

Television Post-Construction Survey Report

Crown Street – Zone 1 – C2

Renaker Build Limited

October 2021

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ADMINISTRATION PAGE

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EXECUTIVE SUMMARY

Report Purpose

Pager Power has been commissioned to undertake a post-construction terrestrial television reception survey for the Crown Street (Zone 1) development located in Manchester City Centre, UK. The assessment pertains to that of the 'C2' building development that has introduced an additional new tall structure into the urban environment which consequently interacts with wireless terrestrial television signals and could cause interference in the surrounding area.

This report presents the results of the original Television Baseline Reception Survey (completed in November 2017), the Post-Construction Reception Survey for the 'C1' building (completed in October 2020), and the Post-Construction Reception Survey for the 'C2' building completed in October 2021. The post-construction survey has been completed so that comparisons, between the old baseline and the new baseline, could be made to determine whether there has been a significant impact upon terrestrial television signals in the surrounding area. Survey measurements were taken in the development's shadow zone and the original locations were revisited as best as possible. This assessment has been undertaken based on guidance produced by Ofcom.

Conclusions

Signal strength appears to have decreased in the shadow of the development, mostly for survey locations within 600m of the development. There are two to three storey residential properties within this distance. It is possible that the decrease is due to buildings C1 and C2; however, all main multiplexes remain available with fine audio and picture quality, therefore, significant interference is not expected. Beyond this distance no significant variation to the terrestrial television signal was observed.

The current signal strength remains good to moderate in the immediate shadow; therefore, mitigation is not recommended; however, any reported television interference within the immediate shadow zone should be investigated by means of a reception measurement.

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ABOUT PAGER POWER

Pager Power is a dedicated consultancy company based in Suffolk, UK. The company has undertaken projects in 51 countries within Europe, Africa, America, Asia and Australasia.

The company comprises a team of experts to provide technical expertise and guidance on a range of planning issues for large and small developments.

Pager Power was established in 1997. Initially the company focus was on modelling the impact of wind turbines on radar systems. Over the years, the company has expanded into numerous fields including:

- Renewable energy projects.
- Building developments.
- Aviation and telecommunication systems.

Pager Power prides itself on providing comprehensive, understandable and accurate assessments of complex issues in line with national and international standards. This is underpinned by its custom software, longstanding relationships with stakeholders and active role in conferences and research efforts around the world.

Pager Power's assessments withstand legal scrutiny and the company can provide support for a project at any stage.

1 BACKGROUND

1.1 Introduction

Pager Power has been commissioned to undertake a post-construction terrestrial television reception survey for the Crown Street (Zone 1) development located in Manchester City Centre, UK. The assessment pertains to that of the 'C2' building development that has introduced an additional new tall structure into the urban environment which consequently interacts with wireless terrestrial television signals and could cause interference in the surrounding area.

This report presents the results of the original Television Baseline Reception Survey (completed in November 2017), the Post-Construction Reception Survey for the 'C1' building (completed in October 2020), and the Post-Construction Reception Survey for the 'C2' building completed in October 2021. The post-construction survey was completed so that comparisons, between the old baseline and the new baseline, could be made to determine whether there has been a significant impact upon terrestrial television signals in the surrounding area. Survey measurements were taken in the development's shadow zone and the original locations were revisited as best as possible. This assessment has been undertaken based on guidance produced by Ofcom.

1.2 Proposed Development Boundary

The development boundary for the proposed development is shown in Figure 1¹ below. C2 is shown on the left-hand side and is illustrated by the blue square.

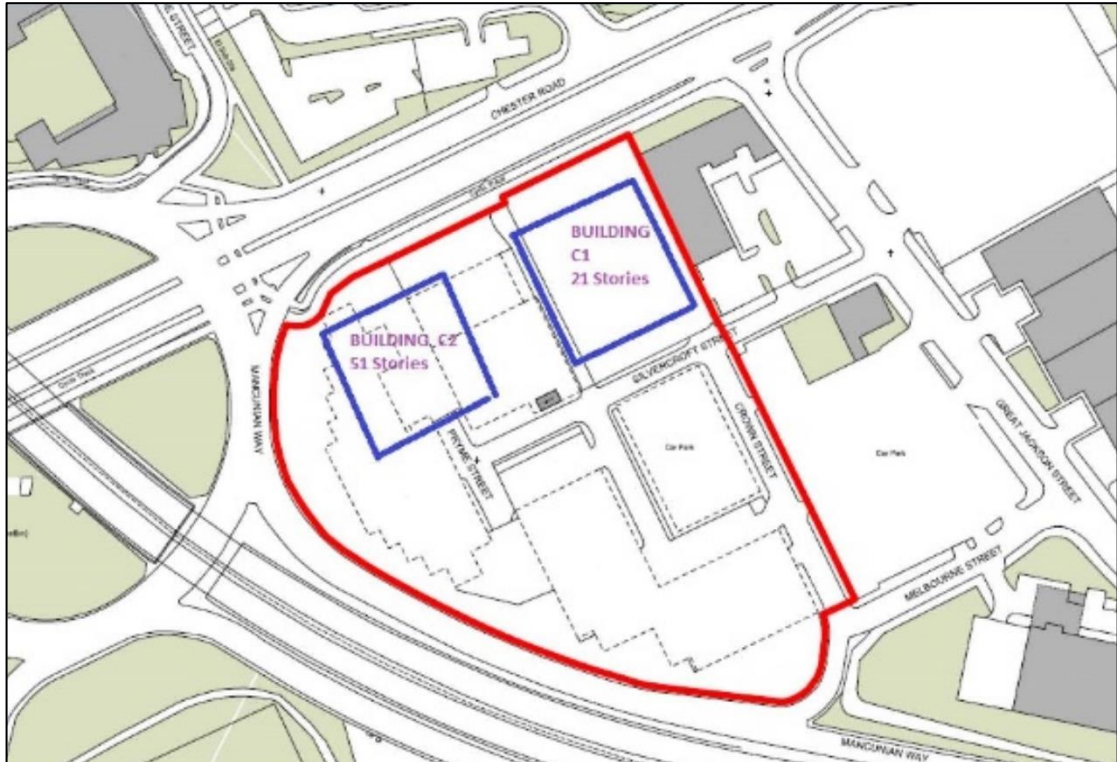


Figure 1 Development boundary

¹ Source: ExtractPage1.pdf (cropped).

2 TELEVISION TRANSMITTER DETAILS

2.1 Relevant Transmitter

The Winter Hill transmitter predominantly serves the area around the development². Digital television services are broadcast via Ultra High Frequency (UHF) signals.

2.2 Winter Hill Main Transmitter

Winter Hill is one of the UK's main television transmitters located approximately 24.2km northwest of the development. Note that the channels broadcast by Winter Hill changed between the surveys.

2.2.1 Baseline Survey Channels

The channels broadcast by Winter Hill during the baseline survey are presented in Tables 1 and 2 below.

	Public (PSB)			Commercial (COM)		
Service	BBC A	Digital 3&4	BBC B	SDN	Arqiva A	Arqiva B
Channel	50	59	54-	58	49	55
Power	100 kilo-Watts (kW)					

Table 1 Winter Hill main transmissions (main multiplexes)

Service	COM 7	COM8	LM/LL/LPR	GIM
Channel	31	37	56	57
Power	25.7 kW	22.6kW	2 kW	1 kW

Table 2 Winter Hill transmissions (local multiplexes)

² Based on coverage maps and Digital UK information.

