conditions and speeds which can be observed currently.

M4 Traffic Model Validation

12. An M3M4 Managed Motorways ("MM") Highway Assignment Model was originally built and validated for a 2008 base year in accordance with relevant WebTAG guidance, and this was initially used for the assessment of alternative managed motorway operational regimes for the M3 motorway between junctions 2-4a.

13. In August 2012, WebTAG Unit 3.19, *Highway Assignment Modelling* ("HAM") was released. A review of the existing M3M4 MM model was undertaken and concluded that the model development and validation was not fully in accordance with that new guidance. Further updating of the model was therefore commissioned to ensure compliance with this new guidance, which was, of course, achieved

14. Model calibration and validation was undertaken and reported in accordance with the HAM guidance. Validation of the model included assessment of the model convergence, together with:

    a. Network validation, in terms of range checking and routeing;
    b. Assignment validation (link based validation); and
    c. Journey time validation.

15. Link flow validation (comparing observed and modelled flows) was undertaken initially using flows crossing screenlines across the model area and then for individual links, for each model time period and separately for light and heavy vehicles.

16. The flow comparison criteria at screenline level were satisfied for light vehicles although not for heavy vehicles. However, statistical comparisons were provided that demonstrated that the heavy vehicle comparisons at screenline level were still acceptable.

17. Link flow comparisons showed that the model development procedure has improved the level of fit for observed and modelled link flows. All of the time period and vehicle types met the WebTAG criteria, thus demonstrating a well validated assignment model at the individual link level.

18. Journey time comparisons between observed and modelled values were undertaken over a large number of routes across the model area, again, for individual time periods. WebTAG criteria were met in most cases although not fully in the PM peak model.

19. The LMVR for the M3M4 model did, however, make note of specific locations/ routes where journey time comparisons were relatively poor. These included:

    a. *A308 Sunbury M25 J13 to Hampton Court AM Peak (Eastbound Direction)*; this section of the A308 is running fast in the model. This was considered to be acceptable at this location;

    b. *A329 Reading to Earley: Inter-peak (Southbound Direction) and PM Peak (Both Directions)*; this section of the A329 is running fast in the model, southbound during the Inter-peak and in both directions during the PM Peak. Given the very short distance and localised nature of this route, this was considered to be acceptable at this location;

c. *A329 Reading to Pangbourne PM Peak (Both Directions)*; this section of the A329 is running fast in the model in both directions during the PM Peak. This was considered to be acceptable at this location;

d. *A327 Reading to Lower Earley PM Peak (Southbound Direction)*; this section of the A327 is running fast in the model, southbound during the PM Peak. Given the short distance and localised nature of this route, this was considered to be acceptable at this location; and

e. *M25 – J10-17 PM Peak (Both Directions)*; this section of the M25 is running fast in the model in both directions during the PM Peak.

20. Further comparisons of observed and modelled speeds were undertaken at four Air Quality Management Areas ("AQMAs") on the M3 and M4. These showed that the model was in broad agreement with observed speeds although validation criteria were not met in some time periods or direction of travel.

21. As a footnote to the journey time validation, some questions were raised over the quite marked variability of observed speeds on the motorway network and, in other locations, the difficulty in capturing a large enough sample of journey time observations, particularly in congested networks, where times are very variable. These points have particular relevance to assessments based on models for which journey times were obtained using direct, 'moving observer' survey methods as they question the reliability of both modelled and observed speeds which are used for the speed banding adjustment process. They have less relevance where journey time data is taken from continually monitored sources and point to the need to ensure a sufficiently large sample of data is analysed to obtain reliable estimates of times and speeds.

22. In summary, the updated M3M4 model was developed in the context of then newly published guidance on highway assignment modelling and was judged by Highways England to have complied overall with this guidance. The model was therefore agreed to be fit-for-purpose in assessing the effects of the proposed smart motorway improvements.

Application of IAN 185/15 to M4 environmental assessments

23. In May 2015, the Alliance was commissioned by Highways England to provide speed banding data from the M4 traffic model for subsequent environmental assessments. The purpose of this exercise was to provide traffic data that could be used to undertake air quality and noise assessments based on IAN 185/15 that could be compared to the air quality and noise assessment results produced previously using traditional approaches and presented in the ES.

24. In line with the IAN 185/15 guidance, the following steps were carried out in order to provide the speed banding information required for the environmental assessments for air quality and noise for the Scheme.

Step 1: Collation/Analysis of Observed Speed data from Trafficmaster Journey Time Data

25. Trafficmaster Journey Time ("JT") data provides observed travel time along the Integrated Transport Network ("ITN") which is available from the Department for Transport on request. As the air quality assessment was based on the base year 2013 data, the Trafficmaster JT data was requested to cover 12 months from 1st September 2013 to 31st August 2014 for consistency with the traffic model which itself was developed from survey data collated from a similar timespan in 2009-2010.

26. The Trafficmaster data were then filtered to include only weekdays (i.e. excluding weekends and bank holidays). The process was then undertaken to aggregate JT data from the initial 15 minute intervals into the various weekday equivalent periods.

Step 2: Aggregate ITN network links to traffic model links

27. The process was carried out to provide a correspondence between ITN links (for which the observed JT data were available) and the modelled links.

Step 3: Aggregate observed travel time from ITN links to modelled links and calculate observed speed for modelled links by time period

