

Technical Report**NOISE AT WORK ASSESSMENT FOR NORTHERN LINE TRAIN OPERATORS**

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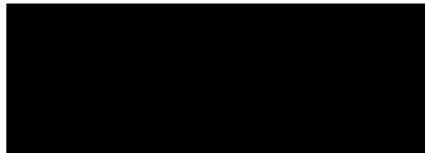
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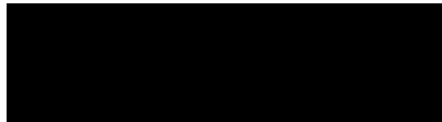
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1. Introduction

The noise and vibration team in Technical Services was asked to measure noise levels in accordance with The Control of Noise at Work Regulations 2005 for train operators on the Northern line and to identify track sections where the noise levels were high.

2. Summary of the Control of Noise at Work Regulations 2005

The aim of the regulations is to protect persons against risk to their health and safety arising from exposure to noise at work. The general aspiration of the regulations is to reduce noise levels for all employees to as low a level as reasonably practicable. The following duties are placed on an employer:

- assessment of employees' risk and periodic review of the risks (this can include noise measurements),
- implementation of controls to eliminate the risk or reduce it to as low as possible (by either reducing the noise levels or exposure time),
- provision of personal hearing protectors as appropriate to the exposure level determined,
- health surveillance as appropriate, and
- provision of information, instruction and training to employees at risk.

The regulations define noise exposure limit values and action values. These are provided in Table 1.

Table 1 – Noise exposure limit values and action values

	Daily Personal Noise Exposure $L_{EP,d}$	Peak Sound Pressure L_{Cpeak}
Lower Exposure Action Values	80 dB(A)	135 dB(C)
Upper Exposure Action Values	85 dB(A)	137 dB(C)
Exposure Limit Values	87 dB(A)	140 dB(C)

The equation used to calculate a daily personal noise exposure, $L_{EP,d}$ is defined as

$$L_{EP,d} = L_{Aeq,Te} + 10 \log \left(\frac{T_e}{T_0} \right)$$

where,

$L_{Aeq,Te}$ is the equivalent continuous A-weighted sound pressure level,

T_e is the duration of exposure to the noise, in seconds, and

T_0 is the reference duration of 8 hours (28,800 seconds).

Hearing protection should only be considered when organisational and technical methods to reduce noise levels to as low as possible have been found not to be reasonably practical. In such circumstances, employees exposed to levels at or above the lower action values shall be advised of the risks and personal hearing protectors shall be made available to them.

Their employer must provide employees exposed to levels at or above the upper action values with personal hearing protectors. The employer is required to enforce their mandatory use.

The employer must ensure that employees are not exposed to noise above the exposure limit values, which includes allowing the employer to take into account the noise reduction provided by hearing protection.

3. Measurements and Results

The LU HSE team asked Technical Services to carry out the monitoring of train operator's noise levels for the Northern line. This is carried out to ensure that train operator noise exposure is minimised and controlled in line with the Control of Noise at Work Regulations 2005.



A train operator's daily noise exposure level is a log average of all the noise levels he/she is exposed to throughout an 8-hour shift. If the amount of time spent at high noise levels can be reduced, either by reducing the noise levels or exposure time this will reduce the daily noise exposure level. The highest noise levels a train operator is exposed to are when he/she is in the cab and the train is moving. These cab noise levels can be broken down into inter-station noise levels.

The measurements were carried out on 10th, 12th, 18th and 19th April 2018 to using one handheld sound level meter (SLM), with the microphone located next to the driver's ear. The details regarding the meter can be found in Appendix A.

Each direction was measured multiple times in randomly selected cabs. The photograph in Appendix C, display the assembly used for the measurements.

The average levels for all cab runs are presented in the tables below. These measurements start when the train starts moving at the start station and finish when the train comes to rest at the end station. These overall levels do not include the dwell time spent at stations, i.e. noise exposure is likely to be lower if rest periods and dwell times are included.

Table 2 – Interstation noise levels for the northbound road between Morden and Edgware (via Bank)

Interstation Section	L _{Aeq} dB(A)	L _{Cpeak} dB(C)	A-Weighted Noise Spectral Analysis in Octave (Hz)							
			63	125	250	500	1000	2000	4000	8000
Morden to South Wimbledon	76.2	106.1	50.7	57.9	68.3	73.9	70.2	64.1	56.7	48.5
South Wimbledon to Colliers Wood	80.6	107.8	49.4	58.3	72.3	78.1	75.1	67.2	57.6	45.1
Colliers Wood to Tooting Broadway	80.0	108.4	51.5	60.0	73.1	77.4	73.6	67.1	60.5	47.2
Tooting Broadway to Tooting Bec	80.9	106.3	47.9	52.7	68.9	79.5	76.2	65.6	54.9	42.1
Tooting Bec to Balham	74.4	105.0	49.5	56.4	66.4	70.9	69.5	63.8	58.5	45.2
Balham to Clapham South	77.6	105.9	49.8	57.9	66.9	75.0	72.5	65.8	57.1	44.4
Clapham South to Clapham Common	75.1	104.7	50.3	57.2	67.5	72.2	69.4	63.8	56.3	45.6
Clapham Common to Clapham North	77.3	106.0	50.2	52.7	64.9	76.5	69.1	63.9	55.1	44.1
Clapham North to Stockwell	81.6	109.6	48.3	55.4	69.0	79.7	77.6	67.2	55.1	40.6
Stockwell to Oval	76.0	105.6	51.8	59.0	69.0	72.6	70.5	65.8	55.9	43.5
Oval to Kennington	74.9	105.9	53.3	59.4	68.5	71.3	69.0	64.5	56.9	45.9
Kennington to Elephant and Castle	78.1	108.8	53.3	56.4	69.9	76.4	70.6	66.2	58.7	46.1
Elephant and Castle to Borough	77.3	108.8	50.0	56.4	68.3	75.0	69.2	64.4	57.5	45.4
Borough to London Bridge	76.4	105.8	51.3	57.5	67.2	75.1	69.9	62.9	54.1	43.5
London Bridge to Bank	79.0	108.9	51.5	60.8	70.6	76.9	72.5	67.9	59.1	45.5
Bank to Moorgate	77.9	110.4	53.5	58.2	68.6	76.4	70.1	64.9	57.0	44.3
Moorgate to Old Street	76.7	103.5	46.6	52.9	64.8	75.8	70.2	61.0	52.7	42.4
Old Street to Angel	78.2	108.8	51.9	58.9	69.1	75.8	71.9	67.1	59.3	48.0
Angel to King's Cross St. Pancras	75.3	103.7	48.3	56.2	65.7	72.2	70.5	63.9	55.6	44.1
King's Cross St. Pancras to Euston	74.5	106.0	51.8	59.1	67.4	71.3	68.4	63.9	55.7	44.6
Euston to Camden Town	85.9	113.9	52.8	60.2	71.8	84.0	81.3	74.9	61.0	46.1
Camden Town to Chalk Farm	76.7	108.8	53.0	60.2	69.2	73.6	71.1	66.1	57.8	48.1
Chalk Farm to Belsize Park	75.9	106.1	49.3	57.0	66.9	72.9	70.4	66.3	56.0	44.0
Belsize Park to Hampstead	74.1	101.7	49.8	56.8	66.5	70.9	68.6	63.9	54.7	42.4
Hampstead to Golders Green	78.2	108.7	51.8	61.8	70.6	75.3	72.3	68.2	57.1	45.1
Golders Green to Brent Cross	66.0	106.3	48.2	53.3	60.9	62.1	59.4	55.9	47.8	38.8
Brent Cross to Hendon Central	65.3	99.0	48.5	52.7	56.9	61.7	59.8	56.6	46.9	36.0
Hendon Central to Colindale	78.8	105.3	49.8	58.2	66.0	74.9	75.6	68.6	55.2	44.0
Colindale to Burnt Oak	63.5	102.5	47.6	50.7	56.6	59.5	57.7	54.3	45.5	34.0
Burnt Oak to Edgware	69.1	103.1	48.0	51.0	56.0	64.4	64.4	62.9	53.2	38.2

Table 3 – Interstation noise levels for between Finchley Central and Mill Hill East

Interstation Section	L _{Aeq} dB(A)	L _{Cpeak} dB(C)	A-Weighted Noise Spectral Analysis in Octave (Hz)							
			63	125	250	500	1000	2000	4000	8000
Finchley Central to Mill Hill East	68.4	102.9	45.0	49.6	58.1	65.7	63.3	57.1	50.2	43.6



Table 4 – Interstation noise levels for the northbound road between Kennington and High Barnet (via Charing Cross)