2.2.2 Post-Construction Survey Channels ('C1' building, October 2020)

The channels broadcast by Winter Hill during the post-construction survey for building 'C1' are presented in Tables 3 and 4 below.

	Public (PSB)			Commercial (COM)		
Service	BBC A	Digital 3&4	BBC B	SDN	Arqiva A	Arqiva B
Channel	32	34	35	29	31	37
Power	100 kilo-Watts (kW)					

Table 3 Winter Hill main transmissions (main multiplexes)

Service	COM 7	LM/LL/LPR	GIM	-	-
Channel	55	56	57	24	27
Power	25.7 kW	1kW	1 kW	-	-

Table 4 Winter Hill transmissions (local multiplexes)

2.2.3 Post-Construction Survey Channels ('C2' building, October 2021)

The channels broadcast by Winter Hill during the post-construction survey for building 'C2' are presented in Tables 5 and 6 below.

	Public (PSB)			Commercial (COM)		
Service	BBC A	Digital 3&4	BBC B	SDN	Arqiva A	Arqiva B
Channel	32	34	35	29	31	37
Power	100 kilo-Watts (kW)					

Table 5 Winter Hill main transmissions (main multiplexes)

Service	COM 7	LTVmux (Manchester)	Glmux
Channel	55	24	27
Power	25.7 kW	2 kW	1 kW

Table 6 Winter Hill transmissions (local multiplexes)

3 BUILDINGS AND TELEVISION INTERFERENCE

3.1 Technical Overview

Terrestrial television services are provided by means of UHF radio waves which propagate from transmitters to receiving aerials which then relay the signal to a television set.

The quality of the image and sound on a television set is dependent on both the strength of the signal received directly from the transmitter (carrier signal) and the strength of any interference signals from other sources.

To achieve good quality reception an aerial must receive a strong carrier signal but weak interference signals.

There are two ways that buildings can cause interference to television and radio reception, these are described below.

3.2 Obstruction of the Signal

This is caused by the building physically blocking the transmitted television signal, reducing the strength of the carrier signal in the shadow of the building. In the case of Winter Hill transmissions, this would affect residences to the southeast of the proposed development. Specifically:

- The highest losses (greatest interference) will be located immediately behind the building.
- Losses near the edge of the shadow zone will be less significant due to diffraction effects (bending of the signal).

The Ofcom document states that:

"In general, there will be three 'zones' behind the structure:

Zone A - close behind the structure (typically a few tens of metres) there may be a large reduction in signal level with a possible complete loss of reception

Zone B - further away (typically a few hundred metres) the signal reduction is less severe and the shadow will be smaller as diffraction effects partially fill in the shadow. Depending on the size of the structure, some locations could still lose reception completely

Zone C - some distance away (1-5km) the shadow will effectively have disappeared."

The zones mentioned are illustrated in Figure 2 on the following page³, taken from Section 3.2 of an Ofcom paper⁴ regarding the impact of buildings on broadcast signals.

³ Source: Ofcom (2009): Tall Structures and their impact on broadcast and other wireless services.

⁴ Reference as above.

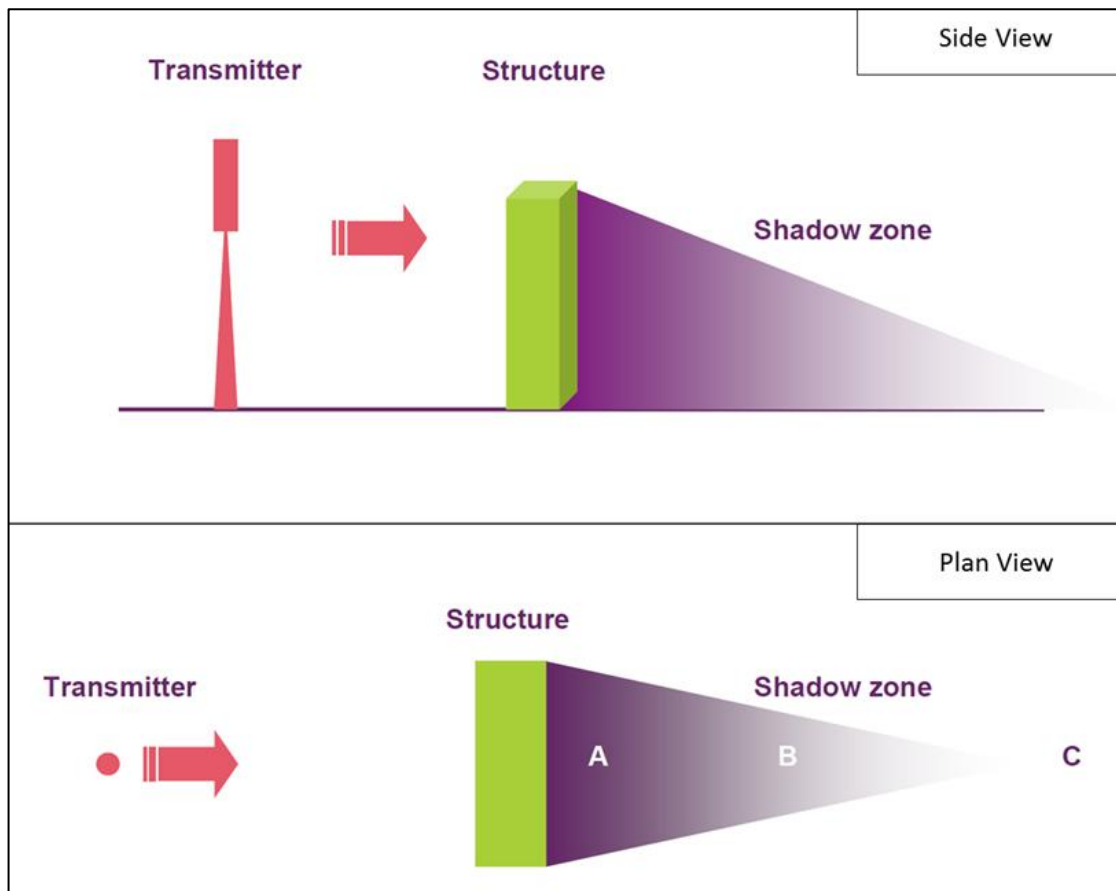


Figure 2 Diffraction loss zones

3.3 Reflection of the Signal

For large developments with straight edges, the transmitted signal can be reflected by the building itself. This causes an effect known as 'multipath interference' whereby the signal is received twice by an aerial at different times. The direct signal arrives first because it has a shorter distance to travel.

Figure 3 on the following page (taken from Section 3.3 of the Ofcom document referenced above) illustrates this effect.