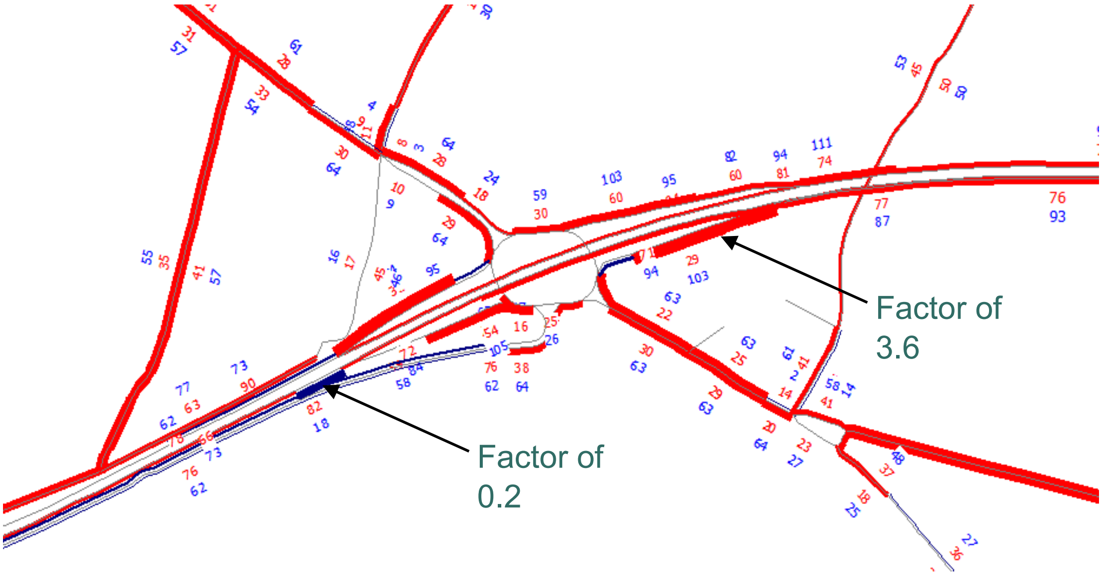
28. The JT data derived from the Step 1 was then aggregated to modelled links using the correspondence as produced in Step 2. Observed speed was then calculated by dividing the modelled link lengths by the total travel times on all the ITN links that constitute each modelled link.

Step 4: Calculate Speed Pivoting Factor, derive base year pivoted speeds and assess performance of base year speed

29. For each link, the ratio of modelled to observed speed (termed the speed pivoting ("SP") factor) was calculated and applied to derive the base year pivoted speed using the IAN 185/15 guidance.

30. An assessment of the performance of the base year speed was then carried out to identify links where the absolute difference between observed speed and modelled speed was greater than 15%. Particular attention was paid to links where the SP factor was greater than 1.15, as this would result in a potential problem with the forecast models. Figure 1 below provides an illustration of the assessment of the base year speed.

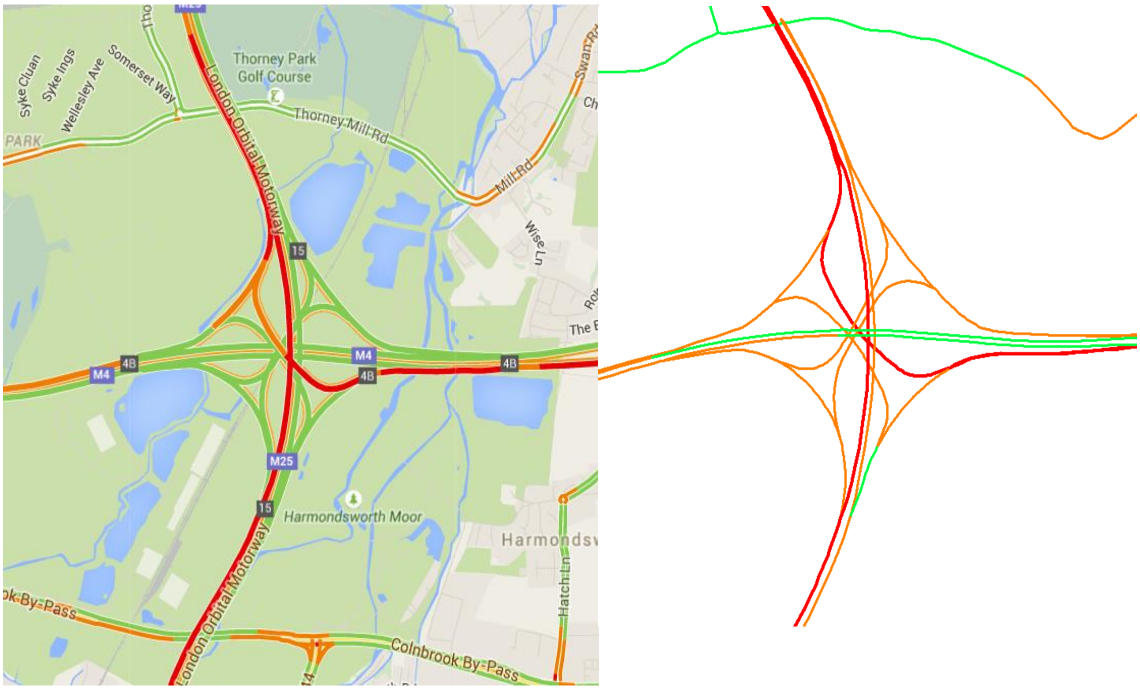
Figure 1 Assessment of base year speed performance



31. As can be seen on the westbound off-slip, the modelled speed (red) shows 29km/h whereas the observed speed (blue) shows 103km/h. That results in a SP factor of 3.6. In the forecast model, if then the modelled speed increases to 50km/h then the observed speed would increase to 3.6x50 = 178km/h.

32. Pivoted speeds were also checked against Google Map Traffic Speed information to provide a sense check on the performance of the pivoted speed, as shown in Figure 2 below. The map on the left is taken from Google's traffic information and shows speeds banded from "fast" (green) through amber to "slow" (red). The map on the right depicts the pivoted speeds colour coded to provide a similar comparative picture.

Figure 2 Comparison of Pivoted Speed (right) against Google Map (left)



Step 5: Assign pivoted speeds to speed band for motorway and non-motorways and manually adjust speed band according to IAN 185/15 guidance

33. This process was carried out in two steps:

a. Apply IAN 185/15 guidance to automatically assign pivoted speed to the relevant speed band; and then

b. Manually adjust the speed band for all the pivoted speeds that fall in the cusp (+/-15km/h) of two speed bands.

34. The manual assigning process was carried out taking into account the following:

a. Model links coded with delay nodes, slip-roads (particularly slip-roads with tight bends), and approaches to junctions;

b. Links in urban or rural areas (comparing speed against speed limit);

c. Road characteristics such as tight bends, turning radius, hills, etc.; and

d. Local knowledge of the area.

35. Figure 3 below shows an illustration of the manual adjustment process on a slip-road. In order to compare speeds and bands on a map base, it was decided to convert the descriptive labels for each speed band to a numerical equivalent. Table 1 below shows the conversions based on the IAN 185 descriptors.

