

## Appendix 11.2

### *Introduction*

This appendix describes the baseline conditions in relation to areas which will be exposed to noise from the construction and operation of the proposed Anfield Road Stand expansion. Residents and users of the area around Anfield Stadium are accustomed to regular football games with associated noise impacts from transportation sources, football crowds both outside the stadium in the lead-up to and after games and within the stadium during games, concessions outside the ground, public address and occasional amplified music emanating from within the ground. **Table A11.2.1** summarises the dates and times of the noise surveys that have been used to quantify the baseline noise conditions for the noise assessments informing this ES.

**Table A11.2.1 Noise Surveys Undertaken**

<b>Company</b>	<b>Date</b>	<b>Times</b>	<b>Type</b>
Mott MacDonald	18 May 2018	11.41-23.45	Non match day
Mott MacDonald	18 to 22 May 2018	15.10-09.10	Non match day
Mott MacDonald	22 May 2018	19:00 – 23:00	Match Day
Mott MacDonald	24 April 2018	18:45 to 23:00	Match Day
Sandy Brown Associates	10 November 2019	08.30-19.35	Match Day

Non-Match day noise levels are dominated by traffic on Walton Breck Road and, at locations remote from Walton Breck Road, by vehicle traffic noise on the local road network. There may be contributions from plant situated on the Stadium and other commercial premises in the vicinity, and noise from the service yard at the Stadium including from deliveries, waste collections etc. Surveys were undertaken during the period of 18 to 23 May 2018 to characterise the noise baseline when no match is being played.

Further noise measurement surveys were undertaken by Mott MacDonald at locations representative of noise sensitive receptors outside the stadium on the evening of 24 April 2018, coinciding with the Champions League semi-final first leg match with Roma FC. These measurements were taken to illustrate current noise levels when Anfield Stadium is staging a significant game.

A further noise survey was conducted on 10 November 2019 by Sandy Brown Associates (SBA). To quantify noise levels in the lead up to, during and after a weekend match. The pre match measurements taken in the morning (08:40-11:00) complement the Mott Macdonald long term measurements in establishing typical ambient noise levels along Walton Breck Road when a match is not in progress.

The SBA report is reproduced below.

### ***Measurement Methodology***

### Mott MacDonald Non-Match Day Survey

Attended noise measurements were undertaken during the period 19:00 – 23:00 on the evening Tuesday 22 May 2018 at locations referenced ST1 – ST6.

Unattended noise levels were measured using automated logging equipment at two locations within the curtilage of Anfield Stadium referenced LT 1 and LT2. LT1 was selected as representative of noise levels at residences at the southern end of Alroy Road and properties along Walton Breck Road. LT2 was selected as representative of noise levels at residences on Anfield Road and at the northern part of Skerries Road, remote from Walton Breck Road.

The main purpose of the non-match day surveys was to determine the reference ambient and background noise levels to inform the assessment of:

- Construction noise – for the duration of the construction period;
- Events noise - The last four hours of an evening event. and
- Operational noise due to mechanical services for the new stand.

### Mott MacDonald Match Day Survey

Attended noise measurements were made at six locations (ST1 – ST6) in the vicinity of Anfield Stadium during the period 18:45 to 23:00 on the evening of 24 April 2018. The measurements were taken in the lead up to, during and immediately after the match at locations considered representative of residential areas which would experience elevated noise levels during an event held at the Stadium.

A map showing the measurement locations is presented in **Appendix 11.5**.

A summary description of each measurement location and measurement circumstance may be found in **Table A11.2.6**.

### Measurement Parameters

Measurements at LT2, ST1 and ST2 were undertaken at 1m from a façade and as such should be regarded as façade levels. The measurements at all other locations were taken under free-field conditions. The microphones were supported using a tripod at a height of 1.2 - 1.5m above local ground level. LT2 was necessarily located in an elevated position to ensure secure placement with line of sight to residential areas. All microphones were fitted with a windshield suitable for outdoor use.

All measurements included the following parameters:

$L_{Amax}$  – the highest value of the A-weighted sound pressure level with a specified time constant that occurs during a given noise event.

$L_{Aeq,T}$  – also referred to as the continuous equivalent noise level, it is the A-weighted sound pressure level that is the same amount of sound energy as the time varying noise over the same period of time (T).

$L_{A90,T}$  – also referred to as the background noise level, it is the A-weighted sound pressure level that is exceeded for 90% of a given time interval (T).

A-weighted – as seen in the parameters above, this weighting is the sound level as perceived by the human ear by reflecting the frequency dependency of sensitivity of the human ear.

All measurements were undertaken by consultants competent in environmental noise monitoring, and completed in accordance with the principles of BS 7445-1<sup>i</sup>.

Descriptions of the site, noise climate and weather conditions were noted at each measurement. Photographs were taken of each position (unless otherwise stated in the results section below) to allow ease of repeatability of the measurement.

#### Equipment

All measurements were conducted using sound level meters designed to comply with either the Class 1 standard as defined within BS EN 61672-1<sup>ii</sup>.

The sensitivity of the noise measurement equipment was checked before and after measurement using a Larson Davis CAL200 field calibrator. No significant drift was noted.