Interstation Section	L _{Aeq} dB(A)	L _{Cpeak} dB(C)	A-Weighted Noise Spectral Analysis in Octave (Hz)							
			63	125	250	500	1000	2000	4000	8000
Kennington to Waterloo	82.4	112.1	54.1	61.8	71.8	78.4	78.2	73.8	65.4	52.3
Waterloo to Embankment	83.7	112.9	53.1	63.0	72.2	81.3	78.9	72.2	63.8	50.0
Embankment to Charing Cross	75.5	105.3	54.5	61.3	67.1	72.2	69.8	66.2	61.1	46.6
Charing Cross to Leicester Square	81.0	111.5	55.8	63.0	74.4	78.3	74.9	68.5	61.1	50.5
Leicester Square to Tottenham Court Road	73.6	101.5	51.0	56.8	65.2	70.4	68.3	62.7	58.2	44.9
Tottenham Court Road to Goodge Street	79.9	106.3	51.3	59.4	71.1	77.5	74.8	66.8	61.3	46.6
Goodge Street to Warren Street	75.0	102.7	52.5	60.2	66.1	72.2	71.7	63.5	57.0	46.3
Warren Street to Euston	82.5	111.3	62.1	65.0	73.3	79.0	78.2	72.1	63.7	50.3
Euston to Mornington Crescent	81.7	110.2	48.8	56.8	68.6	79.9	75.4	69.2	62.1	46.0
Mornington Crescent to Camden Town	76.7	106.4	53.9	61.1	69.3	73.4	71.0	65.8	59.5	46.4
Camden Town to Kentish Town	83.5	114.2	55.2	63.5	71.6	82.3	77.3	68.6	60.2	47.2
Kentish Town to Tufnell Park	86.8	114.5	55.6	63.1	75.2	84.5	82.4	74.7	64.0	48.0
Tufnell Park to Archway	77.8	108.6	55.7	63.4	69.6	76.7	74.5	67.4	60.3	44.8
Archway to Highgate	77.8	108.6	52.6	60.5	69.2	74.2	73.0	68.3	61.0	46.4
Highgate to East Finchley	77.1	107.0	51.1	57.5	68.3	72.6	72.7	69.4	58.8	48.9
East Finchley to Finchley Central	71.3	104.7	48.9	54.8	64.9	69.0	69.1	66.9	56.9	47.9
Finchley Central to West Finchley	71.7	104.2	47.1	51.4	58.2	66.8	67.4	65.5	57.3	43.2
West Finchley to Woodside Park	74.3	111.8	46.3	50.2	57.5	66.1	67.9	71.8	59.5	47.8
Woodside Park to Totteridge & Whetstone	72.7	105.8	48.2	52.0	58.7	66.9	68.9	66.9	57.9	43.6
Totteridge & Whetstone to High Barnet	69.9	103.0	48.4	53.2	59.6	66.2	64.8	61.4	56.6	44.7

Table 5 – Interstation noise levels for the southbound road between Edgware and Morden (via Bank)

Interstation Section	L _{Aeq} dB(A)	L _{Cpeak} dB(C)	A-Weighted Noise Spectral Analysis in Octave (Hz)							
			63	125	250	500	1000	2000	4000	8000
Edgware to Burnt Oak	63.6	104.7	51.3	51.1	55.9	58.8	57.9	55.6	50.2	39.8
Burnt Oak to Colindale	74.2	102.2	52.4	51.4	56.7	59.7	57.1	54.9	50.6	38.4
Colindale to Hendon Central	76.1	110.9	52.6	56.1	64.6	70.8	72.4	69.6	55.9	45.3
Hendon Central to Brent Cross	63.6	98.4	51.1	50.5	55.5	59.1	58.8	53.8	46.0	37.7
Brent Cross to Golders Green	69.3	102.5	51.4	54.2	63.9	65.6	62.9	58.5	49.6	41.6
Golders Green to Hampstead	80.6	109.4	54.0	62.8	70.7	78.5	74.9	68.6	59.4	47.3
Hampstead to Belsize Park	76.9	106.0	52.5	58.1	68.1	73.6	72.1	66.8	59.3	48.2
Belsize Park to Chalk Farm	77.2	106.9	51.1	57.3	68.2	73.7	72.7	67.1	58.4	47.8
Chalk Farm to Camden Town	76.4	104.5	54.0	62.1	69.6	73.1	70.8	64.7	56.4	45.1
Camden Town to Euston	86.5	116.4	53.3	62.4	74.4	83.5	83.1	75.4	62.4	48.2
Euston to King's Cross St. Pancras	73.8	106.5	54.1	58.3	67.1	69.8	68.1	63.9	57.0	44.2
King's Cross St. Pancras to Angel	77.5	105.8	51.8	57.5	68.3	74.1	71.7	67.0	59.8	50.0
Angel to Old Street	79.5	109.4	55.2	63.9	70.3	76.8	73.7	68.4	60.1	47.6
Old Street to Moorgate	74.9	107.2	52.3	56.8	67.8	71.5	69.3	63.8	57.2	44.8
Moorgate to Bank	78.6	107.7	55.3	57.8	68.8	76.6	72.3	68.7	59.5	47.1
Bank to London Bridge	81.6	109.4	58.7	65.8	74.0	78.6	76.3	71.1	61.9	48.2
London Bridge to Borough	80.3	109.3	53.2	61.0	73.2	77.8	74.7	66.5	57.0	46.3
Borough to Elephant and Castle	77.5	106.2	53.1	55.7	66.6	76.6	70.4	63.7	55.2	43.2
Elephant and Castle to Kennington	82.1	113.9	53.3	55.1	74.6	80.2	75.5	68.2	58.3	44.8
Kennington to Oval	74.7	105.8	54.2	59.4	68.2	71.2	68.5	64.2	56.0	43.2
Oval to Stockwell	74.7	107.8	52.8	57.9	67.5	70.6	69.7	64.4	56.5	44.7
Stockwell to Clapham North	80.0	106.7	51.8	61.9	69.5	77.5	75.3	66.8	59.0	44.0
Clapham North to Clapham Common	77.4	105.8	54.6	59.2	69.0	74.7	71.8	66.4	57.9	43.4
Clapham Common to Clapham South	75.5	107.8	53.1	56.5	66.5	73.3	69.4	63.2	55.8	44.5
Clapham South to Balham	76.0	111.6	51.3	56.3	67.4	73.0	70.9	65.8	58.2	46.0
Balham to Tooting Bec	76.2	105.6	53.2	59.1	68.4	72.2	71.1	67.7	59.7	44.7
Tooting Bec to Tooting Broadway	72.6	101.3	52.1	56.9	66.2	69.1	67.2	62.0	54.9	43.1
Tooting Broadway to Colliers Wood	74.4	104.1	52.5	57.7	67.9	70.9	68.3	64.0	56.6	42.6
Colliers Wood to South Wimbledon	74.7	103.6	52.1	56.4	67.0	70.7	69.6	65.1	57.8	44.8
South Wimbledon to Morden	85.6	113.4	51.2	57.1	73.1	84.3	79.9	73.7	62.6	47.1



Table 6 – Interstation noise levels for between Mill Hill East and Finchley Central

Interstation Section	L _{Aeq} dB(A)	L _{Cpeak} dB(C)	A-Weighted Noise Spectral Analysis in Octave (Hz)							
			63	125	250	500	1000	2000	4000	8000
Mill Hill East to Finchley Central	72.3	104.3	49.7	51.8	61.6	69.1	67.4	63.6	56.5	46.1

Table 7 – Interstation noise levels for the northbound road between High Barnet and Kennington (via Charing Cross)

Interstation Section	L _{Aeq} dB(A)	L _{Cpeak} dB(C)	A-Weighted Noise Spectral Analysis in Octave (Hz)							
			63	125	250	500	1000	2000	4000	8000
High Barnet to Totteridge & Whetstone	72.9	104.5	48.4	52.6	61.0	69.3	69.1	61.8	56.2	46.6
Totteridge & Whetstone to Woodside Park	73.5	103.7	49.4	54.1	61.3	69.5	70.0	62.5	57.7	50.8
Woodside Park to West Finchley	70.9	99.1	47.9	51.9	59.1	67.0	66.9	60.2	55.8	47.2
West Finchley to Finchley Central	72.5	117.7	49.0	54.0	61.2	68.5	68.4	62.7	58.2	49.6
Finchley Central to East Finchley	73.6	105.8	48.9	53.7	61.0	69.9	69.9	63.1	56.5	48.3
East Finchley to Highgate	77.9	108.9	50.3	56.3	67.1	74.4	74.1	66.7	59.9	47.6
Highgate to Archway	80.8	107.5	51.1	58.1	69.5	78.3	76.3	70.2	59.3	44.7
Archway to Tufnell Park	80.2	107.5	51.2	59.6	70.4	77.5	75.8	67.1	58.2	44.4
Tufnell Park to Kentish Town	83.7	105.8	52.2	61.0	69.4	75.5	73.6	67.1	59.1	45.9
Kentish Town to Camden Town	81.0	109.0	55.1	64.7	72.5	78.6	75.7	67.8	58.7	44.8
Camden Town to Mornington Crescent	75.9	106.0	51.5	59.7	69.3	72.8	69.8	64.7	58.6	47.1
Mornington Crescent to Euston	82.3	112.0	59.0	67.7	75.0	78.8	77.1	71.1	62.6	50.1
Euston to Warren Street	83.9	112.8	60.1	68.3	75.3	81.2	78.4	71.6	62.4	49.6
Warren Street to Goodge Street	76.8	106.0	52.4	60.3	68.7	72.8	72.6	66.2	58.7	46.4
Goodge Street to Tottenham Court Road	77.5	105.6	50.6	59.4	69.1	73.4	73.9	65.5	58.0	44.4
Tottenham Court Road to Leicester Square	76.8	103.7	51.2	61.2	67.4	72.4	73.1	66.0	60.5	47.5
Leicester Square to Charing Cross	83.5	112.0	53.0	64.1	77.2	80.8	77.6	70.8	62.3	50.4
Charing Cross to Embankment	77.9	106.0	51.9	60.6	69.6	75.1	72.5	66.6	59.0	45.9
Embankment to Waterloo	76.3	104.5	50.6	58.2	68.2	72.8	71.9	65.6	57.2	42.6
Waterloo to Kennington (SB)	82.2	112.4	56.6	62.5	72.2	79.8	77.3	69.8	60.6	47.1
Kennington (SB) to Kennington (NB)	74.1	103.8	53.2	57.2	65.8	70.6	68.0	66.5	57.8	46.3

Charts 1 to 4 show the average weighted noise levels of all runs on each inter station section in a graphical representation. These values are taken from Tables 2 to 7. Levels at stations are not shown since these were often a result of sources such as radio communications, alarms and warnings.



