PAGERPOWER
Urban & Renewables

Television Baseline Survey Report

Great Northern

GNW Developments Limited

November 2022

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ADMINISTRATION PAGE

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1	July 2022	Initial issue
2	November 2022	Second issue – minor amendments

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EXECUTIVE SUMMARY

Report Purpose

Pager Power has been commissioned to investigate the potential impact of a proposed building development upon terrestrial television reception in the surrounding area. The proposed development is located at Great Bridgewater Street, Manchester, and will comprise three tall building plots.

Results

- The proposed development is within the coverage area for the Winter Hill television transmitter. The baseline survey confirmed it was the main transmitter serving the area.
- Any interference would be due to shadowing effects i.e. the weakening of the transmitted signal due to the physical presence of the buildings.
- A site survey was undertaken on the 9th of July 2022 to confirm the relevant transmitter and record the signal quality.
- The average terrestrial signal strength is good in the proposed development shadow zone for the main multiplexes and low on average for the local (lower power) multiplexes.
- Negative effects upon signal strength are most likely at locations close to the proposed development i.e. within 1km of the proposed development and within its shadow zone.
- A three-storey public house and four-storey building are located within approximately 180m of the proposed development. The signal strength within this range was recorded as moderate for the main multiplexes, and therefore, interference is possible. Beyond this distance up to 1km, significant effects are not predicted due to the height (or existence) of any aerials in the area.
- At locations beyond 1km and within the shadow zone, the signal strength was on average very good for the main multiplexes.

Recommendations and Mitigation

It is recommended any reports of interference are investigated to determine whether these are attributable to the proposed development. Comparisons between a post-construction survey and this baseline survey should be made, if undertaken.

If interference is found to be attributable to the proposed development, mitigation measures should be installed. Solutions are likely to be readily available if required, the most common options are presented in Section 6.

No requirement for pre-emptive mitigation has been identified.

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ABOUT PAGER POWER

Pager Power is a dedicated consultancy company based in Suffolk, UK. The company has undertaken projects in 54 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 investigate the potential impact of a proposed building development upon terrestrial television reception in the surrounding area. The proposed development will introduce new tall structures into the urban environment, which could interact with broadcast signals, causing interference. The interference zones have been modelled in accordance with Ofcom guidance (Section 3) and a baseline reception survey has been undertaken within potentially affected areas (Sections 4 and 5).

The proposed development is located at Great Bridgewater Street, Manchester, and will comprise three tall building plots.

1.2 Proposed Development Site Plan

The proposed site layout plan for the tall building plots is shown in Figure 1[1] below.

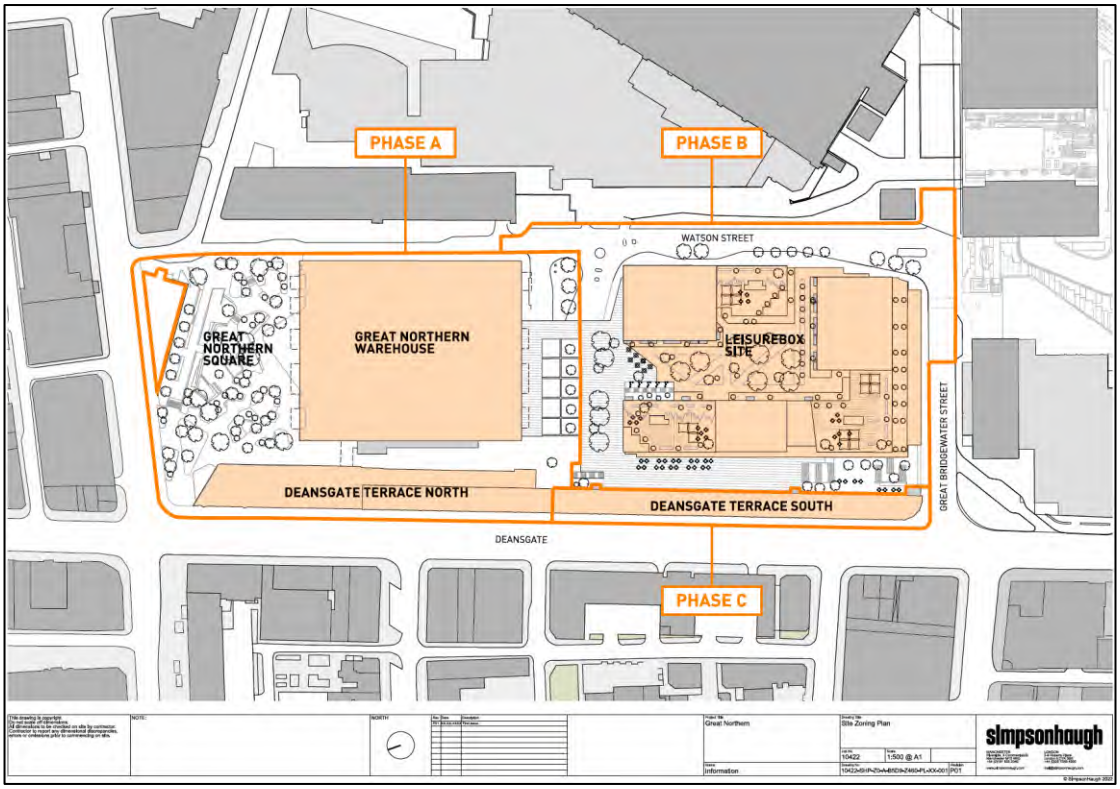


Figure 1 *Proposed development site plan*

[1] Source: GN Project Overview Crib Sheet 211022

1.3 Proposed Development Site Layout – Aerial Image

The approximate proposed development footprint overlaid on aerial imagery is shown in Figure 2 below. Building plot coordinates extrapolated from site drawings are presented in Appendix A.

