Skanska Technology Limited

Our contact
Mark Roberts

Date
28th July 2016

Our reference/No
S15/182/99/2/0003a-jmr

To :

Jo Dimitriadis, Skanska Building LSE

CC.

Paul Roberts, Skanska Building LSE }
Rory McKinnon, Skanska Building LSE }
Eleanor Stewart, Skanska Building LSE }
Felipe Manzatucci, Skanska Technology } Email Copy only.
Alan Wills, Skanska Technology }
Matt Storey, Skanska Technology }

Dear Jo,

St. Giles Circus Development, London
3-D Noise Modelling and Vibration Assessment for Early Works, Piling Works and Main Structure Works

I write further to my Memo dated 7th July and our meeting at the 23, Denmark Street Project offices yesterday. During the meeting you requested that we should present the results from the previous Memo together with the additional modelling for the follow-on Activities to prove a complete set of information for Skanska's works at St. Giles Circus. This combined set of information is to be submitted to the London Borough of Camden Council for their consideration. The noise modelling and associated vibration assessments are required to satisfy a requirement from the London Borough of Camden Council within their Code of Construction Practice.

In June 2016 you supplied a package of information for the St. Giles Circus development which supplemented a few items supplied back in September by Eleanor Stewart. These have been used in developing the model for the noise predictions. The information you supplied included a programme for Skanska's works, construction phasing drawing, various GA drawings and sections, a 3-D Sketch-up model and answers to a set of questions supplied by myself.

In our exchange of emails you have confirmed that the demolition of the existing buildings and structures on the site is being completed by another contractor working directly for the client and as a result does not need to be considered within the noise modelling we have been instructed to complete.

The St. Giles Circus development is situated around Denmark Street and will be on the site of several existing buildings off Denmark Street and Charing Cross Road which will be demolished. The new development includes offices, restaurants, a hotel and a theatre / events venue. The site occupied most of an island bounded by Denmark Street, Charing Cross Road, St. Giles High Street and Andrew Borde Street. The only part of the island site that is not to be redeveloped is Shaldon Mansions in the south-western corner which are residential. The facades on some of the buildings are to be retained in the new development because they are listed. The buildings on the southern half of the site which form what is referred to in the programme as "Zone 2" and include Nos. 20 to 28, Denmark Street, No. 16 Denmark Place and No. 59, St. Giles High Street are to be altered / refurbished to form part of the new development. A listed façade is to be retained on the St. Giles High Street side of the site and incorporated into the new development.

The site is surrounded by a mixture of residential and commercial premises. Nos. 1 to 11 Denmark Street to the South of the site are in commercial use. In addition to Sheldon Mansions, No. 16 to 24, Centre Point to the North-east of the site are in residential use (the rest of Centre Point is being refurbished. Nos. 1 to 53, Matilda Apartments to the East of the site are residential with commercial on the ground floor. The rest of Centre Point to the North of the site is being refurbished. The Tottenham Court Road (TCR) LUL Station Upgrade and Crossrail sites lie to the West of the St. Giles Circus site. It is understood that there is some commercial use of the northern side of the retained buildings in the SW corner of the site next to Shaldon Mansions.

There are a number of other major construction projects underway in the vicinity of the St. Giles Circus site including a Crossrail site, the TCR Station Upgrade and refurbishment of Centre Point. This is understood to be why LBC require noise modelling to be undertaken for the development.

The noise modelling has been undertaken using CadnaA noise modelling software for which Skanska Technology has a license. The base model prepared for the modelling utilises elements from the Sketch-up model supplied by Will Needham. The model-set up and bulk of the modelling was undertaken by Matt Storey in my team.

Based on the programme you supplied, the main works for which Skanska will be Main Contractor include the following items:

- Construction of the Working (Piling) Platform on the site. This assumes that this has not been completed by the demolition contractor prior to Skanska taking possession of the site.
- Establishment and Operation of the Bentonite "Farm" (processing plant) to the North-east of the main site off St. Giles High Street, and adjacent to centre Point. It is expected that the bentonite farm will be established on an existing area of hard standing so there should be no need to install a working platform.
- Mobilisation of the piling plant and equipment to the main site. A small bentonite storage facility will be established on site to supplement the main plant.
- Installation of the bored piles forming the retaining walls around the site perimeter and either side of the Crossrail tunnel alignment which passes under the site in a north-west to south-east orientation. The piled walls will be of the intersecting secant type with the 900 mm diameter female piles being installed first using Continuous Flight Ager (CFA) techniques and the alternate 1,000 mm diameter male piles, which partly cut through the female piles, installed using Large Diameter Rotary techniques. The piles for the secant wall will be up to around 30 m deep. The rotary piles are expected to be installed using a large piling rig such as a Liebherr LB28 or Bauer BG40. The CFA piles are expected to be installed using a Soil Mec SR 70 piling rig.
- Installation of bearing piles within the footprint of the site. The bearing piles are to be installed using large diameter rotary techniques and will be up to 50 m deep and between 1,000 and 1,300 m in diameter. Segmental casings will be used together with the bentonite support fluid particularly for the larger diameter piles which include plunge columns.
- Relocation of the "Smithy" building (No. 23, Denmark Place) which is understood to be a heritage structure that has to be retained within the site. The Smithy is being modified for that it is able to be moved around the site using a mobile crane in order to allow for the piles to be completed across the whole site.
- Pile Trimming and Capping Beam Construction works.
- Nos. 20 to 28, Denmark Street, No. 16 Denmark Place and No. 59, St. Giles High Street, which will be altered / refurbished, and some of these works will be completed in parallel with the piling works. Will include

brickwork repairs / alterations, some slab works and some localised demolitions of e.g. internal walls.

- Excavation and construction of basements including removal of obstructions and trimming piles around LUL Northern Line Escalator Box.
- Operating Tower Cranes 1 and 2.
- Construction of the reinforced concrete cores structures using either Jump-forming or Slip-forming techniques.
- Erection of the frames and construction of the floor and roof slabs for the new buildings.
- Repairs to the fabric of the former Smithy building.
- Installation of cladding to the new buildings.
- Internal fit-out including the installation of internal partitions, mechanical and electrical plant and equipment and finishes. This is considered to be a Low-key Activity.
- External landscaping works. Limited to around the new buildings within the site and as such will be screened from surrounding residential and other receptors.
- Demobilisation from site.