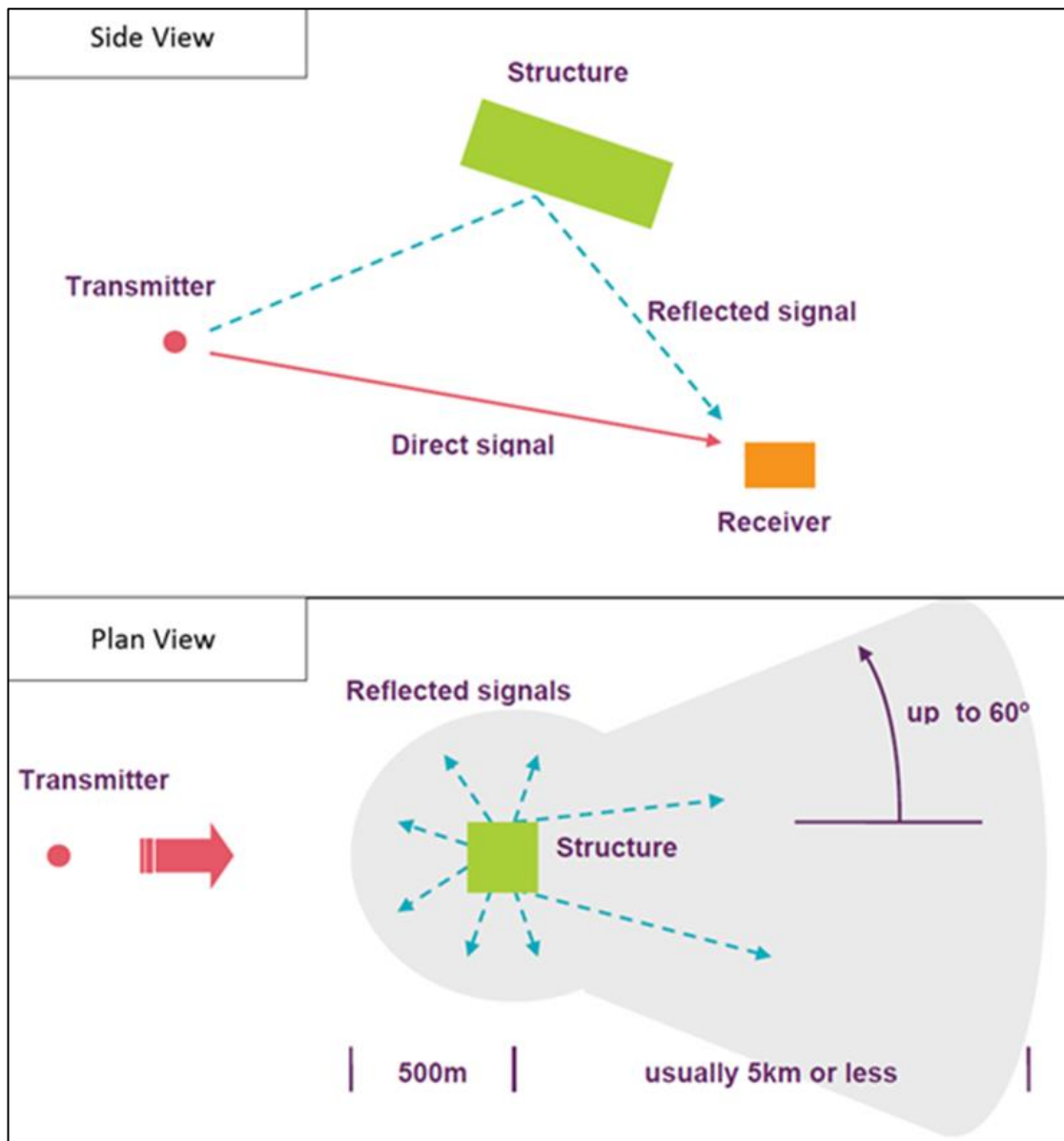


Figure 3 Reflection zones

In practice, it is considered highly unlikely that reflections will have an effect for receivers in front of the building or on either side when viewed from the location of the transmitter. For digital transmissions in particular, it is unlikely that issues will occur if the angle between the direct signal and the reflected signal is more than 30 degrees⁵.

The reflection zone has been constructed in accordance with the Ofcom approach, however the angle considered is 30 degrees rather than 60 degrees. This is in order to represent a more realistic scenario for digital transmissions.

Reflection issues are most likely to cause a noticeable impact if:

- The direct signal from transmitter to receiver is weak (e.g. obstructed by terrain or buildings).
- The reflected signal from the building is strong (e.g. clear radio line of sight from the transmitter to the building and the building to the receiver).

The worst-case scenario is for both of the above conditions to be satisfied. The best-case scenario is for neither of the above conditions to be satisfied.

⁵ This is known to be the angle that Arqiva considers when safeguarding its Television Re-Broadcast Links with regard to reflections from wind turbines – whilst wind turbines cause issues that are different to buildings this particular issue is similar for the two.

4 TECHNICAL ASSESSMENT

4.1 Potential Interference Areas

The shadow and reflection zones have been defined based on the geometry as set out in the previous section. Both zones extend to a distance of 5km beyond the proposed development location in accordance with the Ofcom guidance.

In the case of the shadow zone, this has been modelled as having straight sides in order to be conservative. In actuality, due to diffraction effects, the zone would have a more triangular shape as shown in Figure 2 in the previous section. Figure 4 below shows the potential interference areas associated with the development. The shadow associated with C1 is the top half of the red shadow zone i.e. the north eastern side. The shadow associated with C2 is the bottom half of the red shadow zone i.e. the south western side.