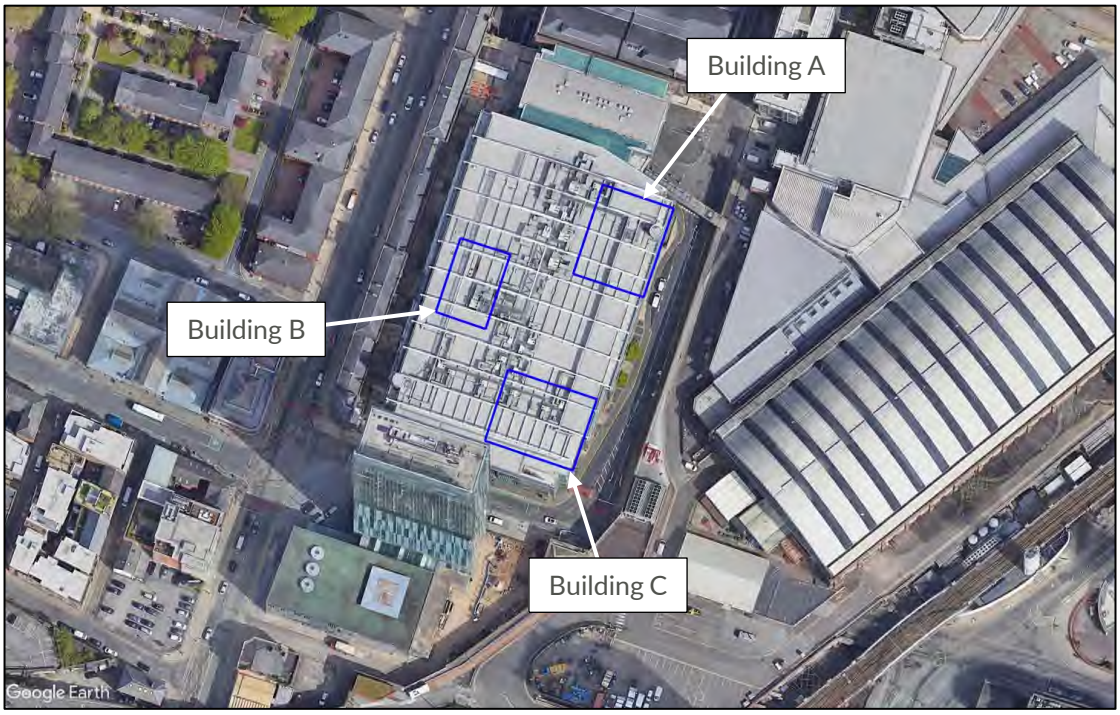


Figure 2 *Proposed development site layout (blue) – aerial image*

1.4 3D Building Representation

A 3D aerial image of the proposed development is shown in Figure 3 below.

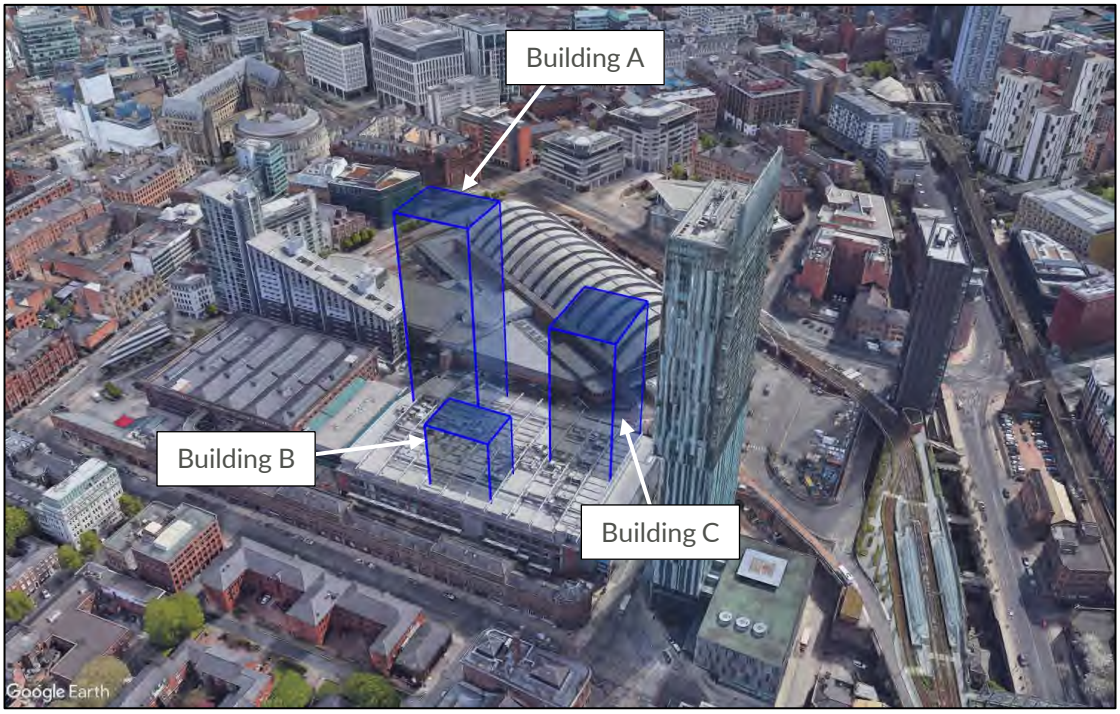


Figure 3 *3D building representation*

2 TELEVISION TRANSMITTER DETAILS

2.1 Relevant Transmitter

The Winter Hill transmitter predominantly serves the area around the development[2]. 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.