A full inventory of the equipment use is shown in **Table A11.2.2**.

**Table A11.2.2: Inventory of Noise Monitoring Equipment**

Type	Item	Make	Model	Serial Number	Calibration Due Date
Match Day Survey	Sound Level Meter	Rion	NL52	1143538	23 February 2019
	Sound level Meter	Rion	NL52	1265461	20 May 2019
	Calibrator	Larson Davis	CAL200	12461	27 October 2018
	Calibrator	Larson Davis	CAL200	6353	7 March 2019
Non-Match Day Survey	Sound Level Meter	Rion	NL52	743137	12 October 2018
	Sound Level Meter	Rion	NL 52	1265461	20 May 2019
	Sound Level Meter	Rion	NL 32	903344	27 September 2018
	Calibrator	Larson Davis	CAL200	2832	29 June 2018
	Calibrator	Larson Davis	CAL200	12461	27 October 2018

#### Meteorological Conditions

During non-match day surveys, the weather was generally dry with warm conditions during the day. Wind speed remained below 5m/s.

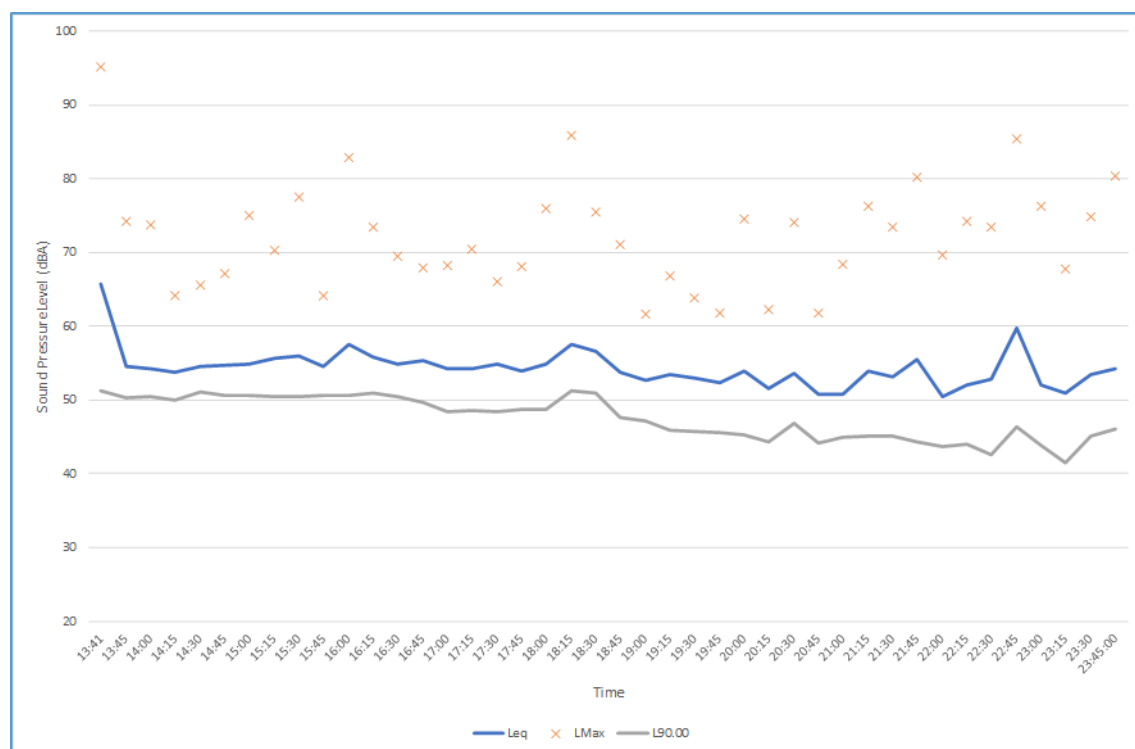
During the match-day measurements, wind speed was below 5m/s however conditions during the evening were wet, this may have elevated measured levels to an extent, however as roads around the stadium were generally closed during the match, traffic noise (which is elevated in wet weather) was not a significant source of noise during the survey.

#### **Noise Measurement Results**

##### Non-Match Day Surveys

Graphs showing the long term measurement data from position LT1 is shown in **Chart A11.2.1**. The measurement was curtailed due to equipment failure so only limited data is available.

**Chart A11.2.1: Measurement at Location LT1**



This measurement position is relevant to residences on northern end of Gilman Street and the southern end of Alroy Road, which are have line of sight to Walton Breck Road but are not located on it. The LT1 measurement was approximately 10 hours long, during the daytime period (11:00-23:00) and measured in a free field position.

Relevant noise data for measurement LT1 is summarised in **Table A11.2.3**. A Logarithmic average of the  $L_{Aeq,15mins}$  has been calculated over the measurement period 14:00-23:00. The background level calculated is an arithmetic average of the  $L_{A90,15mins}$  measured during the 19:00-23:00 period.

