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CH61 & 62 Re-Farming

Study by

Arqiva

Final Report

27 October 2008

Prepared for: Ofcom
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arqiva

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1 SUMMARY

Arqiva on behalf of Ofcom have carried out an initial assessment looking at the possibility of re-farming broadcast services from channels 61 and 62. Re-farming being based on the exchange of channels 61 and 62 for channels 39 and 40. To simplify the study only the first 80 stations, the primary stations in the UK, have been considered and the Continental and Irish use of spectrum is based on their GE-06 position.

In considering the re-farming options three approaches have been tried.

- A Single Step approach that systematically mapped channels 61 and 62 directly to channels 39 and 40. Whilst simple this carried the risk of moving viewers out of group and requiring extensive re-engineering of the transmission infrastructure.

- A two step approach that systematically moved channels 61 and 62 to two intermediate channels, channels 48 and 51. Services on channels 48 and 51 being moved to channels 39 and 40. An attempt at keeping viewers in group and minimising transmission infrastructure re-engineering.

- A Hybrid approach comparable to the two step but allowing a degree of flexibility to avoid some of the issues of the systematic approach.

The single step and two step approaches, being a rigid application of a set of rules resulted in several incompatibilities with our neighbours, a likelihood of re-engineering of some of the transmit antenna infrastructure and domestic receive aerials being moved out of group. Depending on the method for assessing the number of domestic households affected, as a worst case the single step approach could affect up to 4.5 million households and the two step up to 1.1 million households. With both methods predicted overall coverage for both PSB and COM multiplexes fell slightly.

The extra flexibility of the Hybrid approach allowed compatibility issues with our neighbours to be avoided and kept transmit and receive aerials within group. As such the likelihood of transmit antenna infrastructure requiring re-engineering was reduced. PSB coverage improved slightly but COM coverage fell slightly. Such coverage calculations and the estimates of re-engineering works are only an indicator as the study only considered the first 80 sites and did not allow for similar changes on the Continent and in Ireland

The study has shown that a re-farming exercise could be carried out without materially damaging coverage or unduly inconveniencing viewers beyond a rescan. It appears that a plan could be developed that results in few changes, but as much of the transmit infrastructure, though planned, is yet to be built or if built has not been tested on any re-farmed channels, Arqiva Network Access and Managed Transmission Services need to be consulted as to the consequences of any frequency changes.

Though it may appear beneficial to implement any re-farming during the course of DSO, scope for this is limited. DSO planning is well advanced with equipment being ordered for regions up to and including London and Meridian. Only the later DSO regions Tyne-Tees and Ulster, scheduled for late 2012, offer an opportunity for change. Any changes to the DSO frequency plan could alter and increase the number of cases of transitional interference in what is already a highly complex roll-out plan and they could affect the viability of re-broadcast links.

As the re-farming options considered were based on the use of channel 39, the timing of any re-farming exercise may be driven primarily by the need to protect Radio Astronomy rather than agreement with the Continent or protection of the DSO timetable. Whilst Radio Astronomy requires protection, it is anticipated that access to channel 39 would be restricted to the point that it would not be able to replicate the planned post-DSO coverage.

2 INTRODUCTION

UK strategy for clearing spectrum was developed and set in the period 2000 - 2004 following publication of the report on the Genesis Project[1], and subsequent work in the Spectrum Planning Group of the Government's Digital Action Plan. This identified that channels 31 to 40 and 63 to 68 could be cleared (released) of broadcast use, whilst leaving three of the four main analogue channels at each site[2] as available for use by the broadcasters for DTT at switchover. The UK DTT DSO planning developed along the lines proposed in the Genesis Project and the Digital Action Plan culminating in an agreed and co-ordinated plan at the ITU conference in Geneva in 2006. As part of this plan, channels 61 and 62 were allocated to broadcast services, Figure 1.

At the World Radio Conference (WRC) held in Geneva in 2007 mobile services were granted co-primary status with broadcast services in UHF channels 61 to 69, the WRC2007 recommendation being subsequently ratified by the EC in 2007[3]. This decision means that UK plans for spectrum release are potentially out of line with harmonised use of channels 61 to 69 across Europe. Presently, channels 61 and 62 are assigned to broadcasters for use at 228 of the 1154 broadcast sites, which includes 23 of the 80 main sites.

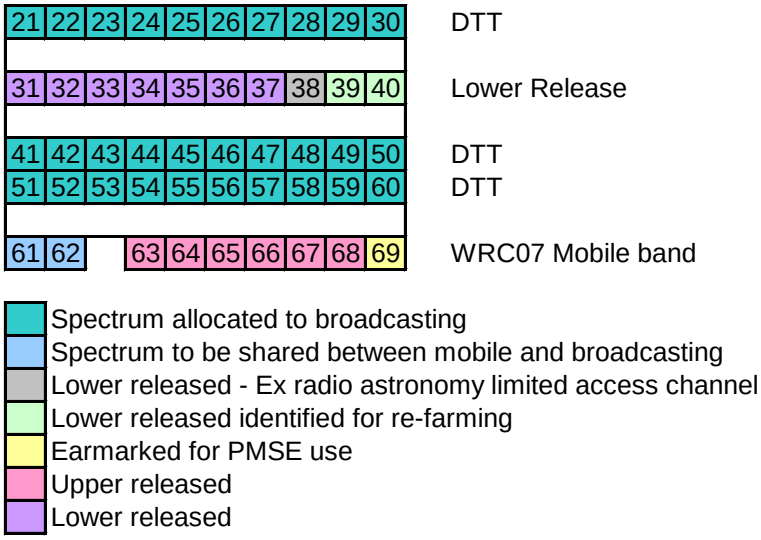

Figure 1 : UHF channel plan

[1] Genesis Project carried out for the ITC (now part of Ofcom) by ntl (now Arqiva) looked at different ways of accommodating broadcasting and releasing spectrum post DSO.

[2] It should be noted that at some sites all four main analogue channels stayed in spectrum retained for use by DTT and at some sites only two channels remained in retained spectrum.

[3] The European Commission has issued a mandate to the CEPT to harmonise use of channels 61 to 69 across Europe for mobile applications.

Ofcom recognise this misalignment and to give the mobile community access to these channels, it is has been proposed in Ofcom's consultation on released spectrum[4] to include channels 61 and 62 as part of the released spectrum auction.

However, as it is recognised that broadcast use of these channels is incompatible with mobile usage their value to the mobile community is limited. To make better use of the spectrum it has been suggested that the broadcast services on channels 61 and 62 should be cleared; re-farmed to another part of the UHF spectrum.

Re-allocating these channels into spectrum retained by the broadcasters (ch21 – 30 and ch41 - 60) is considered impractical as it is anticipated that such a change would result in significant re-planning of the network and would cause a loss of coverage. An alternative approach, aimed at maintaining broadcast coverage, is to take two channels from lower released spectrum for broadcast use in exchange for channels 61 and 62.

The lower released spectrum, channels 31 to 40, not having been harmonised for use by mobile applications is generally viewed as being better suited to digital television applications. Of the available channels in the lower released block, channels 39 and 40 appear to be the most attractive for use in a re-farming exercise. These channels are adjacent to ch38 which because of restrictions to protect radio astronomy is seen as suited to PMSE or similar low power applications and as such would form a guard band between ch39 and any application in ch37. Another factor in favour of the use of channels 39 and 40 as part of a re-farming exercise is that compared with other lower released channels they would minimise the changes required to viewers' receive aerials and the transmit infrastructure.

To assess the potential for re-farming channels 61 and 62 Ofcom have asked Arqiva to investigate three possible scenarios.

1. Single Step – a direct systematic move of channels 61 and 62 to channels 39 and 40.

2. Two Step – a systematic move of channels 61 and 62 to an intermediate pair of channels and then a systematic move of the intermediate channels to channels 39 and 40. The approach being designed to minimise the number of domestic aerials being moved out of group.

3. Hybrid – a more flexible approach based on the two step method allowing greater freedom as to the choice of channels in any area to avoid interactions and keep receive aerials in group.

As any change has the potential to move channels outside of the receive range of viewers receive aerials, Ofcom requested that Arqiva assess coverage not only to ideal receive aerials but also to grouped receive aerials.

This report summarises the findings of the work carried out by Arqiva. It includes an assessment of the coverage of the three plans based on the use of ideal receive aerials and to grouped aerials.

[4] Ofcom consultation on released Spectrum, Digital Dividend Review: 550 – 630MHz and 790 -854 MHz, published 6 June 2008.

3 METHODOLOGY

In order to keep the exercise of assessing the impact of any re-farming manageable only the 80 primary stations are considered, all other UK stations are ignored both as wanted and interfering sources.

Modelling of coverage has been carried out using the UKPM, with Irish and Continental interference being based on the European TVD file dated the 14 April 08 and UK station characteristics being based on the v5.7 DSO plan. Compared with a full v5.7 plan run PSB coverage will be lower as about 1060 relay stations are omitted. COM coverage will be slightly higher as omission of the PSB relays reduces the level of interference to COM services.

For the purpose of this exercise it has been assumed that the antenna pattern of the transmit antenna on its new channels is the same as that of the channel that has been replaced.

To provide a bench mark to assess the effect of changes the coverage of the UK 80 site network was calculated prior to any re-channelling exercise. This base run has then been used to assess the impact of re-farming channels.

For the single step approach, other than the order based on minimising Continental interaction, channels 61 and 62 were replaced with channels 39 and 40 in a systematic manner. Such an approach can result in both domestic receive aerials and transmit aerials being moved out of group (outside of their operating frequency range).

For the two step approach to keep viewers receive aerials in-group, channels 61 and 62 are replaced with two intermediate channels chosen from channels 47[5], 48, 49, 50, 51 and 52; this being step one. This group of channels are in the overlap region between receive aerial group C/D (the aerial group channels 61 and 62 occupy) and group B (the receive aerial group covering channels 39 and 40), Figure 2. As such moving viewers from channels 61 and 62 to these channels will not put them outside their aerial group. The next step, step 2, replaces stations on the two intermediate channels with channels 39 and 40. Again viewers on these channels, with a few exceptions caused by the systematic application of the rules, should not be moved outside their aerial group.

The hybrid approach is a development of the two step that recognises that although the UK plan is based on standard channel groups, along the South and East coasts to align with Continental channel usage non-standard channels are used[6]. This use of non-standard groups means that any systematic approach fails to avoid Continental interactions and keep receive aerials in group. The Hybrid approach, not being systematic, allows more flexibility in channel choice allowing planners to stay in-group and thus avoid major Continental and Irish interactions.

Calculations based on UKPM methodology indicate the effect on coverage channel changes have as a result of different interference patterns. To assess the impact of moving out of

[5] Though channel 47 is outside the specified range of group C/D receive aerials it is sufficiently close as not to significantly compromise coverage. It was included in the study to assess if there was any benefit offered by the flexibility of choosing from a slightly wider selection of channels.

[6] The Irish plan is based on a similar approach to the UK and they use standard channel groups. On the Continent little attempt has been made to keep channels in standard groups, as such the UK has had to select channels to fit as best they could with the Continental plans.

group the coverage calculations have been re-calculated using grouped receive aerials, aerial group having been assigned on the basis of the Post-DSO channel usage.

Estimation of the number of viewers that may require new receive aerials as a result of going out of group is necessarily simplistic, and generally represents the worst case. No account can be taken, as figures are not available, of viewers in areas that have services out of group, particularly existing DTT, that may have upgraded their aerial systems.