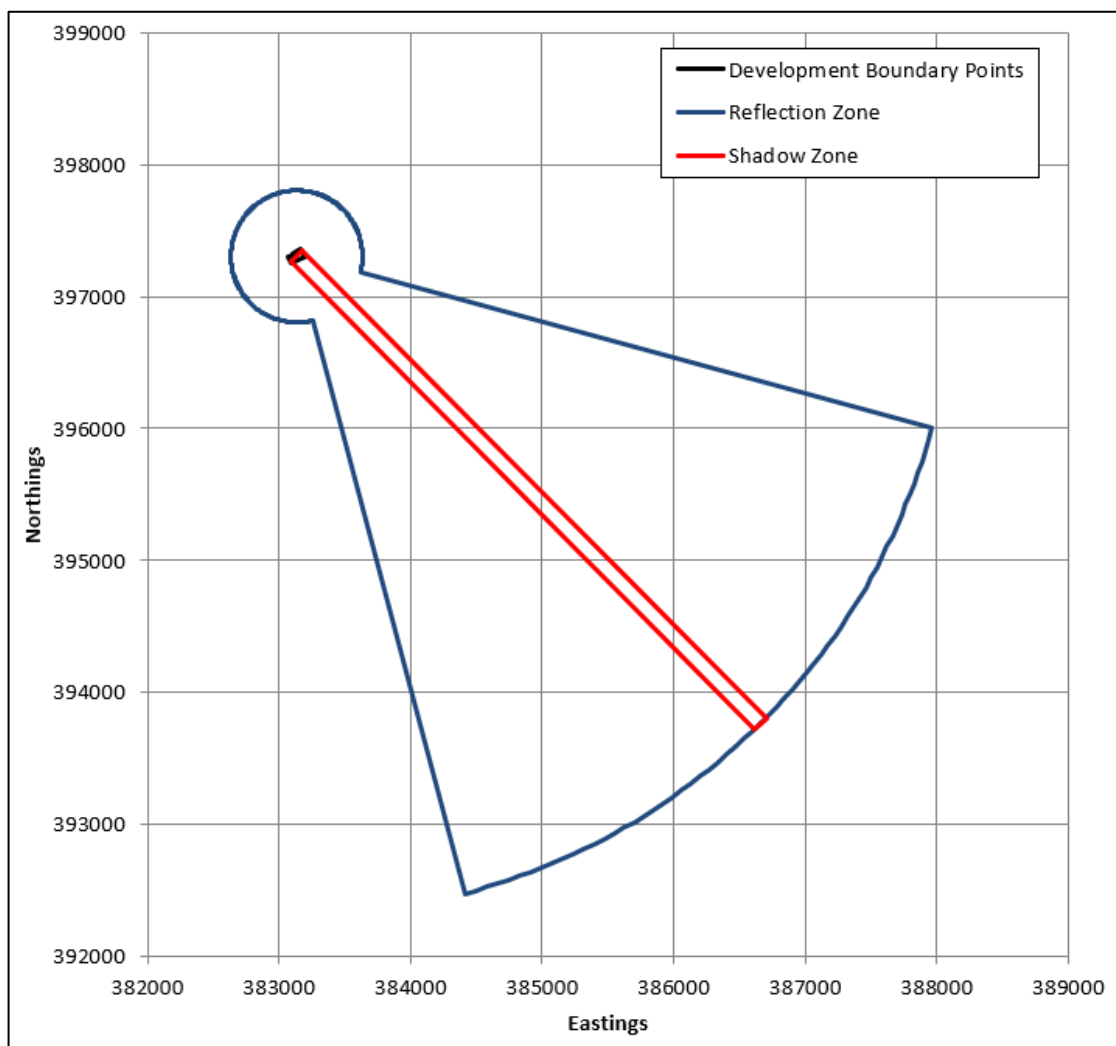


Figure 4 Interference areas

Figure 5⁶ below shows the interference zones overlaid onto mapping of the area.

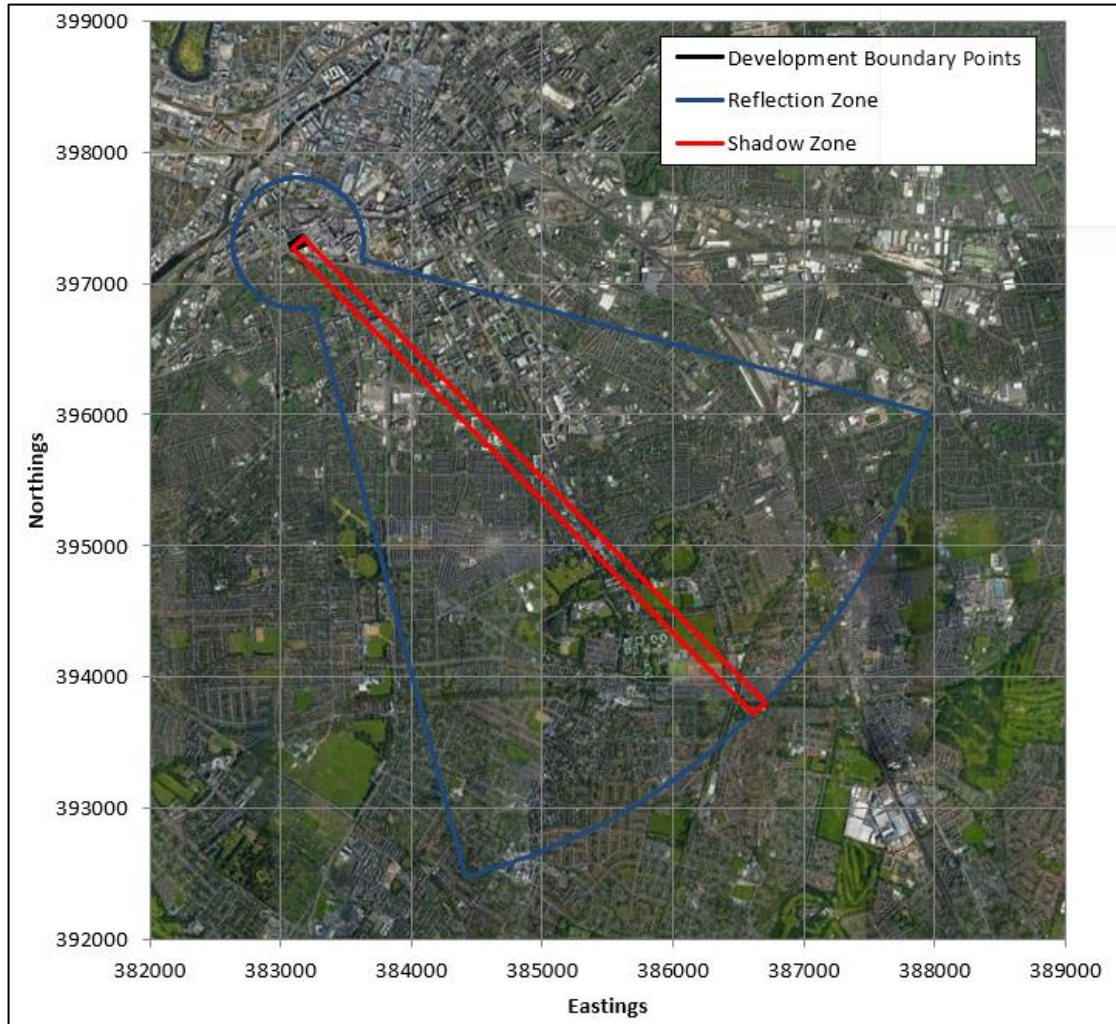


Figure 5 *Interference zones map*

4.2 Potential Diffraction Issues – Terrestrial Television

The shadow zone passes over urban and commercial buildings. Areas closest to the development are at the highest risk of experiencing television interference. This is typically limited to 1km based on Pager Power's assessment experience. Two to three storey residential properties are located between 200m to 1km from the proposed development location.

⁶ Copyright © 2021 Google.

4.3 Potential Reflection Issues

Reflection effects are most likely if the transmitter does not have direct radio line of sight to the receiving aerial.

The predicted coverage of the Winter Hill transmitter is generally good in the surrounding area. Interference due to reflections are most likely when:

- The receiving aerial is unobstructed by existing obstacles.
- The reflected signal path via the proposed development is unobstructed.
- The angle between the reflected signal via the proposed development and the direct signal would be small.

Interference is most likely if all of the above criteria are met. Interference is least likely if none of the above criteria are met.

In practice it is unlikely that all of the above criteria would be met for the proposed development. In particular, locations that are below radio line of sight from the transmitter are unlikely to have an unobstructed path to the proposed development, due to their relative heights. Impacts due to reflections are considered unlikely.

5 TELEVISION AND RADIO BASELINE SURVEY

5.1 Overview – Television Services

The purpose of a baseline survey is to establish current signal strength and quality in the area. The baseline survey serves three purposes these are:

1. It confirms which transmitter is serving most homes in the areas surveyed (for television).
2. It provides an indicator regarding the likelihood of interference. If current signals are of good quality, minor degradation is less likely to have a noticeable effect.
3. It allows a 'before and after' comparison to be made in the event that a complaint is received.

A baseline television reception survey was undertaken for the proposed development on the 20th of October 2021.

Survey measurements were taken using Pager Power's custom survey vehicle with a wideband UHF aerial extended to a height of 10 metres above ground level. This was connected to television analyser to record the signal strength and stability.

The strength of the recorded signals is categorised in accordance with Table 7 below.

Average Signal Strength (dB)	Subjective Signal Strength Definition
<35	Low
35-45	Moderate
45-55	Good
55+	Very Good

Table 7 Television signal strength categories

5.2 Survey Locations

Figure 6⁶ below shows the survey locations overlaid onto aerial photography. The proposed development location and the shadow zone are also shown. The survey locations chosen for the baseline survey were revisited as best as possible for the post-construction survey⁷. The locations below show the actual survey locations. The orange squares show the post-construction survey locations, the red circles show the baseline survey locations from 2017. Where they are closely located, only the post-construction icon is shown⁸. Baseline survey location 2 was re-visited during the post-construction at survey location 2b, post-construction location 2a was added to account for building C2. Survey location 2a is located on the southwestern side of the shadow zone.