**Table A11.2.3: Summary of Measurements at LT1**

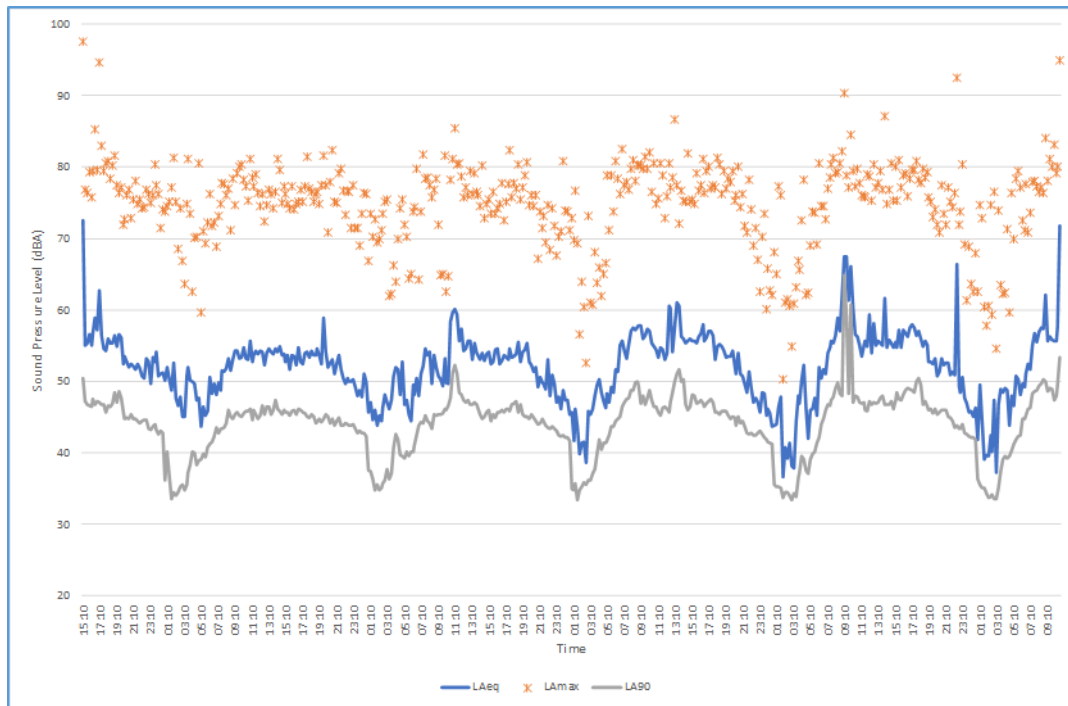
Day/Date	Ambient Noise Level $L_{Aeq,9hours}$ (dB) (free field)	Average Background Noise level 19:00 – 23:00 $L_{A90,15mins}$ (dB) (free field)
Friday 18/05/18	55	48

A graph showing the long term measurement data from position LT2 is shown in **Chart A 11.2.2**. This measurement position is relevant to residences near to Anfield Road which are relatively remote from traffic noise emanating from Walton Breck Road. Relevant noise data for measurement LT2 are summarised in **Table A11.2.4**. This includes the day-time ambient noise level  $L_{Aeq,16hours}$  which is relevant to the WHO guideline threshold for moderate annoyance in amenity areas (Note that this has been corrected to free field by subtraction of 3dB) and the average background noise level between 19:00 and 23:00 to allow variation from day-to day to be seen.

**Table A11.2.4 Summary of Measurements at LT2**

Day/Date	Ambient Noise Level $L_{Aeq,16hours}$ (dB) (free field)	Average Background Noise level 19:00 – 23:00 $L_{A90,15mins}$ (dB) (façade)
Friday 18/05/18	-	45
Saturday 19/05/18	50	44
Sunday 20/05/18	51	45
Monday 21/05/18	53	44
Tuesday 22/05/18	55	46

**Chart 11.2.2: Measurements at location LT2 (façade)**



Review of the data in **Table A 11.2.4** and **Figure A11.2.2** reveals that while overall day-time ambient noise levels expressed as  $L_{Aeq,16hours}$  during the weekend period, are 3 to 4dB quieter than for week-days. There is little variation in average background noise level between weekday evening and weekend evening during the last four hours of likely events.

Limited daytime noise measurements are available for Walton Breck Road.

Levels measured by SBA on the morning before a match are relevant for this location and are presented in Table 4.2.1 of the SBA report.

DEFRA noise mapping accessed DEFRA noise mapping accessed through <https://environment.data.gov.uk/spatialdata/road-noise-laeq-16h-england-round-3/wms> has been further used to characterise the baseline ambient noise levels for noise sensitive receptors directly exposed to traffic noise from Walton Breck Road. The daytime baseline ambient level for those properties based upon these sources is considered to be  $L_{Aeq,16hour}$  73 dB.

A summary of the background noise levels measured at the six short term measurement positions from the Mott MacDonald survey is provided in Table A11.2.5. These levels are corrected to façade

levels where the measurement had been undertaken in the free field to allow ease of comparison with concert MNL where required.

**Table A11.2.5: Summary of Short Term Background Noise Measurements (façade)**

Location	Average Background Noise level 19:00 – 23:00 L <sub>A90,15mins</sub> (dB)
ST1	46
ST2	44
ST3	56
ST4	44
ST5	45
ST6	46

Table **A11.2.6** presents the modal background noise levels for day-time and night-time measured at LT2. Corrected to free field these have been used as reference levels for the setting of limits for rating level of new fixed mechanical plant associated with the Proposed Scheme.