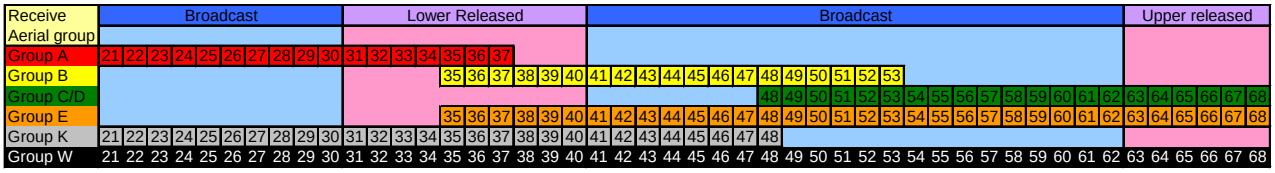

Figure 2: UK receive aerial groups

4 RESULTS

Coverage runs have been completed for the three scenarios with both wideband and grouped receive aerials. Appendices 1 to 3 show the loss and gain of the scenarios compared with the 80 site base run. Appendix 6 summarises the overall coverage of each multiplex.

5 DISCUSSION

Keeping the same available bandwidth for broadcasting by exchanging channels 61 and 62 for channels 39 and 40 should ideally maintain coverage. This would indeed be the case if the UK were isolated from its neighbours. However, as the UK is not isolated from Ireland or the Continent any changes to the UK GE-06 plan inevitably result in some incompatibilities between the UK and its neighbours; these incompatibilities showing up as a loss in coverage.

Of the three approaches for re-farming studied, though the one step and two step systematic approaches are appealing because of their simplicity, they do however,

- Result in a loss in coverage
- Have what are arguably major international incompatibilities at Dover and Limavady
- Take viewers out of group

The third approach (the hybrid method) has shown that, with careful choice of channels, incompatibilities and the associated loss in coverage can be minimised whilst keeping viewers in group. In this assessment a major incompatibility has been taken as being a clash between a UK main station and an Irish or Continental main station or allotment entered in GE-06.

However, regardless of the apparent success of the re-channelling exercise, it should be noted that any re-channelling exercise can not be carried out in isolation. As such, though this study is useful in highlighting what can be done and the implications within the UK in respect of transmission infrastructure re-engineering and domestic receive aerial replacement, without factoring in possible changes in our neighbours' plans to achieve a similar release of spectrum (channels 61 to 69) it only represents a partial picture.

Changes to the plan would require agreement with our neighbours, in itself a time consuming process. If the UK, Ireland and the Continent decide to go down the route of clearing spectrum the planning process is likely to last some time, potentially years. As such it puts it close to the end, or just after the end of DSO.

Though it may appear beneficial to implement any re-farming during the course of DSO, scope for this is limited. DSO planning is well advanced with equipment being ordered for regions up to and including London and Meridian. Any changes to regions up to and including London and Meridian may introduce delays and additional costs to the DSO process. Of the DSO regions possibly only Tyne-Tees and Ulster, scheduled for late 2012, offer an opportunity for change. In addition to equipment and installation issues, changes to the frequency plan to be implemented during DSO could alter and increase the number of cases of transitional interference in what is already a highly complex roll-out plan. It should also be noted that the impact of the changes on the viability of re-broadcast links (RBLs) has not yet been checked, and the changes to the plan could affect upgrades to RBLs that are being proposed as part of DSO implementation.

Though consideration of the transmit infrastructure is made this is on the basis of discussions with antenna and transmitter engineers. As in many cases the DSO systems have yet to be designed and installed, or where they already exist have not been tested on the channels proposed. Arqiva Network Access and Managed Transmission Services should be consulted as to the actual implications to transmit infrastructure.

5.1 Option 1: Single Step

The option of moving directly from channels 61 and 62 to 39 and 40, whilst straight forward has consequences with respect to international co-ordination, reception on domestic aerials and transmitter infrastructure. Details of the coverage achieved are provided in Appendix 1 and are summarised in Table 1. The major impact to the network occurs at Dover, due to the Flemish allotment in West Flanders, and Limavady, due to the Irish station at Moville.

	Base	Base %	Single Step	Single Step %	Difference	Diff %
PSB1	25161747	95.75%	25188505	95.85%	26758	0.10%
PSB2	25150044	95.70%	25118645	95.58%	-31399	-0.12%
PSB3	25134134	95.64%	25121887	95.60%	-12247	-0.05%
COM4	24422698	92.94%	24424490	92.94%	1792	0.01%
COM5	24376916	92.76%	24363819	92.71%	-13097	-0.05%
COM6	24441188	93.01%	24363030	92.71%	-78158	-0.30%
3Core	24945983	94.93%	24889500	94.71%	-56483	-0.21%
6Core	23904262	90.96%	23775353	90.47%	-128909	-0.49%

Table 1 : Single Step coverage compared with Base coverage.

5.1.1 International co-ordination

Irrespective of the order, a move of channels 61 and 62 to channels 39 and 40 at Dover and Limavady is incompatible with Flemish Belgian and Irish use of channels 39 and 40. This shows up as an area of loss around both Dover and Limavady.

Moving Dover ch62 to either ch39 or 40, clashes with the Flemish Belgian allotments in West Flanders that border the North Sea. Belgium is assigned channels 39 and 40 in the GE-06 plan.

A change at Limavady clashes directly with the Irish station at Moville. Moville which is assigned channels 39 and 40 in the GE-06 plan is some 6km from Limavady on the other side of Lough Foyle.

Other interactions with the Continent and Ireland result in a lower impact to UK coverage, Tables 2, 3 & 4. In most cases stations have an existing interaction so co-ordination could be argued on the basis of equalisation of interference. Where an interaction doesn't exist the interference potential from another co-ordinated station could be used in some cases.

UK Station & channel	French Station	Comment
Dover ch61 → 39	Dieppe	Existing interaction on ch50
Midhurst ch61 → 39	Dieppe	Existing interaction on ch50
	Abbeville	Existing interaction on ch55, 58
	Caen	New interaction, South Downs provide some protection, use interference potential from Hannington
	Cap de La Hague	Existing interaction on ch61 which is exchanged with ch39
	Cherbourg Oct.	Existing interaction on ch55
	Brest	Existing interaction on ch55 and ch61
Midhurst ch62 → 40	Rouen	New interaction, South Downs provide some protection
	Cap de La Hague	Existing interaction on ch58 and 61
Mendip ch61 → 39	Cap de La Hague	Existing interaction on ch58 and 61
	Caen	New interaction, use interference potential from Hannington
Bluebell Hill ch61→ 39	Dieppe	New interaction, terrain should provide a degree of protection

Table 2 : The lesser interactions between UK Main stations and France

UK Station & channel	Irish Station	Comment
Limavady ch62 → 40	Moville	Incompatible
Limavady ch61 → 39	Moville	Incompatible
Winter Hill ch62 → 40	Cairn Hill	New Interaction, use interference potential from Llanddona
Winter Hill ch61 → 39	Mount Leinster	New Interaction

Table 3 : The lesser interactions between UK Main stations and Ireland

UK Station & channel	Belgian Allotment	Comment
Dover ch61 → 39	West Flanders	Incompatible
Tacolneston ch62→40	West Flanders	Existing interaction on ch65
Bluebell Hill ch61→ 39	West Flanders	Existing interaction on ch40, 43, 46, 65

Table 4 : The lesser interactions between UK Main stations and Belgium

Note: PSB channels are highlighted in red

5.1.2 Domestic aerials

Of the 23 affected sites, the move from channels 61 and 62 to channels 39 and 40 will put the re-farmed services outside the receive aerial group at 17 sites. Understanding how many households such a change will effect is not straight forward. Basing the number affected on the population served by a station and making some allowance for new aerials that have been installed for existing DTT, indicates that approximately 4.5 million homes may need to change their receive aerials, details are provided in Appendix 4.

5.1.3 Transmitter Infrastructure

The actual changes required to the transmission infrastructure as a result of a direct switch to channels 39 and 40 should be confirmed with Arqiva Network Access and Managed Transmission Services.

It is thought that only three sites (highlighted in green) will accept the channel changes without modification to the antenna systems, Table 5.

It should be assumed that at all sites new combiner modules will be required.

It is anticipated that at all sites it should be possible to re-tune the transmitters.

No assessment has been made on the viability of the RBL network.

In this study, the Continental and Irish use of spectrum is unchanged and based on their GE-06 position. Thus no consideration has been given to potential transmitter infrastructure changes that may be required to obtain international coordination e.g. new restrictions in antennas.

Station	Change	Main Antenna Compatible	Reserve Antenna Compatible
Hemel Hempstead	62 → 40	Yes	Yes
Brierley Hill	62 → 40	No - Cardioid would require changing	N/A
Malvern	62 → 40	No - Cardioid would require changing	N/A
Winter Hill	62 → 40 61 → 39	No – 12 panel around array pattern unlikely to be satisfactory operating this far off the design frequency	No – reserve is the same design as the main antenna
Keighley	61 → 39	No - Cardioid would require changing	N/A
Salisbury	62 → 40	No - Cardioid would require changing	N/A
Pontop Pike	62 → 40 61 → 39	Yes – cantilever antenna using broadband panels	No – reserve is a wrap around antenna pattern unlikely to be satisfactory operating this far off the design frequency
Mendip	61 → 39	Yes – cantilever antenna using broadband panels	No – reserve is a wrap around antenna pattern unlikely to be satisfactory operating this far off the design frequency
Waltham	61 → 39	Yes – cantilever antenna using broadband panels	Unknown – reserve is a wrap around designed to work at ch29 and upper Band V.
Dover	62 → 40	Unknown - Not yet designed	Unknown - Not yet designed
Tacolneston	62 → 40	Yes	Yes
Oxford	62 → 40	Yes – cantilever antenna using broadband panels	No – reserve is a wrap around antenna pattern unlikely to be satisfactory operating this far off the design frequency
Carmel	61 → 39	Yes – cantilever antenna using broadband panels	No – reserve is a wrap around antenna pattern unlikely to be satisfactory operating this far off the design frequency
Olivers Mount	61 → 39	No - Cardioid would require changing	N/A
Angus	61 → 39	Unknown	Unknown
Midhurst	62 → 40 61 → 39	Unknown	Unknown
Limavady	62 → 40 61 → 39	Unknown	Unknown
Plympton	61 → 39	No - Cardioid would require changing	N/A
Huntshaw Cross	62 → 40	Yes – cantilever antenna using broadband panels	No – reserve is a wrap around antenna pattern unlikely to be satisfactory operating this far off the design frequency
Rumster Forest	62 → 40	Yes – cantilever antenna using broadband panels	No – reserve is a wrap around antenna pattern unlikely to be satisfactory operating this far off the design frequency
Rosneath VP	61 → 39	No - Cardioid would require changing	N/A
Bluebell Hill	61 → 39	Yes	Yes
Selkirk	62 → 40	Yes – cantilever antenna using broadband panels	No – reserve is a wrap around antenna pattern unlikely to be satisfactory operating this far off the design frequency

Table 5 : Single Step transmit antenna consequentials

5.2 Option 2: Two Step

The two step approach is aimed at eliminating or at least minimising the number of viewers whose services would be put outside the grouping of their receive aerials. The premise of the approach is to use an intermediate pair of channels chosen from 47, 48, 49, 50, 51 and 52 that could be applied systematically across the country; ensuring that viewers stay in group. At stations already allocated the chosen channels, these would be replaced by channels 39 and 40. Though there are many ways (30) of allocating the channels, international considerations effectively limit us to a single choice.