Chart 1 - Average weighted noise levels on the Northern northbound road between Morden and Edgware (via Bank) and the Mill Hill East branch

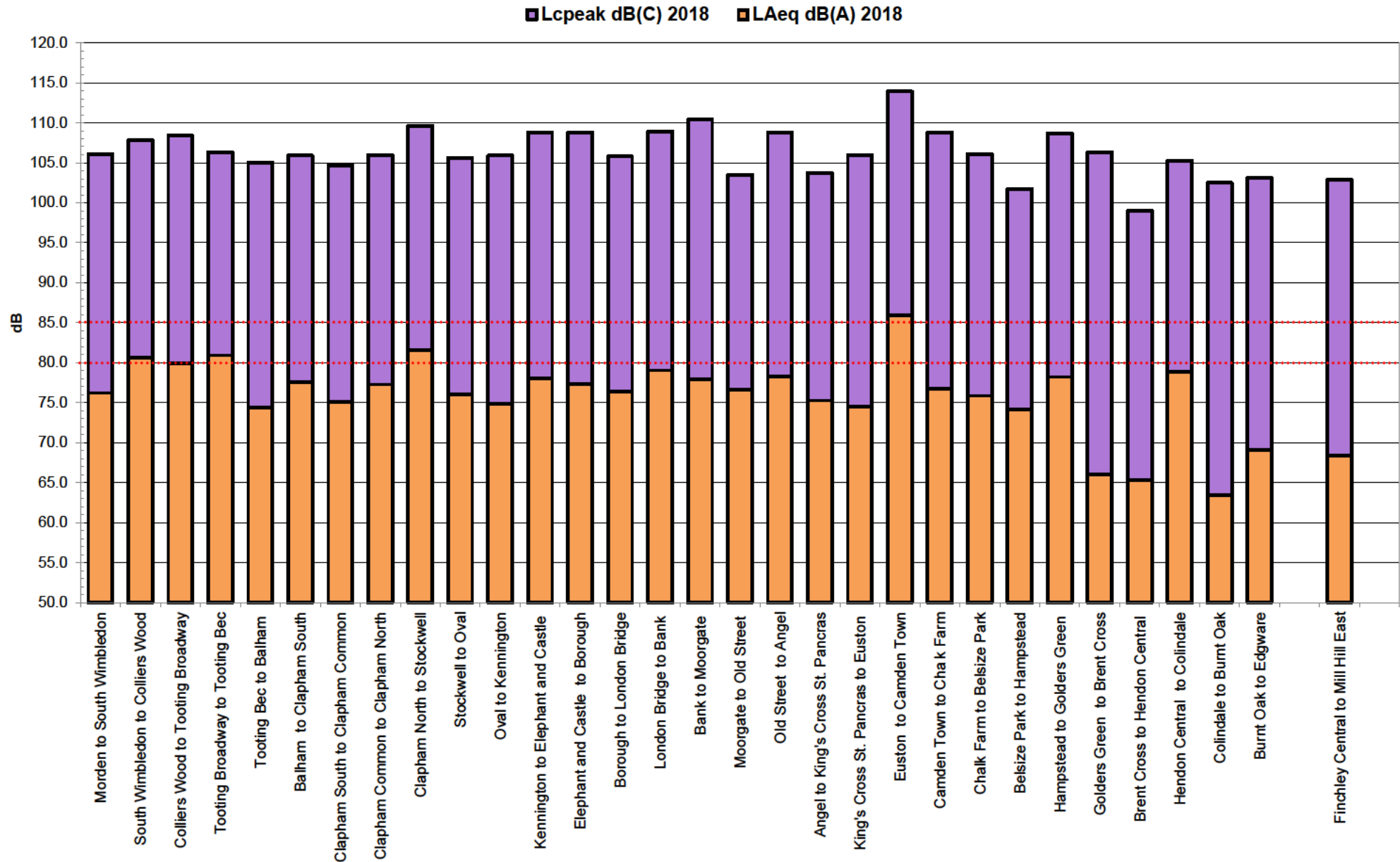




Chart 2 – Average weighted noise levels, on the Northern northbound road between Kennington and High Barnet (via Charing Cross)

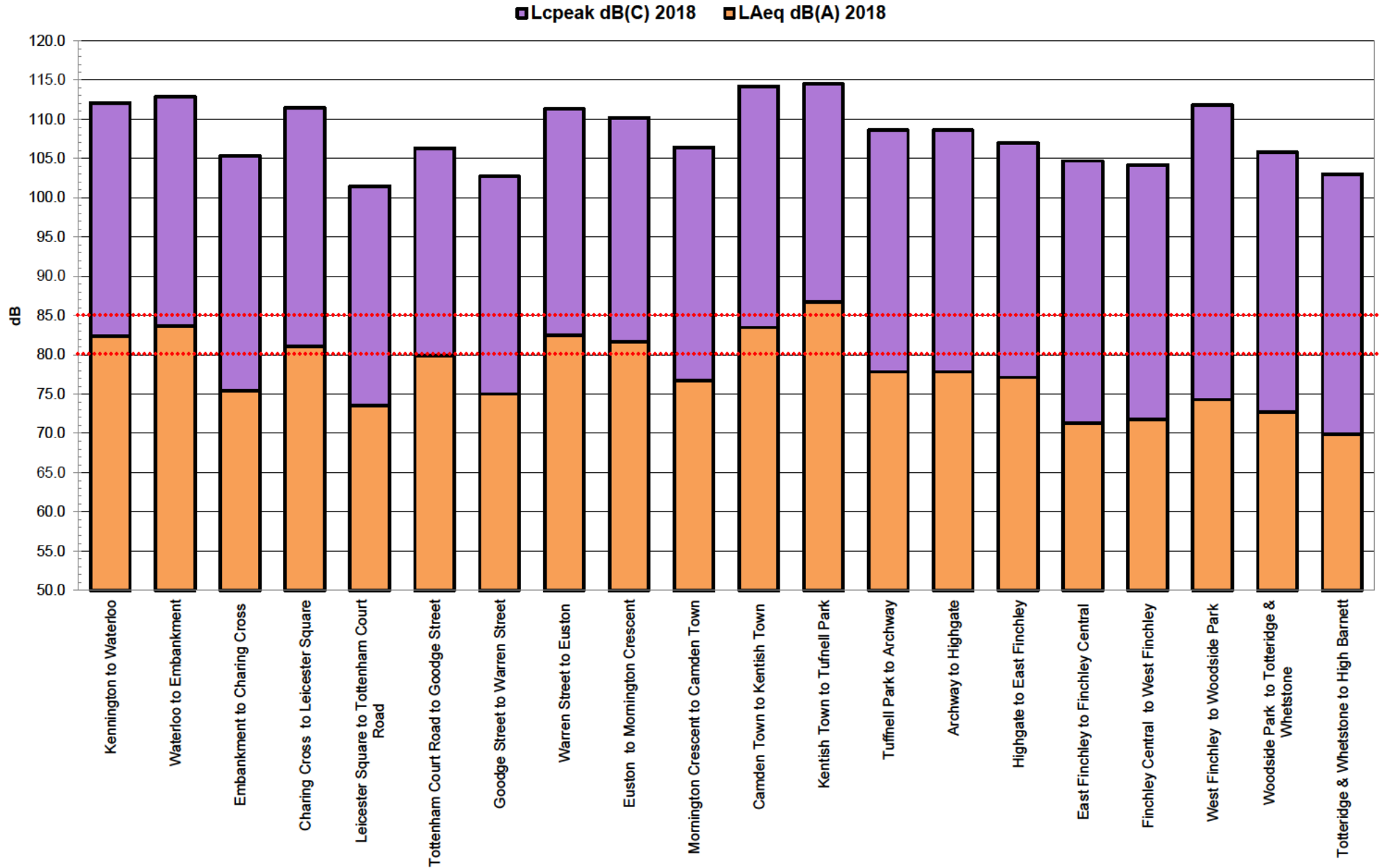




Chart 3 – Average weighted noise levels, on the Northern southbound road between Edgware and Morden (via Bank)