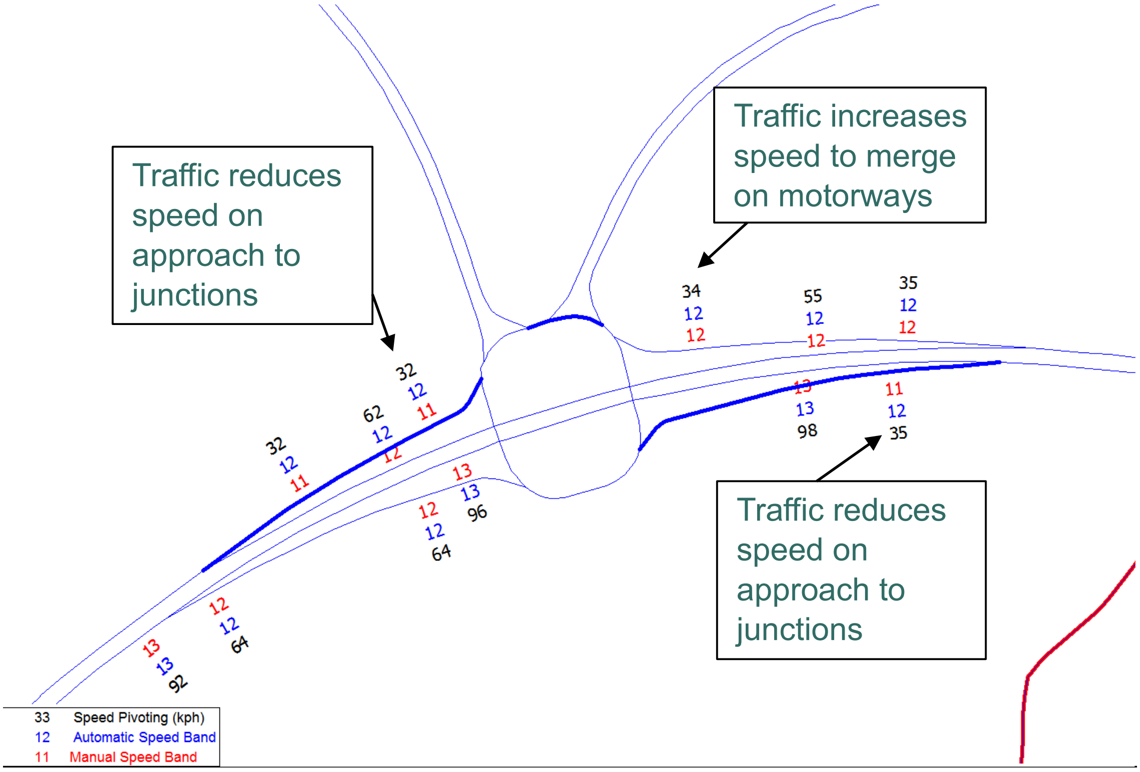
Table 1 Equivalent codes for speed-band descriptors

Speed Band Category	Motorway Link Code	Urban/Rural Link Code
Heavy Congestion	11	21
Light Congestion	12	22
High Speed	13	n/a
Free Flow	n/a	23
High Speed Urban Road	n/a	24

36. The figures in black are the assessed speeds from the speed banding process, the figures in blue are the speed band values automatically applied to the speed values, and the figures in red are the manually adjusted final speed band values. The process is illustrated by way on the following example.

37. The modelled speeds on the exit slip to the north-west quadrant of the junction in Figure 3 commence at 32km/h as traffic leaves the motorway, increase to 62km/h on the slip, and slow to 32km/h at the approach to the junction. Each of these speeds falls into the “light congestion” band, and automatically coded 12 (blue figures). As the speed of 32km/h falls within the cusp of the adjacent “heavy congestion” band (speeds <30km/h), it was decided “heavy congestion” was more representative of local conditions and therefore these values were manually reallocated to that band (code 11 – red figures).

Figure 3 Example of Manual Adjustment Process



Step 6: Apply Speed Pivoting Factor to Do-Minimum and Do-Something networks, manually adjust forecast pivoted speed where required

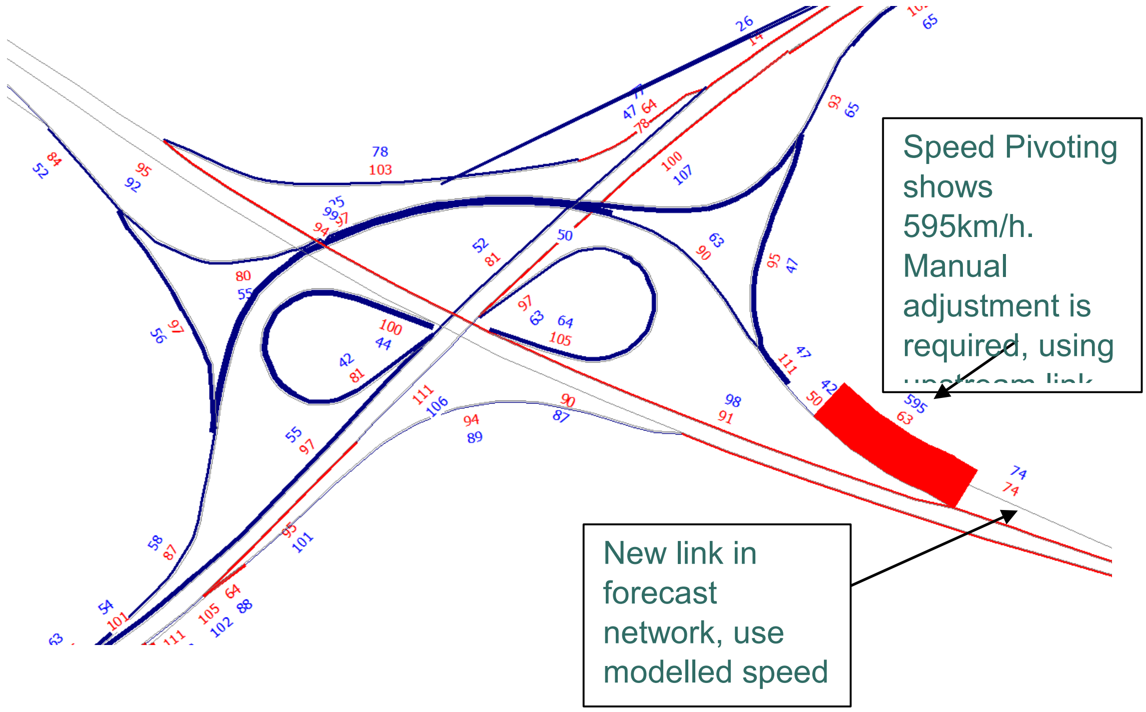
38. The process carried out was to apply the SP factor to the Do-Minimum and Do-Something modelled speed to derive the pivoted speed for the forecast years.