Table 1 shows the Plant Lists for the Activities listed above for which noise modelling has been undertaken.

Table 1. Plant List for the Activities for which Noise Modelling has been Undertaken

All Sound Power Levels are obtained from BS5228 Part 1: 2009 + A1: 2014 unless stated otherwise. S = from Skanska's database; M = from Manufacturer's Information; M* = Estimated from Manufacturer's Information; EC = Plant Noise covered by European Directive.

Construction of Piling Platform

Reference	Plant	No	L_{WA}	On-time %	Source
183	360° Tracked Excavator 30 t.	2	104	60 each	BS5228
28	20t Delivery / Road Lorry.	4	105	10 each	BS5228
100	Bomag BW213 Vibratory Roller.	1	112	30	S

Table 1. (continued)

Operation of Bentonite Farm

Reference	Plant	No	L_{WA}	On-time %	Source
134	Bentonite Mixer.	1	95	50	S
135	Electric Bentonite Pump.	4	90	100 each	M*
18	Silenced Diesel 6" Pump.	1	93	50	BS5228
137	Bauer BE250 Desander.	2	98	100 each	M
28	20t Delivery / Road Lorry.	1	105	5	BS5228
62	Tanker Lorry.	1	104	10	BS5228

Relocation of the Smithy Building

Reference	Plant	No	L_{WA}	On-time %	Source
5	Mobile Crane.	1	109	30	BS5228

Large Diameter & CFA Bored Piling

Reference	Plant	No	L_{WA}	On-time %	Source
11	Ready Mix Concrete Truck Mixer.	4	108	15 each	BS5228
84	Soilmec SR70 Rig in CFA mode drilling / Injecting.	1	111	80	S
141	Crawler Crane.	2	98	20 each	BS5228
145	360° Tracked Excavator 20t.	2	99	25 each	BS5228
86	Concrete Agitator (full revs during loading).	1	113	10	S
87	Silenced Trailer-mounted Concrete Pump.	1	106	40	S
28	20 tonne Delivery / Road Lorry.	4	105	5 each	BS5228
43	Articulated Flatbed Lorry.	2	107	5 each	BS5228
109	Bauer BG40 / Liebherr LB28 Rig in Rotary Mode.	1	114	50	S
8	Small Compressor.	1	93	5	BS5228
18	Silenced Diesel 6" Pump.	1	93	50	BS5228

Table 1. (continued)

Pile Trimming & Capping Beam Construction

Reference	Plant	No	L_{WA}	On-time %	Source
13	Hand-held Pneumatic Breaker	2	111	20 each	BS5228
97	360° Tracked Excavator 30 t with Pile Hydraulic Muncher / Cropper.	1	108	50	S
145	360° Tracked Excavator 20t.	1	99	30	BS5228
11	Ready Mix Concrete Truck Mixer.	2	108	15 each	BS5228
23	Poker Vibrators (Group of Three).	1 set	107	30	BS5228
8	Small Compressor.	2	93	40 each	BS5228
28	20 tonne Delivery / Road Lorry.	3	105	10 each	BS5228

Zone 2 (Denmark Street Buildings) Alteration Works

Reference	Plant	No	L_{WA}	On-time %	Source
13	Hand-held Pneumatic Breaker	2	111	20 each	BS5228
145	360° Tracked Excavator 20t.	1	99	30	BS5228
11	Ready Mix Concrete Truck Mixer.	4	108	10 each	BS5228
23	Poker Vibrators (Group of Three).	2 sets	107	30 each	BS5228
8	Small Compressor.	3	93	40 each	BS5228
28	20 tonne Delivery / Road Lorry.	3	105	10 each	BS5228
203	Stihl Saw.	4	119	15 each	BS5228
22	Electric Hammer Drill.	6	104	20 each	M*
12	Lorry-mounted Concrete Pump.	1	106	40	S

Table 1. (continued)

Excavating Basements and Groundworks.

Reference	Plant	No.	L_{WA}	On-time %	Source
145	360° Tracked Excavator 20t.	1	99	30	BS5228
8	Small Compressor.	2	93	40 each	BS5228
28	20 tonne Delivery / Road Lorry.	3	105	10 each	BS5228
183	360° Tracked Excavator 30t.	1	104	60	BS5228
179	30t excavator with Impact Breaker.	1	118	30	BS5228
3	Mini-excavator with Impact Breaker (3 t).	1	112	30	BS5228
110	Diamond Wire Sawing Equipment.	1	108	60	M*
111	Rotary Diamond Coring Drill.	2	106	40 each	BS5228
203	Stihl Saw.	2	119	15 each	BS5228

Slip-Forming / Jump-forming Core Structures

Reference	Plant	No.	L_{WA}	On-time %	Source
11	Ready Mix Truck Mixer.	6	103	5 each	BS5228
206	Vibrators within Shutters.	1 set	110	30	M*
8	Compressor.	2	93	40 each	BS5228
12	Lorry Mounted Concrete Pump.	1	108	30	BS5228

Steel Fixing and Shuttering (Structural Elements Excluding Cores)

Reference	Plant	No.	L_{WA}	On-time %	Source
5	Mobile Crane.	1	109	10	BS5228
20	Angle Grinder.	2	113	10 each	S
43	Articulated Flat Bed Lorry.	2	107	10 each	BS5228
42	Bar Bender.	1	108	20	M*
21	Circular Saw.	2	108	15 each	BS5228
77	Welder Generator Set.	2	100	50 each	EC
90	78 kW Tele-loader.	1	106	20	EC
40	Cherry Picker.	2	106	30 each	S

Table 1. (continued)

Concreting (Structural Elements Excluding Cores)

Reference	Plant	No.	L_{WA}	On-time %	Source
11	Ready Mix Truck Mixer.	6	103	5 each	BS5228
23	Poker Vibrators (3 of).	2 sets	107	30 each	BS5228
8	Compressor.	2	93	40 each	BS5228
12	Lorry Mounted Concrete Pump.	1	108	30	BS5228
76	Crawler Crane.	1	109	10	S
40	Cherry Picker.	2	106	30 each	S
191	Power Float.	2	100	20 each	BS5228

Surface Preparation and Cleaning Out.

