

Television Baseline and Post-Construction Survey Report

FQ Developments Limited

Owen Street

November, 2019

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1	October, 2018	Initial issue
2	November, 2018	Minor amendments
3	25 October, 2019	Update following 2019 post-construction reception survey
4	30 October, 2019	Administrative updates
5	1 November, 2019	Administrative updates
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EXECUTIVE SUMMARY

Overview

The following assessment presents the results of the television baseline reception survey (completed in September 2015) and the results of two post-construction surveys (completed in October 2018 and October 2019) to determine whether there has been any impact upon terrestrial television services caused by various phases of the development, and if so, the significance. This has been undertaken based on guidance produced by Ofcom.

Findings

Signal strength and the availability of channels appears to have decreased at a number of locations between the most recent surveys. It is possible that this decrease is due to the Owen Street development. Other factors could also have affected signal quality. The most pronounced reduction in reception was shown to be between 1.5 km and 4 km. The most common scenario is for the locations closest a new obstruction to be the worst affected, which is not the case in this instance¹.

¹ It is, however, possible for locations further back to be more significantly affected if, for example, the previous reception strength was borderline.

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ABOUT PAGER POWER

Pager Power is a dedicated consultancy company based in Suffolk, UK. The company has undertaken projects in 46 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

The Owen Street development is located in central Manchester. The development comprises four towers with the tallest of these being Tower A which has a maximum height of 200.5 metres above ground level. This report pertains to all towers within the development².

The following assessment presents the results of the television baseline reception survey (completed in September 2015), the results of the first post-construction survey (completed in October 2018) and the most recent post-construction survey in October 2019 to determine whether there has been any impact upon terrestrial television services caused by the development, and if so, the significance. This has been undertaken based on guidance produced by Ofcom.

1.2 Assessment Requirement

The Owen Street development has introduced a 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 produces the results of the baseline survey (prior to any development at Owen Street in 2015) and two post-construction surveys – undertaken a year apart at different phases of the development.

1.3 Coordinate System

Unless otherwise stated all coordinates used within this report are in British National Grid (OSGB36 datum).

² The development area also includes 'Building E', which is a four-story building reaching 17 metres in height. This building has not been assessed, with the analysis instead focussing on the significantly larger towers.

2 DEVELOPMENT DETAILS

2.1 Owen Street Development

Figure 1³ below shows the location of the development on a map (provided to Pager Power by the developer).

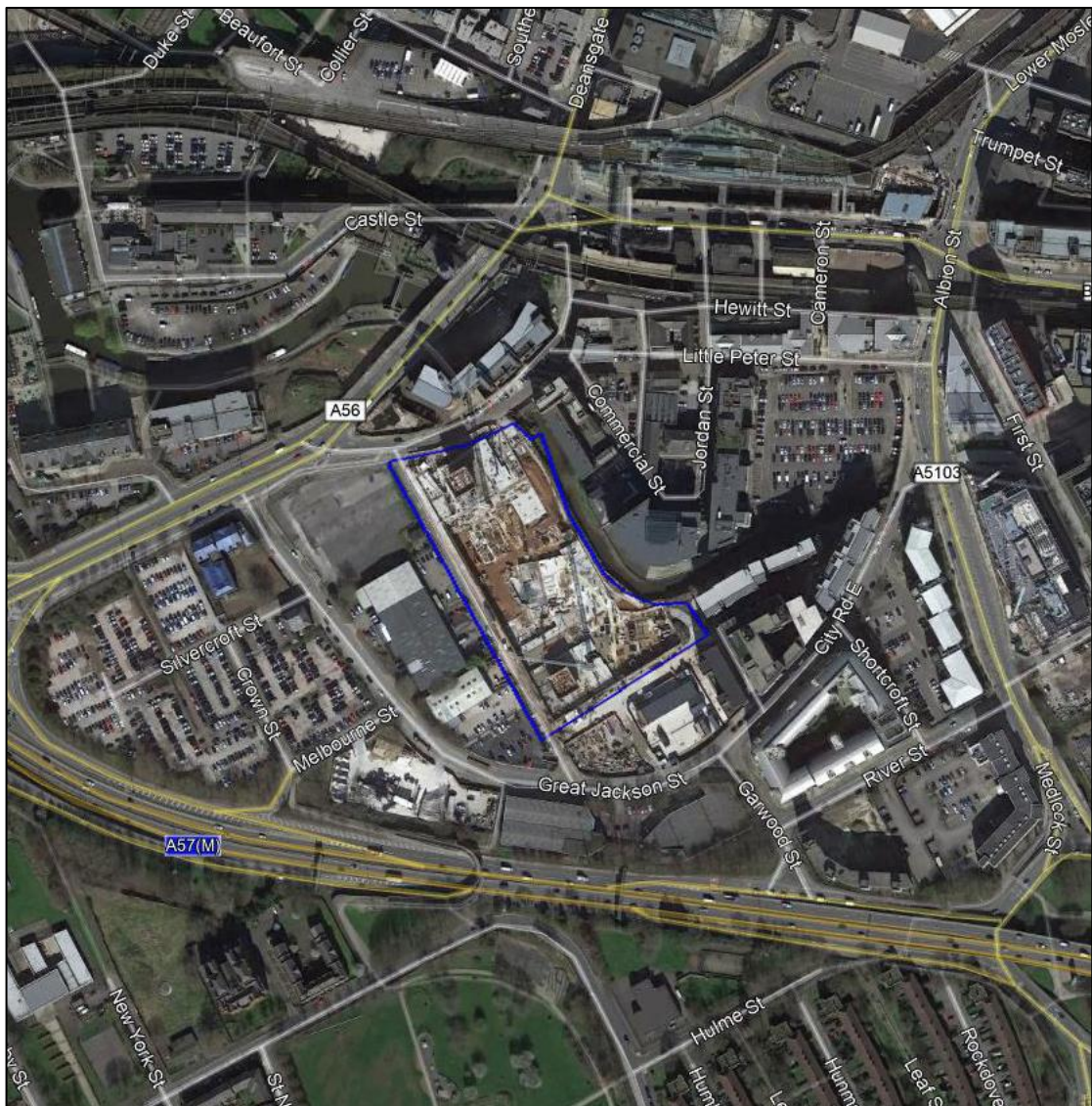


Figure 1 Location of Owen Street

³ Copyright © 2019 Google.

2.2 Development Design

Figure 2⁴ below shows a top down design of the development (not aligned north).



Figure 2 Top down development design

⁴ Source: Ian Simpson Architects (edited).

3 TELEVISION TRANSMITTER DETAILS

3.1 Relevant Transmitter

A comprehensive search of transmitter and coverage maps as well as the baseline survey, confirmed that the Winter Hill transmitter serves the area around the development.

Digital television services are broadcast via Ultra High Frequency (UHF) signals; no analogue television signals are broadcast. The transmitter information is presented below⁵.

3.2 Winter Hill Main Transmitter

Winter Hill is one of the UK's main television transmitters located approximately 24.3km northwest of the development (published coordinates SD66051446). The main digital services provided are shown in Table 1 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

Additional Winter Hill transmissions are shown in Table 2 below.

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

Table 2 Winter Hill additional transmissions

⁵ Source: Ofcom

3.3 Television Transmitter Location

Figure 3 below shows the relative location of the transmitter and the development.