39. The process was then to identify links where:
   a. The SP factor is greater than 1.15;
   b. Pivoted speed is greater than speed limits; and
   c. No observed speed data was available.

40. For those links, the manual adjustment process was carried out, taking into account the following:
   a. Utilise upstream/downstream links with similar characteristics; or
   b. Use modelled speeds.

41. Figure 4 below provides an illustration of the manual adjustment process for forecast link speed.

Figure 4 Manual Process for Forecast Link Speed



Application of IAN 185/15 to Air Quality Assessment

42. This section of the Note sets out the results of the detailed modelling of air quality following the speed banding methodology set out in IAN 185/15. The results of the detailed modelling are compared against the results presented within the ES for the Scheme submitted to the Planning Inspectorate (the Examining Authority ("ExA")) as part of the application for a Development Consent Order.

43. The additional calculations have been undertaken at the request of Highways England as the ES was completed utilising the guidance available during the assessment period for the Scheme, prior to the release of IAN 185/15 in January 2015.

Method

44. Following completion of the traffic dataset for speed banding, the air quality assessment for the Scheme was carried out in line with the methodology in IAN 185/15. The assessment was carried out for the following scenarios:
    a. Baseline 2013;
    b. Do Minimum 2022 (“DM”); and
    c. Do Something 2022 (“DS”).

45. The air quality predictions were carried out in line with the requirements of DMRB Volume 11, Section 3, Part 1 (HA207/07) and other associated IANs (170/12 and 174/13).

46. This speed banded assessment has focused on annual average concentrations of NO_2 as this was the key pollutant in the evaluation of air quality significance for the Scheme.

47. This assessment focused on the Scheme, adjoining routes (e.g. M4 east of Scheme, A4 east of M4 and A329(M)) and included those roads crossing these roads for an accurate assessment of air quality (e.g. A308 at Bray and A329 at Winnersh and Emmbrook). Wider areas, where reductions in flow were identified (e.g. M3 and M40) or where very small changes in annual mean pollutant concentrations were predicted at areas just over the AADT change criteria (e.g. A4 and A308 in Windsor) have not been assessed using the speed banding methodology. These areas have not been assessed as these are unlikely to contribute to any assessment of air quality significance for the scheme using the speed banded approach.

Background

48. The number of receptors informing the overall evaluation of significance for the original results as presented in the ES is presented in Table 2.

Table 2: Original number of receptors in the evaluation of significance

Magnitude of Change in NO_2 ($\mu g/m^3$)	Number of Receptors with:	
	Worsening of air quality already above objective or creation of a new exceedence	Improvement of air quality already above objective or removal of an existing exceedence
Large	0	0
Medium	7	0
Small	11	0

49. Highways England's IAN 174/13 "Updated advice for evaluating significant local air quality effects for users of DMRB Volume 11, Section 3, Part 1 'Air Quality' (HA207/07)" outlines the number of properties within each change band which constitutes a potentially significant effects, as reproduced in Table 3. For example in instances where the numbers of properties with a small change is between 30 and 60 this suggests that a scheme is potentially significant for air quality. For Schemes where the number of small deteriorations is above 60 properties this increases the likelihood that a scheme is potentially significant for air quality.

Table 3: Guideline to Number of Properties Constituting a Significant Effect

Magnitude of Change in NO_2 ($\mu g/m^3$)	Number of Receptors with:	
	Worsening of air quality already above objective or creation of a new exceedance	Improvement of air quality already above objective or removal of an existing exceedance
Large (>4)	1-10	1-10
Medium (>2-4)	10-30	10-30
Small (>0.4-2)	30-60	30-60

Baseline and Verification

50. The 2013 baseline models were prepared and the verification process repeated with the updated modelled road NO_x contributions. The revised assessment led to revised verification factors, which were then used in the post-processing of the NO_2 results. The factors, and those used in the ES assessment for comparison, are presented in Table 4.

Table 4: Adjustment Factors used in Assessment

Zone No.	Zone	ES Assessment	IAN 185/15 Assessment
1	A and B Roads adjacent to M4	2.55	2.28
2	Area between Junctions 6 and 7 of M4	3.64	3.47
3	Area around Bray Wick, south of M4	1.60	1.61
4	Area around A33/B3031	5.28	4.32
5	Area around Brookers Hill	5.09	5.20
6	Area around M3 J3 and 4	2.14	N/A
7	Chobham SSSI, north of M3	2.72	N/A
8	All other areas adjacent to M3	1.24	N/A
9	Rest of the study area	1.64	1.61

N/A = area not included in this assessment

51. The most notable difference in factor in the above comparison is for the A33/B3031 junction. This zone comprises a single tube located close to this junction at the edge of Whitley Wood. The reduction in verification factor is due to a higher road NO_x contribution (i.e. the amount of NO_x at a measurement locations/receptor that comes from road traffic) at this measurement location with the revised methodology. The B3031, adjacent to the measurement location, on the approach to the junction was identified as being in a more congested speed band with the revised methodology compared to the dataset used in the ES, leading to higher emissions.

52. For the receptors identified in Table 1, as contributing to the overall evaluation of significance, these all fall in verification zones 1, 2 and 9. The verification factors for these zones are lower (i.e. the model performs better) following the IAN 185/15 methodology compared to the ES methodology.

Assessment Results

53. The number of sensitive receptors predicted to experience a small, medium or large change in annual mean NO_2 concentrations, with concentrations above the objective value following the methodology set out in IAN 185/15, are set out in Table 5.

Table 5: Number of Receptors in the Evaluation of Significance following IAN 185/15

Magnitude of Change in NO_2 ($\mu g/m^3$)	Number of Receptors with:	
	Worsening of air quality already above objective or creation of a new exceedance	Improvement of air quality already above objective or removal of an existing exceedance
Large (>4)	0	0
Medium (>2-4)	1	0
Small (>0.4-2)	15	0

54. The number of sensitive receptors predicted to experience a small, medium or large change in annual mean NO_2 concentrations, with concentrations above the objective value, following the methodology set out in IAN 185/15 is lower than the number predicted following the methodology in the ES.

55. The receptors that are predicted to experience small and medium increases in annual mean NO_2 concentrations above the objective are located in the same areas as those predicted to experience the same with the ES methodology. Those areas are:

a. Adjacent to the B3030 to the south of the M4 where it crosses;

b. Lake End, near junction 7;

c. Chalvey, adjacent to junction 6; and

d. Adjacent to the A332 to the north of the M4 where it crosses.