Reference	Plant	No.	L_{WA}	On-time %	Source
48	Air Lance.	1	121	5	S
79	Grit Blast Gun (Exhaust).	1	121	1	S
80	Grit Blast Gun.	1	106 (S)	10	S
78	High Pressure Water Jet.	1	111	10	S
8	Compressor.	2	93	25 each	BS5228
17	Pressure Washer.	2	108	10 each	S
40	Cherry Picker.	2	106	30 each	S

Operation of Tower Cranes

Reference	Plant	No.	L_{WA}	On-time %	Source
176	Tower Crane.	2	98	40 each	EC

Table 1. (concluded)

Installing Pre-cast Concrete and Steel Elements

Reference	Plant	No.	L_{WA}	On-time %	Source
43	Articulated Flatbed Lorry.	2	107	5 each	BS5228
90	78 kW Tele-loader.	2	106	20 each	EC
6	Hiab Lorry.	1	107	10	BS5228
22	Electric Hammer Drill.	2	104	20 each	BS5228
10	Super-Silenced Generator.	1	94	30	BS5228
98	Pneumatic Impact Wrench.	2	101 (S)	25 each	S
8	Compressor.	1	93	30	BS5228
40	Cherry Picker.	2	106	30 each	S

Installing Cladding

Reference	Plant	No.	L_{WA}	On-time %	
11	Ready Mix Truck Mixer.	1	103	15	BS5228
90	78 kW Tele-loader.	2	106	20 each	EC
28	20t Delivery / Road Lorry.	4	105	5 each	BS5228
40	Cherry Picker.	2	106	30 each	S
22	Electric Hammer Drill.	2	104	20 each	BS5228
10	Super-Silenced Generator.	1	94	30	BS5228
98	Pneumatic Impact Wrench.	2	101 (S)	25 each	S
8	Compressor.	1	93	30	BS5228

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Figure 1 shows a marked-up drawing extract showing the locations of the receptors listed in Table 2.

Table 2 shows details for the 28 receptors which have been used for the noise modelling. In line with the London Borough of Camden's requirements the noise levels at several levels have been considered for each of the receptors, generally the first 4 storeys of each building which are considered to be the critical ones.

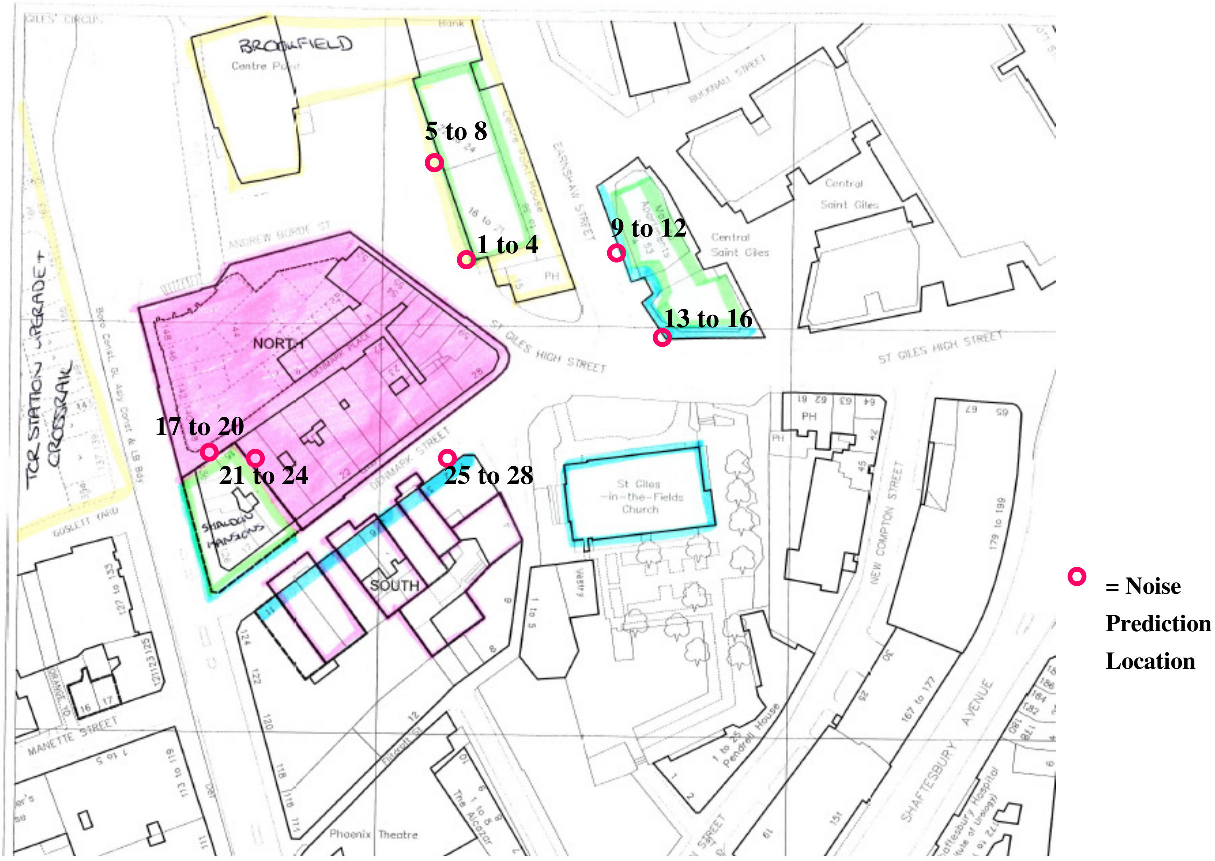

Figure 1. Marked-up Drawing Extract showing the Locations of the Receptors in Table 2.