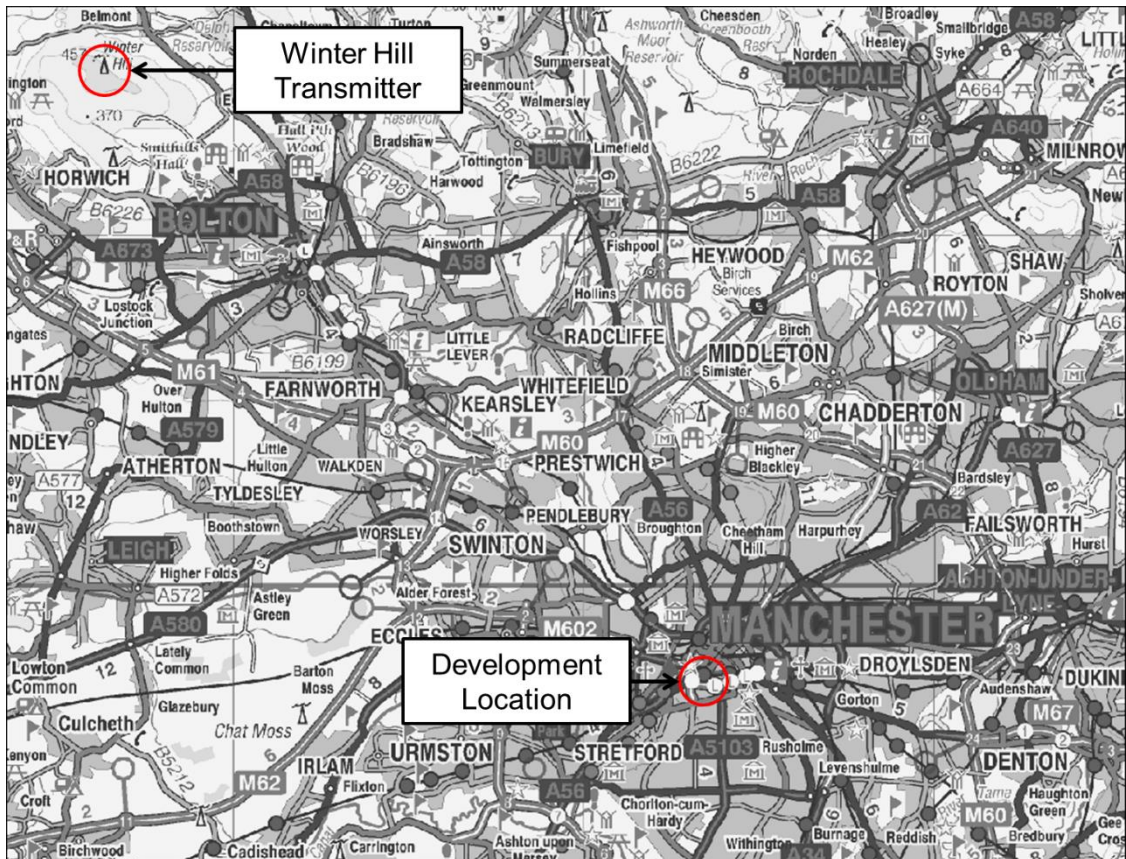


Figure 3 Television transmitter and development location

4 BUILDINGS AND INTERFERENCE MECHANISMS

4.1 Technical Overview

Terrestrial television services are provided by means of electromagnetic waves in the Ultra High Frequency (UHF) range which propagate from land-based transmitters to receiving aerials.

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.

4.2 Obstruction of the signal

This is caused by the building physically blocking the transmitted 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 south-southwest of the development. The following is true for television signals:

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

Ofcom has produced a document⁶ offering guidance on this issue. Relevant extracts from the documents are presented below.

"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."

⁶ Ofcom (2009): Tall Structures and their impact on broadcast and other wireless services

The zones mentioned are illustrated in Figure 4⁷ below, taken from Section 3.2 of the Ofcom guidance regarding the impact of buildings on broadcast signals.

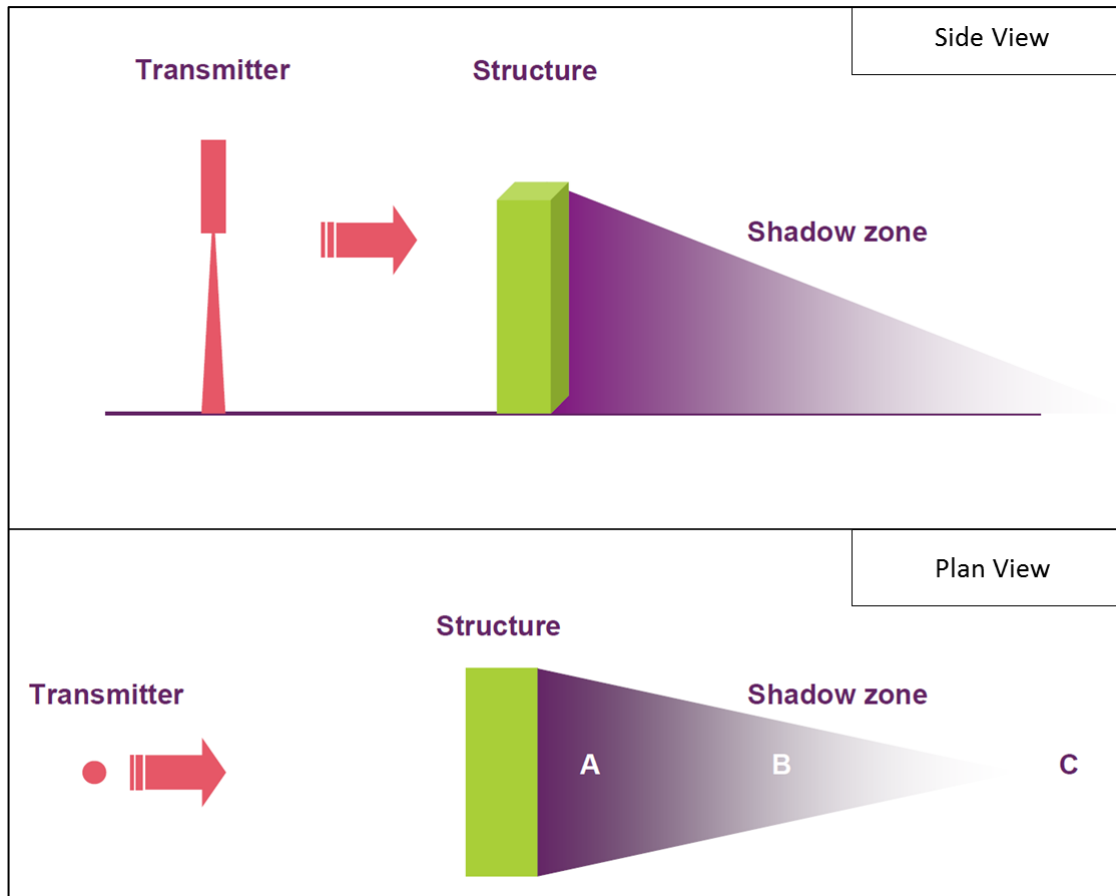


Figure 4 Diffraction Loss Zones

⁷ Source: Ofcom publication

4.3 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 5⁸ below (taken from Section 3.3 of the Ofcom guidance referenced above) illustrates this effect.

