

Appendix E – Air Quality Modelling Techniques – Elevated Road Tool

Introduction

A National Highways' innovation competition for air quality saw the development of a new air quality modelling tool to assess the effect of elevated roads on pollution dispersion.

Following a review of all 129 SRN PCM links previously assessed across commissions 1 – 3, five SRN PCM links have been identified as exhibiting elevated road characteristics i.e. part or all of the SRN that makes up the PCM link is several metres above the local roads, footpaths and / or residential properties. A summary of the details of the elevated sections for each of the five SRN PCM links is provided in Table E1.

Table E1 – Sections of the SRN within the PCM model with elevated road characteristics

SRN PCM link	Location	Description	Previously Assessed Compliance Outcome
28776	A1, Gateshead	The mainline of this SRN PCM link is elevated. However, there is a sports centre within 15m of the northbound entry slip which is at grade with the road i.e. not elevated.	Above limit value
26012	M4, Hillingdon	Only parts of this link are elevated. The elevated sections of the SRN are towards the east end of the PCM link where footpaths are located below the motorway. There are some receptors (gardens) located within 15m along the western edge of the PCM link. This section of the motorway is not elevated. The A4 runs parallel beneath the M4, and has approximately 35,000 vehicles per day which will contribute to local ground level NO ₂ concentrations. The contribution from this road has been accounted for within the modelling.	Predicted to achieve compliance in 2020/2021
47892	M4, Hillingdon	The mainline of this SRN PCM link is elevated and footpaths are located below the motorway. However, there are houses located adjacent to the eastern extents of the PCM link, with roof eaves and upper floors close to the level of the running lane. The A4 runs parallel beneath the M4, and has approximately 35,000 vehicles per day which will contribute to local ground level NO ₂ concentrations. The contribution from this road has been accounted for within the modelling.	Above limit value
46015	M5, West Midlands	This section of the M5 is elevated. However, there are houses located adjacent to the motorway, with roof eaves and upper floors close to the level of the running lane.	Above limit value
70206	M11, Walthamstow	The entire SRN PCM link covering this section of the M11 is elevated with a footpath located beneath the motorway.	Above limit value

Methodology

The location of the nearest qualifying features alongside each of the SRN PCM links with elevated features have been remodelled using the newly developed elevated road tool in the ADMS modelling software.

Table E2 sets out the five SRN PCM links and the additional parameters required to undertake the modelling of the elevated roads. The road width and traffic characteristics normally included within the ADMS model are provided in Table E4.

Table E2 – Elevated Roads Input Parameters

Census ID	Road Name	Receptor	Height of receptor above ground (m)	Height of Elevated Road above ground (m)
28776	A1, Gateshead	Footpath	1.5	6.9
26012	M4, Hillingdon	Footpath	1.5	8.0
47892	M4, Hillingdon	Footpath and Residential property (a)	1.5 4.5 8.0	8.0
46015	M5, West Midlands	Residential property (a)	1.5 4.5 8.3	8.3
70206	M11, Walthamstow	Footpath	1.5	12.0
Notes (a) Receptor heights representing different exposure points corresponding to the height of different floor within the property i.e. ground, 1 st floor, loft space (Figure E1 – Census ID 46015, Figure E2 – Census ID 47892)				

Receptor locations and their grid references are provided in Figures E3 – 5. Note that in some instances due to a change in the PCM model network the receptor location modelled using the elevated roads tool is not in the same location as the original receptor. Both receptor locations have been provided in the figures where applicable.

Results

The verified air quality modelling results using the new elevated roads tool for the 5 SRN PCM links are presented in Table E3. The verification process has followed the same process as described in the various Phase 3 assessment reports.

Elevated Roads Sensitivity Test

As shown in Table E3 the verified modelled NO₂ concentrations for two of the five SRN PCM links (28776 and 70206) are below the annual mean NO₂ limit value at the nearest qualifying receptors using the elevated roads tool. For both SRN PCM links the elevated road is above open fields with public access several metres below the road. It is proposed to recommend to JAQU that these 2 links are now compliant with the NO₂ annual mean limit value and to change their status to 'limit value met'.

It should be noted that for SRN PCM link 28776, an additional qualifying feature (playing fields) has been identified within 15m of the PCM link along a non-elevated section of the A1 (northbound on slip) following an update to the road network in the PCM model. However, verified modelling NO₂ concentrations alongside the slip road are also well below the limit value.