**Table A11.2.6 Mode of Background Noise Measurements at LT2**

Day	Date	L <sub>A90, 15mins</sub> 0700-2300 (modal) freefield	L <sub>A90, 15mins</sub> 2300-0700 (modal) freefield
Friday	18/05/2018	-	40
Saturday	19/05/2018	42	40
Sunday	20/05/2018	42	39
Monday	21/05/2018	44	31
Tuesday	22/05/2018	44	39

Note that the background measurement during the night of Monday 21 May 2018 appears unusually low. This result is considered anomalous and has not been used to inform the assessment.

#### Match Day Survey

Noise measurement surveys were undertaken at locations representative of noise sensitive receptors outside the stadium on Tuesday 24<sup>th</sup> April 2018, with the Champions League semi-final first leg match with Roma FC. These measurements were taken to illustrate current noise levels when Anfield Stadium is staging a significant game. A summary of the match day measurements is shown in **Table A11.2.7**. The match kick-off time was 19:45 with the match ending at approximately 21:30

**Table A11.2.7: Summary of Match Day Noise Measurements**

Location	Description of measurement location	Start Time	Ambient Noise Level L <sub>eq,15mins</sub> (dBA)	Maximum Ambient Noise Level L <sub>max,15mins</sub> (dBA)	Background Noise Level L <sub>90,15mins</sub> (dBA)
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ST1	On pavement approximately 1m from façade, outside #40 Arkles Lane (Façade)	18:52	63	79	57
		20:33	67	81	60
ST2	On pavement approximately 1m from façade, between #8 and #10 Skerries Road	19:43	59	76	53
		21:15	56	65	53
		22:17	57	74	52
ST3	In centre of grass triangle of the ESSO service station at confluence of Oakfield and Walton Breck Roads (freefield)	19:23	72	84	67
		20:57	57	83	53
		21:57	65	77	63
ST4	On the pavement on the corner of the junction of Hartnup and Glaisher Street (freefield)	20:09	65	80	57
		19:35	65	79	58

		21:21	66	97	54
ST5	Approximately 4m from roadside, on waste ground to the north east side of Burleigh Road South (freefield)	20:02	58	80	52
		22:04	56	80	52
ST6	Approximately 4m from roadside, on grass on the west side of the junction between Alroy Road and Anfield Road (freefield)	20:23	66	84	56
		21:43	68	86	61

### ***Photographs of Noise Measurement Positions***

Photograph A11.2.1: Measurement Position LT1





Photograph A11.2.2: Measurement Position LT2



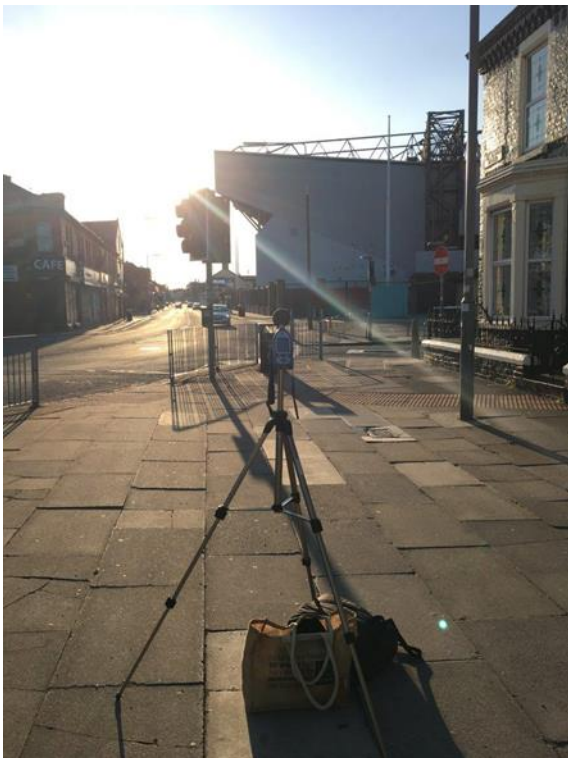
Photograph A11.2.3: Measurement Position ST1



Photograph A11.2.4: Measurement Position ST2



Photograph A11.2.5: Measurement Position ST3



Photograph A11.2.6: Measurement Position ST4



Photograph A11.2.7: Measurement Position ST5





Photograph A11.2.8: Measurement Position ST6



### *Uncertainty of Measurements*

Inevitably there is a degree of uncertainty in measured noise levels. Contributory factors to this uncertainty include tolerances in instrumentation readings, meteorological conditions and the inherent variation in the acoustic environment during the course of a day and indeed over longer periods as the noise sources influencing a given location vary. Any acoustic measurement is representative of the noise climate at the time of the measurement. Every effort has been made to limit uncertainty in the measurements reported. Measures taken to limit uncertainty include:

- Undertaking surveys with appropriately qualified and trained acoustic engineers;
- Use of measurement equipment calibrated to appropriate standards by accredited bodies and checked on site using calibrated reference sound sources;
- Following best practice methodology for environmental noise measurement set out in BS7445-1; and
- Measuring under appropriate meteorological conditions.