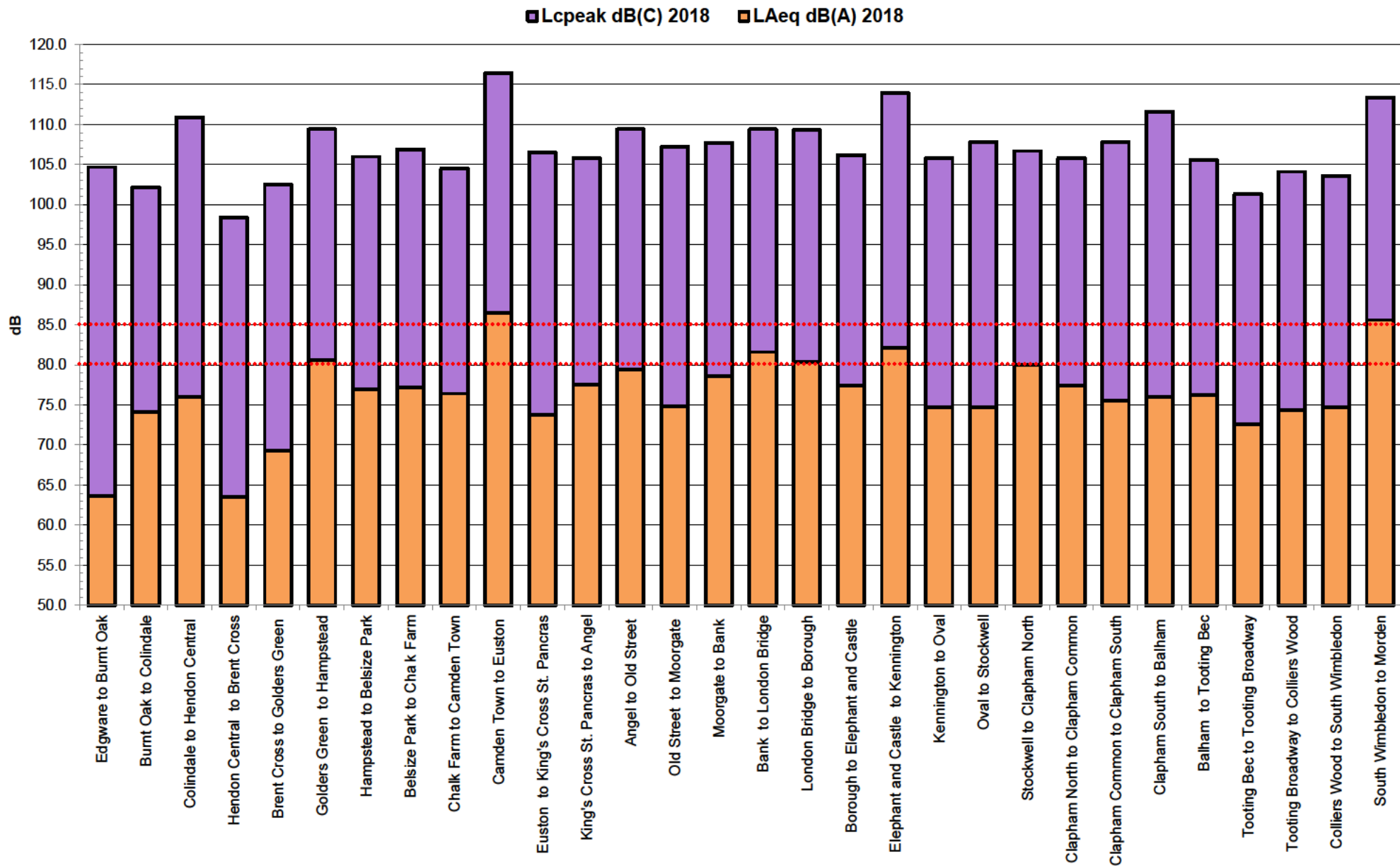
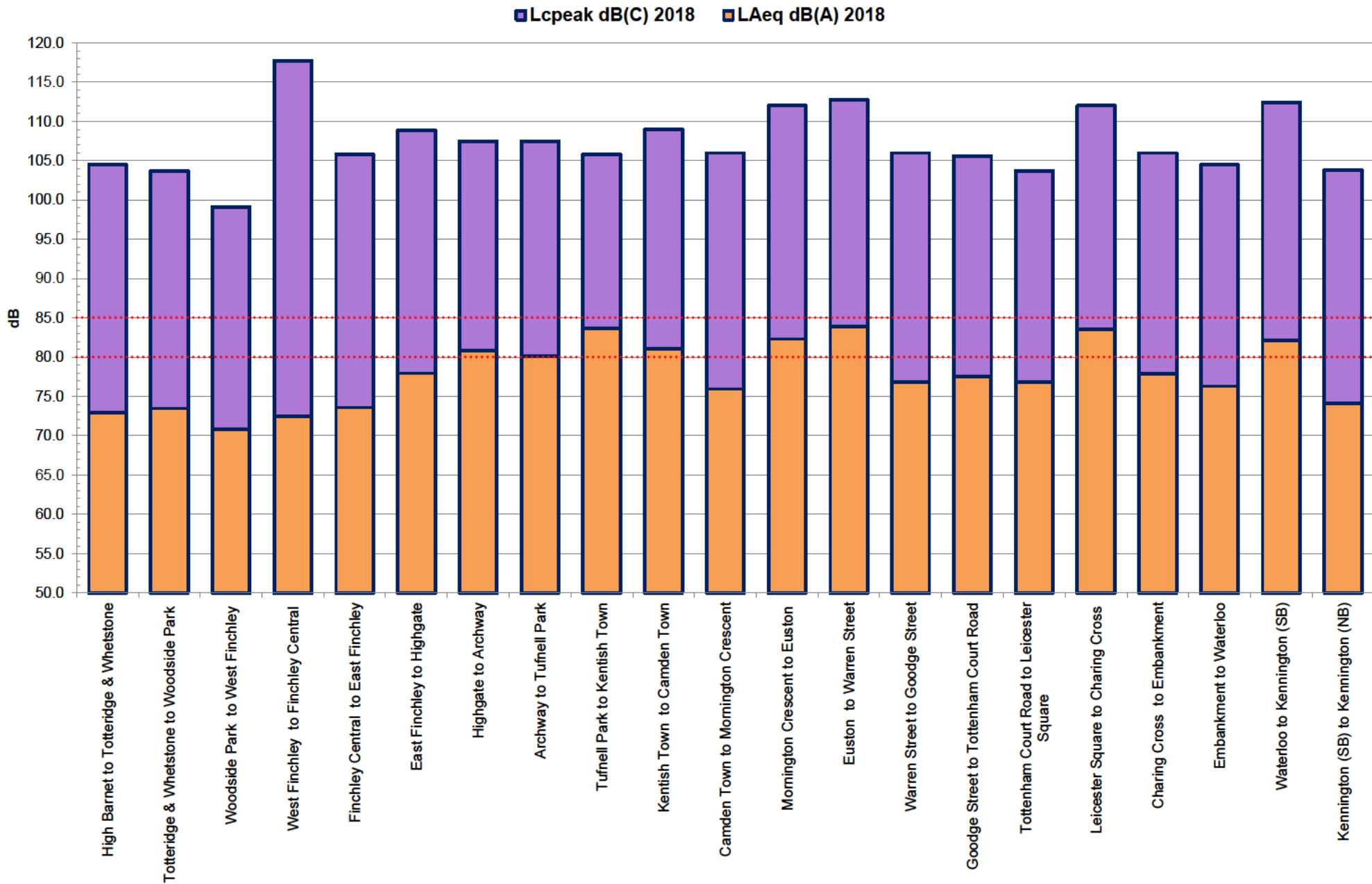




Chart 4 – Average weighted noise levels, on the Northern northbound road between High Barnet and Kennington (via Charing Cross)





The main differences between measurements on the same day are differences in the measured cabs, as each run is on a different train. The track condition on the same day is very unlikely to change. Other things that could affect the results are train speed, cab announcements, drivers talking on the radio and stops at signals.

The calculated daily noise exposure level for train operators is based on the noise level at ear level and is a log average of all the inter-station sections travelled as well as the noise when stopped at signals. The noise level during breaks and stops as well as the noise level at stations are ignored in this report, as these levels are considerably lower when compared to the cab noise levels when the train is moving.

Tables 2 to 7, show that several inter-station sections **reached or exceeded 80dB_{L_{Aeq}}**; **eight on the northbound Charing Cross branch, five on the northbound Bank branch, seven on the southbound Bank branch and eight on the southbound Charing Cross branch.**

Regarding sections that **reached or exceeded 85dB _{L_{Aeq}}**, **one on the northbound Charing Cross branch, one on the northbound Bank branch and two on the southbound Bank branch** met this condition.

The top three inter station sections with the highest noise levels for each of the measured directions are shown below.

- **Northbound** – Waterloo to Embankment; Camden Town to Kentish Town; Kentish Town to Tufnell Park
- **Southbound** – Camden Town to Euston; South Wimbledon to Morden; Euston to Warren Street

4. Daily Exposure $L_{EP,d}$ Levels

The daily exposure $L_{EP,d}$ levels for train operators of the Northern line, found in table 8, were based on the train operator duties. The duty books all apply from 28th January 2018 until further notice (working Timetable 57).

The calculations were based on a sample of 36 duties. These were representative of the spread of duration of the different duties and the different start and end points of the runs. The duties selected ranged between 4 to 8h in duration.

In order to calculate the $L_{EP,d}$ of each trip, they were partitioned into inter station sections. Each inter station exposure level was calculated based on the average value of all runs and the average time between station taken from all runs.

To obtain the total exposure level, all the partial exposures comprised in a specific duty were added, and a $L_{EP,d}$ exposure level was achieved. The table below shows the total duration of the duties chosen for the analysis.

Table 8 – Duration of the duties chosen for the daily exposure calculations

	Driving time (h:min)	$L_{EP,d}$ dB(A)		Driving time (h:min)	$L_{EP,d}$ dB(A)		Driving time (h:min)	$L_{EP,d}$ dB(A)		Driving time (h:min)	$L_{EP,d}$
401	03:46	76	601	03:00	75	301	04:13	77	801	03:00	75
402	04:14	77	602	03:32	75	302	03:59	76	802	04:22	77
403	04:15	76	603	03:33	76	303	04:47	77	803	03:09	75
404	03:40	76	604	03:33	76	304	04:35	77	804	02:59	75
405	03:32	75	605	03:32	75	305	03:35	76	805	04:34	77
406	03:32	75	606	04:56	77	306	04:33	77	806	04:11	77
407	03:10	75	607	03:01	75	307	03:40	76	807	03:00	76
413	04:33	76	610	03:01	75	308	03:49	76	808	04:01	76
415	03:40	76	612	03:32	75	315	04:14	77	809	04:13	76