Annual mean NO₂ concentrations for SRN PCM link 46015 are also below the limit value, as shown in Table E3. These concentrations are highest at the receptor height of 8.3m, which is nearest the road level of the M5, where it passes closest to the property (Figure E1). The annual mean NO₂ concentrations continue to decrease down through the building (4.5m and 1.5m above street level) as it 'effectively' moves further away from the elevated road level of the M5. However, NO₂ concentrations are modelled to be higher at the 1.5m receptor location compared to 4.5m, and this reflects the greater additional contribution from the local road as it passes close to this property.

Table E3 – Annual Mean NO₂ Concentrations (µg/m³) comparing the Elevated Roads Tool and the original modelling results reported within Phase 3 Commission No. 1.

Census ID	Operating Conditions		Year									
			2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
47892 (a)	Previous Modelling for Phase 3 Assessment											
	Footpath	1.5m above ground	61	58	55	52	49	46	43	40	38	36
	Elevated Roads Tool											
	Footpath	1.5m above ground	61	57	53	49	46	43	40	38	35	33
	Residential Property	1.5m above ground	36	34	31	29	28	27	26	25	24	23
		4.5m above ground	39	37	34	32	30	29	27	26	25	24
	8.0m above ground	42	39	37	34	32	31	29	28	26	25	
70206	Previous Modelling for Phase 3 Assessment											
	Footpath	1.5m above ground	59	56	53	50	47	44	42	40	38	36
	Elevated Roads Tool											
	Footpath	1.5m above ground	24	23	21	20	19	19	18	18	17	17
46015	Previous Modelling for Phase 3 Assessment											
	Residential Property	1.5m above ground	58	55	52	49	47	44	42	40	37	36
	Elevated Roads Tool											
	Residential Property	1.5m above ground	37	34	32	29	28	27	26	25	24	23
		4.5m above ground	35	32	30	27	26	25	24	23	22	22
8.3m above ground		38	35	32	30	28	27	26	25	24	23	
28776	Previous Modelling for Phase 3 Assessment											
	Footpath	1.5m above ground	52	50	48	45	43	40	38	36	34	32
	Elevated Roads Tool											
	Footpath	1.5m above ground	20	18	17	16	15	14	14	13	12	11
26012	Previous Modelling for Phase 3 Assessment											
	Footpath	1.5m above ground	49	47	44	42	40	37	35	33	32	30
	Elevated Roads Tool											
	Footpath	1.5m above ground	46	43	39	36	34	32	30	28	27	25
Notes												
(a) Footpath and residential property are in different locations, see Figure E5												

For two M4 SRN PCM links (26012 and 47892), modelled NO₂ concentrations are still above the limit value at the footpaths beneath the M4 when using the elevated roads tool. This is due to contributions from the A4, which is a busy local road, carrying approximately 35,000 vehicles per day, with modelled concentrations indicating that 75% of the NO₂ concentrations is from the A4 rather than the M4 at the footpath below SRN PCM link 26012 and 93% of the NO₂ concentrations is from the A4 rather than the M4 at the footpath below SRN PCM link 47892.

In addition to modelling the footpath for SRN PCM link 47892, an additional qualifying feature, a residential property, 14m away from the main carriageway, has been identified to the east of the M4. Modelled NO₂ concentrations are highest at the second floor of the building (receptor height of 8.0m in Table E3). This is the nearest point to the M4 as it passes closest to the property (Figure E2).

The outcome of the updated modelling using the elevated roads tool suggest for SRN PCM link 26012 the limit value would be achieved two years earlier than previously assessed and one year earlier than previously assessed for SRN PCM link 47892.

SRN PCM link 46015 (M5) is far more complex than the other elevated sections of the SRN assessed. The houses adjacent to the M5, have roof eaves and upper floors close to the level of the running lane. This level of complexity in this area means that the elevated roads tool may be operating outside of its intended design parameters. As a consequence, monitoring has commenced alongside this SRN PCM link to establish the NO₂ concentrations at heights equivalent to both ground level and first floor of the adjoining houses. The outcomes from the monitoring data will help inform the limit value status for this SRN PCM link. Until this monitoring data is available, the 60mph speed limit will remain in place on the M5 in this location and the modelling results will not be used to determine compliance with the annual mean NO₂ limit value.