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<sup>i</sup> BSI, 2003. British Standard 7445 Description and measurement of environmental noise. Part 1 Guide to quantities and procedures.

<sup>ii</sup> BSI, 2003. British Standard BS EN 61672, Electroacoustics. Sound level meters. Part 1 Specifications

# SANDY BROWN

*Consultants in Acoustics, Noise & Vibration*

**19414-R01-A**

**25 November 2019**

## Anfield Road Stand, Liverpool Football Club

*Environmental noise survey report*

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# SANDY BROWN

*Consultants in Acoustics, Noise & Vibration*

Version	Date	Comments	Author	Reviewer
A	25 Nov 19		Christian Clark	James Atha

## Summary

Sandy Brown has been commissioned by Mott MacDonald Limited to provide acoustic advice in relation to the proposed new Anfield Road stand at Liverpool Football Club, Anfield, Anfield Road, Liverpool L4 0TH.

An environmental noise survey has been carried out at the stadium on a match day to establish the existing noise levels prior, during and after a match around the site. This report presents the results from the environmental noise survey, and sets plant noise egress limits in line with the requirements of Liverpool City Council.

The environmental noise survey was carried out on Sunday 10 November 2019 from 8:30 until 19:35 and includes measurements during a football match between Liverpool and Manchester City (kick-off at 16:30), along with measurements before and after the game.

Measurements were carried out outside nearby noise sensitive premises, and also within the stadium.

During the match, the average noise levels inside the stadium were  $L_{Aeq}$  95 dB and outside the stadium ranged from  $L_{Aeq}$  55-75 dB.

The lowest background noise levels measured outside the nearby noise sensitive premises when the match was not underway, was  $L_{A90}$  50 dB (facade level), which would equate to  $L_{A90}$  47 dB when corrected for free-field conditions.

Plant noise at 1 m from the facade of the nearest noise sensitive premises should not exceed  $L_{Aeq}$  50 dB (facade level) during the daytime. Corrections for attention catching features will need to be applied to this in line for BS4142. Noise generating plant associated with the development should be switched off during the night (2300 to 0700 hrs).

In external amenity spaces, such as the stand and bowl, it is recommended that the cumulative noise level from plant should be limited to achieve a maximum noise level of  $L_{Aeq}$  55 dB.

The results of the noise survey will also be used to inform the acoustic strategy as the design progresses.

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## 1 Introduction

Sandy Brown has been commissioned by Mott MacDonald Limited to provide acoustic advice in relation to the proposed development at the Anfield Road stand at Liverpool Football Club, Anfield, Anfield Road, Liverpool L4 0TH.

An environmental noise survey has been carried out to establish the existing noise levels around the site. This report presents the methodology and results from the noise survey, and sets out the recommended plant noise egress limits in line with the requirements of Liverpool City Council.

The results of the noise survey will also be used to inform the acoustic strategy as the design progresses.

## 2 Site description

### 2.1 The site and its surrounding

The site location (highlighted in yellow) in relation to its surroundings is shown in Figure 1. The site is bound by Anfield Road to the north and Walton Breck Road by the south.

The measurement positions 1 to 7 are marked up on the aerial photograph below.



Figure 1 Aerial view of site (courtesy of Google Earth Pro)

## 2.2 Adjacent premises

The surrounding area is mainly residential, with the nearest affected noise sensitive premises highlighted in blue in Figure 1.

The Parks (Phase 4) is a residential development on Venmore Street currently under construction and is highlighted in red in Figure 1.

Nearby commercial premises include pubs, cafes and small convenience shops located to the south of the site on Walton Breck Road (A5089).

## 3 Noise survey method

### 3.1 Attended measurements

Attended sample measurements were taken by Jessica Wright and Christian Clark at 6 locations outside the stadium, and 1 location within the stadium, at the side of the pitch. The measurement positions are indicated in Figure 1 as positions 1 to 7.

The measurements were carried out on 10 November 2019, over 5 minute periods with the purpose of determining the existing noise levels from road traffic, pedestrians and other significant noise sources in the area, including crowd noise/amplified sound during the match.

Measurement positions 1 to 6 were carried out outside nearby residential premises and public areas close to the stadium.

The pre-match measurements were taken between 8:30 and 11:00 at positions 1 to 6 in order to provide representative noise measurements unaffected by matchday activities.

The measurements taken during the match and post-match were at positions 1 to 7.

Positions 3 and 6 are considered facade measurements at approximately 1 m from a fence/wall and as such can be considered to be facade levels. In the other positions, the microphone was mounted on a tripod approximately 1.2 m above the ground level and at least 3m from any other reflective surface.

Details of the equipment used and the noise indices measured are provided in Appendix A.

Dominant noise sources occurring during the measurements were noted and are set out in the following sections of the report.

Photographs showing measurement positions 1 to 6 are shown in Figure 2 with a photograph of the pitchside measurement position 7 shown in Figure 3.



Figure 2 Measurement positions 1 to 6 (from left to right, and top to bottom)





Figure 3 Measurement position 7 (pitch side)

## 3.2 Weather conditions

Weather conditions during the survey are described in Appendix A.