Digital television services are broadcast, details 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	32	34	35	29	31	37
Power	100 kilo-Watts (kW)					

Table 1 *Winter Hill main transmissions (main multiplexes)*

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

Table 2 *Winter Hill transmissions (local multiplexes)*

[2] Based on coverage maps and Digital UK information.

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 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 4 on the following page[3], taken from Section 3.2 of an Ofcom paper[4] 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.

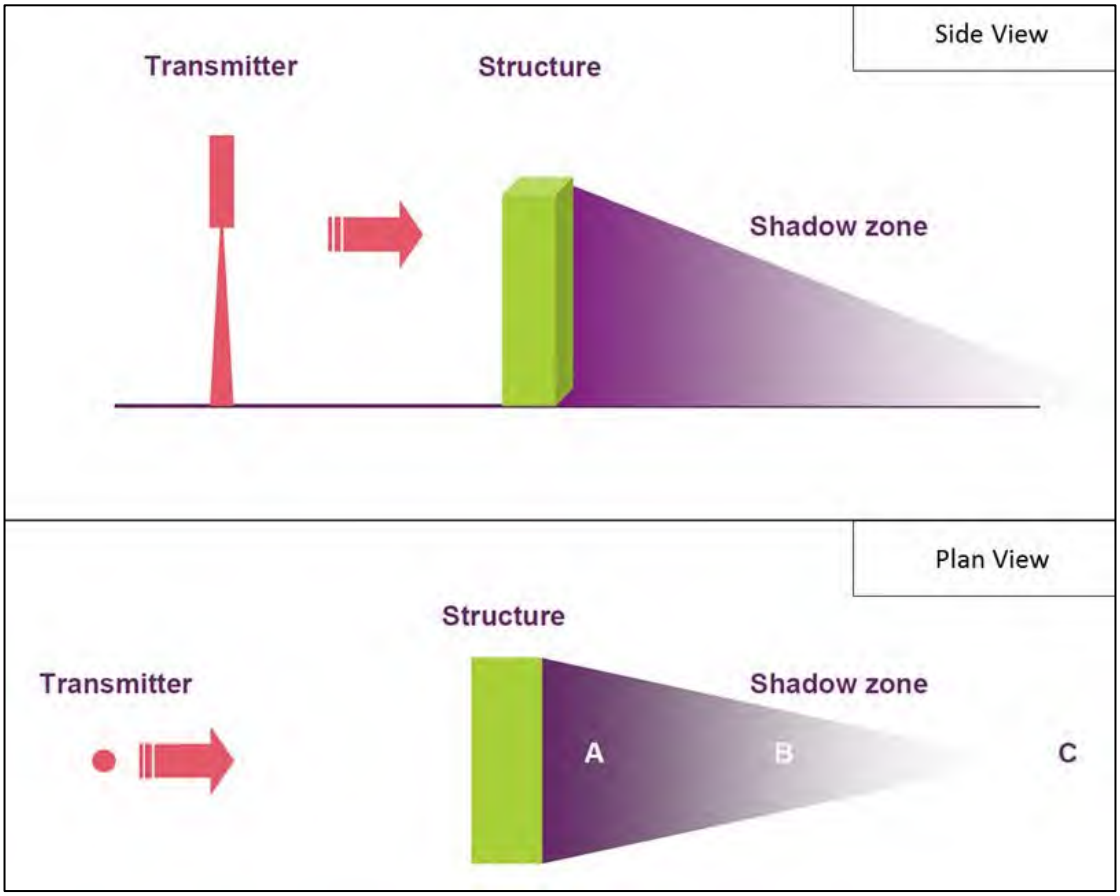


Figure 4 *Diffraction loss zones*

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

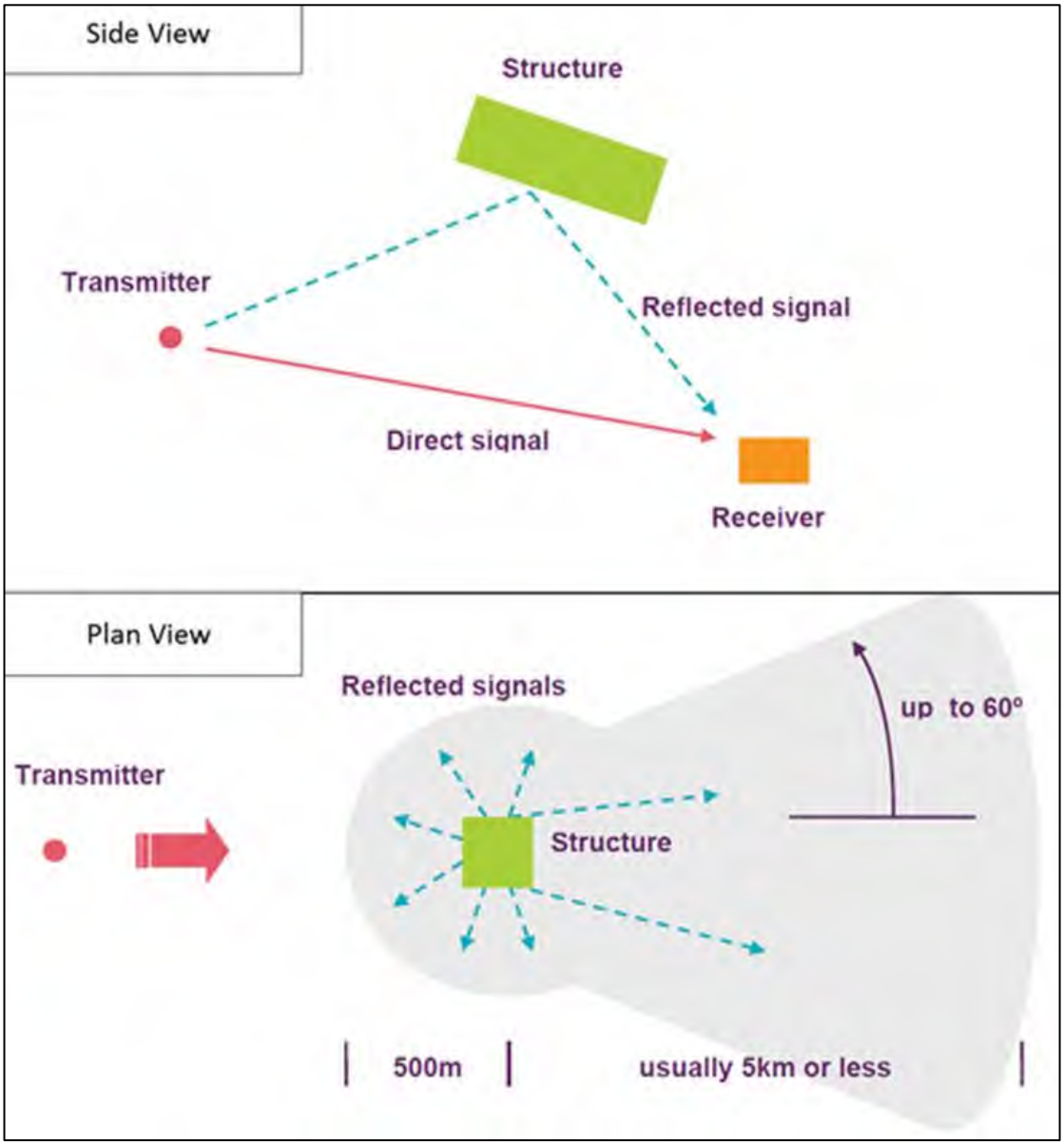


Figure 5 *Reflection zones*

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 degrees[5].

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 4 in the previous section. Figure 6 below shows the potential interference areas associated with the proposed development[6].

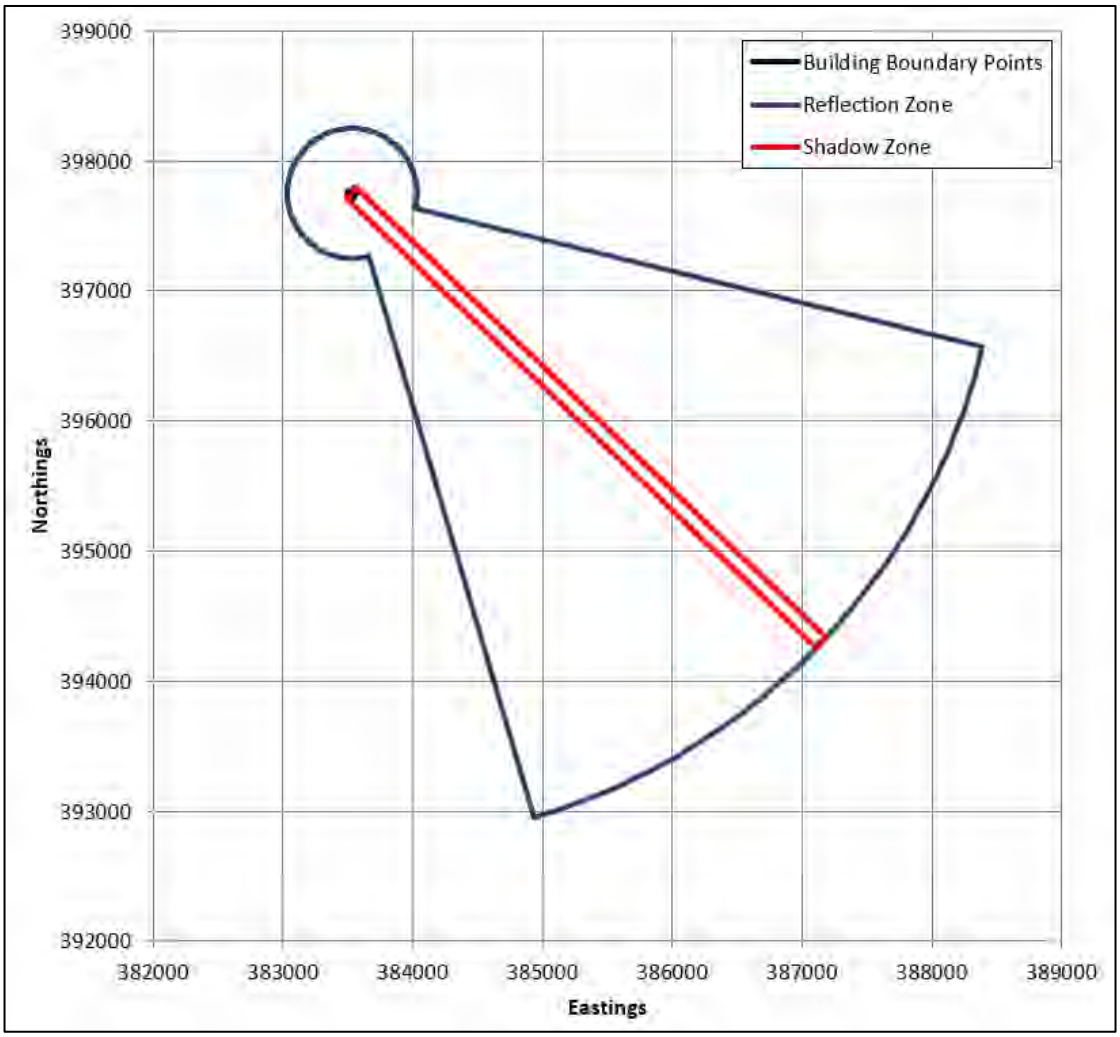


Figure 6 *Interference areas*

[6] The cumulative footprint (site boundary) of the proposed development has been considered.