5. Conclusions

- **The daily exposure levels presented in Table 8 is a worst-case scenario. If dwell times at stations, meal breaks and time waiting to pick up trains were to be included in the measurements, the overall noise exposure would be lower, albeit negligibly. As such, the presented exposure levels are only representative of train operation.**
- **Daily exposure levels are greatly influenced by interstation sections with noise levels below 80dB(A).**
- The 1995 Tube Stock cab noise is dominated by rolling contact noise. This airborne noise outside the train influences the noise levels inside the cab.
- There are two methods to reduce the rolling noise in the cab: the noise can be reduced at source and/or the transmission path can be inhibited.
- The transmission path of the airborne rolling noise includes paths through the cab side doors. Reduced cab sealing will increase noise levels. It should be noted that the microphone position during the measurements, was located next to the right hand side ear of the train operator, i.e. close to the ear furthest away from the cab door. Positioning the microphone located on the left hand side of the train operator, would likely produce noise levels on average 2 to 3dB above those mentioned in this report. Nevertheless, most duties would still fall below an $L_{EP,d}$ of 80dB(A).
- There are sections of the Northern line track that have corrugation (high rail roughness). Corrugation increases rolling noise and thus cab noise levels. In addition, resilient track has been installed in certain sections to cope with groundborne noise, which had a side effect of increased in-tunnel noise.
- Several inter-station sections exceeded 80dB L_{Aeq} . However only four inter-station sections exceeded 85dB L_{Aeq} , namely one on the northbound Charing Cross branch, one on the northbound Bank branch and two on the southbound Bank branch.
- All duties presented a daily exposure level below the Lower Exposure Action Value (LEAV) for continuous noise at an $L_{EP,d}$ of 80dB(A).
- If considered, noise levels during breaks and dwelling in stations would result in lower daily exposure levels. However, the uncertainty of the measurements and calculations, warrant a conservative approach given the likelihood of in some cases, levels exceeding 80dB(A), and as such, information should be provided to TOP's and hearing protection should be made available for their comfort.
- Provided ear defenders should have low attenuation (5-10 dBA) to avoid over-protection, which could lead to train operators having difficulties with communication and hearing warning signals. They may also become isolated from their environment, leading to safety risks.
- **Nevertheless, train operators are not at risk of reaching or exceeding the daily UEAV within an 8-hour working day.**
- All of the measured inter-station sections measured below the LEAV for impulsive noise, namely an instantaneous C-weighted peak level (L_{Cpk}) of 135 dB(C). The highest peak level, 118dB(C), was recorded arriving at Finchley Central, because of the driver rotating the drive mode selector knob, which was not characteristic of this section. If this location is not considered, then the section Camden Town to Euston had the highest peak level, reaching 116dB(C).



6. References

1. Statutory Instrument 2005 No. 1643. The Control of Noise at Work Regulations 2005.
2. Controlling Noise at Work, Guidance Document L108, Health and Safety Executive 2005.
3. Health and Safety Executive Daily Noise Exposure Calculator
www.hse.gov.uk/noise/dailycalc.xls



APPENDIX A – Equipment Details

Table A.1 – Equipment used for the train operator noise exposure measurements

Item	Make	Model	Serial No.
Sound Level Meter	01dB	Fusion	11489



APPENDIX B – Full Line Testing Results

Table B.1 – Inter-station noise levels on the Northern northbound road between Morden and Edgware (via Bank) and the Mill Hill East branch

Interstation section	L _{Aeq} dB(A)	LC _{peak} dB(C)	Noise Spectral Analysis in Octave (Hz)							
			63	125	250	500	1000	2000	4000	8000
Morden To South Wimbledon	76.5	106.1	50.5	56.8	68.9	73.9	70.4	64.9	58.9	52.2
	76.6	105.0	51.2	58.4	68.8	74.6	70.2	64	55.1	43.4
	75.4	103.4	50.2	58.2	66.8	73	70.1	63.4	54.6	44
South Wimbledon to Colliers Wood	81.2	106.0	49.5	58.3	73.0	78.5	75.9	68.1	58.1	45.2
	81.1	107.8	49.8	58.8	73.2	78.8	75.4	67.1	56.8	42.6
	79.2	105.1	48.8	57.7	70	76.9	73.9	66	57.7	46.6
Colliers Wood To Tooting Broadway	79.9	107.8	52.1	60.2	73.6	77.1	73.5	66.7	56.0	42.0
	81.3	108.4	51.7	60.2	74.1	78.8	74.9	68.9	64.1	50.9
	78.1	105.2	50.6	59.5	71.1	75.6	71.9	64.9	55.6	42.6
Tooting Broadway to Tooting Bec	81.0	104.4	48.2	53.1	69.2	79.5	76.4	66.0	54.5	40.1
	82.0	106.3	48.2	53.4	70.3	80.9	76.7	66.3	55.7	42.8
	79.4	103.6	47.3	51.3	66.5	77.6	75.3	64.4	54.3	42.8
Tooting Bec To Balham	73.5	102.0	49.7	56.4	66.6	69.9	68.1	63.2	53.3	40.7
	76.5	105.0	49.8	56.9	67.5	73.1	71.8	65.5	62.1	47.0
	72.1	102.2	49.1	55.8	64.5	68.5	67.1	61.9	54.7	45.8
Balham To Clapham South	77.7	104.9	49.6	57.7	67.3	75.0	72.7	66.3	57.1	42.1
	78.4	105.9	50.3	58.3	67.9	76.1	73.0	66.2	57.1	43.1
	76.4	102.8	49.3	57.7	65.2	73.7	71.6	64.8	57.2	46.6
Clapham South to Clapham Common	74.6	103.7	50.5	57.1	67.5	71.6	68.9	63.0	53.9	40.3
	76.9	104.7	50.9	57.7	69.0	74.1	70.9	65.7	58.9	49.0
	72.9	103.7	49.2	56.7	65.2	69.6	67.8	61.9	54.1	42.8
Clapham Common to Clapham North	78.0	106.0	48.8	52.2	64.7	77.3	68.8	64.3	55.1	43.8
	78.6	105.0	50.7	54	66.4	77.8	70.8	65.6	56.6	46
	74.0	102.5	50.8	51.5	63.1	72.9	67	60.2	52.6	41.3
Clapham North to Stockwell	81.8	108.4	47.8	55.3	69	79.7	77.9	67.7	55.1	40.3
	82.7	109.6	49	55.7	70.1	81.2	78.2	67.8	55.2	41
	79.9	106.0	48	55.2	67.4	77.6	76.5	65.9	54.9	40.6
Stockwell to Oval	76.4	105.6	51.7	59.2	69.3	72.8	71.0	67.1	55.6	41.2
	76.4	105.0	52.3	59.3	69.9	73.3	70.4	64.3	54.2	40.2
	75.1	104.3	51.4	58.6	67.5	71.4	70.2	65.4	57.3	46.4
Oval to Kennington	73.4	103.0	52.4	58.4	67.6	69.6	67.4	63.0	53.4	39.1
	76.5	105.9	54.1	60.0	69.7	73.1	70.6	66.1	58.9	48.8
	74.1	105.9	53.2	59.6	67.8	70.2	68.4	63.9	56.7	45.2
Kennington to Elephant and Castle	78.4	108.8	53.0	56.4	70.7	76.8	70.8	65.0	58.0	43.8
	79.6	108.2	53.6	56.7	70.6	78.0	72.2	68.8	59.7	47.4
	75.1	103.6	53.4	56.2	67.9	73.0	67.8	62.7	58.1	46.3
Elephant and Castle to Borough	77.5	108.8	51.4	57.2	68.4	73.1	69.2	64.6	55.5	42.8
	78.7	105.3	49.0	56.3	69.7	77.3	70.6	65.4	59.6	47.5
	74.9	104.1	49.3	55.5	66.3	73.3	67.2	62.6	56.2	44.6
Borough to London Bridge	76.1	104.5	50.4	57.2	67.4	74.7	69.7	63.1	53.2	38.8
	77.5	105.8	51.5	58.0	67.9	76.4	70.7	63.4	53.7	39.5
	75.2	101.9	51.8	57.4	66.2	73.7	69.0	62.0	55.2	47.1
London Bridge to Bank	79.3	107.8	50.9	60.7	70.9	77.2	72.6	68.3	59.1	43.9
	80.3	108.9	52.2	61.2	71.4	78.5	73.7	68.8	59.8	44.6
	76.8	105.0	51.4	60.5	69.1	73.9	70.6	66.2	58.4	47.2
Bank to Moorgate	78.2	108.1	53.3	58.0	68.8	76.7	70.2	65.0	54.6	40.1
	79.3	110.4	54.0	58.7	69.4	77.9	71.4	66.3	60.0	47.5
	75.4	105.5	53.3	57.8	67.4	73.6	67.9	62.7	53.6	41.3
Moorgate to Old Street	76.9	102.5	46.4	52.9	65.0	76.1	70.2	61.0	51.7	40.3
	77.4	103.5	46.6	53.4	65.4	76.8	70.2	60.9	51.8	40.0
	75.5	101.8	46.9	52.4	63.7	74.1	70.1	61.0	54.1	44.9