Table 2. Receptor Details Used for the Noise Modelling

Location (Receptor ID)	Location Details
1	Centre Point House 22 to 24 Floor 1.
2	Centre Point House 22 to 24 Floor 2.
3	Centre Point House 22 to 24 Floor 3.
4	Centre Point House 22 to 24 Floor 4.
5	Centre Point House 16 to 21 Floor 1.
6	Centre Point House 16 to 21 Floor 2.
7	Centre Point House 16 to 21 Floor 3.
8	Centre Point House 16 to 21 Floor 4.
9	Matilda Apartments 1 to 53 Floor 1.
10	Matilda Apartments 1 to 53 Floor 2.
11	Matilda Apartments 1 to 53 Floor 3.
12	Matilda Apartments 1 to 53 Floor 4.
13	Matilda Apartments 54 + / No. 5, St. Giles Plaza Floor 1.
14	Matilda Apartments 54 + / No. 5, St. Giles Plaza Floor 2.
15	Matilda Apartments 54 + / No. 5, St. Giles Plaza Floor 3.
16	Matilda Apartments 54 + / No. 5, St. Giles Plaza Floor 4.
17*	Shaldon Mansions Floor 1.
18*	Shaldon Mansions Floor 2.
19*	Shaldon Mansions Floor 3.
20*	Shaldon Mansions Floor 4.
21*	Shaldon Mansions North Floor 1.
22*	Shaldon Mansions North Floor 2.
23*	Shaldon Mansions North Floor 3.
24	Shaldon Mansions North Floor 4.
25	1, 2 & 3 Denmark Street Floor 1.
26	1, 2 & 3 Denmark Street Floor 2.
27	1, 2 & 3 Denmark Street Floor 3.
28	1, 2 & 3 Denmark Street Floor 4.

Note for Table 2:

* = This façade of Shaldon House has windows facing north onto the western side of the site. The owners of these properties with windows in rooms which, based on use, qualified for Noise Insulation (Secondary Glazing) under the Crossrail Policy were offered this as part of the nearby Crossrail development works. Many owners took up the offer and the Secondary Glazing was fitted to qualifying windows a few years ago. Other windows did not qualify based on the use of the rooms.

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Predicted Construction Noise Levels.

Tables 3 to 6 present the results of the noise modelling for both the Worst Case and typical Average Case Scenarios.

The Overall Totals in each of Tables 3A, 4, 5A, 5B and 6 show the predicted overall construction noise levels based on a combination of one or more of the Work Items. The Worst Case Scenarios represent the highest predicted noise levels and the Average Case Scenarios the predicted typical noise levels for that period.

General Note for Tables 3A to 6:

* = This façade of Shaldon House has windows facing north onto the western side of the site. The owners of these properties with windows in rooms which, based on use, qualified for Noise Insulation (Secondary Glazing) under the Crossrail Policy were offered this as part of the nearby Crossrail development works. Many owners took up the offer and the Secondary Glazing was fitted to qualifying windows a few years ago. Other windows did not qualify based on the use of the rooms.

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Table 3A. Worst Day Scenario Predicted Noise Levels (Early Works and Piling Phase)

Location (Receptor ID)	Construction of the Piling / Working Platform.	Operation of the Bentonite Plant only (Excluding Piling Works).	Bored Piling Works (CFA + Rotary) including Operation of Bentonite plant).	Relocation of Smithy Building.
	$L_{Aeq,10h}$	$L_{Aeq,10h}$	$L_{Aeq,10h}$	$L_{Aeq,10h}$
1	61.0	58.7	67.9	57.5
2	61.0	58.8	68.1	57.5
3	60.9	58.7	68.4	57.5
4	61.1	61.3	68.7	57.5
5	65.6	63.3	68.8	54.3
6	66.2	63.2	71.2	59.3
7	66.2	65.3	72.6	59.2
8	69.0	64.5	73.2	63.6
9	58.0	55.3	64.7	50.0
10	58.0	55.3	64.8	50.0
11	58.2	55.3	64.9	50.0
12	58.1	55.2	64.8	49.9
13	57.6	54.3	61.6	49.8
14	57.8	54.3	63.7	49.8
15	57.7	54.2	63.6	49.8
16	57.5	54.9	63.7	49.7
17*	95.2*	53.9	85.9*	68.1
18*	86.7*	54.1	94.4*	68.1
19*	82.6*	54.1	88.4*	68.1
20*	79.8*	54.1	84.8*	67.9
21*	83.9*	48.6	78.7*	57.9
22*	81.9*	51.3	83.8*	67.4
23*	78.8*	51.3	79.4*	67.4
24	76.0	51.3	76.5	67.4
25	61.2	52.2	63.7	55.0
26	61.1	52.2	63.7	55.0
27	61.0	52.1	63.7	54.9
28	60.8	52.0	63.5	54.8

Table 3A. Worst Day Scenario Predicted Noise Levels (Early Works & Piling Phase) (concluded)

Location (Receptor ID)	Pile Trimming & Capping Beam Construction. $L_{Aeq,10h}$	Zone 2 (Denmark Street) Building Alteration Works. $L_{Aeq,10h}$	Overall predicted Noise Levels (Early Works & Piling Phase). $L_{Aeq,10h}$
1	62.2	65.6	67.9
2	62.2	66.2	68.1
3	62.2	67.4	68.4
4	62.3	68.3	68.7
5	66.9	71.9	71.9
6	67.7	72.0	72.0
7	67.9	72.1	72.6
8	70.3	72.4	73.2
9	59.4	65.9	65.9
10	59.5	66.0	66.0
11	59.7	65.9	65.9
12	59.6	65.9	65.9
13	58.8	65.9	65.9
14	59.1	65.9	65.9
15	59.0	65.9	65.9
16	58.8	65.8	65.8
17*	95.1*	88.2*	95.2*
18*	88.4*	97.3*	97.3*
19*	84.4*	93.4*	93.4*
20*	81.2*	89.7*	89.7*
21*	85.0*	78.3*	83.9*
22*	83.0*	79.2*	83.8*
23*	79.5*	78.2*	79.4*
24	76.9	77.3	77.3
25	63.1	75.7	75.7
26	63.0	75.9	75.9
27	62.9	75.6	75.6
28	62.7	74.9	74.9

Table 3B. Worst Day Scenario Predicted Noise Levels (Structural Works Phase)