56. Following the ES methodology, there are areas where receptors were predicted to experience small and medium increases in annual mean NO_2 concentrations above the objective but this is not the case when following the IAN 185/15 methodology. Those areas are:

a. Emmbrook, adjacent to the A329 to the south of the M4 where it crosses; and

b. Dorney Reach, Meadow Way, adjacent to the M4 to the south.

57. There are a number of factors that influence the predicted total annual mean concentrations of NO_2 and predicted changes. These include:

a. Road alignment;

b. Meteorological data;

c. Background concentrations;

d. Emission rates/road NO_x concentrations;

e. Adjustment factor; and

f. Gap factor.

58. To calculate the total concentrations in the DM and DS scenarios the road NO_x at each receptor is multiplied by the adjustment factor for each receptor, this is then combined with background concentrations and converted to annual mean NO_2 concentrations. The annual mean concentrations predicted are then adjusted using the long-term trend ("LTT") methodology with the application of the gap factor for each receptor.

59. The first three of the above factors are consistent between the two methodologies. The IAN 185/15 methodology changes the emission rates, and therefore the associated road NO_x concentrations at each receptor. The change in emissions rates and the associated road NO_x predicted at the measurement locations affects the verification factors (as shown in Table 3). The gap factor is calculated within the spreadsheet for LTT calculations (as per IAN 170/12) and is a receptor specific factor, affected by the predicted baseline and future baseline concentrations and assessment years.

60. The annual mean concentrations for the receptors identified as contributing to the overall evaluation of significance in the ES or with the IAN 185/15 methodology are presented in Table 6 for the 2022 DM and 2022 DS scenarios and associated change for both methodologies.

Table 6: Annual Mean NO_2 Concentrations (μg/m^3)

Receptor	ES Methodology			IAN 185/15		
	DM	DS	Change	DM	DS	Change
A247	39.4	40.7	+1.3	40.2	41.5	+1.3
A248	39.3	40.6	+1.3	40.0	41.4	+1.4
A249	39.4	40.8	+1.3	40.1	41.5	+1.5
A250	39.6	41.0	+1.4	40.2	42.6	+2.3
A251	39.9	41.2	+1.4	40.5	42.0	+1.5
A252	40.2	41.6	+1.4	40.9	42.4	+1.6
A252_1	*38.3*	*39.6*	*+1.3*	38.8	40.2	+1.4
A253	40.6	42.0	+1,4	41.3	42.9	+1.6
A253_1	*38.6*	*40.0*	*+1.4*	39.1	40.6	+1.5
A254	39.3	40.6	+1.3	40.0	41.1	+1.4
A322	40.8	42.5	+1.8	39.2	40.4	+1.3
A322_1	40.3	42.1	+1.7	*35.9*	*37.0*	*+1.1*
A65	41.9	44.5	+2.6	39.6	41.2	+1.6
A65a	41.9	44.6	+2.6	39.5	41.2	+1.7
A65b	38.3	40.4	+2.2	*36.1*	*37.4*	*+1.4*
X30	38.7	40.0	+1.3	38.9	40.0	+1.2
X35	44.9	47.7	+2.8	47.0	48.5	+1.5
X36	38.1	40.4	+2.2	*37.7*	*39.3*	*+1.6*
X47	39.1	41.2	+2.1	*38.1*	*39.6*	*+1.5*
X612	43.2	45.8	+2.6	40.7	42.4	+1.6

Does not contribute to overall evaluation of significance for this methodology

61. In addition to the above annual mean NO_2 concentrations a further table of results for selected representative receptors, including unadjusted road NO_x, model adjustment factor, adjusted road NO_x, Defra verified NO_2 concentrations for DM, DS and change, LTT gap factor and NO_2 concentrations for LTT DM, DS and change are presented in Appendix 1. This additional information is presented in support of the below discussion, which describes the reasons for the small differences in predicted NO_2 concentrations between the ES and IAN 185/15 methodologies.

62. For receptors which contribute to the overall evaluation of significance at Dorney and Sindlesham (A65, A65a, A65b, X36 and X612) concentrations of road NO_x for the DM and DS are consistently lower with the IAN 185/15 methodology and that reduction with the IAN 185/15 methodology is most noticeable in the DS scenario. This is because of reductions in emissions in the Off Peak ("OP") hours in both scenarios, and additional reductions in the Inter-peak ("IP") hours in the

DS scenario on some segments of the M4 near these receptors. Although the speed band does not change between the ES and IAN 185/15 methodologies (i.e. if the speed modelled in the ES was assigned a speed band it would have been the same as that used for the IAN 185/15 methodology), the modelled emission rate does change. This is because the IAN methodology assigns an average emission rate to all links within a specific speed band. In the ES assessment a link specific speed was provided in the traffic datasets, which was used in the air quality models to produce an emission rate for that link. That same link is assigned an average emission rate with the IAN 185/15 methodology. The link may have a similar speed to the average for the band, or may have a lower or higher emission. Where a link in the ES was running at the speed limit (e.g. around 111 km/h) for a specific time period it would have a higher emission rate in the ES than it is assigned in the IAN 185/15 methodology. For these areas, in the DM scenario the modelled speed led to an emission rate similar to the emission rate for the band in the IP and OP hours, whereas in the DS scenario the speed, and emission rate, was higher in both the IP and OP hours. Overall this means that emission rates dropped more in the DS scenario than the DM scenario with the IAN 185/15 methodology, even though the links remain in the same speed band. In addition to lower emissions, the revised IAN 185/15 methodology adjustment factor is also lower than the factors used in the ES (as shown in Table 3), thereby resulting in overall lower Defra total concentrations. The gap factor calculated in the LTT adjustment was the same or within 0.01 and consequently overall the DM and DS concentrations and predicted change with the Scheme are lower with the IAN 185/15 methodology.

63. For receptors which contribute to the overall evaluation of significance at Emmbrook (X47) concentrations of road NO_x for DM and DS are higher with the IAN 185/15 methodology. The same reduction in emissions from the motorway links occurs here as described above in the IP and OP hours, however emissions from the A329 are notably higher with the IAN 185/15 methodology as more congested conditions were identified than were anticipated in the ES traffic modelling and, due to the proximity of that road to the receptor, an overall increase in road NO_x contribution is predicted. However, the revised IAN 185/15 methodology adjustment factor is lower than the factor used in the ES.