## 4 Noise survey results

### 4.1 Observations

Prior to the match, dominant noise sources were noted to be due to road traffic, existing plant at the stadium, and pedestrian activities.

The dominant noise sources observed inside the stadium during the match were general crowd noise including chanting, cheering and shouting. In addition, amplified sound from the PA system was a significant source of noise.

The dominant noise sources observed outside the stadium during the match included crowd noise during the match, and traffic noise and plant noise. PA system announcements within the stadium were also notable.

Less significant noise sources included pedestrian and steward activity.

## 4.2 Noise measurement results

### 4.2.1 Pre-match (8:40 – 11:00)

Noise levels and key sources recorded outside the stadium in the morning (before the match) are summarised in Table 1.

Table 1 Noise levels and key noise sources from pre-match attended measurements

Position	Start time	Sound pressure levels (dB)			Noise sources
		$L_{Aeq,5min}$	$L_{AFmax,5min}$	$L_{A90,5min}$	
3	8:40	70	95	50	Road traffic. Maxes caused by cars driving over recessed bollards in road.
	8:45	60	76	50	
	8:50	70	94	51	
					Metal fencing being assembled from 8.45 (match day activity).
2	9:05	66	92	50	Road traffic, pedestrians, distant plant from stadium louvre.
	9:10	62	90	49	
	9:15	58	80	49	
					Trolley wheels rattling briefly during measurement at 9.05 hrs.
1	9:25	56	72	51	Stadium plant dominates.
	9:30	55	69	51	
	9:35	55	73	51	
					Distant road traffic noise from Anfield Road and Walton Breck Road.
6	9:45	73	86	55	Road traffic dominant. (57 car passes during 9:50 measurement).
	9:50	73	85	55	
	10:00	72	89	59	

Position	Start time	Sound pressure levels (dB)			Noise sources
		$L_{Aeq,5min}$	$L_{AFmax,5min}$	$L_{A90,5min}$	
5	10:10	69	81	59	Road traffic dominant, accelerating at junction. Pedestrian activity.
	10:15	68	85	57	
	10:20	70	85	61	
4	10:30	70	83	62	Road traffic dominant.
	10:35	70	84	61	Occasional pedestrian crossing sounder.
	10:40	69	82	63	
3	10:50	64	91	50	Road traffic dominant, however was infrequent with around 5 cars every 5 mins. Maxes likely caused by cars driving over bollards set into road. Some pedestrian activity.
	10:55	71	95	50	

Generally, these levels are not considered to have been influenced by noise associated with match day operations and are therefore considered to be representative of non-match day conditions.

#### 4.2.2 Inside the stadium – during the match (15:55 – 18:30)

Noise levels and key sources recorded inside the stadium at position 7 during the match are summarised in Table 2.

Table 2 Noise levels and key noise sources from pitch side attended measurements

Start time	Sound pressure levels (dB)			Noise sources
	$L_{Aeq,5min}$	$L_{AFmax,5min}$	$L_{A90,5min}$	
15:55	82	90	80	Crowd talking, team on pitch.
16:00	81	89	78	Music playing on PA system
16:10	87	103	80	Crowd cheering
16:15	89	102	84	Stadium almost full, loud music on PA system and chants.

Start time	Sound pressure levels (dB)			Noise sources
	$L_{Aeq,5min}$	$L_{AFmax,5min}$	$L_{A90,5min}$	
16:21	99	107	91	Cheering
16:25	98	111	98	Team coming out, cheering and singing.
16:30	97	110	87	Minute of silence followed by match start.
16:35	101	116	89	Loud cheers following home goal at 16:36
16:40	100	116	87	Loud cheers following home goal at 16:43
16:45	93	105	85	Chanting and cheering
16:50	94	106	84	As above
16:55	94	108	85	As above
17:00	93	106	82	As above
17:05	94	109	84	Vibration from foot stamping.
17:10	92	108	82	Chanting and cheering
17:15	93	108	84	PA system intermittent with chanting and cheering. Half time start at 17:17. Music, conversation.

Start time	Sound pressure levels (dB)			Noise sources
	$L_{Aeq,5min}$	$L_{AFmax,5min}$	$L_{A90,5min}$	
17:20	87	98	78	Half time interviews on PA system, applause and background music on PA system.
17:25	88	96	84	Background music, conversation and singing.
17:30	91	105	82	Both teams back on pitch, cheering.
17:35	99	114	82	Loud cheers following home goal at 17:39
17:40	97	109	88	Cheering, chanting and stamping.
17:45	94	108	84	Loud cheers as LFC take corner.
17:50	94	109	84	Cheering/chanting.
17:55	91	102	81	Cheering/chanting and loud PA announcement.
18:00	93	109	81	Loud cheering as LFC take corner
18:05	93	104	83	Distant cheering following away goal at 18:06. Away fan zone in opposite corner to measurement location.
18:10	90	103	82	Cheering/chanting
18:15	95	108	86	Cheering/chanting
18:20	99	110	88	Singing, cheering and chanting. Loud cheering as LFC win - match ends.
18:25	87	99	81	Background music on PA system and crowd cheering
18:30	77	93	72	Almost empty stadium



## 4.2.3 Outside the stadium - during the match (16:25 – 18:25)

Noise levels and key sources recorded outside the stadium during the match are summarised in Table 3.