Figure 6 Survey locations

⁷ Safe and available access influenced the specific position on the day.

⁸ The coordinate location of the post-construction survey from 2020 is detailed within appendix B.

5.3 Survey Results (Baseline and Post-Construction)

Table 8 on the following page summarises the results of the baseline and the post-construction reception survey carried out in October 2021.

The average signal strength is given for the baseline and post-construction surveys to show the average change. A number of factors, including variable weather and foliage conditions, can lead to minor fluctuations of signal strength.

Detailed survey results are shown in Appendices A to C. Survey photographs are shown in Appendices D and F.

Location	Average Measured Signal Strength (dB)	Remarks	High Level Conclusion
1	Baseline⁹: 49.2 (Good) Post-construction¹⁰: 41.7 (Moderate)	Baseline: All channels decoded with fine picture and sound quality. Post-Construction: 7 of 9 channels decoded with fine picture and sound quality. Two did not decode – both (local) lower power channels. No aerals were visible from this survey location. Aerial pointed away from the building for best signal quality.	Located within the building site, approximately 10m from building C1 and 30m from building C2. Therefore, this location is within the proposed development boundary. The signal strength was good at this location, and it is now moderate for the post-construction survey. It is unlikely that the tall buildings to the east (Owen Street, approximately 150m from C1) will be having any effect at this survey location. Therefore, any signal strength reduction is likely to be attributable to C1 and C2, at this location. There are no dwellings currently present at this location and therefore it is unlikely that terrestrial television interference will be experienced. Therefore, any interference that may occur is deemed inconsequential at this location.

⁹ Full baseline results, undertaken in 2017, shown in Appendix A.

¹⁰ Post-construction result for building C2, undertaken October 2021, full results shown in Appendix C. The post-construction results for building C1, undertaken in 2020, is shown within Appendix B for reference.

Location	Average Measured Signal Strength (dB)	Remarks	High Level Conclusion
2	Baseline: 59.0 (Very good) Post-construction 2a: 43.3 (Moderate) Post-construction 2b: 51.6 (Good)	Baseline: All channels decoded with fine picture and sound quality. Post-Construction: 8 of 9 channels decoded with fine picture and sound quality. One did not decode – a (local) lower power channel. At location 2a, One HP¹¹ UHF¹² aerial directed towards the Winter Hill transmitter was observed. One satellite dish was observed. At location 2b (location 2 baseline), Two HP UHF aerial directed towards the Winter Hill transmitter were observed. One satellite dish was observed.	Location 2a and 2b is approximately 235 metres and 330 metres from the proposed development boundary respectively. The signal strength was very good at this location, and it is now good/moderate for the post-construction survey. It is likely that a reduction in signal strength of this size is attributable to buildings C1 and C2; however, all main multiplexes were decoded with fine picture and sound quality. Just northwest of location 2a and southeast of location 2b, a number of dwellings are present which are circa two to three storeys in height; however, considering the results for main multiplexes, it is unlikely that interference is significant. Significant interference is deemed unlikely to materialise and be caused by building C2.

¹¹ Horizontally Polarised

¹² Ultra-High Frequency

Location	Average Measured Signal Strength (dB)	Remarks	High Level Conclusion
3	Baseline: 58.6 (Very good) Post-construction: 51.6 (Good)	Baseline: All channels decoded with fine picture and sound quality. Post-Construction: 8 of 9 channels decoded with fine picture and sound quality. One did not decode – a (local) lower power channel. Multiple HP UHF aerials were observed, directed towards the Winter Hill transmitter. Multiple satellite dishes were observed.	This location is approximately 590 metres from the proposed development boundary. The signal strength was very good at this location, and it is now good. A number of dwellings are present which are circa two to three storeys in height; however, considering the results for main multiplexes, it is unlikely that interference is significant. Significant interference is deemed unlikely to materialise and be caused by building C2.
4	Baseline: 44.2 (Moderate) Post-construction: 44.2 (Moderate)	Baseline: All channels decoded with fine picture and sound quality. Post-Construction: 7 of 9 channels decoded with fine picture and sound quality. Two did not decode – both (local) lower power channels. Multiple HP UHF aerials were observed, directed towards the Winter Hill transmitter. Multiple satellite dishes were observed.	This location is approximately 1.1km from the proposed development boundary. The signal strength was moderate at this location, and it has remained moderate. A number of dwellings are present which are circa two to storeys in height. Considering the signal strength and distance from the development, significant interference is deemed unlikely to materialise and be caused by building C2.

Location	Average Measured Signal Strength (dB)	Remarks	High Level Conclusion
5	Baseline: 46.9 (Good) Post-construction: 41.7 (Moderate)	Baseline: All channels decoded with fine picture and sound quality. Post-Construction: 7 of 9 channels decoded with fine picture and sound quality. Two did not decode – both (local) lower power channels. Multiple HP UHF aerials were observed, directed towards the Winter Hill transmitter. Multiple satellite dishes were observed.	This location is approximately 1.4km from the proposed development boundary. The signal strength was good at this location, and it now moderate. A number of dwellings are present which are circa two to three storeys in height. Considering the signal strength and distance from the development, significant interference is deemed unlikely to materialise and be caused by building C2.
6	Baseline: 45.5 (Good) Post-construction: 43.8 (Moderate)	Baseline: All channels decoded with fine picture and sound quality. Post-Construction: All 9 channels decoded with fine picture and sound quality. Multiple HP UHF aerials were observed, directed towards the Winter Hill transmitter. Multiple satellite dishes were observed.	This location is approximately 2.35km the proposed development boundary. The signal strength was good at this location, and it now moderate with only a small variation. A number of dwellings are present which are circa two storeys in height. Considering the signal strength and distance from the development, significant interference is deemed unlikely to materialise and be caused by building C2.

Table 8 Television baseline survey results

6 CONCLUSIONS

6.1 Conclusions

Signal strength appears to have decreased in the shadow of the development, mostly for survey locations within 600m of the development. There are two to three storey residential properties within this distance. It is possible that the decrease is due to buildings C1 and C2; however, all main multiplexes remain available with fine audio and picture quality, therefore, significant interference is not expected. Beyond this distance no significant variation to the terrestrial television signal was observed.

The current signal strength remains good to moderate in the immediate shadow; therefore, mitigation is not recommended; however, any reported television interference within the immediate shadow zone should be investigated by means of a reception measurement.

APPENDIX A – BASELINE SURVEY RESULTS 2017

Location 1

Coordinates: Lon: -2.25446, Lat: 53.47187					
Channel	Service	Signal Strength ¹³ (dBμV)	BER ¹⁴	Picture	Audio
31	COM7	45.0-45.3	0%	Fine	Fine
37	COM8	41.8-42.0	0%	Fine	Fine
49	Arqiva A	54.4-54.6	1x10 ⁻⁸	Fine	Fine
50	BBC A	55.1-55.9	1x10 ⁻⁷	Fine	Fine
54-	BBC B	55.7-56.1	0%	Fine	Fine
55	Arqiva B	56.1-56.3	1x10 ⁻⁸	Fine	Fine
56	LM/LL/LPR	37.4-37.6	1x10 ⁻⁷	Fine	Fine
57	GIM	31.6-62.0	1.2x10 ⁻⁸	Fine	Fine
58	SDN	49.7-50.0	6.4x10 ⁻⁸	Fine	Fine
59	Digital 3&4	48.9-49.2	1x10 ⁻⁸	Fine	Fine

Notes: No HP¹⁵ UHF¹⁶ aerials or satellite dishes observed.