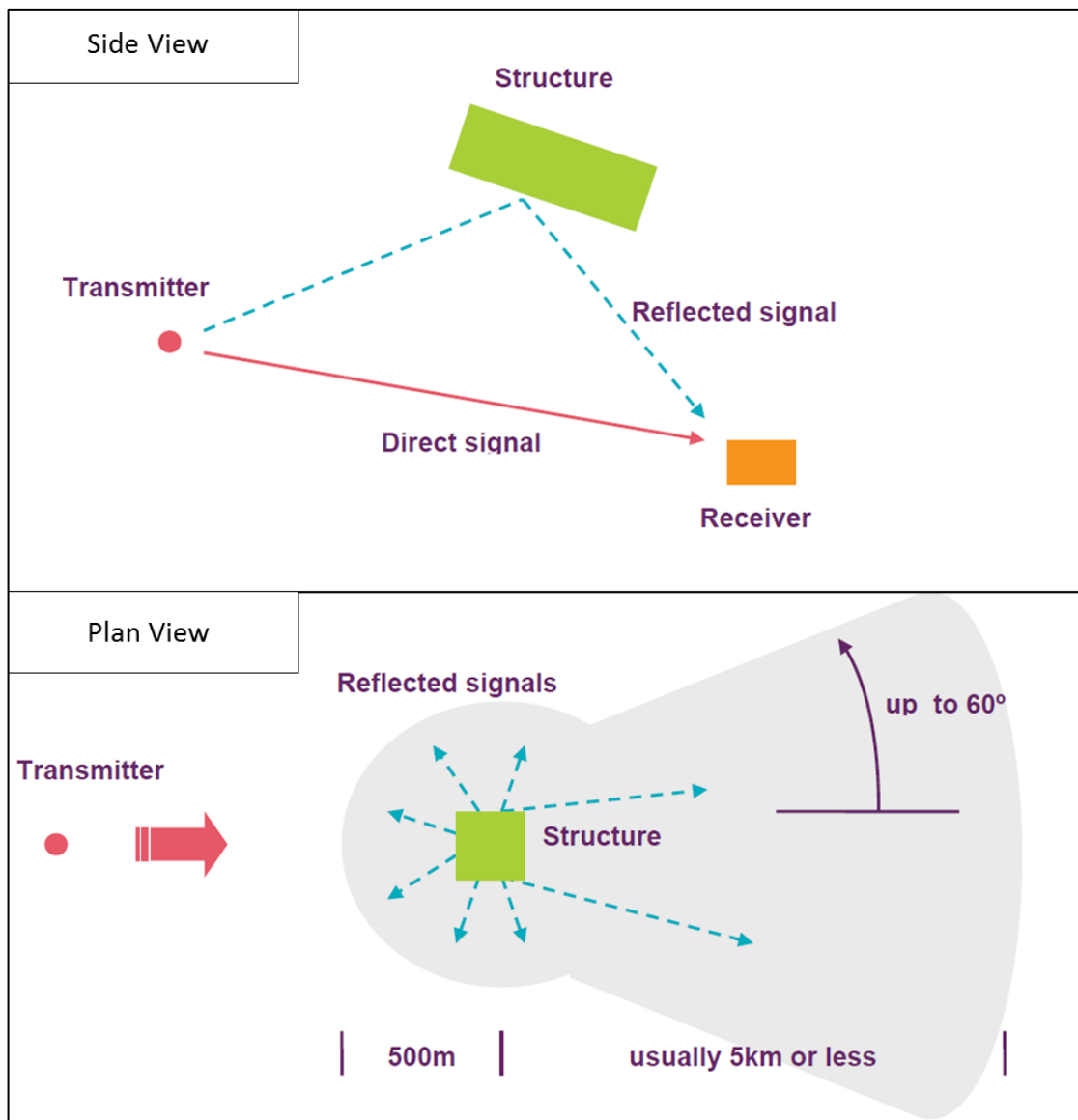


Figure 5 Reflection Zones

⁸ Source: Ofcom publication

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 degrees⁹.

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.

⁹ 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.

5 TECHNICAL ASSESSMENT

5.1 Potential Interference Areas

Figure 6 below shows the potential interference areas associated with the development.

These have been defined based on the geometry of the potential interference zones as set out in the previous section. Both zones extend to a distance of 5km beyond the building 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.

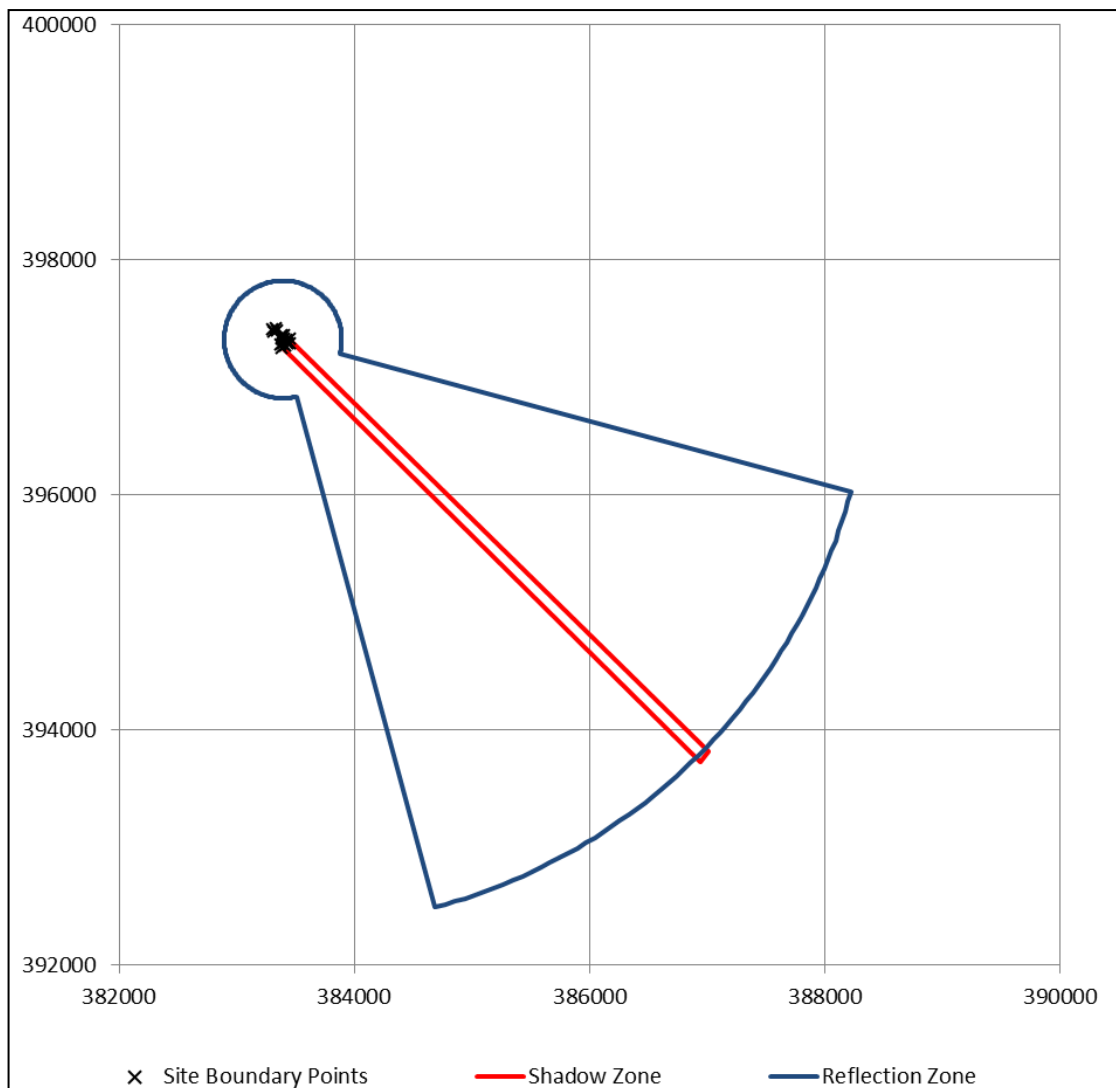


Figure 6 Interference areas

Figure 7¹⁰ below shows the interference zones overlaid onto aerial photography of the area.