SRN PCM link 47892 is as equally complex as the M5 and the elevated tool may not be able to realistically represent air quality conditions at this location. As such, monitoring is recommended for SRN PCM link 47892 to establish the actual NO₂ concentrations at different heights at the adjacent property, if possible.

Table E4 – Model Input Parameters

Census ID	Link ID	Road Width (m)	2017			2020			2023			2026		
			AADT	%HDV	Speed	AADT	%HDV	Speed	AADT	%HDV	Speed	AADT	%HDV	Speed
28776	N_91162_91164	7.2	35,941	8.4	High Speed	37,069	8.7	High Speed	38,233	9.0	High Speed	-	-	-
	N_91165_91163	7.4	34,924	8.4	High Speed	36,021	8.7	High Speed	37,151	9.0	High Speed	-	-	-
70206	SE_34261_35312	7.5	36,263	9.2	Light Congestion	37,629	9.2	Light Congestion	39,046	9.2	Light Congestion	40,517	9.2	Light Congestion
26012	SE_39073_30877	15.5	35,468	8.5	Free Flow	34,554	8.6	Free Flow	33,663	8.8	Free Flow	32,795	9.0	Free Flow
	SE_39027_39024	15.5	45,752	6.4	High Speed	47,122	6.3	High Speed	48,534	6.2	High Speed	49,987	6.1	High Speed
47892	SE_30895_30882	15.5	22,077	5.3	Free Flow	23,272	5.0	Free Flow	24,533	4.6	Free Flow	25,862	4.3	Free Flow
	SE_39026_30896	15.5	27,344	6.9	High Speed	25,724	6.7	High Speed	24,200	6.6	High Speed	22,766	6.5	High Speed
46015	M_58558_52542	16.0	33,514	15.8	High	35,315	15.2	High Speed	37,213	14.7	High Speed	39,213	14.2	High Speed
	M_58559_53297	7.0	57,863	13.4	High	60,492	13.2	Free Flow	63,240	13.0	Free Flow	66,112	12.8	Free Flow

Census ID: 46015	M5, West Midlands
AQ Description: Sensitive Receptors within 15m	



Commentary

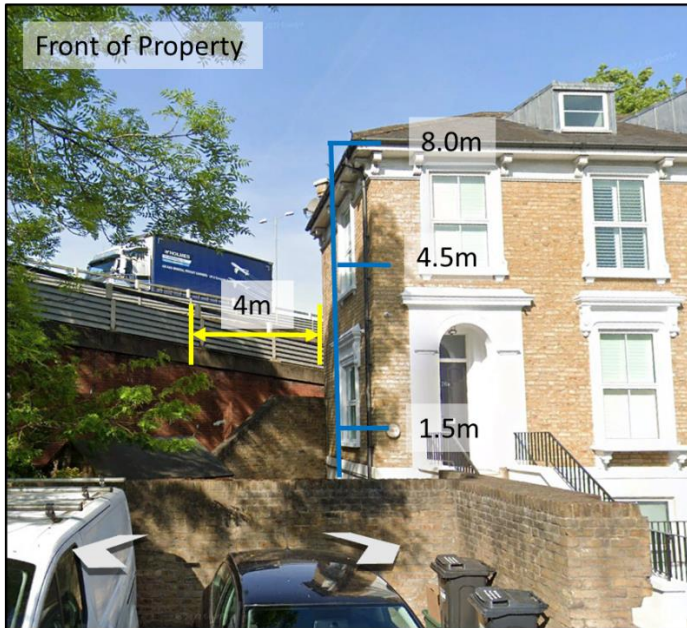
- Receptor modelled at three different heights (1.5m, 4.5m and 8.3m) to represent ground floor level, first floor level and roof height.
- Receptor located approximately 6.7m from the edge of the closest running lane of the M5.
- Receptor located on a busy A road (A457 – Birmingham Road)

Key	
PCM Link	
Approximate Receptor Location	
Approximate Receptor Heights Modelled	
Approximate Distance Between Receptor and M5	



Figure E1 – Modelled receptor heights for SRN PCM link 46015 Receptor representing different exposure points

Census ID: 47892	M4, Hillingdon
AQ Description: Sensitive Receptors within 15m	



Commentary	
-	Receptor modelled at three different heights (1.5m, 4.5m and 8.0m) to represent ground floor level, first floor level and second floor level.
-	Receptor located approximately 4m from the edge of M4 slip road and 14m from the closest running lane of the M4.