¹³ +/- followed by a number represents the approximate signal fluctuation.

¹⁴ E = 1 x10 to the power of the following number e.g. -8.

¹⁵ Horizontally Polarised

¹⁶ Ultra-High Frequency

Location 2

Coordinates: Lon: -2.25122, Lat: 53.47025					
Channel	Service	Signal Strength (dBμV)	BER	Picture	Audio
31	COM7	57.6-57.7	0%	Fine	Fine
37	COM8	55.7-55.8	0%	Fine	Fine
49	Arqiva A	69.7-69.9	1x10 ⁻⁷	Fine	Fine
50	BBC A	70.0-70.2	1x10 ⁻⁶	Fine	Fine
54-	BBC B	66.0-66.2	0%	Fine	Fine
55	Arqiva B	65.8-65.9	1x10 ⁻⁷	Fine	Fine
56	LM/LL/LPR	44.4-44.6	1x10 ⁻⁷	Fine	Fine
57	GIM	36.7-36.8	2.3x10 ⁻⁸	Fine	Fine
58	SDN	63.5-63.6	1x10 ⁻⁸	Fine	Fine
59	Digital 3&4	60.0-60.2	1x10 ⁻⁸	Fine	Fine

Notes: HP UHF aerials observed directed towards Winter Hill. No satellite dishes observed.

Location 3

Coordinates: Lon: -2.24832, Lat: 53.46837					
Channel	Service	Signal Strength (dBμV)	BER	Picture	Audio
31	COM7	54.0-54.2	0%	Fine	Fine
37	COM8	56.0-56.2	0%	Fine	Fine
49	Arqiva A	67.5-67.6	1x10 ⁻⁷	Fine	Fine
50	BBC A	68.7-68.8	1x10 ⁻⁷	Fine	Fine
54-	BBC B	66.0-66.1	0%	Fine	Fine
55	Arqiva B	66.0-66.2	1x10 ⁻⁸	Fine	Fine
56	LM/LL/LPR	45.0-45.1	1x10 ⁻⁸	Fine	Fine
57	GIM	38.5-38.6	1x10 ⁻⁸	Fine	Fine
58	SDN	62.9-63.0	1x10 ⁻⁷	Fine	Fine
59	Digital 3&4	60.5-60.6	1x10 ⁻⁷	Fine	Fine

Notes: HP UHF aerials observed directed towards Winter Hill. Satellite dishes observed.

Location 4

Coordinates: Lon: -2.24341, Lat: 53.46505					
Channel	Service	Signal Strength (dBμV)	BER	Picture	Audio
31	COM7	44.4-44.8	0%	Fine	Fine
37	COM8	45.7-45.9	0%	Fine	Fine
49	Arqiva A	49.5-49.7	1x10 ⁻⁷	Fine	Fine
50	BBC A	52.6-52.8	1x10 ⁻⁷	Fine	Fine
54-	BBC B	47.6-47.7	0%	Fine	Fine
55	Arqiva B	48.6-48.7	3.3x10 ⁻⁸	Fine	Fine
56	LM/LL/LPR	33.1-33.3	1x10 ⁻⁷	Fine	Fine
57	GIM	31.1-31.1	6.7x10 ⁻⁴	Fine	Fine
58	SDN	44.7-44.9	5.4x10 ⁻⁷	Fine	Fine
59	Digital 3&4	43.7-44.0	1x10 ⁻⁷	Fine	Fine

Notes: HP UHF aerials observed directed towards Winter Hill. Satellite dishes observed.

Location 5

Coordinates: Lon: -2.24021, Lat: 53.46314					
Channel	Service	Signal Strength (dBμV)	BER	Picture	Audio
31	COM7	50.7-51.0	0%	Fine	Fine
37	COM8	42.9-43.0	0%	Fine	Fine
49	Arqiva A	53.3-53.4	1x10 ⁻⁷	Fine	Fine
50	BBC A	56.7-56.8	1x10 ⁻⁷	Fine	Fine
54-	BBC B	55.4-55.6	0%	Fine	Fine
55	Arqiva B	52.3-52.4	1x10 ⁻⁸	Fine	Fine
56	LM/LL/LPR	31.9-32.0	1x10 ⁻⁷	Fine	Fine
57	GIM	31.4-31.6	2x10 ⁻⁶	Fine	Fine
58	SDN	47.3-47.6	1x10 ⁻⁸	Fine	Fine
59	Digital 3&4	46.6-46.8	1x10 ⁻⁸	Fine	Fine

Notes: HP UHF aerials observed directed towards Winter Hill. Satellite dishes observed.

Location 6

Coordinates: Lon: -2.23035, Lat: 53.45705					
Channel	Service	Signal Strength (dBμV)	BER	Picture	Audio
31	COM7	46.2-46.4	0%	Fine	Fine
37	COM8	52.8-52.9	0%	Fine	Fine
49	Arqiva A	63.3-63.4	1x10 ⁻⁷	Fine	Fine
50	BBC A	64.9-65.1	1x10 ⁻⁸	Fine	Fine
54-	BBC B	62.0-62.2	0%	Fine	Fine
55	Arqiva B	61.9-62.1	1x10 ⁻⁷	Fine	Fine
56	LM/LL/LPR	42.0-42.1	1x10 ⁻⁷	Fine	Fine
57	GIM	37.1-37.2	1x10 ⁻⁷	Fine	Fine
58	SDN	58.0-58.1	1x10 ⁻⁸	Fine	Fine
59	Digital 3&4	55.9-56.0	1x10 ⁻⁸	Fine	Fine

Notes: HP UHF aerials observed directed towards Winter Hill. Satellite dishes observed.

APPENDIX B – POST-CONSTRUCTION SURVEY 2020 (BUILDING C1) RESULTS

Location 1

Coordinates: Lon: -2.25447, Lat: 53.47191					
Channel	Service	Signal Strength ¹⁷ (dBμV)	BER ¹⁸	Picture	Audio
24	That's TV (COM6) Tiny Pop	37.3 +/- 0.3	9e-8	Fine	Fine
27	POP Max	36.3 +/- 0.2	1.1e-4	Fine	Fine
29	5Star	51.7 +/- 0.2	7.4e-8	Fine	Fine
31	Sky Arts	51.9 +/- 0.2	8.8e-9	Fine	Fine
32	BBC One NW (BBC A)	51.1 +/- 0.1	1e-7	Fine	Fine
34	ITV+1	48.4 +/- 0.2	8e-3	Fine but with some stuttering on the image	Fine some stuttering to begin
35	BBC One HD	48.3 +/- 0.3	1e-7	Fine	Fine
37	Ideal World (COM8) Yesterday	47.6 +/- 0.2	5.2e-7	Fine	Fine
55	BBC News HD (COM7)	37.4 +/- 0.2	1e-7	Fine	Fine
56	QVC (LM) CBeebies HD	25.6 +/- 0.1	DND ¹⁹	n/a	

¹⁷ +/- followed by a number represents the approximate signal fluctuation.

¹⁸ E = 1 x10 to the power of the following number e.g. -8.

¹⁹ Did not decode.

Coordinates: Lon: -2.25447, Lat: 53.47191					
Channel	Service	Signal Strength ¹⁷ (dBμV)	BER ¹⁸	Picture	Audio
57	Sony Channel +1	25.6 +/- 0.1	DND	n/a	

Notes: Located within the building site, within 40m of C1.