Figure 7 Interference zones – aerial image

5.2 Potential Diffraction Issues – Terrestrial Television

It can be seen that the shadow zone passes over both urban and industrial buildings as well as high and low-rise residential developments. Areas closest to the development are generally¹¹ at the highest risk of experiencing television interference.

5.3 Potential Reflection Issues – Terrestrial Television

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

Based on bare-earth terrain, the Winter Hill transmitter has coverage below ten metres for the populated areas within the reflection zone. This means that any receivers that have a low signal strength are likely to be affected by existing obstructions.

¹⁰ Source: © 2019 Google.

¹¹ Under some circumstances, this is not the case e.g. if the pre-existing signal quality was exceptional at close range but borderline at longer range.

For interference to occur due to reflections, the following criteria would need to be met:

- The receiving aerial would not be already obstructed by a building or other existing obstacle;
- The reflected signal path via the development would have to be relatively unobstructed;
- The angle between the reflected signal via the development and the direct signal would have to be small.

In practice it is unlikely that all of the above criteria would be met. Impacts due to reflections are considered unlikely.

6 BASELINE SURVEY

6.1 Overview

The purpose of a baseline survey is to establish current television 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;
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; and
3. It allows a 'before and after' comparison to be made in the event that a complaint is received.

The purpose of a post-construction survey is as follows:

1. To establish the reception quality post-construction;
2. To determine the variation to television signal strength and quality from baseline to post-construction;
3. To determine whether significant interference (reported or otherwise) is occurring and to identify the specific development to which the interference is attributable

6.2 Survey Locations

Figure 8¹² below shows the survey locations (2019 survey) overlaid onto aerial photography with the icons showing where television measurements were taken. The Owen Street site outline is shown in the top left. The survey locations were chosen pre-survey as close to the previous survey locations as possible¹³.

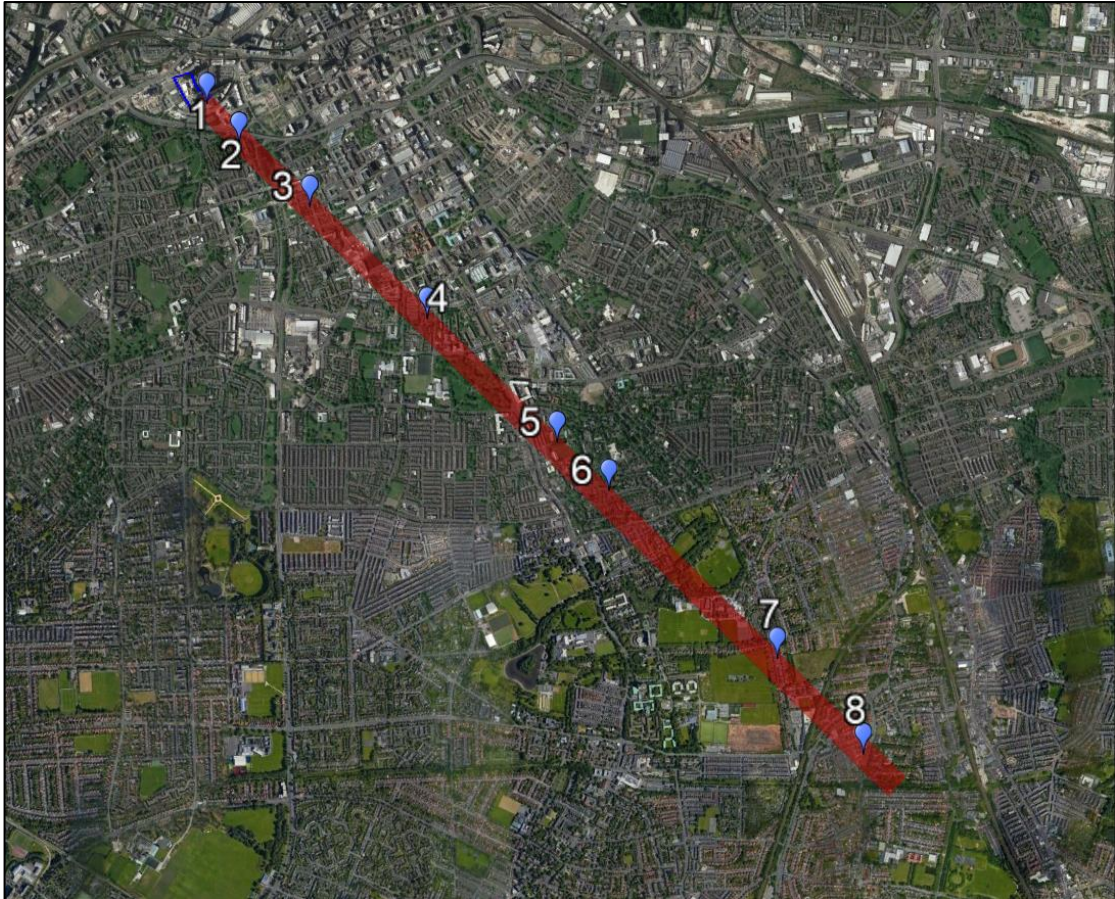


Figure 8 Survey locations

6.3 Survey Results

A baseline reception survey has been carried out for the Owen Street development. A baseline reception survey was undertaken for the development on 7 September 2015. The first post-construction survey was completed on 25 October 2018 for Tower D, the most recent survey was completed on 16 October 2019.

¹² Copyright © 2019.

¹³ Safe and available access influenced the specific position on the day.

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 television signals is categorised in accordance within 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*

The baseline survey confirmed that the Winter Hill transmitter served the surveyed area within the shadow zone.

6.4 Baseline and Post-Construction Results

Table 5 on the following page summarises the results of the baseline and post-construction reception surveys. The term 'MUX' refers to multiplex which is a group of television channels.

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.

Signal strength and the availability of channels appears to have decreased at a number of locations between the most recent surveys. It is possible that this decrease is due to the Owen Street development. The most significant differences are from locations 4-7. The most common scenario is for the locations closest a new obstruction to be the worst affected, which is not the case in this instance. It is, however, possible for locations further back to be more significantly affected if, for example, the previous reception strength was borderline.

Detailed survey results are shown in Appendix A. Survey photographs are shown in Appendix B.

Location	Average Measured Signal Strength (dB)	Comment
1	Baseline Main TV MUX: 49.3 2018 Post-Construction Main TV MUX: 49.7 2019 Post-Construction Main TV MUX: 47.1	The survey location was approximately 200m from the development. One local channel did not decode at this location during the most recent survey. Other channels were received with no discernible difference in picture or audio quality.
2	Baseline Main TV MUX: 45.5 2018 Post-Construction Main TV MUX: 55.5 2019 Post-Construction Main TV MUX: 42.4	The survey location was approximately 410m from the development. Vegetation obscured the aerial during the baseline reading. One main and one local multiplex were not available during the most recent survey. All multiplexes had been available during the previous surveys.
3	Baseline Main TV MUX: 42.9 2018 Post-Construction Main TV MUX: 48.7 2019 Post-Construction Main TV MUX: 44.9	The survey location was 880m-910m from the development. Only one local multiplex was unavailable at this location, this is in keeping with the 2018 survey and in fact shows an improvement compared to the original baseline.
4	Baseline Main TV MUX: 66.6 2018 Post-Construction Main TV MUX: 47.0 2019 Post-Construction Main TV MUX: 36.4	The survey location was 1780m-1830m from the development. Due to access, minor variation in the survey location occurred. Two local and one main multiplex were not available during the most recent survey. All multiplexes had been available during the previous surveys.