The reduction in the adjustment factor is large enough (-0.27) to more than offset the increase in road NO_x with the IAN 185/15 methodology, thereby resulting in overall lower Defra total concentrations. The gap factor calculated in the LTT adjustment was the same for both approaches and consequently overall the DM and DS concentrations and predicted change with the Scheme are lower with the IAN 185/15 methodology.

64. For receptors which contribute to the overall evaluation of significance near the A332 and M4 in Slough (A322 and A332_1) concentrations of road NO_x for DM and DS are very similar (maximum +/-0.2 $\mu g/m^3$) with the IAN 185/15 methodology. This, combined with a lower adjustment factor with the IAN 185/15 methodology, results in overall lower Defra total concentrations. The gap factor calculated in the LTT adjustment was the same and, consequently, the overall DM and DS concentrations and predicted change with the Scheme are lower with the IAN 185/15 methodology.

65. For the receptor which contributes to the overall evaluation of significance at Lake End, near junction 7 (X35) concentrations of road NO_x for DM and DS are both slightly higher with the IAN 185/15 methodology, but the gap between the DM and DS is reduced. This is due to the combined effect of emissions from the M4 and the Junction 7 on slip. Emissions from the slip road go up in all time periods with the IAN 185/15 methodology compared to the ES as the IAN 185/15 methodology identifies light congestion on this slip road in all time periods compared to the free flow conditions identified in the ES modelling. Emissions in the OP hours for both directions of the M4 are lower with the IAN 185/15 methodology due to the smoothing of speeds as described above. In addition, in the DS scenario AM and IP emissions are also lower on the westbound carriageway (closest to X35) for the same reason, therefore concentrations are lower compared to the DM scenario. The adjustment factor for this receptor is broadly similar in both 185/15 methodologies (IAN 185/15 factor is 0.03 lower than the ES factor) therefore the overall Defra total concentrations are also higher with the IAN 185/15 methodology. The gap factor calculated in the LTT adjustment was the same for both approaches and consequently overall the DM and DS concentrations

and predicted change with the Scheme are higher with the IAN 185/15 methodology.

66. For receptors which contribute to the overall evaluation of significance around junction 6 (Chalvey) (A247-A254), to the east of the A355, concentrations of road NO_x for DM and DS are consistently higher with the IAN 185/15 methodology. This is due to an increase in congestion in some or all time periods, and therefore an increase in emissions, on the two roads closest to these receptors (the eastbound on-slip and the A355 SB). These increases more than offset any improvements in emission rates on the motorway and A355 northbound in some times periods. These increases in emissions are not offset by the reduction in adjustment factor, and therefore Defra total concentrations are higher with the IAN 185/15 methodology. The gap factor calculated in the LTT adjustment was very similar (+0.01) and consequently overall the DM and DS concentrations with the Scheme are higher with the IAN 185/15 methodology, with similar predicted changes.

67. For the receptor which contributes to the overall evaluation of significance around junction 6 (Chalvey) (X30), to the west of the A355, concentrations of road NO_x for DM and DS are both slightly higher with the IAN 185/15 methodology. This is due to the increases in emission rates as described above for other Chalvey receptors and on the off-slip, however the A355 northbound (closest to X30) has lower emission rates with the IAN 185/15 methodology in the IP, PM and OP periods, which balances out some of the increases in emissions on the southbound carriageway and off-slip. However, the revised IAN 185/15 methodology adjustment factor is lower than the factor used in the ES. The reduction in the adjustment factor is large enough (-0.17) to more than offset the increase in road NO_x with the IAN 185/15 methodology, thereby resulting in an overall slightly lower Defra total concentrations. The gap factor calculated in the LTT adjustment for the IAN 185/15 methodology is slightly higher (0.02) and as the reductions in Defra predicted concentrations were very small, this has had the effect of resulting in LTT DM concentrations which are slightly higher than the ES methodology and DS concentrations that are the same.

68. The above review of the differences between ES predictions and IAN 185/15 predictions indicates that overall predicted results are very

similar. Increases in emissions in the baseline using the latest IAN approach have resulted in lower model adjustment factors, which is generally reducing concentrations and reducing the gap between DM and DS scenarios. The effect of reduced emissions in OP and often IP (particularly DS) also has the effect of reducing concentrations. Conversely, in areas where the traffic model was under-estimating congestion these areas have some slightly higher predicted concentrations. For this Scheme the risk of a significant effect on air quality is unchanged from the assessment presented in the ES.

Air Quality Assessment – Conclusion

69. The revised predictions for air quality following the IAN 185/15 speed banding methodology identified fewer properties that are predicted to experience a small, medium or large change in concentrations, with concentrations above the objective value. Therefore the risk of a significant effect on air quality is unchanged from the assessment presented in the ES, interpreting these figures cautiously.

Application of IAN 185/15 to Noise Assessment

70. Following completion of the traffic dataset for speed banding, the noise model for the Scheme was also revised to incorporate the speed band data for all links in the study area. The model was run to calculate façade noise levels for all sensitive receptors in the study area and noise level contours in the study area for the following scenarios:

   a. Do Minimum 2022;
   b. Do Minimum 2037;
   c. Do Something 2022; and
   d. Do Something 2037.

71. The calculated façade noise levels were processed according to the requirements of DMRB Volume 11, Section 3, Part 7 (HD213/11) to calculate changes in noise levels and changes in annoyance.

72. The calculated noise level contours were processed according to the requirements of DMRB Volume 11, Section 3, Part 7 (HD213/11) to provide noise level change contours:

a. Do Minimum 2037 minus Do Minimum 2022;

b. Do Something 2022 minus Do Minimum 2022;

c. Do Something 2037 minus Do Minimum 2022; and

d. Do Something 2037 minus Do Minimum 2037.