Location 2

Coordinates: Lon: -2.25143, Lat: 53.47037					
Channel	Service	Signal Strength (dBμV)	BER	Picture	Audio
24	That's TV (COM6) Tiny Pop	37.5 +/- 0.2	1.1e-8	Fine	Fine
27	POP Max	36.4 +/- 0.2	3.3e-8	Fine	Fine
29	5Star	57.0 +/- 0.1	7e-5	Fine	Fine
31	Sky Arts	56.9 +/- 0.1	2.4e-4	Fine	Fine
32	BBC One NW (BBC A)	54.4 +/- 0.2	3.6e-4	Fine	Fine
34	ITV+1	54.1 +/- 0.2	5.9e-5	Fine	Fine
35	BBC One HD	56.8 +/- 0.2	1e-8	Fine	Fine
37	Ideal World (COM8) Yesterday	55.4 +/- 0.1	8e-5	Fine	Fine
55	BBC News HD (COM7)	45.2 +/- 0.2	DND	n/a	
56	QVC (LM) CBeebies HD	26.5 +/- 0.1	DND	n/a	
57	Sony Channel +1	26.5 +/- 0.1	DND	n/a	

Location 3

Coordinates: Lon: -2.24836, Lat: 53.46858					
Channel	Service	Signal Strength (dBμV)	BER	Picture	Audio
24	That's TV (COM6) Tiny Pop	44.8 +/- 0.2	1e-8	Fine	Fine
27	POP Max	38.7 +/- 0.1	1e-8	Fine	Fine
29	5Star	62.9 +/- 0.2	1e-8	Fine	Fine
31	Sky Arts	64.6 +/- 0.2	1e-8	Fine	Fine
32	BBC One NW (BBC A)	62.7 +/- 0.1	1e-8	Fine	Fine
34	ITV+1	60.6 +/- 0.1	1e-7	Fine	Fine
35	BBC One HD	61.9 +/- 0.1	1e-7	Fine	Fine
37	Ideal World (COM8) Yesterday	62.8 +/- 0.2	1e-8	Fine	Fine
55	BBC News HD (COM7)	51.3 +/- 0.1	1e-8	Fine	Fine
56	QVC (LM) CBeebies HD	26.5 +/- 0.1	DND	n/a	
57	Sony Channel +1	26.5 +/- 0.1	DND	n/a	

Notes: Located near terraced housing and apartments ranging from 2-7 storeys. HP aerials observed and satellite dishes.

Location 4

Coordinates: Lon: -2.24368, Lat: 53.46490					
Channel	Service	Signal Strength (dBμV)	BER	Picture	Audio
24	That's TV (COM6) Tiny Pop	37.5 +/- 0.1	8e-9	Fine	Fine
27	POP Max	32.9 +/- 0.2	4e-4	Fine	Fine
29	5Star	46.8 +/- 0.2	2e-7	Fine	Fine
31	Sky Arts	48.4 +/- 0.2	8e-7	Fine	Fine
32	BBC One NW (BBC A)	48.9 +/- 0.2	1e-8	Fine	Fine
34	ITV+1	47.5 +/- 1.2	3e-8	Fine	Fine
35	BBC One HD	48.9 +/- 0.2	1e-8	Fine	Fine
37	Ideal World (COM8) Yesterday	50.6 +/- 0.1	2e-7	Fine	Fine
55	BBC News HD (COM7)	37.6 +/- 0.2	1e-8	Fine	Fine
56	QVC (LM) CBeebies HD	26.5 +/- 0.1	DND	n/a	
57	Sony Channel +1	26.5 +/- 0.1	DND	n/a	

Notes: In a large car park surrounded by two storey terraced housing. All aerials hp towards winter hill and satellite dishes observed on south face of dwellings.

Location 5

Coordinates: Lon: -2.23982, Lat: 53.46322					
Channel	Service	Signal Strength (dBμV)	BER	Picture	Audio
24	That's TV (COM6) Tiny Pop	35.4 +/- 0.2	1E-8	Fine	Fine
27	POP Max	30.2 +/- 0.2	2 to 8e-3	Fine	Fine
29	5Star	55.6 +/- 0.2	1e-8	Fine	Fine
31	Sky Arts	55.7 +/- 0.2	1e-8	Fine	Fine
32	BBC One NW (BBC A)	55.3 +/- 0.2	1e-8	Fine	Fine
34	ITV+1	55.1 +/- 0.2	1e-8	Fine	Fine
35	BBC One HD	56.5 +/- 0.1	1e-8	Fine	Fine
37	Ideal World (COM8) Yesterday	55.2 +/- 0.1	1e-8	Fine	Fine
55	BBC News HD (COM7)	43.8 +/- 0.2	1e-8	Fine	Fine
56	QVC (LM) CBeebies HD	26.5 +/- 0.1	DND	n/a	
57	Sony Channel +1	26.5 +/- 0.1	DND	n/a	

Notes: Surrounded by two and three storey terraced homes and flats. HP aerials orientated towards winter hill. Satellite dishes observed on south face of dwellings.

Location 6

Coordinates: Lon: -2.22986, Lat: 53.45707					
Channel	Service	Signal Strength (dBμV)	BER	Picture	Audio
24	That's TV (COM6) Tiny Pop	34.7 +/- 0.3	1e-8	Fine	Fine
27	POP Max	32.0 +/- 0.2	Fluctuations from in the e-2-e-3 range	Fine but came in and out	Fine but came in and out
29	5Star	54.3 +/- 0.3	1e-8	Fine	Fine
31	Sky Arts	54.8 +/- 0.2	1e-8	Fine	Fine
32	BBC One NW (BBC A)	54.7 +/- 0.3	1E-8	Fine	Fine
34	ITV+1	54.9 +/- 0.2	1E-8	Fine	Fine
35	BBC One HD	58.2 +/- 0.1	1E-8	Fine	Fine
37	Ideal World (COM8) Yesterday	58.2 +/- 0.2	1E-8	Fine	Fine
55	BBC News HD (COM7)	45.8 +/- 0.2	1E-8	Fine	Fine
56	QVC (LM) CBeebies HD	26.1 +/- 0.1	DND	n/a	
57	Sony Channel +1	26.1 +/- 0.1	DND	n/a	

Notes: Surrounded by two storey dwellings in the suburbs. All dwellings had HP aerials orientated northwest towards Winter Hill. Satellite dishes observed on the south face of dwellings.

APPENDIX C – POST-CONSTRUCTION SURVEY 2021 (BUILDING C2) RESULTS

Location 1

Coordinates: Lon: -2.25521, Lat: 53.47211					
Channel	Service	Signal Strength ²⁰ (dBμV)	BER ²¹	Picture	Audio
24	LTVmux	33.4 +/- 0.1	4x10-6	Fine	Fine
27	Glmax	32.7 +/- 0.1	-	DND	DND
29	SDN	47.2 +/- 0.1	6x10-8	Fine	Fine
31	Arq A	47.2 +/- 0.1	1x10-6	Fine	Fine
32	BBC A	48.1 +/- 0.1	1.8x10-8	Fine	Fine
34	D3+4	48.2 +/- 0.1	1x10-8	Fine	Fine
35	BBC B	35.8 +/- 0.1	1x10-8	Fine	Fine
37	Arq B	46.2 +/- 0.1	6x10-7	Fine	Fine
55	COM7	36.9 +/- 0.1	-	DND	DND

Notes: Located within the building site, approximately 10m from building C1 and 30m from building C2. No aerials were visible from this survey location. Aerial pointed away from the building for best signal quality.