Figure 7 below shows the interference zones overlaid onto an aerial image of the area.

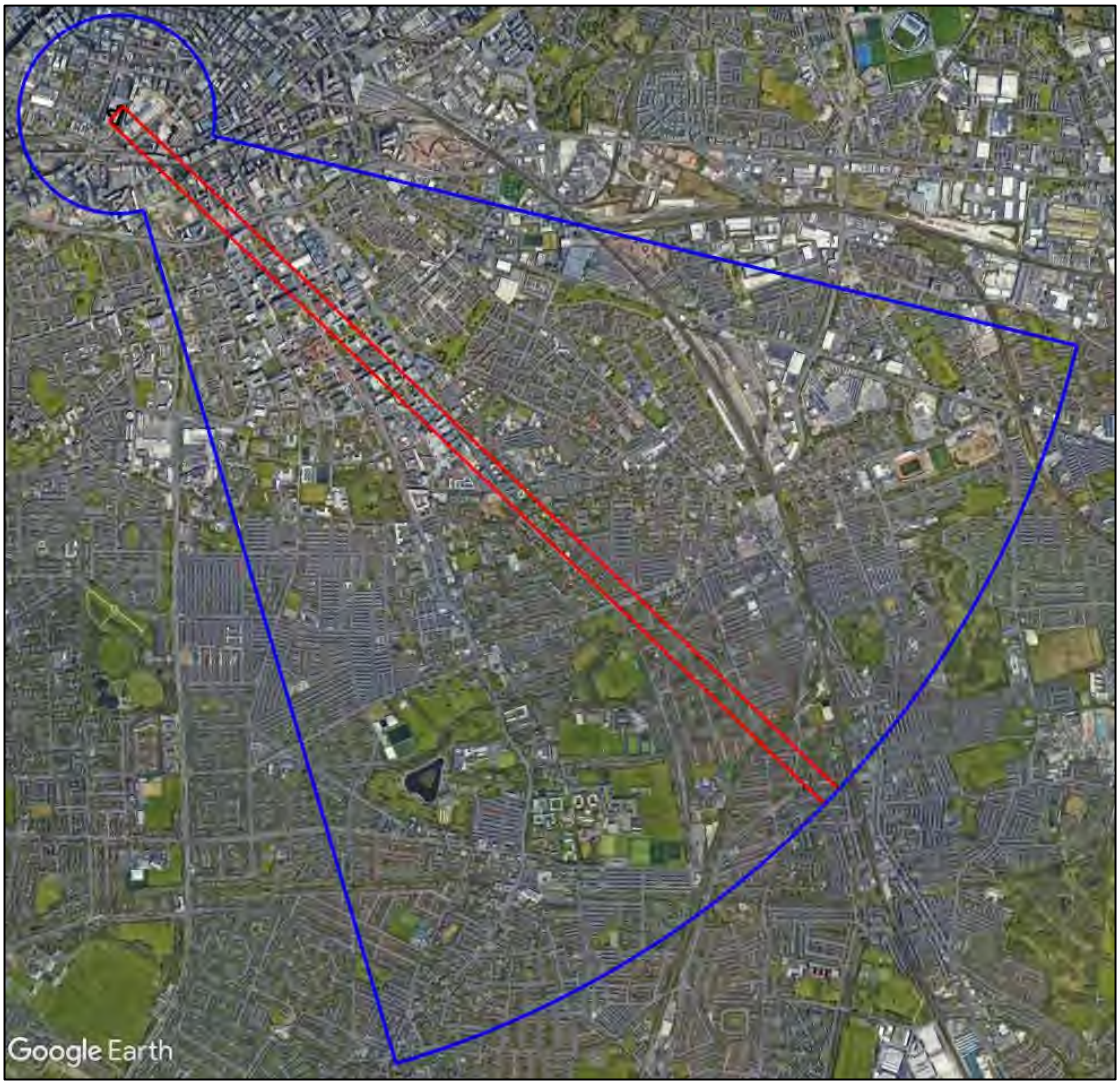


Figure 7 *Interference zones map*

4.2 Potential Diffraction Issues – Terrestrial Television

The shadow zone passes over urban areas that contain commercial and residential buildings. Areas closest to the proposed development are at the highest risk of experiencing television interference. This is typically limited to 1km based on Pager Power's assessment experience. Multi-storey flats and/or commercial property are predominately located within 1km of the proposed development shadow zone. The majority of one to two storey dwellings are located from 2.5km to 5km of the proposed development shadow zone where interference effects at this range are unlikely.

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 is 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 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 9th of July 2022.

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 3 below.

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

Table 3 *Television signal strength categories*

5.2 Survey Locations

Figure 8 below shows the survey locations overlaid onto aerial photography. The proposed development location and the shadow zone are also shown. Survey locations were chosen pre-survey (within the shadow zone) however safe and available access influenced the specific position on the day. The locations below show the actual survey locations. Survey locations are more closely grouped nearer the proposed development because interference is generally more likely the closer the location is to the obstruction. Radial white icons represent television survey locations.



Figure 8 *Survey locations*

5.3 Survey Results

A summary of the survey results is presented in Table 4 on the following page. Full survey results are shown in Appendix A. Survey photographs are shown in Appendix B.