For compatibility with Ireland and given channel usage at Dover the best solution is offered by moving channels 61 and 62 to channels 51 and 48 respectively. Stations already using channels 51 and 48 would be moved to channels 39 and 40 respectively. This approach whilst an improvement over the single step approach still results in use of channel 39 at Dover (exchanged for channel 51) which is considered incompatible with the Flemish Belgian allotment in West Flanders.

As part of the Two Step approach the 23 stations on channel 61 and/or channel 62 need to move to channels 51 and 48 respectively. The 14 stations that use channels 48 and/or 51 need to be moved to channels 40 and 39 respectively. Of these 14 stations, 4 are included in the list of 23 stations, i.e. a total of 33 of the 80 sites considered will require changes to the transmission infrastructure on a total of 48 channels.

To a large extent the two step approach fixes the problem with viewers being moved out of group. Following the changes four stations have channels out of group, Mendip, Dover, Whitehawk Hill and Huntshaw Cross.

Results of the coverage achieved are detailed in Appendix 2 and summarised in Table 6.

	Base	Base %	Two Step	Two Step %	Difference	Diff %
PSB1	25161747	95.75%	25206230	95.92%	44483	0.17%
PSB2	25150044	95.70%	25158104	95.73%	8060	0.03%
PSB3	25134134	95.64%	25066520	95.39%	-67614	-0.26%
COM4	24422698	92.94%	24400153	92.85%	-22545	-0.09%
COM5	24376916	92.76%	24352402	92.67%	-24514	-0.09%
COM6	24441188	93.01%	24397993	92.84%	-43195	-0.16%
3Core	24945983	94.93%	24898832	94.75%	-47151	-0.18%
6Core	23904262	90.96%	23825059	90.66%	-79203	-0.30%

Table 6 : Two Step coverage compared with Base coverage.

5.2.1 International co-ordination

Several iterations of the plan all came to the same conclusion that channel 48 is the best to use at Dover. Of the channels considered between 47 and 52, all are used in adjoining areas other than ch48.

Ch47 – One of the PSB channels at Sudbury, as such incompatible.

Ch48 – Assigned in GE-06 to Neufchatel and the Dutch allotment in Zeeland.

Ch49 – Assigned in GE-06 to the Flemish Belgian West Flanders allotment that borders the North Sea, as such incompatible.

Ch50 – Already in use at Dover

Ch51 – Already in use at Dover

Ch52 – Assigned in GE-06 to Dunkerque, as such incompatible.

With respect to Ireland the best channels to use appear to be channels 48 and 51 as Irish use is limited to the centre and west side of the country.

Using a systematic approach means that Dover channel 51 is assigned channel 39. Use of this channel at Dover is incompatible with the Flemish Belgian allotment in West Flanders.

Other interactions with the Continent and Ireland result in a lower impact to UK coverage, Tables 7 & 8. In most cases stations have an existing interaction so co-ordination could be argued on the basis of equalisation of interference. Where an interaction doesn't exist the interference potential from another co-ordinated station could be used in some cases.

UK Station & channel	French Station	Comment
Dover ch62 → 48	Neufchatel	A new interaction. The antenna pattern at Dover is expected to provide a degree of protection towards Neufchatel
Dover ch51 → 39	Dieppe	Existing interaction on ch50
	Abbeville	Existing interaction on ch55
Midhurst ch61 → 51	Rouen	New Interaction, use interference potential from re-allocated Dover ch51
	Montvilliers	Existing interaction on ch65, 58
Midhurst ch62 → 48	Neufchatel	Existing interaction on ch65
	Montvilliers	Existing interaction on ch65, 58
Bluebell Hill ch61→ 51	Rouen	Existing interaction on ch40
	Montvilliers	Existing interaction on ch65, 48
Mendip ch61 → 51	Rouen	Existing interaction on ch37 use interference potential from re-allocated Dover ch51
Mendip ch48 → 40	Cap de la Hague	Existing interaction on ch61, 58
	Rennes	Existing interaction on ch64
	Rouen	Existing interaction on ch37
Beacon Hill ch51→ 39	Brest	Existing interaction on ch60
	Cap de la Hague	New Interaction
	Caen	Existing interaction on ch42, 25, 63
Redruth ch48 → 40	Cap de la Hague	Existing interaction on ch39
	Rennes	New Interaction
	Surtainville	New Interaction
Whitehawk Hill ch51 → 39	Cap de la Hague	New Interaction
	Caen	Existing interaction on ch63
	Dieppe	Existing interaction on ch57, 60
	Abbeville	Existing interaction on ch57
Whitehawk Hill ch48 → 40	Cap de la Hague	New Interaction
	Rouen	Existing interaction on ch53

Table 7 : The lesser interactions between UK Main stations and France

UK Station & channel	Irish Station	Comment
Winter Hill ch62 → 48	Cairn Hill	New Interaction, use interference potential from Emley Moor and Moel-y-Parc
Winter Hill ch61 → 51	Cairn Hill	New Interaction, use interference potential from Emley Moor and Moel-y-Parc

Table 8 : The lesser interactions between UK Main stations and Ireland

Note: PSB channels are highlighted in red

5.2.2 Domestic aerials

Of the 33 sites where changes occur, 3 main stations Dover (ch39), Huntshaw Cross (ch40) and Mendip (ch40) and one relay, Whitehaven (ch39, 40) are allocated channels out of group. Basing the number of households affected on the population served within the APSA, approximately 1.1 million households would require changes to their receive aerials.

It should be noted that the majority of the affected viewers watch Mendip (~750k) which has a C5 analogue service on channel 37. Mendip viewers that have receive aerial systems that are able to receive the C5 service from Mendip would probably not need to change their receive system.

5.2.3 Transmitter Infrastructure

The actual changes required to the transmission infrastructure need to be confirmed with Arqiva Network Access and Managed Transmission Services.

It is thought that only five sites will not accept the channel changes without modification to the antenna systems, Table 9

It should be assumed that at all sites new combiner modules will be required.

It is anticipated that at all sites it should be possible to re-tune the transmitters.

No assessment has been made on the viability of the RBL network.

In this study, the Continental and Irish use of spectrum is unchanged and based on their GE-06 position. Thus no consideration has been given to potential transmitter infrastructure changes that may be required to obtain international coordination e.g. new restrictions in antennas.

Station	Change	Main Antenna Compatible	Reserve Antenna Compatible
Hemel Hempstead	62 → 48	Yes	Yes
Brierley Hill	62 → 48	Yes	N/A
Malvern	62 → 48	Yes	N/A
Winter Hill	62 → 48 61 → 51	Yes – 12 panel around array	Yes – reserve is the same design as the main antenna
Keighley	61 → 51	Yes	N/A
Salisbury	62 → 48	Yes	N/A
Pontop Pike	62 → 48 61 → 51	Yes – cantilever antenna using broadband panels	Yes – reserve is a wrap around
Mendip	61 → 51 48 → 40	Yes – cantilever antenna using broadband panels	No – reserve is a wrap around antenna pattern unlikely to be satisfactory operate this far off the design frequency
Waltham	61 → 51	Yes – cantilever antenna using broadband panels	Yes – reserve is a wrap around
Dover	62 → 48 51 → 39	Unknown - Not yet designed	Unknown - Not yet designed
Tacolneston	62 → 48	Yes	Yes
Oxford	62 → 48	Yes – cantilever antenna using broadband panels	Yes – reserve is a wrap around
Carmel	61 → 51	Yes – cantilever antenna using broadband panels	Yes – reserve is a wrap around
Olivers Mount	61 → 51	Yes	N/A
Angus	61 → 51	Unknown - Probably	Unknown – Probably
Midhurst	62 → 48 61 → 51	Unknown – Probably	Unknown – Probably
Limavady	62 → 48 61 → 51	Unknown – Probably	Unknown - Probably
Plympton	61 → 51	Yes	N/A
Huntshaw Cross	62 → 48 48 → 40	Yes – cantilever antenna using broadband panels	No – reserve is a wrap around antenna pattern unlikely to be satisfactory operate this far off the design frequency
Rumster Forest	62 → 48	Yes – cantilever antenna using broadband panels	Yes – reserve is a wrap around
Rosneath VP	61 → 51	Yes	N/A
Bluebell Hill	61 → 51 48 → 40	Yes	Yes
Selkirk	62 → 48	Yes – cantilever antenna using broadband panels	Yes – reserve is a wrap around
Guildford	48 → 40	Yes	N/A
Saddleworth	48 → 40 51 → 39	Yes	N/A
Emley Moor	48 → 40 51 → 39	Yes	Yes
Whitehawk Hill	48 → 40	Unknown	N/A

	51 → 39		
Nottingham	48 → 40 51 → 39	Unknown	N/A

Table 9 : Two Step transmit antenna consequentials

Station	Change	Main Antenna Compatible	Reserve Antenna Compatible
Sandy Heath	48 → 40 51 → 39	Yes	Yes
Hannington	51 → 39	Yes	Yes
Beacon Hill	51 → 39	Yes	Yes
Redruth	48 → 40 51 → 39	Yes	Yes
Moel-y-Parc	48 → 40 51 → 39	Yes	Yes

Table 9 : Two Step transmit antenna consequentials

Note: channel changes in green are a move from one GE-06 position to another GE-06 position. Such changes may be subject to restrictions, e.g. Redruth channel 39. PSB channels are highlighted in red

5.3 Option 3: Hybrid

The systematic approach of the Two Step method whilst simple to plan, results in some international incompatibilities and though it is an improvement on the One Step approach still results in a significant number of households potentially requiring a change to their receive aerials. The Hybrid approach is aimed at providing an optimal solution both in terms of transmitter infrastructure, coverage, international co-ordination and domestic receive aerials. To allow such a plan no channel changes are considered taboo. The only restriction to the approach being that a wholesale re-plan is not considered viable.

After several iterations running different re-farming scenarios, the best option with respect to coverage achieved and domestic aerial replacement was chosen; the plan requiring changes at 36 stations and to 44 channels. As such it affects 3 more stations than the Two Step method but results in 4 fewer channel changes.

The chosen solution keeps all domestic aerials in-group and is not expected to require any antenna re-engineering of the transmitter infrastructure, Table 13.

With respect to international co-ordination the solution avoids any major incompatibilities with Ireland and the Continent but, as with any changes to the GE-06 plan, will require negotiation.

Overall coverage of the PSB multiplexes improves slightly. The coverage of the COM multiplexes falls slightly, Table 12.

5.3.1 International co-ordination

As with the Two Step solution, the best solution appears to be based on the use of channel 48 at Dover and channels 48 and 51 at Winter Hill and Limavady with the consequent impact on the coverage of Winter Hill on channel 51 from Cairn Hill, Tables 10 & 11.

UK Station & channel	French Station	Comment
Dover ch62 → 48	Neufchatel	A new interaction. The antenna pattern at Dover is expected to provide a degree of protection towards Neufchatel
Midhurst ch61 → 51	Rouen	New Interaction, use interference potential from re-allocated Dover ch51
	Montvilliers	Existing interaction on ch65, 58
Midhurst ch62 → 48	Neufchatel	Existing interaction on ch65
	Montvilliers	Existing interaction on ch65, 58
Bluebell Hill ch48→ 39	Dieppe	New Interaction
	Caen	Existing interaction on ch45
Mendip ch61 → 51	Rouen	Existing interaction on ch37 use interference potential from re-allocated Dover ch51
Mendip ch48 → 40	Cap de la Hague	Existing interaction on ch61, 58
	Rennes	Existing interaction on ch64
	Rouen	Existing interaction on ch37
Beacon Hill ch51→ 40	Cap de la Hague	New Interaction – beam tilt may help
	Rennes	Existing interaction on ch60
	Rouen	Existing interaction on ch53

Table 10 : The lesser interactions between UK Main stations and France

UK Station & channel	Irish Station	Comment
Winter Hill ch62 → 48	Cairn Hill	New Interaction, use interference potential from Emley Moor and Moel-y-Parc
Winter Hill ch61 → 51	Cairn Hill	New Interaction, use interference potential from Emley Moor and Moel-y-Parc

Table11 : The lesser interactions between UK Main stations and Ireland

5.3.2 Domestic aerials

None of the planned changes result in domestic aerials being taken out of group.