Location	Average Measured Signal Strength (dB)	Comment
5	Baseline Main TV MUX: 50.0 2018 Post-Construction Main TV MUX: 43.2 2019 Post-Construction Main TV MUX: 36.7	The survey location was 2,620m-2,640m from the development. Due to access, minor variation in the survey location occurred. A number of main and local multiplexes were not available during the most recent survey. The number of available multiplexes has apparently decreased at each successive survey.
6	Baseline Main TV MUX: 57.1 2018 Post-Construction Main TV MUX: 52.8 2019 Post-Construction Main TV MUX: 36.6	The survey location was approximately 3,030m from the development. survey location occurred. A number of main and local multiplexes were not available during the most recent survey. The number of available multiplexes has apparently decreased since the previous surveys.
7	Baseline Main TV MUX: 62.3 2018 Post-Construction¹⁴ Main TV MUX: 67.7 2019 Post-Construction Main TV MUX: 37.1	The survey location was more than 4 km from the development. survey location occurred. A number of main and local multiplexes were not available during the most recent survey. The number of available multiplexes has apparently decreased since the previous surveys.
8	Baseline Main TV MUX: 65.8 2018 Post-Construction Main TV MUX: 56.1 2019 Post-Construction Main TV MUX: 55	The survey location was approximately 4,890m from the development. All multiplexes were received with clear picture and audio quality.

Table 4 Baseline and post-construction survey results

¹⁴ The survey location was just outside the shadow zone due to access limitations.

7 CONCLUSIONS

7.1 Findings

Signal strength and the availability of channels appears to have decreased at a number of locations between the most recent surveys. It is possible that this decrease is due to the Owen Street development. Other factors could also have affected signal quality. The most significant differences are from locations 4-7. The most common scenario is for the locations closest a new obstruction to be the worst affected, which is not the case in this instance. It is, however, possible for locations further back to be more significantly affected if, for example, the previous reception strength was borderline.

APPENDIX A – BASELINE AND POST-CONSTRUCTION SURVEY RESULTS

Baseline and Post-Construction Survey Result – Location 1

Location B1 – GPS Coordinates: SJ 83498 97243					
Channel	Service	Signal Strength (dBμV)	Typical Fluctuation (dB)	Picture Quality	Audio Quality
49	Arqiva A	50.7	0.5	Good	Good
50	BBC A	51.1	0.1	Good	Good
54-	BBC B	50.5	0.2	DND ¹⁵	DND
55	Arqiva B	47.4	0.2	Good	Good
58	SDN	48.1	0.2	Good	Good
59	Digital 3&4	48.0	0.3	Good	Good

Notes (aerial direction / satellite dishes): Aerials pointing towards Winter Hill

Location PC1 (GPS Coordinates: SJ 83476 97247 +/- 22ft)					
Channel	Service	Signal Strength (dBμV)	BER	Picture Quality	Audio Quality
31	COM7	50.0 ± 0.2	0%	Good	Good
37	COM8	53.6 ± 0.2	1x10 ⁻⁷	Good	Good
49	Arqiva A	52.7 ± 0.2	2x10 ⁻⁷	Good	Good
50	BBC A	54.8 ± 0.2	1x10 ⁻⁷	Good	Good
54-	BBC B	50.0 ± 0.3	0%	Good	Good
55	Arqiva B	47.7 ± 0.7	0%	Good	Good

¹⁵ Did not decode.

Location PC1 (GPS Coordinates: SJ 83476 97247 +/- 22ft)					
Channel	Service	Signal Strength (dBμV)	BER	Picture Quality	Audio Quality
56	LM/LL/LPR	38.3 ± 0.4	1x10 ⁻⁷	Good	Good
57	GIM	34.0 ± 0.5	2x10 ⁻⁵	Good	Good
58	SDN	46.9 ± 0.4	3x10 ⁻⁷	Good	Good
59	Digital 3&4	45.9 ± 0.2	2.8x10 ⁻⁸	Good	Good

Visible aerals were directed towards Winter Hill, those in the immediate vicinity were at high elevation.

Television					
Location PC1 2019 (GPS Coordinates: SJ 83464 97271 +/- 25ft)					
Channel	Service	Signal Strength (dBμV)	BER	Picture Quality	Audio Quality
31	COM7	41.6 ± 0.3	1e-8	Good	Good
37	COM8	55.8 ± 0.1	1e-8	Good	Good
49	Arqiva A	51.6 ± 0.1	1e-8	Good	Good
50	BBC A	51.1 ± 0.1	1e-8	Good	Good
54-	BBC B	50.8 ± 0.2	1e-8	Good	Good
55	Arqiva B	46.7 ± 0.2	1e-8	Good	Good
56	LM/LL/LPR	32.6 ± 0.1	5e-7	Good	Good
57	GIM	30.7 ± 0.1	-	-	-
58	SDN	41.8 ± 0.2	3e-6	Good	Good
59	Digital 3&4	40.3 ± 0.1	1e-7	Good	Good

Notes: Aerials directed towards Winter Hill were observed.

Radio			
Location PC1 2019			
Frequency (MHz)	Service	Signal Strength (dB μ V)	Audio Quality
88-106	FM (various)	Up to 51 ± 0.3	Fine
216.928	DAB Digital 2	29.7 ± 0.5	Fine
222.064	DAB Digital 1	43.7 ± 0.3	Fine
225.648	DAB National (12B)	47.4 ± 0.4	Fine
227.360	Manchester Multiplex	45.9 ± 0.3	Fine

Baseline and Post-Construction Survey Result – Location 2

Location B2 – GPS Coordinates: SJ 83621 97081					
Channel	Service	Signal Strength (dBμV)	Typical Fluctuation (dB)	Picture Quality	Audio Quality
49	Arqiva A	48.2	0.2	Good	Good
50	BBC A	46.8	0.5	Good	Good
54-	BBC B	46.2	0.7	DND	DND
55	Arqiva B	44.8	0.5	Good	Good
58	SDN	43.5	1.0	Good	Good
59	Digital 3&4	43.5	0.5	Good	Good

Notes (aerial direction / satellite dishes): Aerials pointing towards Winter Hill. Note survey antenna obscured by trees in leaf.

Location PC2 (GPS Coordinates: SJ 83636 97067 +/- 22ft)					
Channel	Service	Signal Strength (dBμV)	BER	Picture Quality	Audio Quality
31	COM7	49.7 ± 0.3	0%	Good	Good
37	COM8	59.3 ± 0.2	1x10 ⁻⁷	Good	Good
49	Arqiva A	57.2 ± 0.2	1x10 ⁻⁸	Good	Good
50	BBC A	57.8 ± 0.5	1x10 ⁻⁸	Good	Good
54-	BBC B	55.9 ± 0.3	0%	Good	Good
55	Arqiva B	53.9 ± 0.3	0%	Good	Good
56	LM/LL/LPR	44.3 ± 0.2	1x10 ⁻⁷	Good	Good
57	GIM	37.6 ± 0.2	1x10 ⁻⁸	Good	Good
58	SDN	55.2 ± 0.2	1x10 ⁻⁸	Good	Good
59	Digital 3&4	52.8 ± 0.2	1x10 ⁻⁸	Good	Good

Aerials directed towards Winter Hill and satellite dishes were observed.