Location (Receptor ID)	Zone 2 (Denmark Street) Building Alteration Works. $L_{Aeq,10h}$	Excavating Basements and Groundworks. $L_{Aeq,10h}$	Steel-fixing & Shuttering. $L_{Aeq,10h}$	Concreting (Slip-forming / Jump-forming Cores). $L_{Aeq,10h}$
1	65.6	68.4	63.5	64.0
2	66.2	68.7	63.8	64.1
3	67.4	68.7	63.7	64.2
4	68.3	69.5	66.9	64.2
5	71.9	72.0	66.7	65.6
6	72.0	73.2	66.7	69.8
7	72.1	76.5	68.5	70.0
8	72.4	76.7	70.9	71.2
9	65.9	64.7	59.1	61.5
10	66.0	64.7	59.1	61.6
11	65.9	67.2	59.0	61.6
12	65.9	67.5	59.0	61.6
13	65.9	64.0	58.5	61.1
14	65.9	66.6	58.5	61.2
15	65.9	66.6	58.5	61.2
16	65.8	67.5	58.5	61.2
17*	88.2*	94.8*	85.5*	76.4*
18*	97.3*	92.9*	83.5*	77.2*
19*	93.4*	89.3*	80.6*	77.7*
20*	89.7*	86.5*	78.3*	78.1*
21*	78.3*	85.2*	78.0*	69.7
22*	79.2*	88.8*	83.3*	77.4*
23*	78.2*	86.6*	82.1*	78.1
24	77.3	84.2	79.5	78.6
25	75.7	70.3	67.1	59.3
26	75.9	70.2	67.0	59.3
27	75.6	70.0	66.8	59.4
28	74.9	69.7	66.4	62.7

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Table 3B. Worst Day Scenario Predicted Noise Levels (Structural Works) (continued)

Location (Receptor ID)	Concreting (Ground Floor & Basements Excluding Cores). $L_{Aeq,10h}$	Concreting (Level 5 and Above Excluding Cores). $L_{Aeq,10h}$	Surface Preparation & Cleaning Out $L_{Aeq,10h}$	Operating Tower Cranes. $L_{Aeq,10h}$
1	60.5	64.8	58.7	49.7
2	60.6	64.9	61.4	49.7
3	60.5	65.0	61.3	49.6
4	60.5	65.1	61.3	50.6
5	65.6	70.0	65.1	47.3
6	66.3	70.8	65.7	50.9
7	66.1	71.2	65.4	51.6
8	68.5	71.9	66.3	51.7
9	58.3	63.6	57.2	44.4
10	58.4	63.7	57.5	45.4
11	58.4	63.8	57.5	44.3
12	58.4	63.9	57.4	44.3
13	58.0	63.2	57.2	43.9
14	58.0	63.3	57.2	43.9
15	58.0	63.4	57.1	43.9
16	57.9	63.5	57.6	43.8
17*	92.6*	85.2*	96.2*	58.3
18*	86.1*	82.2*	87.6*	58.4
19*	81.6*	80.1*	82.4*	58.2
20*	78.8*	80.2*	79.2*	58.0
21*	82.1*	74.9*	83.3*	50.0
22*	82.2*	81.7*	81.3*	59.8
23*	79.2*	79.9*	77.7*	59.5
24	76.7	80.0	74.7	59.2
25	61.1	60.5	61.9	43.4
26	61.0	60.6	61.8	43.4
27	60.8	63.8	61.6	43.4
28	60.6	63.9	61.3	43.3

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Table 3B. Worst Day Scenario Predicted Noise Levels (Structural Works) (concluded)

Location (Receptor ID)	Install Pre-cast Concrete & Steel Elements. $L_{Aeq,10h}$	Installing Cladding. $L_{Aeq,10h}$	Overall predicted Noise Levels (Structural Works Phase). $L_{Aeq,10h}$
1	63.1	63.0	68.4
2	63.5	63.5	68.7
3	63.6	63.5	68.7
4	63.6	63.5	69.5
5	65.2	64.9	72.0
6	70.2	70.2	73.2
7	70.3	70.3	76.5
8	70.5	70.2	76.7
9	61.9	61.9	65.9
10	62.0	62.0	66.0
11	62.0	62.0	67.2
12	62.0	62.0	67.5
13	60.0	60.0	65.9
14	60.0	60.0	66.6
15	60.0	60.1	66.6
16	60.0	60.0	67.5
17*	85.3*	85.3*	96.2*
18*	83.0*	83.0*	97.3*
19*	81.6*	81.5*	93.4*
20*	86.2*	86.2*	89.7*
21*	75.3*	75.3*	85.2*
22*	82.6*	82.4*	88.8*
23*	81.6*	81.5*	86.6*
24	85.4	85.4	85.4
25	60.4	60.3	75.7
26	60.4	60.3	75.9
27	60.3	60.3	75.6
28	60.6	60.6	74.9

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Table 4. Worst Evening Scenario Predicted Noise Levels (Early Works & Piling Phase)

Location (Receptor ID)	Bored Piling Works (Concreting LD Rotary Pile including Limited Operation of Bentonite plant). $L_{Aeq,1h}$	Overall predicted Noise Levels (Early Works & Piling Phase). $L_{Aeq,1h}$
1	60.2	60.2
2	60.6	60.6
3	61.2	61.2
4	62.9	62.9
5	64.5	64.5
6	65.2	65.2
7	67.5	67.5
8	68.0	68.0
9	58.0	58.0
10	58.1	58.1
11	58.0	58.0
12	57.9	57.9
13	57.2	57.2
14	57.2	57.2
15	57.2	57.2
16	57.1	57.1
17*	76.4*	76.4*
18*	83.1*	83.1*
19*	77.6*	77.6*
20*	74.1*	74.1*
21*	79.0*	79.0*
22*	85.8*	85.8*
23*	79.9*	79.9*
24	76.2	76.2
25	58.1	58.1
26	58.1	58.1
27	58.0	58.0
28	57.8	57.8

Table 5A. Typical Average Day Scenario Predicted Noise Levels (Early Works & Piling Phase)