²⁰ +/- followed by a number represents the approximate signal fluctuation.

²¹ E = 1 x10 to the power of the following number e.g. -8.

Location 2a

Coordinates: Lon: -2.25328, Lat: 53.47036					
Channel	Service	Signal Strength (dBμV)	BER	Picture	Audio
24	LTVmux	35.1 +/- 0.1	1x10 ⁻⁷	Fine	Fine
27	Glmax	33.0 +/- 0.1	7x10 ⁻⁶	Fine	Fine
29	SDN	48.5 +/- 0.1	1x10 ⁻⁸	Fine	Fine
31	Arq A	48.7 +/- 0.1	1x10 ⁻⁸	Fine	Fine
32	BBC A	49.1 +/- 0.1	5x10 ⁻⁸	Fine	Fine
34	D3+4	44.8 +/- 0.1	1x10 ⁻⁸	Fine	Fine
35	BBC B	47.5 +/- 0.1	1x10 ⁻⁸	Fine	Fine
37	Arq B	47.0 +/- 0.2	5x10 ⁻⁷	Fine	Fine
55	COM7	36.0 +/- 0.1	-	DND	DND

Notes: One HP²² UHF²³ aerial directed towards the Winter Hill transmitter was observed. One satellite dish was observed.

²² Horizontally Polarised

²³ Ultra-High Frequency

Location 2b

Coordinates: Lon: -2.25137, Lat: 53.47030					
Channel	Service	Signal Strength (dBμV)	BER	Picture	Audio
24	LTVmux	40.0 +/- 0.1	1x10 ⁻⁷	Fine	Fine
27	Glmax	30.2 +/- 0.1	-	DND	DND
29	SDN	55.1 +/- 0.1	1x10 ⁻⁸	Fine	Fine
31	Arq A	56.9 +/- 0.1	1x10 ⁻⁸	Fine	Fine
32	BBC A	58.0 +/- 0.1	1x10 ⁻⁷	Fine	Fine
34	D3+4	58.2 +/- 0.1	1x10 ⁻⁸	Fine	Fine
35	BBC B	59.4 +/- 0.1	1x10 ⁻⁸	Fine	Fine
37	Arq B	60.6 +/- 0.1	1x10 ⁻⁸	Fine	Fine
55	COM7	46.3 +/- 0.2	1x10 ⁻⁸	Fine	Fine

Notes: Two HP UHF aerial directed towards the Winter Hill transmitter were observed. One satellite dish was observed.

Location 3

Coordinates: Lon: -2.24906, Lat: 53.46829					
Channel	Service	Signal Strength (dBμV)	BER	Picture	Audio
24	LTVmux	32.0 +/- 0.1	2.4x10 ⁻⁷	Fine	Fine
27	Glmax	30.1 +/- 0.1	-	DND	DND
29	SDN	41.5 +/- 0.2	1x10 ⁻⁴	Fine	Fine
31	Arq A	52.9 +/- 0.1	1x10 ⁻⁸	Fine	Fine
32	BBC A	51.3 +/- 0.1	1x10 ⁻⁸	Fine	Fine
34	D3+4	50.9 +/- 0.1	1x10 ⁻⁸	Fine	Fine
35	BBC B	49.9 +/- 0.1	1x10 ⁻⁸	Fine	Fine
37	Arq B	49.2 +/- 0.1	1x10 ⁻⁸	Fine	Fine
55	COM7	40.0 +/- 0.1	1x10 ⁻⁸	Fine	Fine

Notes: Multiple HP UHF aerials were observed, directed towards the Winter Hill transmitter.
Multiple satellite dishes were observed.

Location 4

Coordinates: Lon: -2.24371, Lat: 53.46505					
Channel	Service	Signal Strength (dBμV)	BER	Picture	Audio
24	LTVmux	30.5 +/- 0.1	3x10 ⁻⁵	Fine	Fine
27	Glmax	29.0 +/- 0.1	-	DND	DND
29	SDN	43.7 +/- 0.1	4x10 ⁻⁵	Fine	Fine
31	Arq A	49.1 +/- 0.1	1x10 ⁻⁸	Fine	Fine
32	BBC A	50.2 +/- 0.1	1x10 ⁻⁸	Fine	Fine
34	D3+4	45.7 +/- 0.1	1x10 ⁻⁸	Fine	Fine
35	BBC B	43.8 +/- 0.1	1x10 ⁻⁸	DND	DND
37	Arq B	47.9 +/- 0.1	1x10 ⁻⁸	Fine	Fine
55	COM7	35.4 +/- 0.1	-	DND	DND

Notes: Multiple HP UHF aerials were observed, directed towards the Winter Hill transmitter.
Multiple satellite dishes were observed.

Location 5

Coordinates: Lon: -2.24038, Lat: 53.46311					
Channel	Service	Signal Strength (dBμV)	BER	Picture	Audio
24	LTVmux	30.9 +/- 0.1	4x10 ⁻⁵	Fine	Fine
27	Glmax	27.6 +/- 0.1	-	DND	DND
29	SDN	45.3 +/- 0.1	4x10 ⁻⁵	Fine	Fine
31	Arq A	47.1 +/- 0.1	7x10 ⁻⁸	Fine	Fine
32	BBC A	49.4 +/- 0.1	1x10 ⁻⁸	Fine	Fine
34	D3+4	47.0 +/- 0.1	1x10 ⁻⁸	Fine	Fine
35	BBC B	45.6 +/- 0.1	1x10 ⁻⁷	Fine	Fine
37	Arq B	48.4 +/- 0.1	1x10 ⁻⁷	Fine	Fine
55	COM7	34.1 +/- 0.1	-	DND	DND

Notes: Multiple HP UHF aerials were observed, directed towards the Winter Hill transmitter.
Multiple satellite dishes were observed.

Location 6

Coordinates: Lon: -2.23033, Lat: 53.45697					
Channel	Service	Signal Strength (dBμV)	BER	Picture	Audio
24	LTVmux	31.7 +/- 0.1	1x10-8	Fine	Fine
27	Glmax	31.2 +/- 0.1	7*10-5	Fine	Fine
29	SDN	47.5 +/- 0.1	1x10-8	Fine	Fine
31	Arq A	46.3 +/- 0.1	1x10-8	Fine	Fine
32	BBC A	45.0 +/- 0.1	1x10-8	Fine	Fine
34	D3+4	48.0 +/- 0.1	1x10-8	Fine	Fine
35	BBC B	48.0 +/- 0.1	1x10-7	Fine	Fine
37	Arq B	51.9 +/- 0.1	1x10-8	Fine	Fine
55	COM7	44.4 +/- 0.1	1x10-8	Fine	Fine

Notes: Multiple HP UHF aerials were observed, directed towards the Winter Hill transmitter.
Multiple satellite dishes were observed.

APPENDIX D – BASELINE SURVEY 2017 PHOTOGRAPHS

Location 1



Location 2



Location 3



Location 4



Location 5



Location 6



APPENDIX E – POST-CONSTRUCTION SURVEY 2020 (BUILDING C1) PHOTOGRAPHS

Location 1



Location 2



Location 3

No survey photo taken. Street view image of survey location shown for reference. The silver car is located at the survey location.



Location 4



Location 5



Location 6



APPENDIX F – POST-CONSTRUCTION SURVEY 2021 (BUILDING C2) PHOTOGRAPHS

Location 1



Location 2a



Location 2b



Location 3



Location 4



Location 5



Location 6





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