Interstation section	L _{Aeq} dB(A)	LC _{peak} dB(C)	Noise Spectral Analysis in Octave (Hz)							
			63	125	250	500	1000	2000	4000	8000
Old Street to Angel	78.2	108.8	51.6	58.8	69.0	75.1	71.6	66.7	56.7	43.6
	79.7	107.6	52.4	59.8	70.5	77.7	73.2	68.5	61.1	50.4
	76.1	106.4	51.6	58.0	67.2	73.5	70.4	65.6	58.9	47.7
Angel to King's Cross St. Pancras	75.0	102.6	48.0	56.0	65.7	71.9	70.0	63.8	54.7	39.1
	76.6	103.7	48.6	56.9	66.8	73.7	71.7	65.3	57.3	46.6
	73.7	103.4	48.4	55.5	64.1	70.5	69.4	62.2	54.1	43.6
King's Cross St. Pancras to Euston	75.2	105.5	52.2	59.8	68.0	72.1	69.1	64.9	55.3	40.3
	74.3	106.0	51.3	58.4	67.4	71.4	67.7	63.0	54.4	40.2
	73.9	105.0	51.8	59.0	66.8	70.3	68.3	63.7	57.1	48.2
Euston to Camden Town	86.3	112.2	53.3	60.6	72.4	84.4	81.6	75.0	60.6	44.8
	86.9	113.9	53.1	60.7	72.6	85.3	82.1	75.0	61.2	46.9
	84.2	109.8	52.0	59.0	69.7	81.7	79.9	74.6	61.3	46.3
Camden Town to Chalk Farm	76.3	106.1	53.3	59.8	69.0	73.1	70.7	65.9	57.0	45.8
	78.0	108.5	52.9	60.4	70.1	75.1	72.2	67.2	59.2	50.7
	75.5	108.8	52.9	60.4	68.2	72.0	70.1	64.8	56.7	45.9
Chalk Farm to Belsize Park	76.6	104.4	49.8	57.2	67.1	73.0	71.4	68.7	56.7	41.3
	76.3	106.1	48.9	57.2	67.7	74.0	70.1	65.2	55.6	44.5
	74.4	101.8	49.1	56.7	65.6	71.4	69.5	63.3	55.5	45.3
Belsize Park to Hampstead	74.4	101.6	50.3	56.9	66.9	71.1	68.8	63.9	54.8	40.1
	74.3	101.7	49.4	56.9	67.0	71.3	68.3	63.6	54.5	43.5
	73.6	100.9	49.8	56.7	65.4	70.1	68.6	64.1	54.7	42.9
Hampstead to Golders Green	78.8	107.2	52.7	62.3	71.6	76.0	72.9	67.7	57.6	44.8
	79.7	108.7	52.0	62.6	71.9	76.9	73.5	70.1	58.1	45.3
	74.8	106.7	50.2	60.3	66.5	71.4	69.3	65.5	55.2	45.1
Golders Green to Brent Cross	65.2	98.3	49.1	53.3	60.6	61.6	57.5	53.5	45.4	33.2
	65.7	106.3	47.6	53.4	60.4	62.0	59.0	55.5	48.8	41.8
	66.9	99.2	47.8	53.3	61.7	62.6	61.0	57.7	48.5	37.3
Brent Cross to Hendon Central	64.9	97.9	49.3	52.4	57.3	61.0	58.8	56.6	45.7	33.6
	65.4	98.0	49.3	54.0	57.1	61.9	59.3	56.5	46.0	36.0
	65.7	99.0	46.2	51.1	56.3	62.0	60.9	56.6	48.4	37.6
Hendon Central to Colindale	78.6	105.1	50.5	57.9	66.6	74.8	75.5	66.4	54.5	39.5
	79.5	105.1	50.3	58.7	66.6	75.6	76.1	70.1	55.3	42.5
	78.3	105.3	48.2	57.8	64.4	74.2	75.3	68.4	55.8	46.9
Colindale to Burnt Oak	63.5	99.7	48.4	51.3	57.2	59.2	57.4	54.5	44.8	32.8
	63.5	101.9	48.2	51.6	56.8	59.6	57.2	54.0	44.9	33.1
	63.5	102.5	45.7	48.8	55.6	59.6	58.4	54.3	46.6	35.6
Burnt Oak to Edgware	72.7	103.1	48.1	50.3	55.8	67.7	68.2	67.0	57.2	40.1
	63.4	100.7	48.9	52.3	55.7	59.7	57.1	54.7	44.5	34.6
	65.6	97.2	46.9	50.2	56.5	61.7	60.7	57.0	49.0	38.4

Table B.2 – Inter-station noise levels on the Northern northbound road between Kennington and High Barnet (via Charing Cross)

Interstation section	L _{Aeq} dB(A)	LC _{peak} dB(C)	Noise Spectral Analysis in Octave (Hz)							
			63	125	250	500	1000	2000	4000	8000
Kennington to Waterloo	84.3	112.1	54.2	62.4	71.9	79.4	80.7	76.4	68.4	54.9
	80.7	111.0	54.2	61.9	71.6	77.4	75.5	72.2	60.3	44.1
	81.3	110.3	53.9	60.9	71.9	78.3	76.5	70.6	63.9	52.4
Waterloo to Embankment	84.6	110.3	53.5	63.8	72.9	81.7	79.8	75.2	66.3	53.0
	82.4	111.4	53.3	63.0	71.8	80.7	77.2	67.5	56.8	40.9
	83.8	112.9	52.5	62.0	71.8	81.5	79.4	70.4	63.8	49.4
Embankment to Charing Cross	73.4	104.4	53.7	61.7	65.9	70.7	66.0	63.2	57.1	46.3
	73.7	105.1	54.1	61.0	67.3	70.6	67.4	61.4	53.7	39.3
	77.8	105.3	55.5	61.1	67.8	74.2	72.9	69.5	64.9	49.4
Charing Cross to Leicester Square	80.7	111.5	55.8	63.5	74.4	77.8	74.3	68.3	61.4	51.8
	80.1	106.5	55.2	62.6	73.4	77.4	73.7	67.9	60.0	47.3
	82.1	106.7	56.3	62.8	75.1	79.4	76.3	69.2	61.8	51.1
Leicester Square to Tottenham Court Road	72.3	101.5	50.9	57.7	65.4	69.3	66.2	59.7	52.0	37.0
	70.3	100.0	50.2	55.9	63.9	66.9	64.1	58.7	51.4	37.9
	76.1	101.2	51.7	56.5	66.0	72.9	71.3	65.9	62.3	49.1



Interstation section	L _{Aeq} dB(A)	LC _{peak} dB(C)	Noise Spectral Analysis in Octave (Hz)							
			63	125	250	500	1000	2000	4000	8000
Tottenham Court Road to Goodge Street	79.3	105.4	51.8	60.0	71.3	77.1	73.6	64.6	56.2	42.8
	76.8	103.3	50.5	59.1	69.9	74.4	70.1	62.8	55.8	43.3
	82.1	106.3	51.6	59.1	71.8	79.6	77.6	69.8	65.1	49.9
Goodge Street to Warren Street	74.0	101.3	52.2	60.5	65.7	70.6	69.3	61.1	52.7	37.2
	73.4	100.6	52.0	59.4	65.1	70.5	68.3	61.2	53.1	39.7
	78.1	102.7	53.3	60.7	67.3	74.4	74.6	66.2	60.5	50.5
Warren Street to Euston	81.1	109.7	60.6	64.8	72.9	77.5	76.5	70.7	62.4	49.3
	82.1	109.8	61.7	64.9	73.0	78.6	77.8	72.0	62.9	48.3
	83.9	111.3	63.5	65.3	73.8	80.4	79.8	73.3	65.3	52.3
Euston to Mornington Crescent	79.6	107.6	49.3	57.1	68.2	77.8	72.9	68.5	57.8	40.0
	80.7	107.9	48.6	57.0	67.8	79.5	73.1	65.3	54.3	39.1
	83.7	110.2	48.4	56.3	69.6	81.6	78.0	71.6	66.0	50.0
Mornington Crescent to Camden Town	74.8	104.4	53.6	61.2	68.6	71.5	68.2	63.0	55.2	42.8
	75.5	104.6	54.3	61.4	69.0	72.2	69.4	64.1	55.2	40.5
	78.7	106.4	53.9	60.8	70.1	75.4	73.5	68.4	63.1	50.0
Camden Town to Kentish Town	82.4	111.9	55.1	64.1	71.8	81.3	75.4	67.1	57.3	42.8
	82.6	111.5	55.4	63.4	71.3	81.5	75.9	67.5	56.9	42.1
	85.0	114.2	55.1	62.9	71.6	83.7	79.5	70.5	63.3	50.9
Kentish Town to Tufnell Park	86.5	111.9	55.8	64.0	76.0	84.5	81.7	74.3	60.7	43.9
	80.3	105.6	54.7	62.2	73.8	77.7	74.1	65.8	55.5	40.2
	89.4	114.5	56.2	63.0	75.6	87.1	85.4	77.6	67.8	51.9
Tufnell Park to Archway	78.3	106.7	55.5	64.1	69.8	75.7	72.7	65.9	56.8	42.5
	78.7	106.3	55.5	63.1	69.3	75.9	73.9	66.6	56.3	40.7
	80.7	107.6	56.0	63.0	69.6	78.0	76.1	69.0	63.7	47.8
Archway to Highgate	76.3	105.5	52.8	61.0	69.3	72.9	71.0	66.5	56.7	43.1
	76.7	107.8	52.4	60.2	68.8	73.1	71.3	66.5	56.2	40.7
	79.7	108.6	52.5	60.2	69.6	75.9	75.3	70.6	64.6	49.9
Highgate to East Finchley	77.0	107.0	50.7	57.7	68.7	71.7	72.2	70.6	58.1	50.3
	76.6	105.3	50.9	57.9	68.0	72.3	71.7	69.4	56.0	42.4
	77.7	105.8	51.6	56.8	68.3	73.6	73.8	67.8	60.9	50.3
East Finchley to Finchley Central	73.2	104.7	50.9	57.9	69.0	72.0	72.4	70.9	58.4	50.5
	67.2	100.1	46.1	51.8	56.8	64.0	62.8	55.6	48.7	38.0
	71.6	102.1	48.4	51.7	59.7	67.5	67.3	63.3	58.5	48.2
Finchley Central to West Finchley	63.6	101.9	47.2	50.3	53.8	61.3	58.1	49.6	44.0	35.2
	73.3	104.2	46.3	51.7	58.2	67.2	68.9	68.7	56.9	37.7
	73.2	102.0	47.6	52.1	60.3	68.9	69.0	65.1	60.4	47.3
West Finchley to Woodside Park	77.3	104.1	46.7	49.2	53.8	64.4	69.7	76.0	60.8	48.7
	67.5	111.8	45.9	51.0	56.5	61.6	62.8	61.4	55.9	46.9
	73.3	100.1	46.4	50.3	60.0	69.0	68.6	66.5	60.4	47.5
Woodside Park to Totteridge & Whetstone	75.1	105.8	47.7	52.0	57.8	67.9	71.9	70.4	59.2	39.9
	65.2	99.2	48.1	52.2	56.2	59.4	57.9	56.0	46.8	35.4
	73.0	100.9	48.7	51.9	60.8	68.8	68.7	65.2	59.9	47.5
Totteridge & Whetstone to High Barnet	65.7	102.5	48.4	53.4	58.0	62.1	59.5	56.1	49.4	38.7
	65.1	100.3	47.7	53.7	57.7	60.6	59.0	57.2	48.9	38.5
	73.5	103.0	49.0	52.4	61.8	69.9	68.7	65.0	60.8	48.7
Finchley Central to Mill Hill East	68.7	102.6	45.2	49.8	58.0	66.5	63.4	56.2	49.0	39.7
	67.7	102.9	45.0	49.6	57.5	64.4	63.3	57.3	50.1	44.0
	68.6	102.7	44.7	49.4	58.8	65.9	63.1	57.7	51.1	45.3