Location (Receptor ID)	Construction of the Piling / Working Platform.	Operation of the Bentonite Plant only (Excluding Piling Works).	Bored Piling Works (CFA + Rotary) including Operation of Bentonite plant).	Relocation of Smithy Building.
	$L_{Aeq,10h}$	$L_{Aeq,10h}$	$L_{Aeq,10h}$	$L_{Aeq,10h}$
1	54.6	52.7	58.7	49.5
2	54.6	52.8	58.7	49.5
3	54.5	52.7	58.7	49.5
4	54.5	55.3	62.5	49.5
5	51.4	57.3	60.9	46.3
6	56.4	57.2	61.3	51.3
7	56.3	59.3	64.1	51.2
8	60.7	58.5	64.6	55.6
9	47.6	49.3	52.9	42.0
10	47.6	49.3	52.9	42.0
11	47.6	49.3	52.9	42.0
12	47.6	49.2	52.8	41.9
13	46.8	48.3	52.4	41.8
14	46.8	48.3	52.4	41.8
15	46.8	48.2	52.3	41.8
16	46.7	48.9	52.3	41.7
17*	64.8	47.9	61.5	60.1
18*	64.7	48.1	71.4	60.1
19*	64.8	48.1	71.2	60.1
20*	64.6	48.1	70.9	59.9
21*	54.6	42.6	61.3	49.9
22*	64.1	45.3	71.2	59.4
23*	64.1	45.3	71.1	59.4
24	64.1	45.3	70.8	59.4
25	52.0	46.2	56.3	47.0
26	52.0	46.2	56.3	47.0
27	51.9	46.1	56.2	46.9
28	51.8	46.0	56.2	46.8

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Table 5A. Typical Average Day Scenario Predicted Noise Levels (Early Works & Piling Phase) (concluded)

Location (Receptor ID)	Pile Trimming & Capping Beam Construction. $L_{Aeq,10h}$	Zone 2 (Denmark Street) Building Alteration Works. $L_{Aeq,10h}$	Overall predicted Noise Levels (Early Works & Piling Phase). $L_{Aeq,10h}$
1	53.6	58.7	63.2
2	53.6	59.8	63.6
3	53.6	60.5	63.9
4	53.5	60.0	65.3
5	50.3	59.1	63.7
6	55.3	60.1	65.2
7	55.3	60.1	66.5
8	59.6	61.8	68.4
9	47.5	55.2	58.2
10	47.6	55.2	58.2
11	47.6	55.2	58.2
12	47.6	55.1	58.1
13	45.9	55.3	57.9
14	45.9	55.3	57.9
15	45.9	55.3	57.9
16	45.8	55.2	57.8
17*	64.7	59.7	69.7
18*	64.6	69.2	74.6
19*	64.6	69.3	74.6
20*	64.4	69.3	74.4
21*	54.4	58.4	64.3
22*	64.0	58.5	73.0
23*	64.0	58.4	72.9
24	63.9	58.4	72.7
25	51.1	65.1	66.0
26	51.1	65.2	66.1
27	51.0	65.1	66.0
28	51.0	64.8	65.8

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Table 5B. Typical Average Day Scenario Predicted Noise Levels (Structural Works Phase)

Location (Receptor ID)	Zone 2 (Denmark Street) Building Alteration Works. $L_{Aeq,10h}$	Excavating Basements and Groundworks. $L_{Aeq,10h}$	Steel-fixing & Shuttering. $L_{Aeq,10h}$	Concreting (Slip-forming / Jump-forming Cores). $L_{Aeq,10h}$
1	58.7	58.0	53.6	53.1
2	59.8	58.0	53.6	53.2
3	60.5	58.0	53.6	53.2
4	60.0	57.9	57.4	54.3
5	59.1	57.9	55.2	51.9
6	60.1	59.9	55.2	55.0
7	60.1	59.9	57.0	56.0
8	61.8	64.2	59.5	56.5
9	55.2	54.5	51.0	50.5
10	55.2	54.5	51.0	50.5
11	55.2	54.5	51.0	50.6
12	55.1	54.5	51.8	50.6
13	55.3	50.5	45.8	42.5
14	55.3	50.5	45.8	42.5
15	55.3	50.5	45.8	45.8
16	55.2	50.5	45.8	45.8
17*	59.7	68.9	63.9	60.4
18*	69.2	69.0	64.1	60.7
19*	69.3	68.9	64.0	60.7
20*	69.3	68.7	64.0	60.7
21*	58.4	59.0	54.2	50.4
22*	58.5	68.5	63.8	60.3
23*	58.4	68.5	63.8	60.4
24	58.4	68.4	63.8	60.4
25	65.1	56.0	50.8	47.5
26	65.2	56.0	50.8	47.6
27	65.1	56.0	50.8	47.6
28	64.8	55.9	50.7	51.0

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Table 3B. Typical Average Day Scenario Predicted Noise Levels (Structural Works) (continued)

Location (Receptor ID)	Concreting (Excluding Cores).	Surface Preparation & Cleaning Out	Operating Tower Cranes.	Install Pre-cast Concrete & Steel Elements.
	$L_{Aeq,10h}$	$L_{Aeq,10h}$	$L_{Aeq,10h}$	$L_{Aeq,10h}$
1	54.6	49.9	45.7	52.5
2	54.6	49.9	45.7	52.6
3	54.7	49.9	45.6	52.6
4	55.9	49.8	46.6	52.9
5	53.5	51.6	43.3	52.8
6	56.4	51.6	46.9	54.5
7	57.6	51.5	47.6	54.8
8	58.3	55.8	47.7	57.2
9	52.0	47.3	40.4	49.2
10	52.0	47.3	41.4	50.0
11	52.0	47.3	40.3	50.0
12	52.0	47.2	40.3	50.3
13	46.7	42.1	39.9	43.4
14	46.8	42.1	39.9	43.4
15	46.8	42.1	39.9	45.2
16	46.8	42.0	39.8	45.2
17*	60.9	60.0	54.3	61.3
18*	61.1	60.1	54.4	61.5
19*	61.1	60.0	54.2	61.4
20*	61.2	59.9	54.0	61.4
21*	50.9	50.3	46.0	51.3
22*	60.7	59.8	55.8	61.0
23*	60.8	59.8	55.5	61.0
24	60.9	59.7	55.2	61.0
25	48.7	47.1	39.4	48.6
26	48.8	47.1	39.4	48.6
27	48.8	47.1	39.4	48.6
28	51.7	47.0	39.3	50.4