Television					
Location PC2 2019 (GPS Coordinates: SJ 83628 97069 +/- 29 ft)					
Channel	Service	Signal Strength (dBμV)	BER	Picture Quality	Audio Quality
31	COM7	39.1 ± 0.1	1e-8	Good	Good
37	COM8	48.7 ± 0.2	1e-8	Good	Good
49	Arqiva A	43 ± 0.2	4e-7	Good	Good
50	BBC A	50.2 ± 0.1	1e-8	Good	Good
54-	BBC B	39.4 ± 0.1	-	-	-
55	Arqiva B	41.1 ± 0.2	1e-8	Good	Good
56	LM/LL/LPR	30.7 ± 0.2	1e-8	Good	Good
57	GIM	26.3 ± 0.1	-	-	-
58	SDN	39.5 ± 0.2	4e-8	Good	Good
59	Digital 3&4	41.4 ± 0.1	7e-8	Good	Good

Radio			
Location PC2 2019			
Frequency (MHz)	Service	Signal Strength (dBμV)	Audio Quality
88-106	FM (various	Up to 49 ± 0.5	Fine
216.928	DAB Digital 2	25.9 ± 0.1	Fine
222.064	DAB Digital 1	42.8 ± 0.5	Fine
225.648	DAB National (12B)	47.8 ± 0.3	Fine
227.360	Manchester Multiplex	47.7 ± 0.5	Fine

Baseline and Post-Construction Survey Result – Location 3

Location B3 – GPS Coordinates: SJ 83986 96780					
Channel	Service	Signal Strength (dBμV)	Typical Fluctuation (dB)	Picture Quality	Audio Quality
49	Arqiva A	41.7	0.2	n/a	n/a
50	BBC A	44.2	0.3	Pixelating/ freezing	Nil
54-	BBC B	44.4	0.2	DND	DND
55	Arqiva B	42.0	0.2	Pixelating/ freezing	Nil
58	SDN	43.2	0.1	Broken	Broken
59	Digital 3&4	42.1	0.1	Good	Good

Notes (aerial direction / satellite dishes): Local aerials pointing towards Winter Hill

Location PC3 (GPS Coordinates: SJ 83993 96735 +/- 16ft)					
Channel	Service	Signal Strength (dBμV)	BER	Picture Quality	Audio Quality
31	COM7	50.2 ± 0.2	0%	Good	Good
37	COM8	59.3 ± 0.3	1x10 ⁻⁷	Good	Good
49	Arqiva A	54.1 ± 0.2	1x10 ⁻⁸	Good	Good
50	BBC A	55.1 ± 0.1	1x10 ⁻⁷	Good	Good
54-	BBC B	51.3 ± 0.2	0%	Good	Good
55	Arqiva B	43.1 ± 0.2	0%	Good	Good
56	LM/LL/LPR	39.1 ± 0.1	1x10 ⁻⁷	Good	Good
57	GIM	33.3 ± 0.1	DND	DND	DND
58	SDN	44.4 ± 0.2	2x10 ⁻⁶	Good	Good
59	Digital 3&4	44.0 ± 1.0	1x10 ⁻⁷	Good	Good

Aerials directed towards Winter Hill and satellite dishes were observed.

Television					
Location PC3 2019 (GPS Coordinates: SJ 83990 96744 +/- 13 ft)					
Channel	Service	Signal Strength (dBμV)	BER	Picture Quality	Audio Quality
31	COM7	38.7 ± 0.1	1e-8	Good	Good
37	COM8	46.9 ± 0.1	4e-8	Good	Good
49	Arqiva A	51.4 ± 0.1	1e-7	Good	Good
50	BBC A	49.2 ± 0.1	1e-8	Good	Good
54-	BBC B	44.3 ± 0.1	1e-8	Good	Good
55	Arqiva B	42.2 ± 0.1	1e-8	Good	Good
56	LM/LL/LPR	30.5 ± 0.1	5e-6	Good	Good
57	GIM	27.2 ± 0.1	-	-	-
58	SDN	39.9 ± 0.1	2e-5	Good	Good
59	Digital 3&4	42.8 ± 0.1	1e-8	Good	Good

Notes: Aerials directed towards Winter Hill were observed.

Baseline and Post-Construction Survey Result – Location 4

Location B4 – GPS Coordinates: SJ 84626 96080					
Channel	Service	Signal Strength (dBμV)	Typical Fluctuation (dB)	Picture Quality	Audio Quality
49	Arqiva A	65.8	0.1	Good	Good
50	BBC A	66.1	0.1	Good	Good
54-	BBC B	67.2	0.1	DND	DND
55	Arqiva B	66.9	0.2	Good	Good
58	SDN	67.0	0.1	Good	Good
59	Digital 3&4	66.8	0.1	Good	Good

Notes (aerial direction / satellite dishes): Local aerials pointing towards Winter Hill. Satellite television antennae noted.

Location PC4 (GPS Coordinates: SJ 83993 96735 +/- 16ft)					
Channel	Service	Signal Strength (dBμV)	BER	Picture Quality	Audio Quality
31	COM7	49.1 ± 0.1	0%	Good	Good
37	COM8	52.0 ± 0.4	1x10 ⁻⁸	Good	Good
49	Arqiva A	49.2 ± 0.2	1x10 ⁻⁸	Good	Good
50	BBC A	50.8 ± 0.2	1x10 ⁻⁸	Good	Good
54-	BBC B	44.0 ± 0.2	0%	Good	Good
55	Arqiva B	42.9 ± 0.2	0%	Good	Good
56	LM/LL/LPR	36.1 ± 0.2	1x10 ⁻⁷	Good	Good
57	GIM	33.2 ± 0.2	1x10 ⁻⁸	Good	Good
58	SDN	48.1 ± 0.2	1x10 ⁻⁸	Good	Good
59	Digital 3&4	47.1 ± 0.2	1x10 ⁻⁸	Good	Good

Aerials directed towards Winter Hill and satellite dishes were observed.

Television					
Location PC4 2019 (GPS Coordinates: SJ 84590 96170 +/- 15ft)					
Channel	Service	Signal Strength (dBμV)	BER	Picture Quality	Audio Quality
31	COM7	36.0 ± 0.1	1e-8	Good	Good
37	COM8	43.5 ± 0.1	1e-8	Good	Good
49	Arqiva A	36.3 ± 0.1	3e-4	Good	Good
50	BBC A	42.2 ± 0.3	1e-8	Good	Good
54-	BBC B	37.8 ± 0.3	1e-8	Good	Good
55	Arqiva B	37.6 ± 0.1	1e-8	Good	Good
56	LM/LL/LPR	32.6 ± 0.1	1e-7	Good	Good
57	GIM	36.6 ± 0.1	-	-	-
58	SDN	33.4 ± 0.2	-	-	-
59	Digital 3&4	30.8 ± 0.2	-	-	-

Notes: Aerials directed towards Winter Hill were observed.

Baseline and Post-Construction Survey Result – Location 5

Location B5 – GPS Coordinates: SJ 85188 95509					
Channel	Service	Signal Strength (dBμV)	Typical Fluctuation (dB)	Picture Quality	Audio Quality
49	Arqiva A	53.9	0.2	Good	Good
50	BBC A	53.5	0.2	Good	Good
54-	BBC B	50.9	0.1	DND	DND
55	Arqiva B	48.9	0.2	Good	Good
58	SDN	47.1	0.1	Good	Good
59	Digital 3&4	45.6	0.2	Good	Good

Notes (aerial direction / satellite dishes): Local aerials pointing towards Winter Hill. Local Satellite television antennae noted.