Table B.3 – Inter-station noise levels on the Northern southbound road between Edgware and Morden (via Bank) and the Mill Hill East branch

Interstation section	L _{Aeq} dB(A)	LC _{peak} dB(C)	Noise Spectral Analysis in Octave (Hz)							
			63	125	250	500	1000	2000	4000	8000
Edgware to Burnt Oak	61.2	97.6	52.4	50.1	54.1	55.7	56.4	51.2	43.1	33.6
	62.4	104.7	51.7	49.3	54.4	56.9	57.6	54.4	47.4	41.1
	65.9	98.4	49.2	53.0	58.0	61.5	59.2	58.4	53.8	41.4
Burnt Oak to Colindale	78.6	100.1	53.5	50.1	55.6	57.7	56.3	50.7	43.0	31.9
	61.8	98.6	53.4	49.7	55.1	57.8	55.4	50.3	42.7	34.4
	66.2	102.2	49.1	53.4	58.6	62.0	58.9	58.5	54.9	42.1
Colindale to Hendon Central	74.5	109.6	53.6	56.4	64.8	70.3	71.4	62.4	54.0	40.5
	77.0	110.6	52.5	55.1	64.7	71.1	73.2	71.6	55.8	47.4
	76.3	110.9	51.3	56.7	64.2	71.0	72.3	70.5	57.2	45.6
Hendon Central to Brent Cross	62.9	97.5	50.6	50.8	55.5	57.4	58.6	52.9	43.8	30.8
	64.9	98.4	52.8	50.4	56.5	60.8	59.9	54.8	48.6	41.7
	62.5	97.6	49.1	50.3	54.1	58.2	57.5	53.6	43.5	32.6
Brent Cross to Golders Green	68.4	102.5	51.3	54.5	64.0	64.6	61.8	55.7	46.2	33.6
	71.1	102.2	52.4	53.7	65.1	67.2	65.4	61.5	52.6	45.5
	67.5	101.7	50.3	54.3	62.3	64.5	59.7	55.4	47.2	37.6
Golders Green to Hampstead	80.9	109.4	54.1	63.4	71.5	79.2	74.4	67.7	58.8	48.1
	79.7	107.7	53.9	62.5	70.0	77.6	74.2	67.1	56.9	43.1
	81.0	108.1	54.0	62.3	70.4	78.6	75.9	70.3	61.3	48.9
Hampstead to Belsize Park	77.6	104.5	52.6	58.3	69.2	74.5	72.1	67.4	59.8	51.2
	75.7	103.7	52.9	57.8	67.6	72.4	70.8	65.2	56.6	42.0
	77.3	106.0	51.8	58.1	67.3	73.7	73.2	67.4	60.5	46.9
Belsize Park to Chalk Farm	78.0	106.9	51.5	57.6	69.0	74.6	73.4	67.6	58.6	47.8
	76.1	104.7	52.0	57.0	67.6	72.6	71.6	65.6	56.2	43.4
	77.3	103.3	49.5	57.2	68.0	73.7	72.9	67.7	59.6	49.9
Chalk Farm to Camden Town	75.2	104.4	53.7	61.4	68.9	72.0	69.0	62.4	55.0	45.7
	76.3	103.7	54.2	62.1	69.9	72.8	70.7	63.5	54.5	39.6
	77.5	104.5	54.2	62.6	69.8	74.2	72.1	66.9	58.6	47.0
Camden Town to Euston	87.2	115.8	53.3	62.8	75.1	84.9	83.1	74.9	62.1	49.7
	85.6	113.7	54.3	62.0	73.4	82.2	82.7	74.2	61.3	46.6
	86.6	116.4	52.0	62.5	74.5	82.9	83.6	76.7	63.4	47.8
Euston to King's Cross St. Pancras	73.6	102.8	54.4	58.9	68.0	69.9	66.9	62.8	55.6	47.1
	71.7	101.9	53.9	57.5	66.5	67.6	65.1	60.7	52.8	38.9
	75.3	106.5	53.9	58.5	66.8	71.2	70.5	66.4	59.8	42.9
King's Cross St. Pancras to Angel	78.2	104.9	52.7	58.0	69.3	75.5	72.3	68.5	60.6	53.0
	76.5	105.8	51.7	57.2	68.3	73.7	70.5	66.1	60.3	46.6
	77.6	104.3	53.1	62.2	69.2	74.5	72.2	66.6	58.2	45.6
Angel to Old Street	79.3	109.4	55.8	64.3	71.0	77.3	72.5	66.9	58.0	46.6
	79.0	107.7	55.3	63.8	70.4	76.6	72.8	67.2	58.8	49.1
	80.0	108.2	55.3	65.2	71.8	77.3	74.7	67.5	57.9	43.7
Old Street to Moorgate	74.0	107.2	52.6	57.2	68.3	70.9	66.9	60.9	52.9	45.1
	74.0	103.9	52.9	56.0	67.4	71.2	67.4	62.4	55.6	46.3
	76.2	106.7	51.3	57.2	67.7	72.4	71.8	66.3	60.1	42.2
Moorgate to Bank	79.8	106.6	55.4	57.5	69.6	77.6	73.1	71.6	61.3	47.1
	78.1	106.6	55.4	56.9	68.7	76.8	70.7	65.2	57.5	47.8
	77.7	107.7	55.2	58.8	68.0	75.2	72.8	66.4	58.9	46.1
Bank to London Bridge	81.2	109.4	58.1	65.4	74.3	78.8	74.7	68.9	59.6	46.4
	80.6	107.9	58.3	65.3	73.7	77.8	74.8	68.9	59.4	45.9
	82.7	109.4	59.5	66.6	73.9	79.0	78.3	73.7	64.5	50.7
London Bridge to Borough	79.9	107.5	53.5	60.7	73.0	77.5	74.2	65.4	56.3	42.3
	80.9	108.9	53.6	60.9	73.5	78.4	75.5	67.4	57.1	43.1
	80.1	109.3	52.3	61.5	73.2	77.5	74.2	66.5	57.5	49.6
Borough to Elephant and Castle	76.7	106.1	53.9	55.3	66.2	76.3	68.5	59.6	51.1	39.7
	77.1	104.3	52.7	55.5	67.0	76.3	69.9	62.6	51.8	40.6
	78.4	106.2	52.7	56.3	66.6	77.2	72.0	66.3	58.5	46.2
Elephant and Castle to Kennington	81.7	112.8	54.3	55.1	74.4	79.7	75.2	66.6	55.8	41.6
	82.5	113.2	53.8	55.5	75.0	80.8	75.4	66.9	55.8	41.5
	82.2	113.9	51.3	54.8	74.3	80.0	75.9	70.2	61.1	47.9