Table 3 Noise levels and key noise sources from attended measurements during the match (outside).

Position	Start time	Sound pressure levels (dB)			Noise sources
		$L_{Aeq,5min}$	$L_{AFmax,5min}$	$L_{A90,5min}$	
3	16:25	66	89	59	Some plant from food truck. Crowd cheers from inside, late-arrival pedestrian activity.
	16:36	66	83	60	Crowd chanting dominating, max from trolley wheel rattling.
	16:41	66	86	59	Plant noise from food truck, crowd noise constant and dominant with home goal at 16:43.
2	16:50	60	77	55	Idling coach, crowd dominant.
	16:56	59	73	55	Crowd dominant, three distant firework bangs
	17:01	60	73	55	Crowd chanting dominating, max from trolley wheel rattling.
1	17:10	64	77	58	Dominated by crowd and nearby idling van. Occasional traffic including street sweeper.
	17:15	61	77	55	Occasional traffic. Less crowd noise as half time.
	17:20	59	72	55	As above

Position	Start time	Sound pressure levels (dB)			Noise sources
		$L_{Aeq,5min}$	$L_{AFmax,5min}$	$L_{A90,5min}$	
5	17:30	65	79	55	Road traffic dominates, with regular music and crowd noise from stadium
	17:35	67	84	56	Pedestrian conversation and road traffic Home goal at 17:39.
	17:42	66	80	56	As above
6	17:50	70	86	56	Buses parked and idling near measurement position, traffic dominating
	17:56	65	84	53	As above
	18:02	58	80	52	As above
4	18:15	72	86	67	Dominated by idling bus on main road. Moderate crowd of people leaving early. Helicopter overhead.
	18:20	74	92	70	Match finished at 18:20. Crowd cheering, helicopter also dominant.
	18:25	75	91	70	As above

## 4.2.4 Post-match (18:35 – 19:30)

Noise levels and key sources recorded during the post-match attended measurements are summarised in Table 4.

Table 4 Noise levels and key noise sources from post-match attended measurements

Position	Start time	Sound pressure levels (dB)			Noise sources
		$L_{Aeq,5min}$	$L_{AFmax,5min}$	$L_{A90,5min}$	
3	18:35	77	91	73	Dominated by helicopter
1	18:45	66	84	60	As above
6	18:55	73	92	64	As above and buses idling.
3	18:55	71	85	61	Dominated by helicopter
1	19:05	60	82	57	Occasional traffic
4	19:05	69	86	63	Pedestrians, congested road traffic, music from temporary stall.
3	19:15	69	88	56	Road traffic and pedestrian activity
6	19:15	62	83	58	Regular road traffic, buses idling and conversation from passengers
1	19:25	58	79	54	Occasional road traffic
4	19:25	68	85	62	Pedestrian activity and road traffic
6	19:30	69	92	58	Busy road traffic (51 cars and 9 vans pass during measurement)

## 5 Plant noise egress limits

### 5.1 Standard guidance

BS 4142:2014+A1:2019 *Methods for rating and assessing industrial and commercial sound* (BS 4142) provides a method for assessing noise from items such as building services plant against the existing background sound levels at nearby noise sensitive premises.

BS 4142 suggests that if the noise level is 10 dB or more higher than the existing background sound level, it is likely to be an indication of a significant adverse impact. If the level is 5 dB above the existing background sound level, it is likely to be an indication of an adverse impact. If the level does not exceed the background level, it is an indication of having a low impact.

If the noise contains 'attention catching features' such as tones, bangs etc, a penalty, based on the type and impact of those features, is applied.

### 5.2 Local Authority criteria

Liverpool City Council advise the following regarding noise egress criteria:

*'The rating level of the noise emitted from any plant shall not exceed the existing background noise level. The noise level shall be determined at the nearest noise sensitive premises. The measurements and assessments shall be made according to BS4142:2014. 'Method for Rating Industrial and Commercial Sound'*

### 5.3 Basic limits

Based on the above criteria and the measurement results, the cumulative noise level from the operation of all new plant associated with the Anfield Road stand development should not exceed  $L_{Aeq}$  50 dB (during the daytime 07:00-23:00).

The limit applies at 1 m from the worst affected windows of the nearest noise sensitive premises and is presented as a facade level.

All noise generating plant should be switched off during the night (23:00-07:00).

This limit does not include any attention catching features. Penalty corrections for attention catching features may be significant and will need to be considered as the building services design progresses. This is discussed in Appendix C.

In addition, it is recommended that plant noise egress be limited to be no higher than  $L_{Aeq}$  55 dB in any external amenity or publicly accessible spaces.

### 5.4 Assessment

All building services plant will be designed to achieve the noise limits set out above, including any corrections for attention catching features. At this stage, no information is available in relation to the proposed plant. This will need to be assessed as the design progresses.

## 6 Conclusion

An environmental noise survey was carried out on Sunday 10 November 2019, including measurements during a football match between Liverpool and Manchester City (kick-off at 16:30), as well as pre-match and post-match measurements.