	Base	Base %	Hybrid	Hybrid %	Difference	Diff %
PSB1	25161747	95.75%	25199416	95.89%	37669	0.14%
PSB2	25150044	95.70%	25157526	95.73%	7482	0.03%
PSB3	25134134	95.64%	25172386	95.79%	38252	0.15%
COM4	24422698	92.94%	24410370	92.89%	-12328	-0.05%
COM5	24376916	92.76%	24360149	92.70%	-16767	-0.06%
COM6	24441188	93.01%	24450666	93.04%	9478	0.04%
3Core	24945983	94.93%	24954224	94.96%	8241	0.03%
6Core	23904262	90.96%	23893276	90.92%	-10986	-0.04%

Table 12 : Hybrid coverage compared with Base coverage.

5.3.3 Transmitter Infrastructure

The actual changes required to the transmission infrastructure need to be confirmed with channels Arqiva Network Access and Managed Transmission Services.

It is believed that none of the 36 sites will require changes to the transmit antenna infrastructure, Table 13.

It should be assumed that at all sites new combiner modules will be required.

It is anticipated that at all sites it should be possible to re-tune the transmitters.

No assessment has been made on the viability of the RBL network, but as PSB coverage improves slightly it is expected that the viability of RBLs should broadly remain unchanged.

In this study, the Continental and Irish use of spectrum is unchanged and based on their GE-06 position. Thus no consideration has been given to potential transmitter infrastructure changes that may be required to obtain international coordination e.g. new restrictions in antennas.

Station	Change	Main Antenna Compatible	Reserve Antenna Compatible
Hemel Hempstead	62 → 50	Yes	Yes
Brierley Hill	62 → 50	Yes	N/A
Malvern	62 → 50	Yes	N/A
Winter Hill	62 → 48 61 → 51	Yes – 12 panel around array	Yes – reserve is the same design as the main antenna
Keighley	61 → 51	Yes	N/A
Salisbury	62 → 50	Yes	N/A
Pontop Pike	62 → 48 61 → 51	Yes – cantilever antenna using broadband panels	Yes – reserve is a wrap around
Mendip	61 → 51	Yes – cantilever antenna using broadband panels	Yes – reserve is a wrap around
Waltham	61 → 51	Yes – cantilever antenna using broadband panels	Yes – reserve is a wrap around
Dover	62 → 48	Unknown - Probably	Unknown – Probably
Tacolneston	62 → 49	Yes	Yes
Oxford	62 → 50	Yes – cantilever antenna using broadband panels	Yes – reserve is a wrap around
Carmel	61 → 48	Yes – cantilever antenna using broadband panels	Yes – reserve is a wrap around
Olivers Mount	61 → 51	Yes	N/A
Angus	61 → 51	Unknown - Probably	Unknown – Probably
Midhurst	62 → 48 61 → 51	Unknown – Probably	Unknown – Probably
Limavady	62 → 48 61 → 51	Unknown – Probably	Unknown – Probably
Plympton	61 → 49	Yes	N/A
Huntshaw Cross	62 → 50	Yes – cantilever antenna using broadband panels	Yes – reserve is a wrap around
Rumster Forest	62 → 48	Yes – cantilever antenna using broadband panels	Yes – reserve is a wrap around
Rosneath VP	61 → 51	Yes	N/A
Bluebell Hill	61 → 40 48 → 39	Yes	Yes
Selkirk	62 → 48	Yes – cantilever antenna using broadband panels	Yes – reserve is a wrap around
Guildford	48 → 40	Yes	N/A
Saddleworth	48 → 50 51 → 39	Yes	N/A
Emley Moor	48 → 50 51 → 39	Yes	Yes
Presely	50 → 40	Yes - cantilever antenna using broadband panels	Yes – reserve is a wrap around
Nottingham	51 → 39	Unknown - Probably	N/A

Table 13: Hybrid transmit antenna consequentials

Station	Change	Main Antenna Compatible	Reserve Antenna Compatible
Sandy Heath	51 → 39	Yes	Yes
Hannington	51 → 39	Yes	Yes
Beacon Hill	51 → 40	Yes	Yes
Sutton Coldfield	50 → 40	Yes	Yes
Moel-y-Parc	48 → 50 51 → 39	Yes	Yes
Llanddona	50 → 40	Yes	Yes
Bilsdale	50 → 40	Yes	Yes
Chesterfield	50 → 40	Unknown – Probably	N/A

Table 13: Hybrid transmit antenna consequentials

Note: channels highlighted in red are PSB. Channels in green move to a GE-06 position.

5.4 Grouped receive aerials

UKPM predictions assume the use of wideband aerials. At DSO viewers actual aerial installations, unless they have recently upgraded to receive existing DTT, are likely to be based on the analogue group. Post-DSO, PSB multiplexes will remain in-group but 24 of the 80 stations carrying COM services will have channels outside of the analogue aerial group. At these stations viewers may have to upgrade their existing aerials though it should be noted that at 17 of these sites, existing DTT is outside the analogue group

In assessing the impact to coverage caused by re-farming putting viewers' aerials out of group, it has been assumed that prior to any re-farming exercise that viewers will have upgraded to aerials suitable to cover the post-DSO channel grouping, see Appendix 4 Table A4-2.

5.4.1 The Single Step option

The loss due to aerials going out of group is shown in Table 14. The comparison here is between Single Step using a wideband receive aerial and Single Step using a grouped aerial. Such a comparison removes the effects of internal and Continental interference and illustrates just the loss due to a change in aerial group. Loss due to internal and Continental interference is been covered by the main analysis section 5.1.

Results V5.7 Straight Swap AG		3CORE	Chg on Straight Swap	%Chg on Straight Swap	6CORE	Chg on Straight Swap	%Chg on Straight Swap
10203	BRIERLEY HILL	140203	0	0.00%	127816	-414	-0.32%
10207	MALVERN	117802	0	0.00%	92882	-1175	-1.25%
10300	WINTER HILL	3059310	-3574	-0.12%	2982683	-5459	-0.18%
10407	KEIGHLEY	104089	-1019	-0.97%	84239	-321	-0.38%
10801	SALISBURY	36036	0	0.00%	32740	-235	-0.71%
10900	PONTOP PIKE	1104514	-1792	-0.16%	1070123	-800	-0.07%
11000	MENDIP	1352238	-6043	-0.44%	1264841	-8352	-0.66%
11300	DOVER	276683	0	0.00%	179675	-331	-0.18%
11700	OXFORD	566325	0	0.00%	442145	-1755	-0.40%
11900	CARMEL	156025	0	0.00%	101831	-477	-0.47%
12002	OLIVERS MOUNT	37008	0	0.00%	32018	-61	-0.19%
12300	ANGUS	421667	0	0.00%	371820	-7248	-1.91%
12500	MIDHURST	134850	-638	-0.47%	126041	-614	-0.48%
13000	LIMAVADY	20257	-96	-0.47%	10918	-338	-3.00%
13105	PLYMPTON	75167	-125	-0.17%	74908	-101	-0.13%
13800	HUNTSHAW CROSS	77548	-397	-0.51%	56320	-252	-0.45%
15211	ROSNEATH VP	245513	-6149	-2.44%	230356	-3197	-1.37%
15800	BLUEBELL HILL	1116408	0	0.00%	555681	-161	-0.03%
16100	SELKIRK	39600	-866	-2.14%	32737	-33	-0.10%

Table 14 : Single Step Plan Loss to Core Coverage because of the use of Aerial Group

The impact of moving channels 61 and 62 to channels 39 and 40 and taking viewers at affected stations out of group is not that great. The roll off in performance of a group C/D aerial at channels 39 and 40 is only 2dB, Appendix 5 Table A5-1. Using the loss of coverage due to a change in aerial group as a measure to identify the number of viewers that may

need to change their receive aerials provides a range of results. Looking at the impact to the gross core coverage of stations just under 40,000 (36,992) households are predicted as losing a service. An alternative measure is the predicted loss to the gross coverage of individual muxes at stations, which indicates that just under 245,000 (241,132) households lose coverage. The overall effect on national coverage, because of overlap in service areas is much smaller. The effect of viewers going out of group results in a loss to overall 6Core coverage of just 4,683 viewers and 3Core loss increases by 1,818 households.

5.4.2 The Two Step option

The loss due to aerials going out of group is shown in Table 15. The comparison here is between Two Step using a wideband receive aerial and Two Step using a grouped aerial. Such a comparison removes the effects of internal and Continental interference and illustrates just the loss due to a change in aerial group. Loss due to internal and Continental interference is been covered by the main analysis section 5.2.

Results V5.7 Systematic 2 Step		3CORE	Chg on Syst 2Step	%Chg on Syst 2Step	6CORE	Chg on Syst 2Step	%Chg on Syst 2Step
10203	BRIERLEY HILL	140203	0	0.00%	128060	-330	-0.26%
10207	MALVERN	117802	0	0.00%	94513	-738	-0.77%
10300	WINTER HILL	3088795	-1885	-0.06%	3035292	-676	-0.02%
10805	WHITEHAWK HILL	98780	-94	-0.10%	90888	0	0.00%
10900	PONTOP PIKE	1088911	0	0.00%	1062320	-144	-0.01%
11000	MENDIP	1415673	0	0.00%	1283446	-8328	-0.64%
11300	DOVER	217678	-385	-0.18%	191408	-215	-0.11%
11700	OXFORD	566325	0	0.00%	444506	-705	-0.16%
12500	MIDHURST	151235	0	0.00%	136584	-243	-0.18%
13000	LIMAVADY	73983	-121	-0.16%	67821	0	0.00%
13600	BEACON HILL	128581	0	0.00%	92108	-170	-0.18%
13800	HUNTSHAW CROSS	81548	-124	-0.15%	55555	-438	-0.78%
16100	SELKIRK	38337	-528	-1.36%	32724	-30	-0.09%

Table 15 : Two Step Plan Loss to Core Coverage because of Aerial Groups

The systematic Two Step approach, compared with the Single Step approach, reduces the number of viewers with aerials put out of group. Using the loss of coverage due to a change in aerial group as a measure to identify the number of viewers that may need to change their receive aerials provides a range of results. Looking at the impact to the gross core coverage of stations just under 15,000 (14,109) households are predicted as losing a service. An alternative measure is the predicted loss to the gross coverage of individual muxes at stations, which indicates that just under 115,000 (111,837) households lose coverage. The overall effect on national coverage, because of overlap in service areas is much smaller. The effect of viewers going out of group results in a loss to overall 6Core coverage of just 2,614 viewers and 3Core loss increases by 510 households.

5.4.3 Hybrid Plan

Though the hybrid plan doesn't put any channel out of group, the fact that the receive aerial response for channel 48 has a drop in gain of 1dB results in some households losing coverage, Table 16.