Location PC5 (GPS Coordinates: SJ 85206 95513 +/- 9ft)					
Channel	Service	Signal Strength (dBμV)	BER	Picture Quality	Audio Quality
31	COM7	47.0 ± 0.2	0%	Good	Good
37	COM8	48.9 ± 0.3	1x10 ⁻⁸	Good	Good
49	Arqiva A	50.9 ± 0.2	1x10 ⁻⁸	Good	Good
50	BBC A	48.8 ± 0.3	1x10 ⁻⁸	Good	Good
54-	BBC B	40.8 ± 0.2	0%	Good	Good
55	Arqiva B	32.5 ± 0.2	DND	DND	DND
56	LM/LL/LPR	31.1 ± 0.2	3x10 ⁻⁶	Good	Good
57	GIM	31.2 ± 0.2	4x10 ⁻⁶	Good	Good
58	SDN	42.6 ± 0.2	1x10 ⁻⁸	Good	Good
59	Digital 3&4	43.3 ± 0.2	1x10 ⁻⁸	Good	Good

Aerials directed towards Winter Hill and satellite dishes were observed.

Television					
Location PC5 2019 (GPS Coordinates: SJ 85253 95534 +/- 16 ft)					
Channel	Service	Signal Strength (dBμV)	BER	Picture Quality	Audio Quality
31	COM7	29.3 ± 0.2	-	-	-
37	COM8	31.2 ± 0.2	-	-	-
49	Arqiva A	39.5 ± 0.1	1e-8	Good	Good
50	BBC A	43.1 ± 0.2	1e-8	Good	Good
54-	BBC B	38.9 ± 0.1	1e-8	Good	Good
55	Arqiva B	29.1 ± 0.3	-	-	-
56	LM/LL/LPR	28.9 ± 0.1	6e-7	Good	Good
57	GIM	26.2 ± 0.1	-	-	-
58	SDN	34.7 ± 0.5	6e-4	Good	Good
59	Digital 3&4	30.0 ± 0.3	-	-	-

Notes: Aerials directed towards Winter Hill were observed.

Baseline and Post-Construction Survey Result – Location 6

Location B6 – GPS Coordinates: SJ 85514 95268					
Channel	Service	Signal Strength (dBμV)	Typical Fluctuation (dB)	Picture Quality	Audio Quality
49	Arqiva A	57.7	0.1	Good	Good
50	BBC A	57.5	0.2	Good	Good
54-	BBC B	58.4	0.2	DND	DND
55	Arqiva B	57.5	0.2	Good	Good
58	SDN	56.3	0.1	Good	Good
59	Digital 3&4	55.4	0.1	Good	Good

Notes (aerial direction / satellite dishes): Local aerials pointing towards Winter Hill. Local Satellite television antennae noted.

Location PC6 (GPS Coordinates: SJ 85506 95265 +/- 21ft)					
Channel	Service	Signal Strength (dBμV)	BER	Picture Quality	Audio Quality
31	COM7	54.0 ± 0.4	0%	Good	Good
37	COM8	60.6 ± 0.2	1x10 ⁻⁸	Good	Good
49	Arqiva A	57.4 ± 0.2	1x10 ⁻⁸	Good	Good
50	BBC A	58.6 ± 0.2	1x10 ⁻⁸	Good	Good
54-	BBC B	55.5 ± 0.2	0%	Good	Good
55	Arqiva B	46.9 ± 0.2	0%	Good	Good
56	LM/LL/LPR	35.8 ± 0.2	1x10 ⁻⁷	Good	Good
57	GIM	27.0 ± 0.1	DND	DND	DND
58	SDN	50.3 ± 0.2	1x10 ⁻⁸	Good	Good
59	Digital 3&4	48.2 ± 0.1	1x10 ⁻⁸	Good	Good

Aerials directed towards Winter Hill and satellite dishes were observed.

Television					
Location PC6 2019 (GPS Coordinates: SJ 85517 95288 +/- 9 ft)					
Channel	Service	Signal Strength (dBμV)	BER	Picture Quality	Audio Quality
31	COM7	40.3 ± 0.2	1e-8	Good	Good
37	COM8	45.0 ± 0.2	1e-8	Good	Good
49	Arqiva A	40.4 ± 0.3	1e-6	Good	Good
50	BBC A	42.0 ± 0.4	1e-8	Good	Good
54-	BBC B	41.9 ± 0.2	1e-8	Good	Good
55	Arqiva B	34.5 ± 0.3	-	-	-
56	LM/LL/LPR	27.2 ± 0.1	-	-	-
57	GIM	26.1 ± 0.1	-	-	-
58	SDN	30.5 ± 0.5	-	-	-
59	Digital 3&4	30.0 ± 0.1	-	-	-

Notes: Aerials directed towards Winter Hill were observed. It is possible that the adjacent building caused local blocking.

Baseline and Post-Construction Survey Result – Location 7

Location B7 – GPS Coordinates: SJ 86393 94359					
Channel	Service	Signal Strength (dBμV)	Typical Fluctuation (dB)	Picture Quality	Audio Quality
49	Arqiva A	61.5	0.1	Good	Good
50	BBC A	61.7	0.2	Good	Good
54-	BBC B	63.1	0.1	DND	DND
55	Arqiva B	62.0	0.2	Good	Good
58	SDN	62.9	0.1	Good	Good
59	Digital 3&4	62.3	0.1	Good	Good

Notes (aerial direction / satellite dishes): Local aerials pointing towards Winter Hill. Local Satellite television antennae noted.

Location PC7 (GPS Coordinates: SJ 86450 94158 +/- 10ft)					
Channel	Service	Signal Strength (dBμV)	BER	Picture Quality	Audio Quality
31	COM7	62.3 ± 0.2	0%	Good	Good
37	COM8	72.1 ± 0.2	1x10 ⁻⁸	Good	Good
49	Arqiva A	70.8 ± 0.2	1x10 ⁻⁸	Good	Good
50	BBC A	71.9 ± 0.2	1x10 ⁻⁸	Good	Good
54-	BBC B	69.3 ± 0.2	0%	Good	Good
55	Arqiva B	62.5 ± 0.2	0%	Good	Good
56	LM/LL/LPR	53.8 ± 0.2	1x10 ⁻⁷	Good	Good
57	GIM	43.8 ± 0.2	1x10 ⁻⁸	Good	Good
58	SDN	66.3 ± 0.2	1x10 ⁻⁸	Good	Good
59	Digital 3&4	65.4 ± 0.3	1x10 ⁻⁸	Good	Good

Aerials directed towards Winter Hill and satellite dishes were observed.

Television					
Location PC7 2019 (GPS Coordinates: SJ 86375 94427 +/- 12 ft)					
Channel	Service	Signal Strength (dBμV)	BER	Picture Quality	Audio Quality
31	COM7	41.2 ± 0.2	1e-8	Good	Good
37	COM8	49.3 ± 0.2	1e-8	Good	Good
49	Arqiva A	47.0 ± 0.3	1e-8	Good	Good
50	BBC A	43.9 ± 0.3	1e-8	Good	Good
54-	BBC B	36.0 ± 0.5	-	-	-
55	Arqiva B	34.3 ± 0.2	-	-	-
56	LM/LL/LPR	27.5 ± 0.1	4e-4	Good	Good

Television					
Location PC7 2019 (GPS Coordinates: SJ 86375 94427 +/- 12 ft)					
Channel	Service	Signal Strength (dBμV)	BER	Picture Quality	Audio Quality
57	GIM	26.1 ± 0.1	-	-	-
58	SDN	30.0 ± 0.2	-	-	-
59	Digital 3&4	31.5 ± 0.5	-	-	-

Notes: Aerials were predominantly directed towards Winter Hill, however the specific directions varied.