During the match the average noise levels inside the stadium were  $L_{Aeq}$  95 dB and outside the stadium ranged from  $L_{Aeq}$  55-75 dB.

Key noise sources observed outside the stadium included crowd noise during the match, and traffic noise from Walton Breck Road, PA system announcements during the match and plant noise from the stadium.

The lowest background noise level measured during the survey, outside the nearby noise sensitive premises at position 3 was  $L_{A90,5mins}$  50 dB (as a facade level), which equates to  $L_{A90}$  47 dB when corrected for free-field conditions.

Plant noise egress limits have been set and are  $L_{Aeq}$  50 dB during the day at 1 m from the facade of the nearest noise sensitive premises (facade level). Corrections will need to be applied to this in line with BS4142.

The results of the noise survey will also be used to inform the acoustic strategy as the design progresses.

## Appendix A

### Survey details

## Equipment

The attended noise measurements were taken using a B&K 2250 sound level meter and a Norsonic 118 sound level meter.

Calibration details for the equipment used during the survey are provided in table A1.

Table A1 Equipment calibration data

Equipment description	Type/serial number	Manufacturer	Calibration expiry	Calibration certification number
<b>B&amp;K 2250</b>				
Sound level meter	2250/3011964	Brüel & Kjær	4 Sep 21	UCRT19/1970, UTRC19/1976
Microphone	4189/3100176	Brüel & Kjær	4 Sep 21	UCRT19/1970, UTRC19/1976
Pre-amp	ZC0032/26376	Brüel & Kjær	4 Sep 21	UCRT19/1970, UTRC19/1976
Calibrator	4231/3019123	Brüel & Kjær	3 Sep 21	UCRT19/1969
<b>Norsonic 118</b>				
Sound level meter	Nor118/31754	Norsonic	14 Feb 21	UCRT19/1201
Microphone	40AF/62396	Gras	14 Feb 21	UCRT19/1200
Pre-amp	1206/30873	Norsonic	14 Feb 21	UCRT19/1200
Calibrator	1251/31322	Norsonic	14 Feb 21	UCRT19/1199

Calibration of the meters used for the measurements is traceable to national standards. Calibration certificates for the sound level meters used in this survey are available upon request.

Calibration checks were carried out on the meters and their measurement chains at the beginning and end of the survey. No significant calibration deviation occurred.

## Noise indices

Noise indices recorded included the following:

- $L_{Aeq,T}$  The A-weighted equivalent continuous sound pressure level over a period of time, T.
- $L_{AFmax,T}$  The A-weighted maximum sound pressure level that occurred during a given period, T, with a fast time weighting.
- $L_{ASmax,T}$  The A-weighted maximum sound pressure level that occurred during a given period, T, with a slow time weighting.
- $L_{A90,T}$  The A-weighted sound pressure level exceeded for 90% of the measurement period. Indicative of the background sound level.

Sound pressure level measurements are normally taken with an A-weighting (denoted by a subscript 'A', eg  $L_{A90}$ ) to approximate the frequency response of the human ear.

A more detailed explanation of these quantities can be found in BS7445: Part 1: 2003 *Description and measurement of environmental noise, Part 1. Guide to quantities and procedures*.

## Weather conditions

During the attended noise measurements, the weather was generally clear and dry and no rain occurred. Wind speeds were measured at each position and varied between 2 m/s and 4 m/s.

These weather conditions are considered suitable for obtaining representative measurements.



## Appendix B

### BS4142 – attention catching features

The following applies where plant noise is assessed in accordance with BS 4142:2014+A1:2019.

If the proposed plant noise contains attention catching features (such as tonal elements, whines, whistles, bangs etc), penalty corrections should be applied based on the type and impact of the features.

If appropriate, a subjective assessment of the plant features can be adopted. Where the plant noise contains tonal elements, the following corrections can be made depending on how perceptible the tone is at the noise receptor:

- 0 dB where the tone is not perceptible
- 2 dB where the tone is just perceptible
- 4 dB where the tone is clearly perceptible
- 6 dB where the tone is highly perceptible.

Where the plant noise is impulsive, the following corrections can be made depending on how perceptible the impulsivity is at the noise receptor:

- 0 dB where the impulse is not perceptible
- 3 dB where the impulse is just perceptible
- 6 dB where the impulse is clearly perceptible
- 9 dB where the impulse is highly perceptible.

For noise which is equally both impulsive and tonal, then both features can be accounted for by linearly summing the corrections for both characteristics.

If the plant has other distinctive characteristics, such as intermittency, then a 3 dB correction can be made.

If a subjective assessment of tonality is not appropriate, an objective assessment can be made by analysis of time-averaged, third-octave band sound pressure levels. A noise source is deemed to be tonal if the level in a third-octave band exceeds the level in adjacent third-octave bands by the level differences given below:

- 15 dB in the low frequency third-octave bands (25 Hz to 125 Hz)
- 8 dB in the mid frequency third-octave bands (160 Hz to 400 Hz)
- 5 dB in the high frequency third-octave bands (500 Hz to 10000 Hz).

If an objective assessment identifies the plant noise to be tonal then a 6 dB correction must be made.