Location	Average Measured Signal Strength (dB)	Remarks	High Level Conclusion
1	Average: 37.6 (Moderate) Main TV MUX: 44.2 (Moderate) Local TV MUX: 24.5 (Low)	One HP[7] UHF[8] located on adjacent four storey building (Albion Wharf) directed towards the Winter Hill transmitter was observed. One HP UHF also identified on adjacent three-storey public house (The Britons Protection) following a review of the available street view imagery. No satellite dishes were observed. All main multiplexes displayed fine picture and audio quality, an average of moderate signal strength and signal fluctuations of less than or equal to 0.4dB. All three local multiplexes did not decode.	This location is approximately 180 metres from the proposed development. A three-storey public house and four storey building is located adjacent to location 1. A reduction in signal strength is possible based on the proximity to the proposed development. Based on the current signal quality and height of identified aerials relative to the proposed development, interference is possible.

[7] Horizontally Polarised.
[8] Ultra-High Frequency

Location	Average Measured Signal Strength (dB)	Remarks	High Level Conclusion
2	Average: 35.5 (Moderate) Main TV MUX: 40.7 (Moderate) Local TV MUX: 25.0 (Low)	No aerials or satellite dishes were observed. Three of the six main multiplexes displayed fine picture and audio quality. One main multiplex displayed poor picture and audio quality and had intermittent reception. The remaining 2 main multiplexes did not decode. An average of moderate signal strength and signal fluctuations of less than or equal to 0.3dB. All three local multiplexes did not decode.	This location is approximately 360 metres from the proposed development. Predominately multistorey flats and/or commercial property is located adjacent to location 2. A reduction in signal strength is possible based on the proximity to the proposed development and current signal strength. Significant effects are not predicted due to the height (or existence) of any aerials in the area.
3	Average: 44.5 (Moderate) Main TV MUX: 51.6 (Good) Local TV MUX: 30.3 (Low)	Best signal was available when directing the aerial south-southwest, away from Winter Hill transmitter. No aerials or satellite dishes were observed. All main multiplexes displayed fine picture and audio quality, an average of good signal strength and signal fluctuations of less than or equal to 0.4dB. One of the three local multiplex displayed fine picture and audio quality. Two of the three local multiplexes did not decode. An average of low signal strength and signal fluctuations of less than or equal to 0.5dB.	This location is approximately 530 metres from the proposed development boundary. Predominately multistorey flats and/or commercial property is located adjacent to location 3. A reduction in signal strength is possible based on the proximity to the proposed development and current signal strength. Significant effects are not predicted due to the height (or existence) of any aerials in the area.

Location	Average Measured Signal Strength (dB)	Remarks	High Level Conclusion
4	Average: 38.5 (Moderate) Main TV MUX: 44.9 (Moderate) Local TV MUX: 25.8 (Low)	Best signal found when pointing in opposite direction of Winter Hill. An existing building is obstructing the signal towards the Winter Hill transmitter. One HP UHF was observed on a six-storey building marginally outside of the shadow zone, no other aerials were observed. No satellite dishes were observed. All main multiplexes displayed fine picture and audio quality, an average of moderate signal strength and signal fluctuations of less than or equal to 0.3dB. Two of the three local multiplexes displayed fine picture and audio quality. One local multiplex did not decode. an average of low signal strength and signal fluctuations of less than or equal to 0.2dB.	This location is approximately 680 metres from the proposed development. Predominately multistorey flats and/or commercial property is located adjacent to location 4. A reduction in signal strength is possible based on the proximity to the proposed development and current signal strength. Significant effects are not predicted due to the height (or existence) of any aerials in the area.

Location	Average Measured Signal Strength (dB)	Remarks	High Level Conclusion
5	Average: 36.0 (Moderate) Main TV MUX: 44.3 (Moderate) Local TV MUX: 19.5 (Low)	Multiple HP UHF aerials directed towards the Winter Hill transmitter was observed. Multiple satellite dishes were observed. All main multiplexes displayed fine picture and audio quality, an average of moderate signal strength and signal fluctuations of less than or equal to 0.2dB. One of the three local multiplexes displayed fine picture and audio quality. Two local multiplexes did not decode. an average of low signal strength and signal fluctuations of less than or equal to 0.2dB.	This location is approximately 2.71km from the proposed development. Effects at this range are likely to be relatively small based on previous experience. Based on the current signal quality, effects are unlikely to be noticeable. Interference is unlikely.
6	Average: 60.1 (Very good) Main TV MUX: 70.3 (Very good) Local TV MUX: 39.8 (Moderate)	Multiple HP UHF aerials directed towards the Winter Hill transmitter was observed. Multiple satellite dishes were observed. All main multiplexes displayed fine picture and audio quality, an average of very good signal strength and signal fluctuations of less than or equal to 0.2dB. Two of the three local multiplexes displayed fine picture and audio quality. One local multiplex did not decode. an average of moderate signal strength and signal fluctuations of less than or equal to 0.2dB.	This location is approximately 4.08km from the proposed development. Effects at this range are likely to be relatively small based on previous experience. Based on the current signal quality, effects are unlikely to be noticeable. Interference is unlikely.

Location	Average Measured Signal Strength (dB)	Remarks	High Level Conclusion
7	Average: 52.7 (Good) Main TV MUX: 62.1 (Very good) Local TV MUX: 33.9 (Low)	Multiple HP UHF aerials directed towards the Winter Hill transmitter was observed. Multiple satellite dishes were observed. All main multiplexes displayed fine picture and audio quality, an average of very good signal strength and signal fluctuations of less than or equal to 0.2dB. Two of the three local multiplexes displayed fine picture and audio quality. One local multiplex did not decode. An average of low signal strength and signal fluctuations of less than or equal to 0.4dB.	This location is approximately 4.89km from the proposed development. Effects at this range are likely to be relatively small based on previous experience. Based on the current signal quality, effects are unlikely to be noticeable. Interference is unlikely.