Noise Results

73. Table 7a shows the long term changes in noise levels (DM 2022 to DM 2037) as reported in the ES.

Table 7a: Long-term change in traffic noise levels (DM 2022 to DM 2037) as reported in the Environmental Statement

<table>
<tr><th colspan="2" rowspan="2">Change in noise level</th><th colspan="2">Daytime</th><th>Night-time</th></tr>
<tr><th>Number of dwellings</th><th>Number of other sensitive receptors</th><th>Number of dwellings</th></tr>
<tr><td rowspan="4">Increase in noise level
Daytime $L_{A10,18h}$ dB
Night-time $L_{night,outside}$ dB</td><td>0.1-2.9</td><td>2,954</td><td>35</td><td>1,179</td></tr>
<tr><td>3.0-4.9</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>5.0-9.9</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>≥10</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>No Change</td><td>0</td><td>640</td><td>4</td><td>327</td></tr>
<tr><td rowspan="4">Decrease in noise level
Daytime $L_{A10,18h}$ dB
Night-time $L_{night,outside}$ dB</td><td>0.1-2.9</td><td>19,426</td><td>49</td><td>4,290</td></tr>
<tr><td>3.0-4.9</td><td>5</td><td>0</td><td>0</td></tr>
<tr><td>5.0-9.9</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>≥10</td><td>0</td><td>0</td><td>0</td></tr>
</table>

74. Table 7b shows the long term changes in noise levels (DM 2022 to DM 2037) using the speed band data.

Table 7b: Long-term change in traffic noise levels (DM 2022 to DM 2037) using speed banding procedure

Change in noise level		Daytime		Night-time
		Number of dwellings	Number of other sensitive receptors	Number of dwellings
Increase in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1-2.9	2,889	34	1,099
	3.0-4.9	0	0	0
	5.0-9.9	0	0	0
	≥10	0	0	0
No Change	0	572	5	332
Decrease in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1-2.9	19,563	49	4,203
	3.0-4.9	1	0	1
	5.0-9.9	0	0	0
	≥10	0	0	0

75. It can be seen that the employment of the speed band data results in a slight improvement in the noise level changes, with fewer receptors experiencing noise increases.

76. Table 8a shows the short term changes in noise levels (DM 2022 to DS 2022) as reported in the ES.

Table 8a: Short-term change in traffic noise levels (DM 2022 to DS 2022) as reported in the Environmental Statement

Change in noise level		Daytime	
		Number of dwellings	Number of other sensitive receptors
Increase in noise level Daytime $L_{A10,18h}$ dB	0.1-0.9	505	3
	1.0-2.9	2	0
	3.0-4.9	0	0
	≥5	0	0
No Change	0	1,117	17
Decrease in noise level Daytime $L_{A10,18h}$ dB	0.1-0.9	12,893	51
	1.0-2.9	8,488	17
	3.0-4.9	20	0
	≥5	0	0

77. Table 8b shows the short term changes in noise levels (DM 2022 to DS 2022) using the speed band data.

Table 8b: Short-term change in traffic noise levels (DM 2022 to DS 2022) using speed banding procedure

Change in noise level		Daytime	
		Number of dwellings	Number of other sensitive receptors
Increase in noise level Daytime $L_{A10,18h}$ dB	0.1-0.9	333	2
	1.0-2.9	4	0
	3.0-4.9	0	0
	≥5	0	0
No Change	0	708	10
Decrease in noise level Daytime $L_{A10,18h}$ dB	0.1-0.9	10,894	56
	1.0-2.9	11,050	20
	3.0-4.9	35	0
	≥5	1	0

78. It can be seen that employment of the speed band data results in a slight improvement in the noise level changes, with fewer receptors experiencing noise increases.

79. The four residential properties with noise level increases between 1.0 and 2.9 dB using the speed band data are affected by noise from road links other than the Scheme. The maximum increase at these four properties is 1.4 dB. It is noted that the facades which experience these increases are the “quietest” facades of the properties. The facades which experience the highest noise level for these properties experience no change or a negligible decrease in noise level as a result of the Scheme opening.

80. Table 9a shows the long term changes in noise levels (DM 2022 to DS 2037) as reported in the ES.

Table 9a: Long-term change in traffic noise levels (DM 2022 to DS 2037) as reported in the Environmental Statement

Change in noise level		Daytime		Night-time
		Number of dwellings	Number of other sensitive receptors	Number of dwellings
Increase in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1-2.9	4,590	42	1,463
	3.0-4.9	0	0	0
	5.0-9.9	0	0	0
	≥10	0	0	0
No Change	0	1,418	4	433
Decrease in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1-2.9	17,003	42	3,892
	3.0-4.9	14	0	8
	5.0-9.9	0	0	0
	≥10	0	0	0

81. Table 9b shows the long term changes in noise levels (DM 2022 to DS 2037) using the speed band data.

Table 9b: Long-term change in traffic noise levels (DM 2022 to DS 2037) using speed banding procedure

Change in noise level		Daytime		Night-time
		Number of dwellings	Number of other sensitive receptors	Number of dwellings
Increase in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1-2.9	3,321	38	1,170
	3.0-4.9	0	0	0
	5.0-9.9	0	0	0
	≥10	0	0	0
No Change	0	929	3	293
Decrease in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1-2.9	18,766	47	4,167
	3.0-4.9	9	0	5
	5.0-9.9	0	0	0
	≥10	0	0	0

82. It can be seen that employment of the speed band data results in a slight improvement in the noise level changes, with fewer receptors experiencing noise increases.

83. Table 10a shows the worst case changes in annoyance for the DM and DS scenarios as reported in the ES.

Table 10a: Worst case change in traffic noise annoyance as reported in the Environmental Statement

Change in annoyance level		Do-Minimum	Do-Something
		Number of dwellings	Number of dwellings
Increase in annoyance level	<10%	2,954	4,512
	10<20%	0	72
	20<30%	0	6
	30<40%	0	0
	≥40%	0	0
No Change	0	640	1,420
Decrease in	<10%	19,431	17,014

Change in annoyance level		Do-Minimum	Do-Something
		Number of dwellings	Number of dwellings
annoyance level	10<20%	0	1
	20<30%	0	0
	30<40%	0	0
	≥40%	0	0

84. Table 10b shows the worst case changes in annoyance for the DM and DS scenarios using the speed band data.

Table 10b: Worst case change in traffic noise annoyance using speed banding procedure

Change in annoyance level		Do-Minimum	Do-Something
		Number of dwellings	Number of dwellings
Increase in annoyance level	<10%	2,889	3,278
	10<20%	0	49
	20<30%	0	5
	30<40%	0	0
	≥40%	0	0
No Change	0	572	959
Decrease in annoyance level	<10%	19,564	18,733
	10<20%	0	1
	20<30%	0	0
	30<40%	0	0
	≥40%	0	0

85. It can be seen that employment of the speed band data results in a slight improvement in the annoyance changes.

86. The results show that there is no requirement for the provision of additional noise mitigation as a consequence of employing the speed band data in the noise assessment for the Scheme.