Interstation section	L _{Aeq} dB(A)	LCpeak dB(C)	Noise Spectral Analysis in Octave (Hz)							
			63	125	250	500	1000	2000	4000	8000
Kennington to Oval	73.2	105.8	53.8	58.6	67.1	69.2	67.4	62.3	56.5	45.8
	75.1	104.6	54.7	59.2	69.1	71.6	68.7	63.6	54.3	39.7
	75.5	105.5	54.0	60.3	68.3	72.3	69.2	65.9	56.8	42.0
Oval to Stockwell	73.8	107.8	52.3	58.0	67.8	70.1	67.6	62.8	56.1	44.0
	74.1	107.0	53.9	57.6	67.6	70.7	67.9	63.1	55.3	43.5
	75.8	104.6	51.8	58.0	67.2	71.0	72.1	66.4	57.8	46.2
Stockwell to Clapham North	80.1	106.7	51.8	61.9	69.8	77.7	75.1	65.8	57.3	43.0
	80.2	105.7	53.1	61.0	69.7	78.0	74.8	66.3	58.7	44.2
	79.8	106.7	49.8	62.7	68.9	76.6	75.8	68.1	60.5	44.6
Clapham North to Clapham Common	76.9	105.8	54.6	59.4	69.2	74.5	70.1	64.2	56.3	43.6
	77.0	105.8	55.3	58.8	69.3	74.6	70.5	64.6	53.0	38.4
	78.3	103.6	53.9	59.3	68.6	74.9	73.7	68.8	60.9	45.5
Clapham Common to Clapham South	75.7	107.8	53.3	57.1	66.9	73.4	69.8	63.2	56.6	43.1
	75.4	106.7	53.2	55.9	66.4	73.7	68.8	62.0	52.9	41.9
	75.4	106.4	52.8	56.4	66.3	72.9	69.6	64.1	56.9	46.8
Clapham South to Balham	74.7	103.7	51.2	56.8	67.6	71.9	68.7	63.0	56.8	44.1
	74.4	102.5	52.0	55.7	66.9	71.7	68.7	62.3	53.6	41.8
	78.0	111.6	50.5	56.3	67.7	74.7	73.4	68.8	61.1	49.0
Balham to Tooting Bec	74.5	105.6	53.4	59.2	68.7	70.1	68.9	64.0	57.4	44.6
	74.3	103.9	53.4	58.9	68.2	70.5	68.6	63.3	54.1	40.8
	78.5	103.6	52.7	59.3	68.4	74.5	73.7	71.1	63.0	46.7
Tooting Bec to Tooting Broadway	72.6	100.0	52.5	57.5	66.5	69.2	67.6	62.7	56.9	44.8
	72.5	100.0	52.8	56.5	66.2	68.7	66.8	61.4	53.3	42.8
	72.8	101.3	50.6	56.7	65.9	69.3	67.3	61.9	53.5	40.8
Tooting Broadway to Colliers Wood	73.9	104.1	52.6	57.7	67.9	70.6	67.3	62.5	56.1	43.0
	74.1	103.8	52.8	57.7	68.3	70.5	68.0	62.3	53.0	40.9
	75.1	102.2	51.9	57.7	67.6	71.6	69.3	66.1	58.9	43.6
Colliers Wood to South Wimbledon	74.8	103.6	53.0	57.6	68.3	70.6	69.6	63.6	57.2	44.7
	72.3	101.9	52.1	55.6	66.1	69.1	65.7	60.8	53.0	41.5
	76.1	101.6	50.8	55.6	66.2	72.0	71.7	67.9	60.4	46.8
South Wimbledon to Morden	86.6	113.4	51.7	57.9	74.5	85.8	79.6	73.4	60.3	45.5
	85.6	109.9	51.2	56.9	73.2	83.9	80.2	74.5	65.5	49.4
	84.3	111.1	50.5	56.2	70.8	82.4	79.9	73.2	59.4	45.1
Mill Hill East to Finchley Central	67.8	102.9	49.4	50.4	59.9	65.3	61.7	55.1	48.7	43.1
	71.8	104.3	49.8	53.0	61.8	69.1	66.4	60.7	55.8	45.9
	74.8	104.3	49.8	51.7	62.7	71.0	70.3	67.3	59.4	47.9

Table B.4 – Inter-station noise levels on the Northern northbound road between High Barnet and Kennington (via Charing Cross)

Interstation section	L _{Aeq} dB(A)	LCpeak dB(C)	Noise Spectral Analysis in Octave (Hz)							
			63	125	250	500	1000	2000	4000	8000
High Barnet to Totteridge & Whetstone	76.4	104.5	46.9	53.2	63	73	72.8	63.9	58.2	49.8
	68.4	100.8	46.5	50.7	58.9	64.1	63.8	60.4	55.1	43.2
	69.2	99.4	50.6	53.4	60.1	65.1	64.7	59.9	54.4	43.2
Totteridge & Whetstone to Woodside Park	76.7	103.7	49.6	55.5	63.1	72.7	73.7	64	60.1	54.5
	69.6	99.1	48.2	52.5	59.1	65.4	64.9	61.4	55.8	43.4
	70.4	99.6	50.1	53.7	60.6	66.6	65.5	61.5	55.7	47.5
Woodside Park to West Finchley	72.3	99.1	47.0	52.1	59.4	68.4	69.1	59.4	55.4	48.5
	70.1	96.7	46.4	50.8	58.8	66.3	65.3	60.9	56.9	46.2
	69.7	98.3	49.7	52.5	59.0	65.8	65.2	60.2	55.0	46.6
West Finchley to Finchley Central	72.7	100.9	46.9	54.8	60.9	69.3	68.8	60.6	55.1	47.4
	72.8	117.7	47.5	53.9	61.8	68.4	68.7	63.7	60.0	50.1
	71.9	112.4	51.2	53.2	60.7	67.6	67.7	63.3	58.3	50.6
Finchley Central to East Finchley	76.3	105.8	47.8	53.8	61.8	72.7	73.1	63.4	57.6	49.7
	70.0	102.3	49.7	53.1	59.1	66.1	65.6	60.9	54.9	43.7
	72.0	103.6	48.9	54.0	61.6	68.1	67.0	64.3	56.6	49.3



Interstation section	L _{Aeq} dB(A)	LC _{peak} dB(C)	Noise Spectral Analysis in Octave (Hz)							
			63	125	250	500	1000	2000	4000	8000
East Finchley to Highgate	79.2	108.9	49.5	56.7	67.0	75.4	75.9	67.8	60.8	50.8
	77.4	106.4	49.3	55.8	66.7	74.1	73.0	66.4	60.7	45.9
	76.9	105.3	51.6	56.4	67.6	73.5	72.7	65.6	57.3	41.9
Highgate to Archway	80.1	106.3	50.2	58.3	69.0	77.5	75.4	70.1	58.8	44.0
	81.1	107.5	50.6	57.6	69.1	78.5	76.6	71.3	60.2	45.9
	81.2	106.6	52.3	58.4	70.3	78.8	76.9	68.7	58.6	44.0
Archway to Tufnell Park	78.8	105.4	51.0	59.9	69.6	76.1	74.3	66.5	57.0	43.9
	80.9	107.5	50.8	59.4	70.6	78.4	76.5	67.4	59.1	45.4
	80.6	105.8	51.8	59.5	70.9	77.7	76.3	67.3	58.1	43.8
Tufnell Park to Kentish Town	77.6	104.3	53.1	62.2	69.2	74.5	72.2	66.6	58.2	45.6
	79.5	105.8	51.1	60.4	69.2	76.7	74.7	67.9	60.1	46.1
	87.4	103.9	52.1	60.2	69.8	75.1	73.6	66.7	58.9	45.9
Kentish Town to Camden Town	80.0	108.2	55.3	65.2	71.8	77.3	74.7	67.5	57.9	43.7
	81.8	109.0	55.2	64.7	72.9	79.5	76.3	68.0	59.3	45.0
	81.1	107.8	54.7	64.2	72.8	78.7	75.8	67.8	58.9	45.4
Camden Town to Mornington Crescent	74.1	105.2	51.5	60.1	68.3	70.8	67.5	62.2	54.0	39.8
	77.2	106.0	51.3	59.6	69.3	74.3	71.4	66.2	59.5	47.7
	76.0	104.3	51.6	59.4	70.1	72.5	69.7	64.8	60.2	49.4
Mornington Crescent to Euston	81.1	108.7	58.4	67.4	74.3	77.4	75.5	70.0	61.1	47.5
	82.7	112.0	59.5	67.9	74.9	79.3	77.7	71.7	64.1	52.7
	82.9	111.4	58.9	67.8	75.7	79.4	77.7	71.3	62.1	47.9
Euston to Warren Street	82.7	109.7	59.3	67.7	74.3	80.1	76.8	70.7	61.3	48.4
	85.0	112.8	60.6	69.4	75.9	82.3	79.9	72.5	63.4	50.2
	83.6	112.5	60.2	67.5	75.4	81.0	77.8	71.4	62.3	50.0
Warren Street to Goodge Street	75.9	104.8	52.4	60.9	68.7	71.8	71.3	65.3	56.6	43.3
	77.4	105.8	51.7	59.2	68.3	73.5	73.4	66.6	60.7	49.4
	77.0	106.0	53.0	60.6	69.1	72.8	72.8	66.5	57.9	43.3
Goodge Street to Tottenham Court Road	76.3	102.2	49.8	59.7	68.8	72.0	72.4	64.2	54.9	41.1
	78.0	102.6	50.1	58.7	68.6	74.0	74.5	66.5	60.5	47.3
	78.1	105.6	51.7	59.8	69.9	73.8	74.5	65.6	56.8	42.1
Tottenham Court Road to Leicester Square	74.8	102.7	50.5	61.2	66.7	70.1	71.1	63.0	55.6	48.8
	78.5	103.7	51.2	61.5	68.0	74.5	74.5	68.5	64.0	48.9
	76.3	102.1	51.8	60.9	67.4	71.2	73.2	64.7	56.6	41.3
Leicester Square to Charing Cross	82.5	110.4	53.1	64.2	76.5	79.7	76.1	70.0	60.5	48.2
	83.7	111.6	52.3	63.4	76.9	80.7	78.4	71.0	63.6	52.4
	84.2	112.0	53.6	64.7	78.0	81.7	77.9	71.2	62.2	49.4
Charing Cross to Embankment	77.7	104.7	51.4	61.0	69.4	75.0	72.1	67.1	58.8	45.8
	78.0	106.0	52.2	60.2	69.3	75.1	72.9	66.4	59.3	45.3
	77.9	105.6	52.2	60.7	70.0	75.1	72.5	66.3	59.0	46.4
Embankment to Waterloo	75.3	104.5	49.9	58.5	67.6	71.7	70.3	65.2	56.2	41.3
	76.0	103.2	50.4	57.3	67.6	72.8	71.3	64.7	57.6	43.7
	77.4	102.3	51.3	58.7	69.1	73.6	73.4	66.7	57.6	42.4
Waterloo to Kennington (SB)	81.1	110.4	56.0	62.4	71.6	78.8	75.9	69.1	59.5	46.5
	82.4	110.5	57.4	62.3	72.2	80.1	77.5	69.6	61.3	48.0
	82.8	112.4	56.3	62.9	72.8	80.4	78.2	70.6	60.8	46.7
Kennington (SB) to Kennington (NB)	71.4	103.5	52.5	57.0	64.2	68.5	65.1	60.5	52.2	39.6
	74.0	103.8	53.9	57.3	65.9	70.8	68.4	63.4	56.9	46.4
	75.9	103.0	53.1	57.4	67.0	71.9	69.4	70.0	60.6	48.8

APPENDIX C – PHOTOGRAPHS



Figure C1 - Northern line 1995 tube stock cab and microphone arrangement