Table 4 *Television baseline survey results*

6 MITIGATION

6.1 Mitigation Requirement

If an adverse effect on television services occurs and is attributable to the proposed development, mitigation may be required. The most effective form of mitigation is dependent on the specific impact. Common options are shown below.

Mitigation options for television include:

- Replacement of receiving aerial with a more directional or higher gain aerial.
- Repositioning the receiving aerial so that the received signal is stronger.
- Directing the receiving aerial to an alternative transmitter that covers the area and retuning the television accordingly.
- Upgrading antenna cabling and connections.
- Installation of signal amplifiers.
- Development of a bespoke local solution using a receiving aerial some distance from the dwelling.
- A combination of the above.
- Replacing terrestrial reception equipment with satellite reception equipment or cable.

6.2 Recommended Options

If interference were to occur for a small number of dwellings it is likely that installation of satellite television receiver would be the most suitable option.

If effects are experienced for dwellings with poor quality or low receiving aerials, the best option may be to upgrade and/or elevate the existing aerial.

It is also possible that the television services could be supplied by an alternate transmitter in the surrounding area.

6.3 Recommended Process

It is possible that no adverse effects will occur due to the current reception quality in the surrounding area and the scarcity of residential receptors at a low height in the immediate shadow zone.

It is therefore recommended to investigate any reports of interference in order to determine whether these are attributable to the proposed development. If this is found to be the case, mitigation can be applied.

There is no reason to install pre-emptive mitigation.

7 CONCLUSIONS

7.1 Results

- The proposed development is within the coverage area for the Winter Hill television transmitter. The baseline survey confirmed it was the main transmitter serving the area.
- Any interference would be due to shadowing effects i.e. the weakening of the transmitted signal due to the physical presence of the buildings.
- A site survey was undertaken on the 9th of July 2022 to confirm the relevant transmitter and record the signal quality.
- The average terrestrial signal strength is good in the proposed development shadow zone for the main multiplexes and low on average for the local (lower power) multiplexes.
- Negative effects upon signal strength are most likely at locations close to the proposed development i.e. within 1km of the proposed development and within its shadow zone.
- A three-storey public house and four-storey building are located within approximately 180m of the proposed development. The signal strength within this range was recorded as moderate for the main multiplexes, and therefore, interference is possible. Beyond this distance up to 1km, significant effects are not predicted due to the height (or existence) of any aerials in the area.
- At locations beyond 1km and within the shadow zone, the signal strength was on average very good for the main multiplexes.

7.2 Recommendations and Mitigation

It is recommended any reports of interference are investigated to determine whether these are attributable to the proposed development. Comparisons between a post-construction survey and this baseline survey should be made, if undertaken.

If interference is found to be attributable to the proposed development, mitigation measures should be installed. Solutions are likely to be readily available if required, the most common options are presented in Section 6.

No requirement for pre-emptive mitigation has been identified.

APPENDIX A – DETAILED SURVEY RESULTS

Location 1

Coordinates: Lon: -2.24725, Lat: 53.47480					
Channel	**Service**	**Signal Strength[9] (dBµV)**	**BER[10]**	**Picture**	**Audio**
24	LTVmux	27.5 +/- 0.2	DND[11]	-	-
27	Glmax	24.8 +/- 0.2	DND	-	-
29	SDN	45.8 +/- 0.2	2.5x10^-8	Fine	Fine
31	Arq A	45.8 +/- 0.2	1x10^-8	Fine	Fine
32	BBC A	45.4 +/- 0.4	6x10^-8	Fine	Fine
34	D3+4	41.9 +/- 0.2	9x10^-7	Fine	Fine
35	BBC B	43.5 +/- 0.4	0%[12]	Fine	Fine
37	Arq B	42.9 +/- 0.3	2.5x10^-5	Fine	Fine
55	COM7	21.2 +/- 0.2	DND	-	-

Notes: One HP[13] UHF[14] located on adjacent four storey building (Albion Wharf) directed towards the Winter Hill transmitter was observed. One HP UHF also identified on adjacent three-storey public house (The Britons Protection) following a review of the available street view imagery. No satellite dishes were observed.

[9] +/- followed by a number represents the approximate signal fluctuation.
[10] E = 1 x10 to the power of the following number e.g. -8.
[11] Did not decode.
[12] Displayed as a percentage for HD channels.
[13] Horizontally Polarised.
[14] Ultra-High Frequency

Location 2

Coordinates: Lon: -2.24502, Lat: 53.47393					
Channel	**Service**	**Signal Strength[15] (dBμV)**	**BER**	**Picture**	**Audio**
24	LTVmux	25.7 +/- 0.2	DND	-	-
27	Glmax	23.0 +/- 0.3	DND	-	-
29	SDN	39.2 +/- 0.3	DND	-	-
31	Arq A	42.2 +/- 0.2	2x10^-5	Fine	Fine
32	BBC A	41.4 +/- 0.3	5.5x10^-4	Fine	Fine
34	D3+4	39.6 +/- 0.2	2.5x10^-6	Fine	Fine
35	BBC B	42.0 +/- 0.3	DND	-	-
37	Arq B	40.0 +/- 0.3	1.8x10^-2	Poor and intermittent.	Poor and intermittent.
55	COM7	26.3 +/- 0.1	DND	-	-

Notes: No aerials or satellite dishes were observed.

[15] +/- followed by a number represents the approximate signal fluctuation.