Results V5.7 Hybrid		3CORE	Chg on Hybrid Swap	%Chg on Hybrid Swap	6CORE	Chg on Hybrid Swap	%Chg on Hybrid Swap
10300	WINTER HILL	3080811	-4264	-0.14%	3029063	-1895	-0.06%
10805	WHITEHAWK HILL	138173	0	0.00%	117034	-27	-0.02%
10900	PONTOP PIKE	1096172	0	0.00%	1064416	-296	-0.03%
11000	MENDIP	1413184	0	0.00%	1292615	-6514	-0.50%
11300	DOVER	285163	0	0.00%	206397	-100	-0.05%
11900	CARMEL	156025	0	0.00%	99098	-493	-0.50%
12500	MIDHURST	154958	0	0.00%	122697	-356	-0.29%
13000	LIMAVADY	73982	-122	-0.16%	67821	0	0.00%
13800	HUNTSHAW CROSS	81564	0	0.00%	53990	-292	-0.54%
15800	BLUEBELL HILL	1116408	0	0.00%	503358	-540	-0.11%
16100	SELKIRK	38294	-569	-1.46%	32724	-30	-0.09%

Table 16 : Hybrid plan loss to Core Coverage because of the use of ch48

Using the loss of coverage due to a change in aerial group as a measure to identify the number of viewers that may need to change their receive aerials provides a range of results. Looking at the impact to the gross core coverage of stations just under 15,000 (13,573) households are predicted as losing a service. An alternative measure is the predicted loss to the gross coverage of individual muxes at stations, which indicates that just under 75,000 (73,338) households lose coverage. The overall effect on national coverage, because of overlap in service areas is much smaller. The effect of viewers going out of group results in a loss to overall 6Core coverage of just 1,839 viewers and 3Core loss increases by 458 households.

5.5 Filtering

The timing of any re-farming exercise will have an impact on the filtering required. Channel 39 is adjacent to Radio Astronomy in channel 38. Post 2012 Ofcom have indicated that Radio Astronomy use in channel 38 in the UK will cease and protection of this service in the UK will no longer be required. As such the UK will only have to protect Radio Astronomy services in the Netherlands. In this case subject to the location of the station it is likely that normal band edge filtering will suffice.

If channel 39 services were launched whilst channel 38 still required protection, services on channel 39 would be significantly restricted and would require expensive filtering. The restrictions on this channel, whilst radio astronomy operates in the UK, are expected to be such that coverage is unlikely to match that of other broadcast channels. This has not been investigated as part of this study.

With channel 60 becoming the new upper edge of the broadcast band services using this channel may require offsets and/or additional filtering to meet band edge requirements.

6 CONCLUSION

Of the three approaches investigated only the hybrid approach achieved the goal of keeping viewers in-group whilst probably requiring no transmit antenna infrastructure changes, Table 17.

The one step method based on a direct move of channels 61 and 62 to channels 39 and 40 results in a loss of coverage, changes to transmit infrastructure and potentially significant numbers of viewers requiring new receive aerials.

The two step method, moving channels 61 and 62 to an intermediate pair of channels 47, 48, 49, 50, 51 or 52, and then moving these intermediate channels to channels 39 and 40 resulted in fewer infrastructure changes and fewer viewers moving out of group. The method is not completely successful when applied rigidly because of the use of non standard groups in some areas of the UK, those adjoining the Continent and across the Continent.

Using the hybrid method, based on a more flexible application of the two step approach, channels 61 and 62 can be cleared with little impact to viewers and apparently without changes being required to the transmit antenna infrastructure.

It should be noted that assumptions about transmit infrastructure are based on the planners' best knowledge but, as in many cases the DSO antennas are not built or have not been tested on channels other than those proposed for DSO, to better understand the actual implications of re-farming channels Arqiva Network Access and Managed Transmission Services should be consulted.

	Change in overall coverage compared with base run			Antennas requiring modification					
				Main Stations					
Method	3Core	6Core	Domestic Aerials Retunes[7]	Main	Res.	Relay	Stations affected and Pop served	Channels affected	Major International Incompatibility
One Step	-56,483	-128,909	4.5 million	1	9	5	23 6837637	27	3
Two Step	-47,151	-79,203	1.1 million	0	3	2	33 10291132	48	1
Hybrid	+8,241	-10,986	0	0	0	0	36 11150319	44	0

Table 17: Summary of the three channel re-farming options

The analysis of the loss due to channels being moved out of aerial group has shown that overall loss is small. The worst case loss occurs for the single step option and is less than 6k households. However, the gross loss to individual multiplexes is greater at just under 250k households. These low numbers are explained by the fact that the performance of a group C/D receive aerial only rolls off by 2dB by channel 39.

[7] Retunes based on the number of viewers in the service areas of stations with channels moving out of group.

Though the timing of any re-farming exercise may at first sight be thought to be driven by the need to avoid disruption to the DSO timetable and the need to achieve agreement with our Irish and Continental neighbours, it will probably be driven by the need to protect Radio Astronomy. The re-farming plans considered are predicated on the use of channel 39. Whilst Radio Astronomy requires protection within the UK use of this channel will be restricted to the point that it will not be possible to replicate the coverage of re-farmed channels. As such any re-farming exercise based on the use of channel 39 should not start until radio Astronomy is cleared from channel 38.