Table 3B. Typical Average Day Scenario Predicted Noise Levels (Structural Works) (concluded)

Location (Receptor ID)	Installing Cladding. $L_{Aeq,10h}$	Overall predicted Noise Levels (Structural Works Phase). $L_{Aeq,10h}$
1	52.1	64.1
2	52.2	64.5
3	52.2	64.7
4	53.7	65.3
5	52.3	64.3
6	53.9	65.8
7	53.9	66.3
8	56.6	68.8
9	48.2	60.9
10	49.6	61.0
11	49.6	61.0
12	49.6	61.1
13	43.0	57.9
14	43.0	57.9
15	44.9	58.2
16	44.9	58.2
17*	61.8	72.5
18*	62.0	74.1
19*	61.9	74.1
20*	61.8	74.0
21*	51.9	63.8
22*	61.6	72.2
23*	61.6	72.2
24	61.6	72.1
25	48.2	66.1
26	48.3	66.2
27	48.2	66.1
28	50.0	66.1

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Table 6. Typical Average Evening Scenario Predicted Noise Levels (Early Works & Piling Phase)

Location (Receptor ID)	Bored Piling Works (Concreting LD Rotary Pile including Limited Operation of Bentonite Plant). $L_{Aeq,1h}$	Overall predicted Noise Levels (Early Works & Piling Phase). $L_{Aeq,1h}$
1	50.6	50.6
2	50.6	50.6
3	50.6	50.6
4	53.7	53.7
5	53.6	53.6
6	54.3	54.3
7	56.0	56.0
8	56.5	56.5
9	46.8	46.8
10	47.1	47.1
11	47.1	47.1
12	46.7	46.7
13	45.3	45.3
14	45.3	45.3
15	45.2	45.2
16	45.2	45.2
17*	47.2	47.2
18*	56.3	56.3
19*	56.3	56.3
20*	56.3	56.3
21*	46.9	46.9
22*	55.8	55.8
23*	55.9	55.9
24	55.8	55.8
25	46.0	46.0
26	45.9	45.9
27	45.9	45.9
28	45.8	45.8

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Construction Vibration Assessment

This section of the Memo presents an assessment of the potential risk of vibration generated by the works to be carried out by Skanska up to and including the Main piling Works, Pile Trimming and Construction of the Capping Beams for the Secant Piled Walls. This risk assessment has been based on the Activities and plant items listed earlier in this Memo.

Significant impact is predicted where there is exceedance of the relevant vibration limits set out in BS 5228-2: 2009 + A1: 2014, BS 6472-1: 2008 and BS 7385-2: 1993.

The risk assessment considers vibration impacts in terms of both potential damage to buildings and subjective response to occupiers of the buildings. The Criteria as set out in Table 7 below have been used during the assessment:

Table 7. Summary of Recommended Vibration Criteria

Receptor	Reason for Criteria (To avoid significant...)	Vibration Criteria (PPV)	Measurement Conditions
Dwellings (non-Listed)	Nuisance	1 mm/s	On a structural element immediately outside the building in question
	Building Damage	5 mm/s	
Offices (non-Listed)	Nuisance	2 mm/s	
	Building Damage	5 mm/s	
Listed Buildings	Building Damage	3 mm/s	

Two of the Activities involve the use of plant items that are considered to have potential temporarily to generate perceptible levels of vibration:

- Compaction of Backfill used to form the Piling / Working Platform using a twin-drum vibrating roller.
- The Large Diameter Bored Piling Works.
- Breaking out of obstructions / hand standing during Basement Works.

The closest residential receptors to the Activities listed above are Shaldon Mansions in the south-western corner of the island site. The mansions are adjacent to the site boundary and the closest part of the site working are is only a few m away from the boundary. At these distances, the level of vibration, from a

vibrating roller is predicted to be perceptible and potentially could occasionally exceed the criterion for nuisance in residential premises.
A Bomag 130 twin drum vibrating roller which has been used for platform construction at the Bond Street Crossrail Package C411 site was assessed by reference to empirical formulae published in TRL Report 429 and subsequently incorporated in BS 5228-2: 2009. This assessment indicated a PPV of 10.6 mm/s at 5 m, 4.4 mm/s at 10 m and 1.7 mm/s at 20 m.

Data obtained during the compaction of granular fill in layers for preparation of a working platform for embankment stabilisation in West London, using a comparatively small double drum vibrating roller yielded maximum PPV levels of 11.6 mm/s at 2½ m and 6.67 mm/s at 6 m. Extrapolating pro rata, indicates a PPV of approximately 0.9 mm/s at 40 m and 0.5 mm/s at 60 m. The vibration levels were much reduced when the roller was used solely in deadweight mode (maximum PPV of 0.35 mm/s at 2 m) but more passes were required in order to achieve the required state of compaction.

The levels of vibration from the bored piling (Large Diameter and CFA) are predicted to be low. No vibrator is being used to install either the temporary casings or the pile cages. Therefore the only vibrations will be from the rigs boring the piles themselves. The vibrations from bored piling are transient (occasional events) rather than continuous and as such are hard to predicted, unlike for continuous sources of vibration for which predictive formula exist. Use has to be made of case history data for comparable sites. Data from our case history files for similar sites in the London area indicates that the vibration levels from piling close to Shaldon Mansions may occasionally be above the threshold of perception.

Based on the GS iGeology App, the piles are being bored through River Terrace Deposits and into the underlying London Clay Formation (Thames Group). It is not known how thick the London Clay is at this location and the pile toe levels will either be within the London Clay or the underlying Lambeth Group.

With the present generation of high torque piling rigs, there is in general no need to use a dolly to seat the casing; the casing is advanced by a combination of rotary twisting and crowd force. Although none of the case histories relate specifically to secant piling, there are examples of boring in rock, grinding out old concrete piles and large diameter rotary coring through an existing deep concrete ground slab, all of which would yield vibration levels comparable to those from secant piling.