Location 3

Coordinates: Lon: -2.24365, Lat: 53.47250					
Channel	**Service**	**Signal Strength[16] (dBμV)**	**BER**	**Picture**	**Audio**
24	LTVmux	39.1 +/- 0.3	1x10^-8	Fine	Fine
27	Glmax	30.5 +/- 0.5	DND	-	-
29	SDN	50.4 +/- 0.3	2.5x10^-8	Fine	Fine
31	Arq A	52.6 +/- 0.3	1x10^-8	Fine	Fine
32	BBC A	51.4 +/- 0.3	1x10^-8	Fine	Fine
34	D3+4	51.7 +/- 0.4	1x10^-7	Fine	Fine
35	BBC B	51.3 +/- 0.2	0%	Fine	Fine
37	Arq B	52.3 +/- 0.2	1x10^-8	Fine	Fine
55	COM7	21.3 +/- 0.2	DND	-	-

Notes: Best signal was available when directing the aerial south-southwest, away from Winter Hill transmitter. No aerials or satellite dishes were observed.

[16] +/- followed by a number represents the approximate signal fluctuation.

Location 4

Coordinates: Lon: -2.24151, Lat: 53.47191					
Channel	**Service**	**Signal Strength[17] (dBμV)**	**BER**	**Picture**	**Audio**
24	LTVmux	31.6 +/- 0.2	1x10^-5	Fine	Fine
27	Glmax	29.0 +/- 0.2	3.4x10^-3	Fine	Fine
29	SDN	45.7 +/- 0.1	4.6x10^-6	Fine	Fine
31	Arq A	46.7 +/- 0.2	1x10^-8	Fine	Fine
32	BBC A	48.6 +/- 0.2	1x10^-8	Fine	Fine
34	D3+4	44.1 +/- 0.3	1x10^-8	Fine	Fine
35	BBC B	42.3 +/- 0.2	0%	Fine	Fine
37	Arq B	41.9 +/- 0.2	1x10^-8	Fine	Fine
55	COM7	16.8 +/- 0.2	DND	-	-

Notes: Best signal found when pointing in opposite direction of Winter Hill. An existing building is obstructing the signal towards the Winter Hill transmitter. One HP[18] UHF[19] was observed on a six-storey building marginally outside of the shadow zone, no other aerials were observed. No satellite dishes were observed.

[17] +/- followed by a number represents the approximate signal fluctuation.
[18] Horizontally Polarised.
[19] Ultra-High Frequency

Location 5

Coordinates: Lon: -2.21928, Lat: 53.45938					
Channel	**Service**	**Signal Strength[20] (dBμV)**	**BER**	**Picture**	**Audio**
24	LTVmux	23.2 +/- 0.2	2x10^-5	Fine	Fine
27	Glmax	18.6 +/- 0.2	DND	-	-
29	SDN	44.5 +/- 0.2	1x10^-8	Fine	Fine
31	Arq A	44.8 +/- 0.2	1x10^-8	Fine	Fine
32	BBC A	44.5 +/- 0.2	1x10^-8	Fine	Fine
34	D3+4	43.5 +/- 0.2	1x10^-8	Fine	Fine
35	BBC B	44.3 +/- 0.1	0%	Fine	Fine
37	Arq B	44.2 +/- 0.1	1x10^-8	Fine	Fine
55	COM7	16.6 +/- 0.1	DND	-	-

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

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

Location 6

Coordinates: Lon: -2.20492, Lat: 53.45054					
Channel	**Service**	**Signal Strength[21] (dBμV)**	**BER**	**Picture**	**Audio**
24	LTVmux	51.2 +/- 0.2	1x10^-8	Fine	Fine
27	Glmax	46.9 +/- 0.2	1x10^-8	Fine	Fine
29	SDN	70.5 +/- 0.1	1x10^-8	Fine	Fine
31	Arq A	71.7 +/- 0.2	1x10^-8	Fine	Fine
32	BBC A	71.3 +/- 0.2	1x10^-8	Fine	Fine
34	D3+4	69.5 +/- 0.2	1x10^-8	Fine	Fine
35	BBC B	69.6 +/- 0.1	0%	Fine	Fine
37	Arq B	69.1 +/- 0.1	1x10^-8	Fine	Fine
55	COM7	21.4 +/- 0.1	DND	-	-

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

[21] +/- followed by a number represents the approximate signal fluctuation.

Location 7

Coordinates: Lon: -2.19535, Lat: 53.44590					
Channel	**Service**	**Signal Strength[22] (dBμV)**	**BER**	**Picture**	**Audio**
24	LTVmux	44.1 +/- 0.1	1x10^-8	Fine	Fine
27	Glmax	40.8 +/- 0.1	1x10^-8	Fine	Fine
29	SDN	61.4 +/- 0.2	1x10^-8	Fine	Fine
31	Arq A	62.7 +/- 0.2	1x10^-8	Fine	Fine
32	BBC A	63.1 +/- 0.1	1x10^-8	Fine	Fine
34	D3+4	62.0 +/- 0.1	1x10^-8	Fine	Fine
35	BBC B	62.1 +/- 0.2	0%	Fine	Fine
37	Arq B	61.4 +/- 0.1	1x10^-8	Fine	Fine
55	COM7	16.7 +/- 0.4	DND	-	-

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

[22] +/- followed by a number represents the approximate signal fluctuation.

APPENDIX B – SURVEY PHOTOGRAPHS

Location 1



Location 2



Location 3



Location 4


PAGERPOWER
Urban & Renewables
SURVEYING
www.pagerpower.com

Location 5



Location 6



Location 7



PAGERPOWER

Urban & Renewables

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