APPENDIX 1 : SINGLE STEP

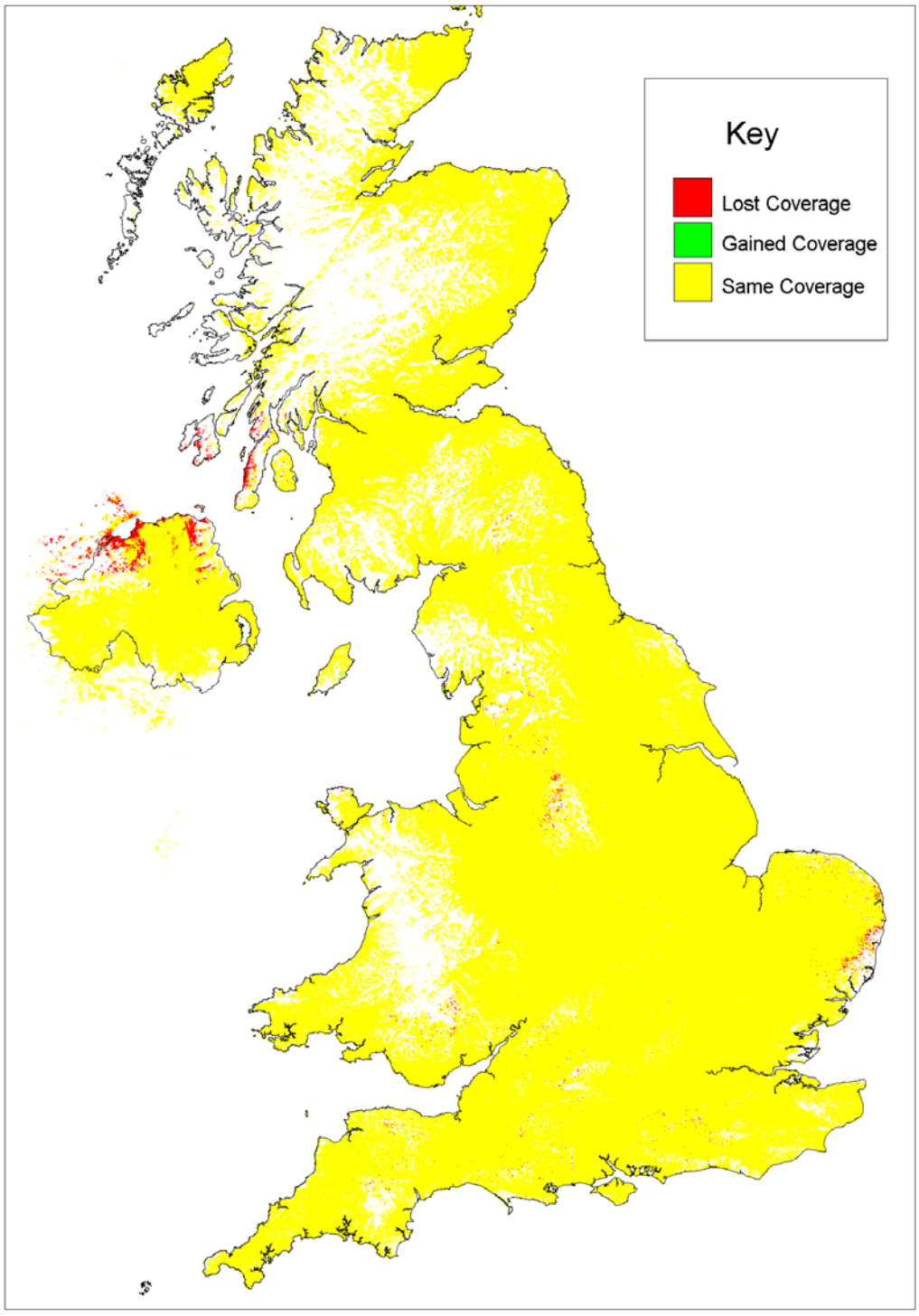

Figure A1-1 : Comparison between base run and the single step 3Core coverage

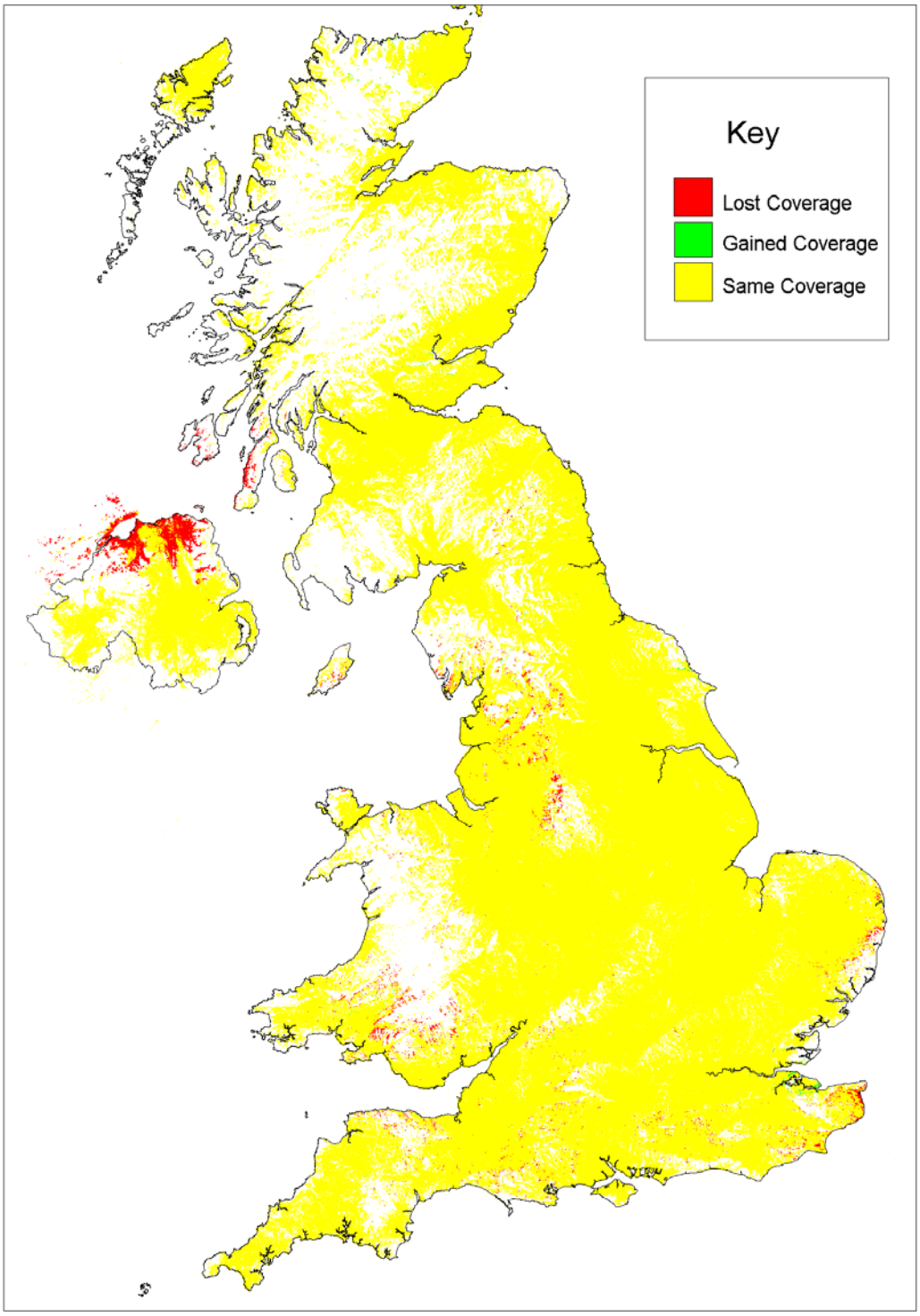

Figure A1-2 : Comparison between base run and the single step 6Core coverage

APPENDIX 2 : TWO STEP

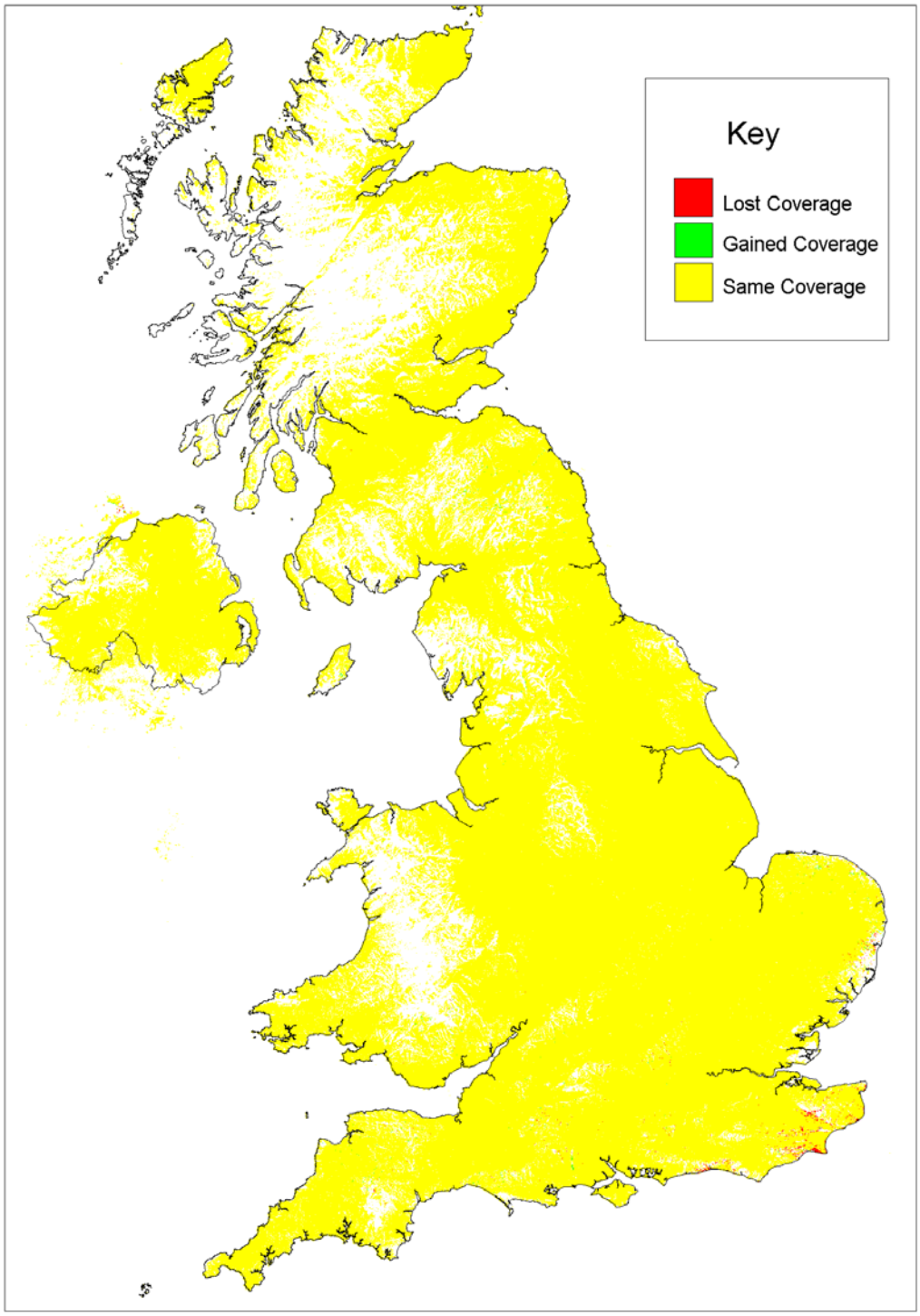

Figure A2-1 : Comparison between base run and two step 3Core coverage

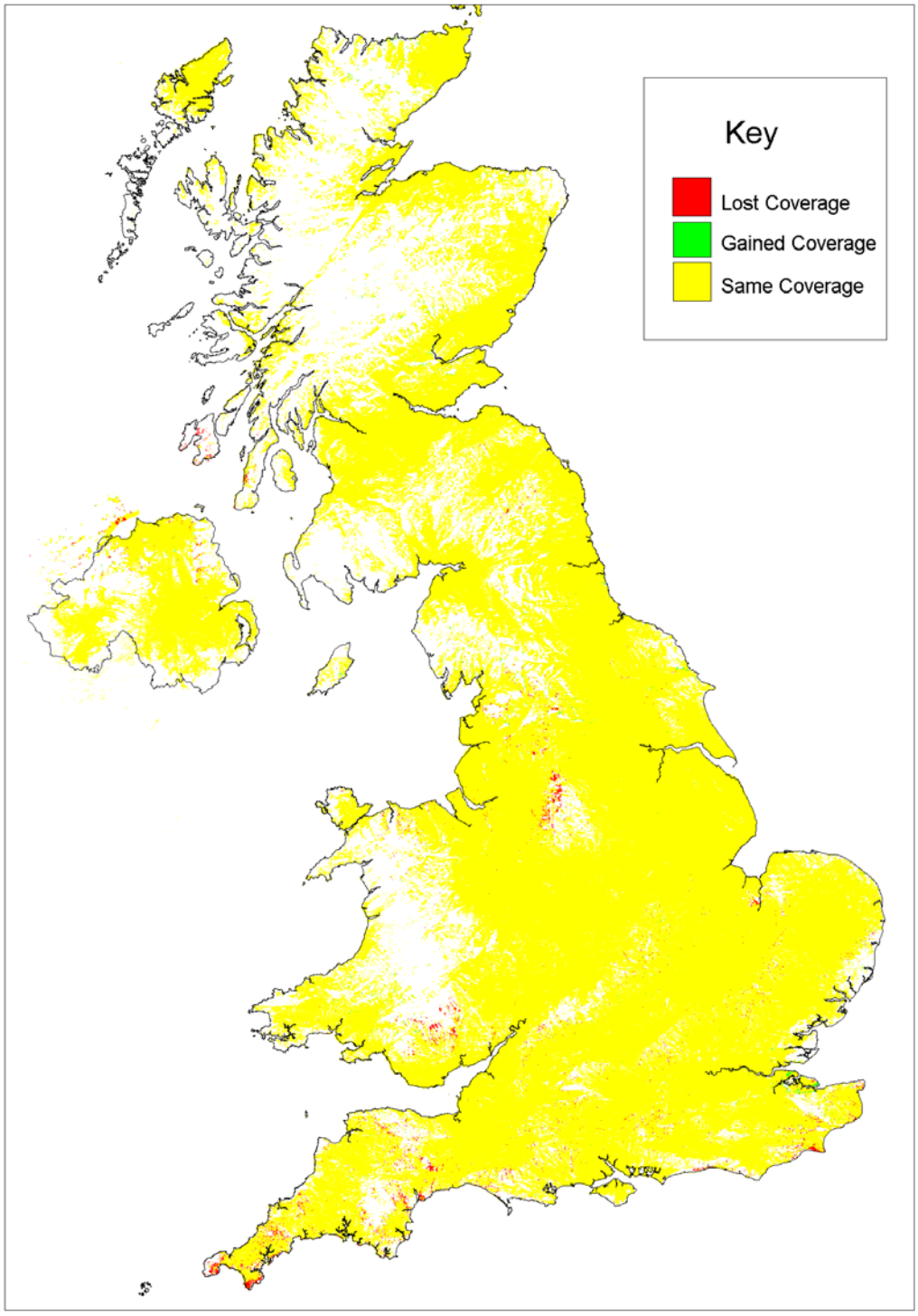

Figure A2-2 : Comparison between base run and two step 6Core coverage

APPENDIX 3 : HYBRID

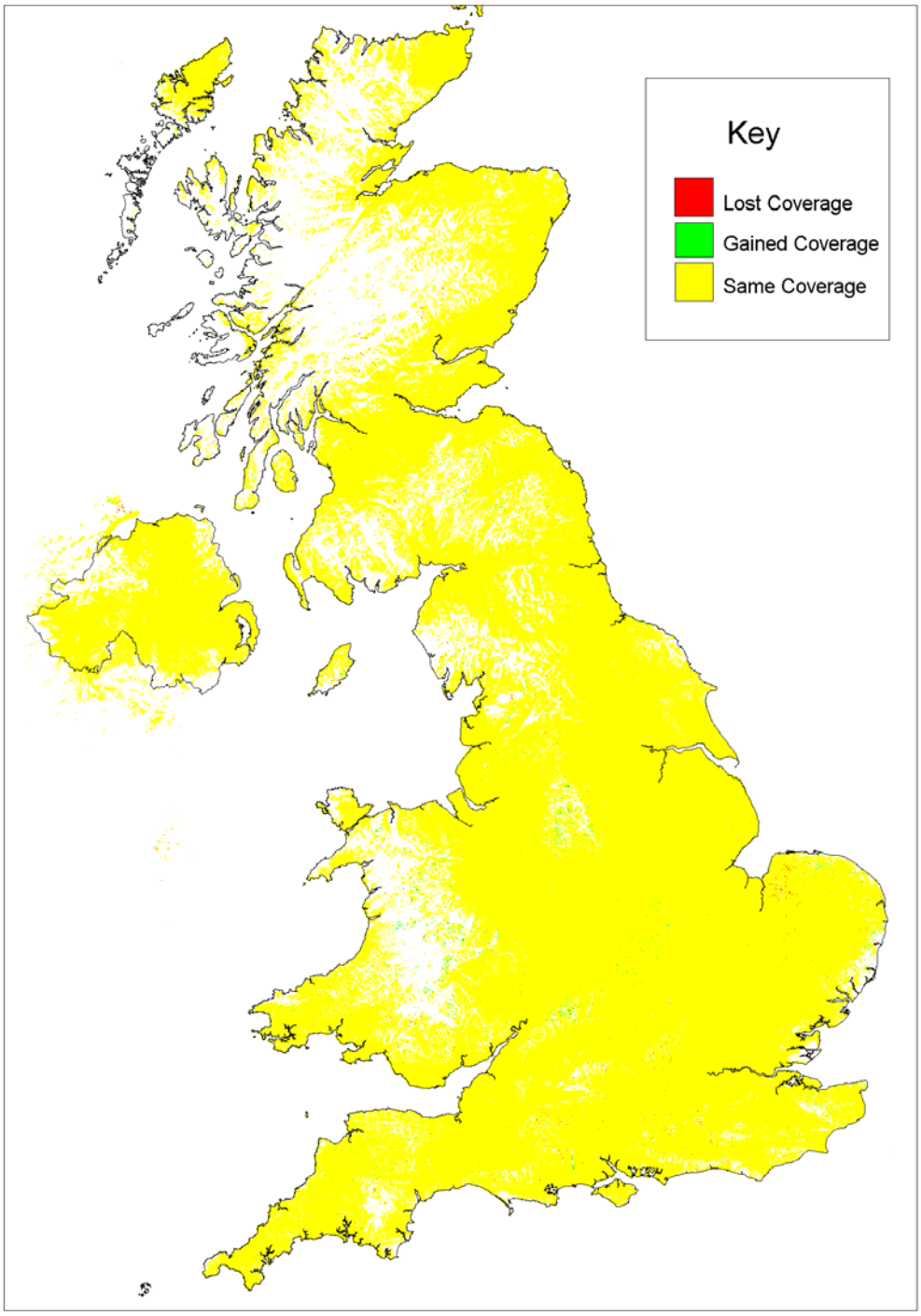

Figure A3-1 : Comparison between base run and Hybrid 3Core coverage

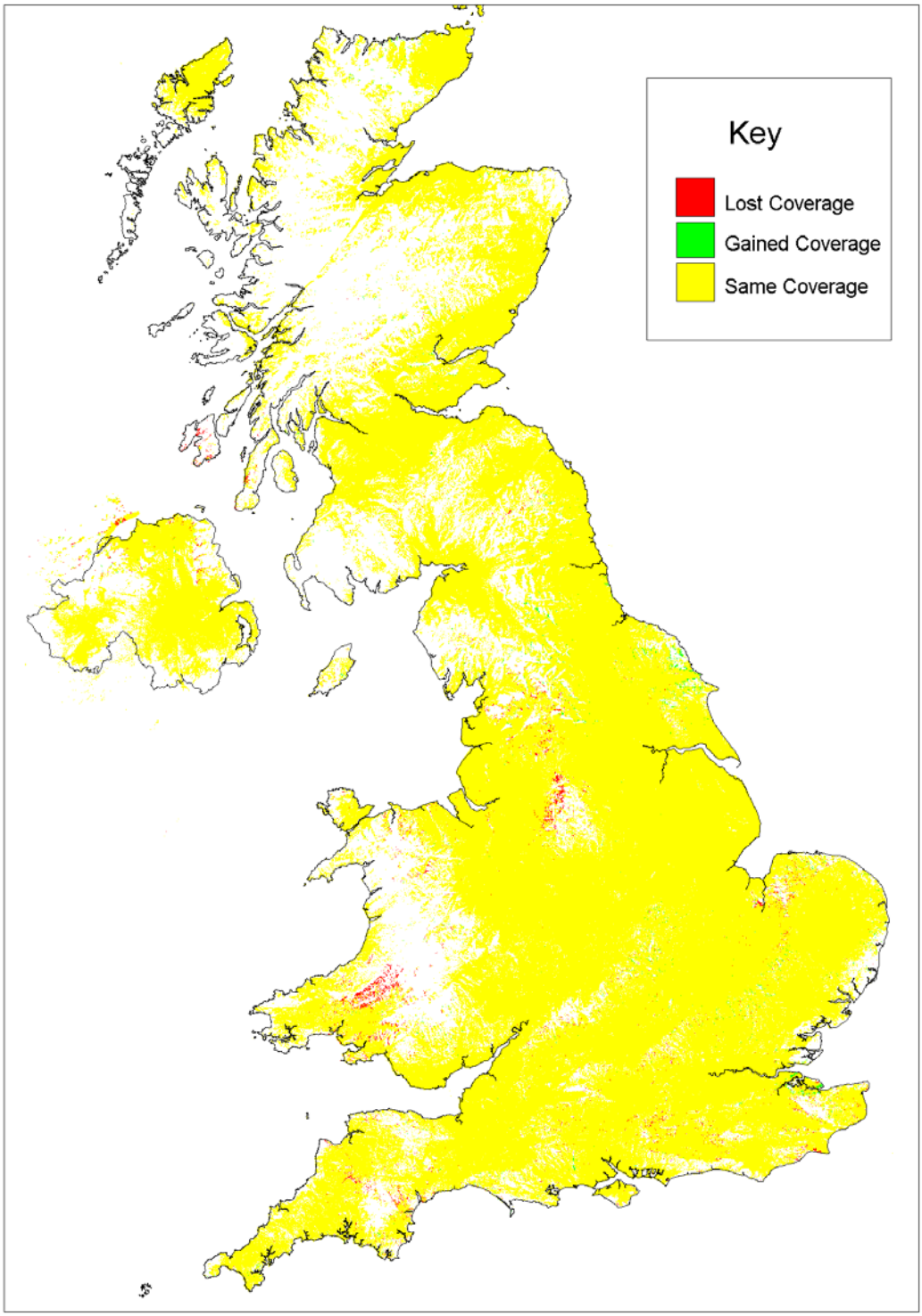

Figure A3-2 : Comparison between base run and Hybrid 6Core coverage

APPENDIX 4 : DOMESTIC AERIAL GROUPING

Re-farming of channels will affect viewers where the new channels are outside the receive aerial group. In order to estimate the number of viewers that may be affected by channel re-farming, the following methodology has been applied.

- If the re-farmed channels fall within the Post-DSO Group then it is considered that no viewers will be affected.

- If the re-farmed channels fall outside the Post-DSO Group but are inside the existing DTT group then assume that 50% of viewers watch DTT and that 50% of the DTT viewers will have upgraded their antennas. So, in such an area 25% of viewers will have suitable receive aerials.

For the case where channels 61 & 62 are directly re-farmed to channels 39 and 40, of the 23 stations affected viewers at 17 will need to change their aerials. At 6 of these, based on the above assumption, only 75% of the viewers will require to change their aerials. This gives an estimated total of 4.5 million homes that will require changes to their domestic aerials as a consequence of re-farming, Table A4 – 1.

Station	Ana	DTT	Post-DSO	DSO Channels	PSB pop in APSA	Prop.	Number requiring new ants
Hemel Hempstead	B	E	E	41,44,47,62,59,55	74,733	0.0	0
Brierley Hill	C/D	C/D	C/D	53,57,60,62,59,55	82,844	100.0	82,844
Malvern	C/D	E	C/D	53,57,60,62,59,55	57,799	75.0	43,349
Winter Hill	C/D	E	C/D	62,59,54,58,61,55	2,703,455	75.0	2,027,591
Keighley	C/D	W	C/D	54,58,61,57,53,60	33,977	75.0	25,482
Salisbury	C/D	C/D	C/D	57,60,53,62,59,55	30,737	100.0	30,737
Pontop Pike	C/D	C/D	C/D	54,58,61,62,59,55	697,388	100.0	697,388
Mendip	C/D	C/D	C/D	61,54,58,48,52,56	718,146	100.0	718,146
Waltham	C/D	W	W	54,61,58,29,56,57	761,450	0.0	0
Dover	C/D	E	C/D	50,53,51,55,59,62	195,227	75.0	146,420
Tacolneston	C/D	C/D	E	55,59,62,42,45,50	341,948	0.0	0