Baseline and Post-Construction Survey Result – Location 8

Location B8 – GPS Coordinates: SJ 86807 93932					
Channel	Service	Signal Strength (dBμV)	Typical Fluctuation (dB)	Picture Quality	Audio Quality
49	Arqiva A	66.1	0.2	Good	Good
50	BBC A	67.3	0.2	Good	Good
54-	BBC B	65.6	0.2	DND	DND
55	Arqiva B	65.6	0.2	Good	Good
58	SDN	65.8	0.2	Good	Good
59	Digital 3&4	64.2	0.2	Good	Good

Notes (aerial direction / satellite dishes): Local aerials pointing towards Winter Hill. Local Satellite television antennae noted.

Location PC8 (GPS Coordinates: SJ 86814 93932 +/- 11ft)					
Channel	Service	Signal Strength (dBμV)	BER	Picture Quality	Audio Quality
31	COM7	52.9 ± 0.2	0%	Good	Good
37	COM8	59.2 ± 0.2	1x10 ⁻⁸	Good	Good
49	Arqiva A	61.6 ± 0.2	1x10 ⁻⁸	Good	Good
50	BBC A	61.8 ± 0.2	1x10 ⁻⁸	Good	Good
54-	BBC B	56.8 ± 0.2	0%	Good	Good
55	Arqiva B	48.6 ± 0.2	0%	Good	Good
56	LM/LL/LPR	37.6 ± 0.2	1x10 ⁻⁷	Good	Good
57	GIM	35.1 ± 0.2	1x10 ⁻⁸	Good	Good
58	SDN	56.0 ± 0.2	1x10 ⁻⁸	Good	Good
59	Digital 3&4	51.9 ± 0.2	1x10 ⁻⁸	Good	Good

Aerials directed towards Winter Hill and satellite dishes were observed.

Television					
Location PC8 2019 (GPS Coordinates: SJ 86813 +/- 13ft)					
Channel	Service	Signal Strength (dBμV)	BER	Picture Quality	Audio Quality
31	COM7	53.2 ± 0.2	1e-8	Good	Good
37	COM8	58.6 ± 0.2	1e-8	Good	Good
49	Arqiva A	59.3 ± 0.2	1e-8	Good	Good
50	BBC A	59.8 ± 0.2	1e-8	Good	Good
54-	BBC B	57.0 ± 0.2	1e-8	Good	Good
55	Arqiva B	50.1 ± 0.1	1e-8	Good	Good
56	LM/LL/LPR	36.5 ± 0.3	1e-7	Good	Good
57	GIM	32.2 ± 0.1	4.1e-8	Good	Good
58	SDN	53.0 ± 0.3	1e-8	Good	Good
59	Digital 3&4	50.8 ± 0.2	1e-8	Good	Good

Notes: HP UHF aerials directed towards Winter Hill were observed.

APPENDIX B – BASELINE AND POST-CONSTRUCTION SURVEY PHOTOGRAPHS

Baseline and Post-Construction Survey – Location 1

Baseline



Post-Construction (2018)



Post-Construction (2019)



Baseline and Post-Construction Survey – Location 2

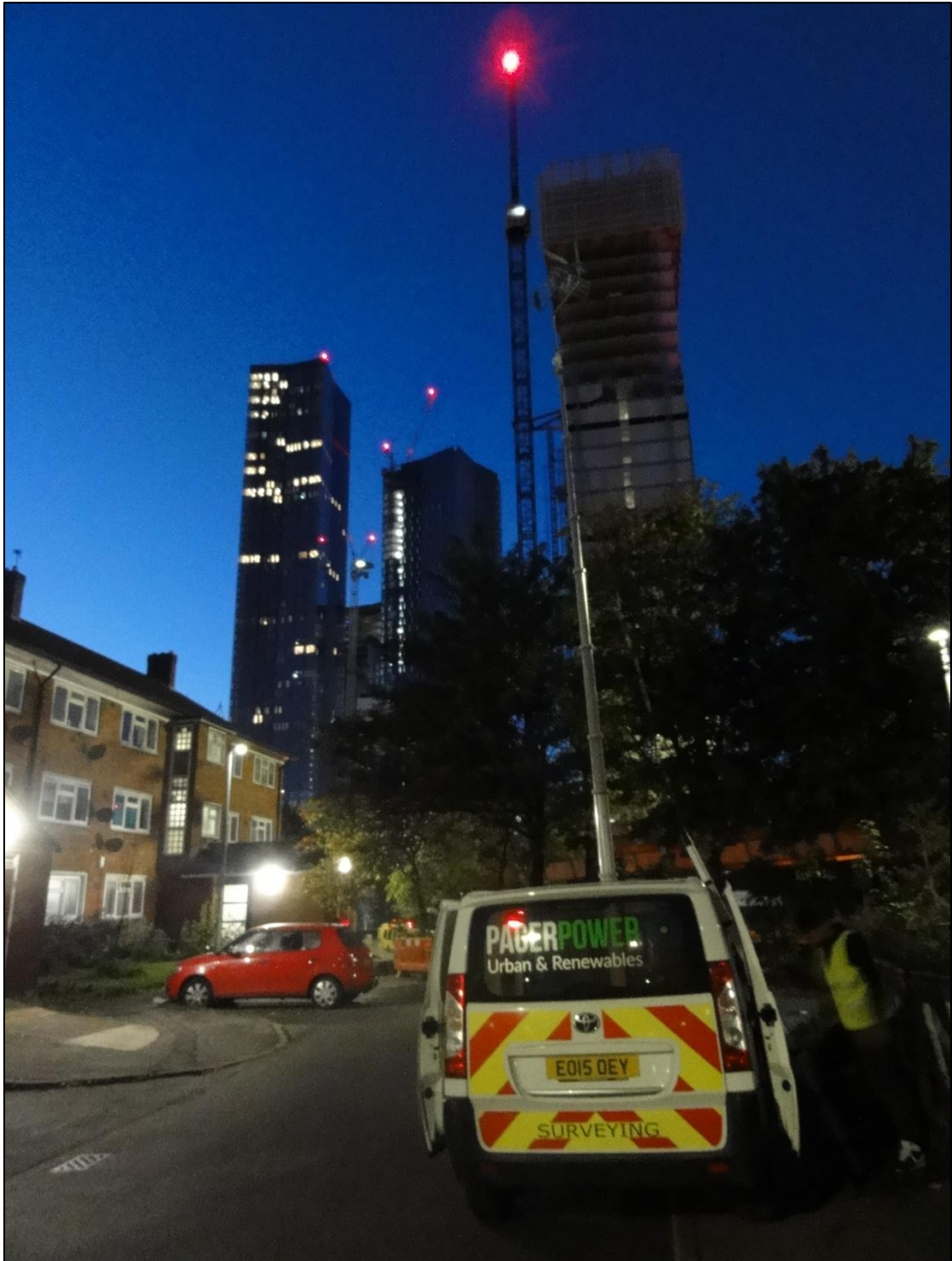
Baseline



Post-Construction (2018)



Post-Construction (2019)



Baseline and Post-Construction Survey – Location 3

Baseline



Post-Construction (2018)



Post-Construction (2019)



Baseline and Post-Construction Survey – Location 4

Baseline



Post-Construction (2018)



Post-Construction (2019)



Baseline and Post-Construction Survey – Location 5

Baseline



Post-Construction (2018)



Post-Construction (2019)



Baseline and Post-Construction Survey – Location 6

Baseline



Post-Construction (2018)



Post-Construction (2019)



Baseline and Post-Construction Survey – Location 7

Baseline



Post-Construction (2018)



Post-Construction (2019)



Baseline and Post-Construction Survey – Location 8

Baseline



Post-Construction (2018)



Post-Construction (2019)





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