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Table 8. Case History Vibration Data For Rotary Bored Piling

Location	Ground Conditions	Distance from Auger, m	Peak Particle Velocity, mm/s
Cheltenham Regent Arcade	Made ground over wet sands and gravels over stiff Lias clay below 6 m	8 9	1.6 (hitting casing with kelly bar) 0.2 (mudding in)
Chadwell Heath	Alluvia over London clay	10 20	1.0 (boring) 0.3 (boring)
London, Bruton Street	Made ground / sand to 5 m/ London clay	10	0.4 (boring)
St. Albans	Sands and gravels over chalk	3.5 3.5 8.5	0.23 (boring) 2.4 (auger hitting base of hole) 1.7 (auger hitting base of hole)
Portland Dockyard	6 – 7 m mixed soft deposits over rock	5	0.54 (boring in rock)
Lincoln County Hospital	Topsoil over 6 – 7 m of loosely placed limestone blocks with some sandy clay infill over Lias clay	3.5 8.5	0.19 (boring in limestone blocks) 0.14 (as above)
London, Grosvenor Street	Made ground over alluvium over sands & gravel to 4 – 5 m depth, over London clay	3 8	2.2 (boring) 1.5 (boring)

Table 8. (continued)

Location	Ground Conditions	Distance from Auger, m	Peak Particle Velocity, mm/s
London, Great Marlborough Street	Made ground and alluvium over sands and gravels over London clay	6	1.6 (boring)
Islington, Liverpool Road	Made ground and ballast over London clay	7	1.2 (boring)
Lancaster, Market Hall	Made Ground and Alluvium over Cobbles and Boulders over Sandstone (~ 14 m)	2.5 2.5	0.8 (boring) 1.8 (extracting casing with oscillator)
Canterbury Whitefriars	Not recorded	14	Boring out (grinding) old concrete piles 0.75 max
London Arthur Street	Made ground and alluvium over sands and gravels over London clay	 6 9	Boring out (grinding) old concrete piles 1.4 maximum 1.0 maximum
London Palestra	Made ground and alluvium over sands and gravels over London clay	2.7 4.5 13	0.8 0.6 0.4

Table 8. (concluded)

Location	Ground Conditions	Distance from Auger, m	Peak Particle Velocity, mm/s
London Plantation Place	Made ground/alluvia/ Thames Ballast/London Clay	2	(coring through concrete slab) 0.5, 0.6, 0.5, 0.4, 0.4, 0.3, 0.4*, 0.5*, 0.4, 0.4, 0.4, 0.5, 0.5*, 0.6*, 0.4, 0.5, 0.4, 0.5, 0.5*, 0.9*, 0.5*, 0.4, 0.3, 0.4, 0.5, 0.5, 0.7, 0.6, 0.5, 0.5, 0.5, 0.6, 0.5, 0.5, 0.6, 0.5, 0.5, 0.5, 0.6, 0.4, 0.4, 0.5, 0.5, 0.5, 0.4, 0.6, 0.5, 0.4, 0.4, 0.5, 0.4, 0.3, 0.4, 0.5, 0.4, 0.3, 0.4, 0.5, 0.5*, 0.4*, 0.4*, 0.3, 0.5, 0.3, 0.4, 0.5, 0.4, 0.3, 0.4, 0.5, 0.4, 0.3, 0.4, 0.5, 0.5, 0.4, 0.4, 0.4, 0.7, 0.4, 0.3, 0.5, 0.4, 0.3, 0.4, 0.4, 0.3, 0.9#, 1.2#, 0.4, 0.9, 0.5, 0.4, 0.3, 0.4, 0.5, 0.4, 0.3, 0.3, 0.5, 0.5, 0.6, 0.4, 0.4, 0.5, 0.4, 0.6, 0.4, 0.4, 0.5, 0.4, 0.3, 0.4

Notes:

* also with mini- hydraulic impact breaker working.
# coring barrel caught on obstruction.

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In the Table 8, the figures shown, except for Plantation Place, were the maximum levels measured at the distances quoted, and the "average" levels of peak particle velocity were substantially lower than the maximum levels. The Plantation Place data are shown in full, and on inspection can be seen to bear out the foregoing statement in relation to "average" levels.

During the excavation for the basements below the new buildings and associated groundworks, it will be necessary to remove any remaining redundant concrete slabs and obstructions using machine-mounted hydraulic breakers. Where possible the vibration levels will be mitigated by introducing saw cuts using a circular saw to sever any structural continuity between the section of hard standing being broken out and the hard standing immediately adjacent to the surrounding buildings. Consideration will also be given to excavating an isolation trench to mitigate against transmission of vibration. However, space constraints may not allow this. Data recently to hand from impact breaking trials in the City of London using what was described as a standard 7.4 tonne breaker yielded a PPV of approximately 8 mm/s 1 m from the point of the breaker; the vibration level fell to below 0.1 mm/s at a distance of 20 m. (Older data obtained elsewhere in London with large breakers yielded higher PPV levels.) Although TRL 429 does not include empirical formulae for impact breaking, by analogy with the formulae for impact (driven) piling, there is a dependence of the PPV on the square root of the energy per blow, and on the inverse of some function of the distance between source and receiver. In trials of saw cutting at the same site, vibration levels were found to be negligible. In addition, recent trials conducted at the Crossrail Package C405 site for the Costain Skanska JV (CSJV) at Paddington Station investigated the attenuation of vibration with distance from impact breakers mounted on excavators ranging in size from 3 tonnes to 20 tonnes. It was found that the breaker on the mini-excavator yielded a PPV of 1.2 mm/s at both 3 m and 5 m from the breaker point, falling to 0.7 mm/s at 10 m distance, whereas the heavier breaker on the 20 tonne machine yielded 10.2 mm/s at 3 m, 2.8 mm/s at 5 m and 1.3 mm/s at 10 m distance. Measurements were also made of vibration levels from a concrete floor saw, which indicated a PPV of about 0.3 mm/s at a distance of 3 m. It should be noted that the measurements at Paddington were made without the introduction of an isolation slot between the breaker and the measuring positions. As indicated above, if saw-cuts can be introduced sufficient to sever structural connections via ground slabs between the breaker and the receiver, the above levels would be expected to be reduced by at least 25 %.

The supplied data gives an idea of the likely vibration levels at various distances.

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28th July 2016

If you have any queries or comments on the above, please contact me.

Kind regards,

Mark Roberts
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Noise & Vibration Team Leader