Oxford	C/D	W	C/D	53,57,60,62,59,55	405,295	75.0	303,971
Carmel	C/D	C/D	C/D	60,53,57,54,58,61	71,536	100.0	71,536
Olivers Mount	C/D	C/D	C/D	53,57,60,54,58,61	29,508	100.0	29,508
Angus	C/D	C/D	C/D	60,53,57,54,58,61	133,078	100.0	133,078
Midhurst	C/D	W	C/D	61,55,58,62,59,50	94,034	75.0	70,525
Limavady	C/D	C/D	C/D	55,62,59,54,58,61	45,024	100.0	45,024
Plympton	C/D	C/D	E	54,61,58,42,45,56	34,807	0.0	0
Huntshaw Cross	C/D	C/D	C/D	62,59,55,48,52,56	36,572	100.0	36,572
Rumster Forest	A	W	W	27,24,21,30,59,62	20,565	0.0	0
Rosneath VP	C/D	C/D	C/D	61,58,54,53,57,60	40,650	100.0	40,650
Bluebell Hill	E	W	E	43,54,46,45,48,61	204,520	0.0	0
Selkirk	C/D	C/D	C/D	62,59,55,57,53,60	24,344	100.0	24,344
						Total	4,527,167

Table A4-1 Population requiring aerial changes following re-farming ch61 & 62 directly to ch39 & 40.

Aerial group of the 80 main stations is listed in Table A4 – 2.

Station	Code	Ana. Group	DTT Group	Post-DSO Group	DSO Channels
Crystal Palace	CP	A	A	A	23,26,30,25,22,28
Guildford	*GI*	*B*	*B*	*E*	*43,46,49,48,52,56*
Reigate	*REI*	*C/D*	*W*	*W*	*53,57,60,21,24,27*
Tunbridge Wells	TW	B	E	B	49,52,47,42,44,41
Hemel Hempstead	*HH*	*B*	*E*	*E*	*41,44,47,62,59,55*
Sutton Coldfield	SC	B	B	B	43,46,50,42,45,49
Brierley Hill	BOF	C/D	C/D	C/D	53,57,60,62,59,55
Bromsgrove	*BGE*	*A*	*A*	*K*	*23,26,30,41,44,47*
Malvern	MVR	C/D	E	C/D	53,57,60,62,59,55
Lark Stoke	*LKK*	*A*	*W*	*K*	*23,26,30,41,44,47*
Fenton	FNT	A	A	A	21,24,27,25,22,28
Winter Hill	WRH	C/D	E	C/D	62,59,54,58,61,55
Pendle Forest	PLF	A	A	A	28,25,22,27,21,24
Saddleworth	SWH	B	B	B	45,49,42,51,52,48
Storeton	SEN	A	A	A	28,25,22,23,26,29
Lancaster	LCR	A	A	A	27,24,21,25,28,22
Emley Moor	MLM	B	B	B	41,44,47,51,52,48
Sheffield	*SF*	*A*[a]	*W*	*K*	*21,24,27,42,45,49*
Chesterfield	*CD*	*A*	*W*	*K*	*23,26,29,43,46,50*
Keighley	KJ	C/D	W	C/D	54,58,61,57,53,60
Idle	*IDL*	*A*	*W*	*K*	*21,24,27,42,45,49*
Black Hill	BKH	B	E	B	46,43,50,41,44,47
Torosay	TOY	A	A	A	28,25,22,23,26,29
Wenvoe	WV	B	W	B	41,44,47,42,45,49
Kilvey Hill	KVH	A	A	A	23,26,29,25,22,28
Aberdare	ABR	A	A	A	24,21,27,25,22,28
Pontypool	PPL	A	W	A	23,26,29,25,22,28
Divis	DIV	A	K	A	27,24,21,23,26,29
Rowridge	ROW	A	A	A	24,27,21,25,22,28
Salisbury	SA	C/D	C/D	C/D	57,60,53,62,59,55
Whitehawk Hill	WL	C/D	C/D	C/D	53,60,51,57,56,48
Rowridge VP	ROW	-	-	A	24,27,21,25,22,28
Pontop Pike	PP	C/D	C/D	C/D	54,58,61,62,59,55
Fenham	FNH	A[b]	W	A	21,24,27,25,22,28
Mendip	MEN	C/D[c]	C/D	C/D	61,54,58,48,52,56
Bristol Kings Weston	*BSK*	*B*	*K*	*E*	*43,50,46,53,57,60*
Bristol Ilchester Crescent	BSL	B	B	B	41,44,47,42,45,49