87. In support of the results provided in Tables 7a through 10b, the predicted noise level change contours are provided as follows:

   a. Drawing 1: Do Minimum 2037 minus Do Minimum 2022 (key plan plus 16 sheets);
   b. Drawing 2: Do Something 2022 minus Do Minimum 2022 (key plan plus 16 sheets);
   c. Drawing 3: Do Something 2037 minus Do Minimum 2022 (key plan plus 16 sheets); and
   d. Drawing 4: Do Something 2037 minus Do Minimum 2037 (key plan plus 16 sheets).

88. These drawings are directly comparable with Drawing 12.3, Drawing 12.4, Drawing 12.5 and Drawing 12.6 in the ES. The differences between the noise level change contours in the above drawings and the corresponding noise level change contours in the ES are negligible.

Noise Assessment - Conclusion

89. Based on the results in Tables 8a to 11b and a comparison of Drawings 1 to 4 with Drawings 12.3 to 12.6 in the ES, it is concluded that employment of speed banding data in the noise assessment for the Scheme results in minimal differences in the short term and long term noise level and annoyance changes, when compared to the results using modelled speed data as reported in the ES. It is concluded that there is no requirement for the provision of additional noise mitigation (beyond that specified in the ES) as a consequence of employing the speed band data in the noise assessment for the Scheme.

Appendix 1: Air Quality Results

Receptor	Ass. Method	Road NOx (µg/m³)			Adj. Factor	Adjusted Road NOx (µg/m³)*			Defra Total Annual Mean NO_2 (µg/m³)			Gap Factor	LTT Total Annual Mean NO_2 (µg/m³)		
		DM	DS	Change		DM	DS	Change	DM	DS	Change		DM	DS	Change
A65	ES	18.6	20.8	2.2	2.55	47.4	53.0	5.6	33.4	35.5	2.1	1.26	42.0	44.6	2.6
	IAN	18.5	20.0	1.5	2.28	42.2	45.6	3.4	31.3	32.6	1.3	1.26	39.6	41.2	1.6
	Dif.	-0.1	-0.8	-0.7	-0.27	-5.3	-7.4	-2.2	-2.1	-2.9	-0.8	0.00	-2.4	-3.4	-1.0
A247	ES	9.8	10.5	0.8	3.64	35.5	38.3	2.7	33.5	34.5	1.0	1.18	39.4	40.7	1.3
	IAN	10.4	11.2	0.8	3.47	36.1	38.9	2.8	33.7	34.8	1.1	1.19	40.2	41.5	1.3
	Dif.	0.6	0.7	0.0	-0.17	0.6	0.6	0.0	0.2	0.3	0.1	0.01	0.8	0.8	0.0
A250	ES	9.9	10.7	0.8	3.64	36.0	38.9	2.9	33.7	34.8	1.1	1.18	39.6	41.0	1.4
	IAN	10.5	11.4	0.9	3.47	36.4	39.6	3.1	33.8	35.8	2.0	1.19	40.2	42.6	2.4
	Dif.	0.6	0.7	0.1	-0.17	0.4	0.6	0.2	0.1	1.0	0.9	0.01	0.6	1.6	1.0
A252	ES	10.2	11.1	0.9	3.64	37.1	40.4	3.3	34.1	35.3	1.2	1.18	40.2	41.6	1.4
	IAN	10.9	11.9	1.0	3.47	37.8	41.3	3.5	34.3	35.6	1.3	1.19	40.9	42.4	1.5
	Dif.	0.7	0.8	0.1	-0.17	0.7	0.9	0.2	0.2	0.3	0.1	0.01	0.7	0.8	0.1
A322	ES	13.9	15.4	1.5	2.55	35.4	39.3	3.8	35.9	37.4	1.5	1.14	40.8	42.5	1.7
	IAN	14.1	15.3	1.2	2.28	32.1	34.9	2.7	34.6	35.7	1.1	1.13	39.2	40.4	1.2
	Dif.	0.2	-0.1	-0.3	-0.27	-3.3	-4.4	-1.1	-1.3	-1.7	-0.4	-0.01	-1.6	-2.1	-0.5
X30	ES	9.4	10.2	0.8	3.64	34.2	37.1	2.9	33.0	34.2	1.2	1.17	38.7	40.0	1.3
	IAN	9.7	10.5	0.8	3.47	33.7	36.4	2.8	32.8	33.8	1	1.19	38.9	40.0	1.1
	Dif.	0.3	0.3	0.0	-0.17	-0.6	-0.7	-0.1	-0.2	-0.4	-0.2	0.02	0.2	0.0	-0.2
X35	ES	31.4	35.3	3.9	1.64	51.5	57.9	6.4	36.8	39.1	2.3	1.22	44.9	47.7	2.8
	IAN	35.1	37.2	2.1	1.61	56.5	59.9	3.4	38.6	39.8	1.2	1.22	47.0	48.5	1.5
	Dif.	3.7	1.9	-1.8	-0.03	5.0	2.0	-3.0	1.8	0.7	-1.1	0.00	2.1	0.8	-1.3
X36	ES	22.4	25.3	2.9	1.64	36.7	41.5	4.8	31.9	33.8	1.9	1.19	38.1	40.4	2.3

	IAN	22.1	24.2	2.1	1.61	35.6	39.0	3.4	31.4	32.8	1.4	1.20	37.7	39.3	1.6
	Dif.	-0.3	-1.1	-0.8	-0.03	-1.2	-2.5	-1.4	-0.5	-1.0	-0.5	0.01	-0.4	-1.1	-0.7
X47	ES	16.2	17.9	1.7	2.55	41.3	45.6	4.3	31.7	33.5	1.8	1.23	39.1	41.2	2.1
	IAN	17.3	18.6	1.3	2.28	39.4	42.4	3.0	30.9	32.1	1.2	1.23	38.1	39.6	1.5
	Dif.	1.1	0.7	-0.4	-0.27	-1.9	-3.2	-1.4	-0.8	-1.4	-0.6	0.00	-1	-1.6	-0.6
X612	ES	19.7	21.9	2.2	2.55	50.2	55.8	5.6	34.4	36.5	2.1	1.25	43.2	45.8	2.6
	IAN	19.6	21.1	1.5	2.28	44.7	48.1	3.4	32.3	33.6	1.3	1.26	40.7	42.4	1.7
	Dif.	-0.1	-0.8	-0.7	-0.27	-5.5	-7.7	-2.2	-2.1	-2.9	-0.8	0.01	-2.5	-3.4	-0.9

[*]Note. This is an approximation based on multiplying the road contribution by the factor identified in the table. In practice in the assessment data to more decimal places is carried through the calculations.