Key	
PCM Link	
Approximate Receptor Location	
Approximate Receptor Heights Modelled	
Approximate Distance Between Receptor and M4 Slip Road	

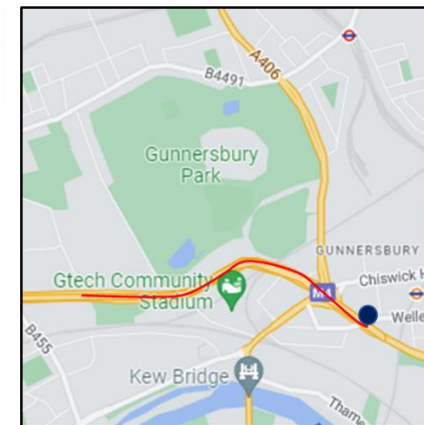


Figure E2 – Modelled receptor heights for SRN PCM link 47892 Receptor representing different exposure points



Figure E3 –Modelled receptor locations for SRN PCM link 28776, 46015 and 70206



Figure E4 – Previous and updated modelled receptor locations for SRN PCM link 26012

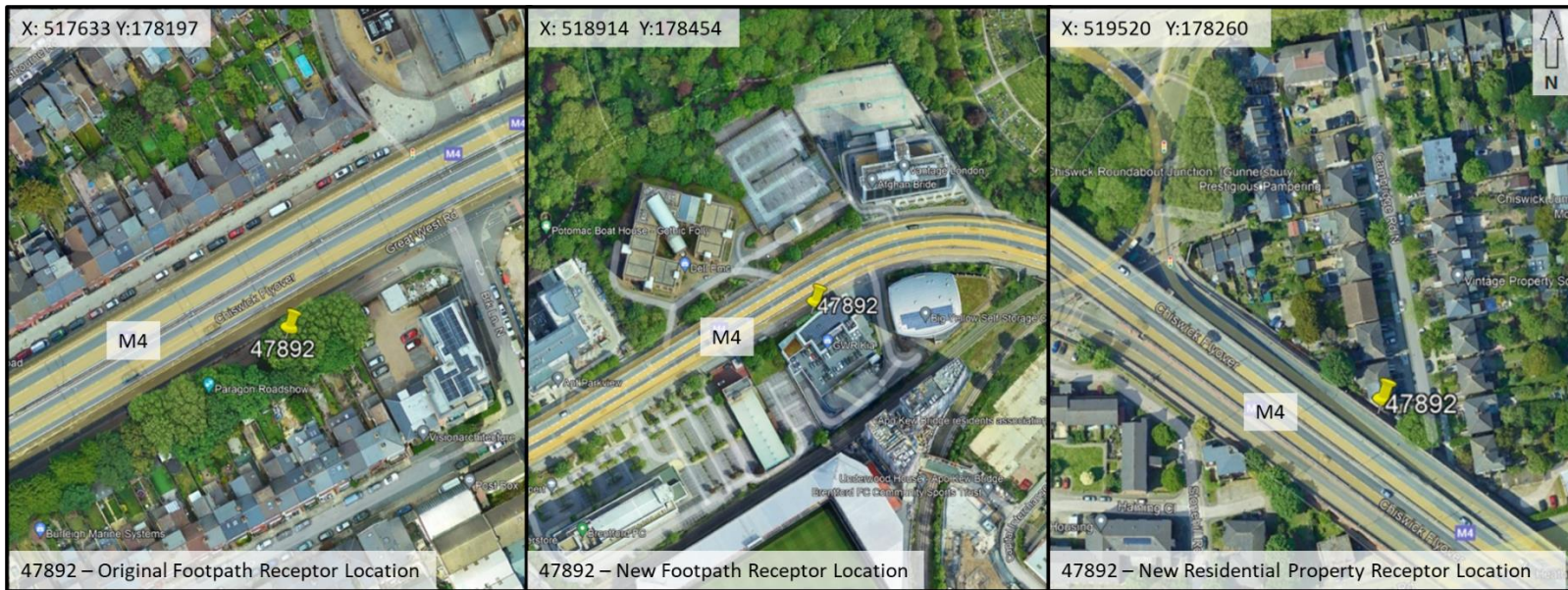


Figure E5 – Previous and updated modelled receptor locations for SRN PCM link 47892