Table A4 - 2 : Receive aerial grouping for the 80 main sites

[a] Sheffield C5 uses ch67 so viewers may use a wideband aerial

[b] Fenham C5 uses ch56 so viewers may use a wideband aerial

[c] Mendip C5 uses ch37 so viewers may use a group E aerial

Station	Code	Ana Group	DTT Group	Post-DSO Group	DSO Channels
Waltham	*WBF*	*C/D*[d]	*W*	*W*	*54,61,58,29,56,57*
Nottingham	*NOU*	*A*	*W*	*K*	*21,24,27,51,52,48*
Durris	DUS	A[e]	W	A	28,25,22,23,26,29
Dover	DOV	C/D	E	C/D	50,53,51,55,59,62
Tacolneston	*TAC*	*C/D*	*C/D*	*E*	*55,59,62,42,45,50*
Sudbury	*SUY*	*B*	*E*	*E*	*41,44,47,58,60,56*
Bilsdale	*BIL*	*A*	*K*	*K*	*23,26,29,43,46,50*
Oxford	OF	C/D	W	C/D	53,57,60,62,59,55
Llanddona	*LLA*	*C/D*	*E*	*E*	*57,60,53,43,46,50*
Carmel	CRL	C/D	C/D	C/D	60,53,57,54,58,61
Belmont	*BMN*	*A*[f]	*W*	*W*	*22,25,28,30,53,60*
Olivers Mount	OMT	C/D	C/D	C/D	53,57,60,54,58,61
The Wrekin	*WRK*	*A*	*K*	*K*	*23,26,30,41,44,47*
Angus	AGU	C/D	C/D	C/D	60,53,57,54,58,61
Sandy Heath	*SDT*	*A*	*K*	*W*	*21,24,27,51,52,48*
Midhurst	MH	C/D	W	C/D	61,55,58,62,59,50
Hannington	HAN	E	E	B	42,45,51,41,44,47
Presely	PRS	B	B	B	43,46,50,42,45,49
Limavady	LTS	C/D	C/D	C/D	55,62,59,54,58,61
Caradon Hill	CNH	A	K	A	28,25,22,21,24,27
Plympton	*PTN*	*C/D*[g]	*C/D*	*E*	*54,61,58,42,45,56*
Stockland Hill	SDL	A	A	A	26,23,29,25,22,28
Keelylang Hill	KEE	B	B	B	46,43,50,42,45,49
Bressay	BRQ	A	W	A	28,25,22,27,24,21
Blaenplwyf	BY	A[h]	A	A	27,24,21,25,22,28
Beacon Hill	*BNL*	*C/D*	*C/D*	*E*	*60,53,57,42,45,51*
Caldbeck	CDK	A[i]	K	A	28,25,30,23,26,29
Huntshaw Cross	HC	C/D	C/D	C/D	62,59,55,48,52,56
Heathfield	*HJV*	*C/D*	*W*	*B*	*49,52,47,42,44,41*
Hastings	HS	A	W	A	22,25,28,23,26,30
Redruth	RR	B	B	B	44,41,47,48,52,51
Moel Y Parc	MYP	B	W	B	45,49,42,51,52,48
Craigkelly	*CGK*	*A*[j]	*K*	*K*	*27,24,21,42,45,49*
Rumster Forest	*RMF*	*A*[k]	*W*	*W*	*27,24,21,30,59,62*

Table A4 - 2 : Receive aerial grouping for the 80 main sites

[d] Waltham C5 uses ch35 so viewers may use a group E aerial

[e] Durris C5 uses ch67 so viewers may use a wideband aerial

[f] Belmont C5 uses ch56 so viewers may use a wideband aerial

[g] Plympton C5 uses ch30 so viewers may use a wideband aerial

[h] Blaenplwyf C5 uses ch56 so viewers may use a wideband aerial

[i] Caldbeck C5 uses ch56 so viewers may use a wideband aerial

[j] Craigkelly C5 uses ch48 so viewers may use a wideband aerial

[k] Rumster Forest C5 uses ch67 from Mount Eagle so viewers may use a wideband aerial

Station	Code	Ana Group	DTT Group	Post-DSO Group	DSO Channels
Ridge Hill	RHA	A	W	A	22,25,28,21,24,27
Brougher Mountain	BRM	A	A	A	22,28,25,21,24,27
Darvel	DVL	A	A	A	22,25,28,23,26,29
Rosneath VP	ROS	C/D	C/D	C/D	61,58,54,53,57,60
Knockmore	*KMR*	*A*	*W*	*W*	*26,23,29,53,57,60*
Eitshal	ETL	A	A	A	26,23,29,25,22,28
Chatton	CHN	B	B	B	42,45,49,41,44,47
Rosemarkie	RK	B	B	B	45,49,42,43,46,50
Bluebell Hill	BBL	E	W	E	43,54,46,45,48,61
Selkirk	SXJ	C/D	C/D	C/D	62,59,55,57,53,60

Table A4 - 2 : Receive aerial grouping for the 80 main sites

In table A4-2 highlighted stations use either channel 61 and/or channel 62. Stations in italics have a change in group between analogue and the group required to receive the final post-DSO 6 channels.

APPENDIX 5 : RECEIVE AERIAL PERFORMANCE

To assess the loss of coverage as a result of moving outside of the receive aerial group, account needs to be taken of the performance of receive aerials.

For planning purposes the UKPM assumes that the gain of a receive aerial system is 7dB. This is a somewhat idealised figure based on a good aerial and feeder and no pre-amplifier. The performance of actual receive installations is known to vary considerably from this ideal. Two studies, one for the Virgin consortium that bid for the Channel 5 licence in 1995 and the other for the ITC in 2004 investigated the actual received level for a large sample of domestic installations. This study considered aerial group but not the performance of actual receive installations.

In addition to variability in receive aerial system gain, most aerials are banded and their performance falls away outside their design operating band. The ITC as part of the documentation for the original DTT plan, Notes for applicants on coverage of Digital Television, October 1996, listed the out of group response of representative receive aerials. This table is provided below, Table A5 – 1.

	Attenuation dB						Attenuation dB						Attenuation dB					
Channel	Group A	Group B	Group C/D	Group E	Group K	Channel	Group A	Group B	Group C/D	Group E	Group K	Channel	Group A	Group B	Group C/D	Group E	Group K
21	0	19	16	14	0	**37**	2	2	4	2	0	**53**	21	0	0	0	8
22	0	17	18	12	0	**38**	8	1	3	1	0	**54**	20	1	0	0	15
23	0	15	20	10	0	**39**	15	0	2	1	0	**55**	19	2	0	0	16
24	0	13	22	8	0	**40**	16	0	2	0	0	**56**	19	4	0	0	17
25	0	11	24	7	0	**41**	17	0	2	0	0	**57**	19	6	0	0	18
26	0	9	25	6	0	**42**	18	0	2	0	0	**58**	19	8	0	0	19
27	0	7	26	5	0	**43**	19	0	2	0	0	**59**	19	10	0	0	20
28	0	5	28	4	0	**44**	20	0	2	0	0	**60**	19	16	0	0	21
29	0	4	29	3	0	**45**	21	0	1	0	0	**61**	19	17	0	0	22
30	0	3	30	2	0	**46**	22	0	1	0	0	**62**	19	18	0	0	23
31	0	3	25	2	0	**47**	23	0	1	0	0	**63**	19	18	0	0	23
32	0	3	20	2	0	**48**	23	0	1	0	0	**64**	19	19	0	0	23
33	0	3	15	2	0	**49**	23	0	0	0	2	**65**	19	20	0	0	22
34	0	3	12	2	0	**50**	22	0	0	0	8	**66**	19	20	0	0	22
35	0	3	9	2	0	**51**	22	0	0	0	15	**67**	19	21	0	0	21
36	0	2	6	2	0	**52**	21	0	0	0	16	**68**	19	22	0	0	21

Table A5 – 1 : ITC receive aerial out of group attenuation

APPENDIX 6 : OVERALL COVERAGE NUMBERS

National coverage of the various scenarios investigated, UK population is taken as 26,279,245 Households.

	PSB1	PSB2	PSB3	COM4	COM5	COM6	3PSB	6CORE	
Base Run	25161747	25150044	25134134	24422698	24376916	24441188	24945983	23904262	1
Single Step	25188505	25118645	25121887	24424490	24363819	24363030	24889500	23775353	2
Two Step	25206230	25158104	25066520	24400153	24352402	24397993	24898832	23825059	3
Hybrid	25199416	25157526	25172386	24410370	24360149	24450666	24954224	23893276	4
AG Base run	25161747	25150044	25134134	24030263	23966025	24130230	24945983	23335958	5
AG Single Step	25171225	25118599	25119894	24410212	24355274	24357992	24887682	23770670	6
AG Two Step	25199739	25157313	25066220	24385273	24352402	24397177	24898322	23822445	7
AG Hybrid	25193437	25156735	25172386	24401707	24360051	24449677	24953766	23891437	8

Table A6 – 1 : Overall coverage of the various options considered.

APPENDIX 7 : SCOPE AND DELIVERABLE

This initial exploratory study is based on the 80 main sites and is to consider the following:

- Single Step – direct move of ch61 and ch62 to ch39 and ch40 or vice versa depending on which option provides the least interaction with the Continent.

- Two Step – move ch61 and ch62 to the best pair of ch47, ch48, ch49, ch50, ch51 and ch52 – best in this case meaning the least Continental interaction and least number of domestic aerials being put out of group. The chosen channels then being moved to ch39 and ch40 the order being chosen to minimise Continental interaction.

- Hybrid – move ch61 and ch62 to any channels, allowing channel swaps between stations as well as use of ch39 and 40, to attempt to provide the best option with respect to domestic antenna re-tuning and Continental interaction.

For each scenario Arqiva is to provide Ofcom with:

- A commentary for each site, where applicable, on the consequences with regard to domestic aerial re-tuning, transmit and reserve antenna re-engineering and transmitter re-tuning.

- An indication of the number of households that will require domestic aerial upgrades taking into account the number of households on DSAT and cable. Consider both primary and secondary sets.

- Coverage to ideal antennas with maps based on the proposed modifications to the v5.7 plan and the current European TVD file. Note coverage will only be for 80 sites so a base run for the 80 sites pre-changes will be required to provide a comparison of losses and gains.

- Coverage to grouped antennas with maps based on the proposed modifications to the v5.7 plan and the current European TVD file using the Virgin study. The methodology adopted by Arqiva to be documented[8].

- A commentary on the impact on PSB coverage and any recommendations to restore PSB coverage if lost, such as channel re-ordering.

The study will not consider:

- The effect on the remaining 1000+ sites.

- RBL viability

- The consequences of Irish and European clearing of channels 61 to 69.

[8] Though originally part of the brief the coverage based on the Virgin study was not included as part of the final report.