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**Digital Switchover (DSO) Programme**

**Radio DSO Initial Investigations into  
optimisation of the frequency plan**

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**Document Reference:** Radio DSO investigations–1.0

**Release Date:** 31st May 2011

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## 1 Summary of initial investigations

A rigorous coverage assessment has been carried out for all 57 local multiplexes according to the Ofcom frequency plan of December 2010. The results of this assessment and that in general the plan works reasonably well except for a number of 'difficult' cases where the coverage due to co-block interference is less than optimal.

This document seeks to address these 'difficult' cases however it does not discuss or address issues such as changes to editorial areas, merging of multiplexes or the impact to international co-ordination. The solutions presented in this document are purely technical.

Four cases are presented in this document:

- Swindon on 11C
- Bournemouth on 11B
- Peterborough on 12D
- Leicester on 11B

It should be noted that this investigation shows that any changes made to the above multiplexes have significant consequences for a number of other multiplexes.

### Swindon 11C:

This allocation is very close geographically to South Hampshire, Cardiff and Newport and Birmingham. The consequence is that this multiplex affects the coverage of these multiplexes to varying degrees.

The coverage of Swindon itself is 'not great' due to incoming interference and the terrain in the Swindon area which is quite high and vulnerable to interference. The proposal is to extend the 10B allocation of West Wilts and Salisbury into Swindon editorial area and replace the use of 11C for the Swindon multiplex. The results of this investigation are detailed in section 2 of this document, but in summary it can be done but it would also be necessary to change the editorial boundary in the Oxford and Reading.

### Bournemouth 12A:

The coverage of Bournemouth on 11B is quite poor due to incoming interference from Sussex and Bath. There is also impact on Bath and the western part of the Sussex multiplexes due to Bournemouth. The proposal is to re-allocate Bournemouth to 12A. The impact of this change is minimal to London (Switch) and the regional multiplexes. The coverage is significantly improved. Due to the change this multiplex would require co-ordination with France.

In addition both Bath and Sussex coverage is improved and it may be possible to reduce the number of sites required in Sussex. Details of this proposal are in section 2.

### Peterborough 12D:

The coverage of Peterborough is quite poor and required a significant number of transmitters to 'fill' the editorial area. In addition outgoing interference was significant and reduced the coverage areas of Coventry and Southend (Essex) markedly.

The proposal is to extend the use of 11C Cambridge into Peterborough (making Peterborough an 11C allocation). This has a number of impacts:

11C: There is a degradation of South Yorkshire (mostly road coverage) but much of this is in an area of variable coverage with overlaps with Lincolnshire and Humberside. There is some reduction of the coverage in Birmingham (mitigated by the change at Swindon). There is minimal impact on all other 11C allocations.

12D: Significant improvement in Essex and Coventry; notable improvements to Stoke and Leeds and Reading & Basingstoke.

### Leicester 11B:

There is a significant impact on Norfolk and Wolverhampton from Leicester. Leicester itself has quite poor coverage particularly for roads. This is due to its geographic proximity and the terrain in the region. The proposal is replace 11B with 10C from Northamptonshire. Northamptonshire will use 10D and be combined with Herts Beds & Bucks.

11B: This removal of Leicester from 11B gives a very significant improvement to both Norfolk and Wolverhampton (particularly Norfolk). Small improvements are also noted for Bath. There is minimal impact on other 11B allocations.

10D: This change only affects Humberside to any degree and its impact is relatively small. All other allocations are unaffected.

The coverage of the combined Northamptonshire/HBB is very good.

Figure 1.0 below shows Ofcom proposed block allocation plan:



## 2 Assessment of the difficult areas

### 2.1 Swindon

It is proposed to replace 11C with 10B by extending West Wilts and Salisbury. This gives a reasonable coverage however there are still issues with coverage in the east and northern parts of the editorial area. To make the 10B allotment (which includes Swindon) it is proposed that:

- Reading & Basingstoke editorial area to be extended to the west to include all areas to the east of the A338 from the junction of the A303 to Swindon. This will entail re-allocating Ogbourne St George and Marlborough to Reading, withdrawing Tidworth from West Wilts & Salisbury and withdrawing Membury from Swindon. In addition Bampton Castle S should be removed from Swindon (already allocated in Oxfordshire).

Figure 2.1.1 shows the case 4 from the current Ofcom plan for 11C Swindon. Figure 2.1.2 is the case 4 for the current 10B West Wilts and Salisbury. Figure 2.1.3 shows the combined Swindon and West Wilts & Salisbury on 10B and figure 2.1.4 shows a composite of combined Swindon and West Wilts & Salisbury plus the modified Reading & Basingstoke. Figure 2.1.5 shows the extended Reading & Basingstoke using two sites from the original 10B plan for West Wilts & Salisbury. Figure 2.1.6 shows the case 4 coverage for Oxfordshire and finally 2.1.7 shows the case 4 coverage for Reading & Basingstoke without any additional transmitters.

A summary of all changes and improvements for 11C multiplexes is given in section 2.3 (table 2.3.1) of this document.

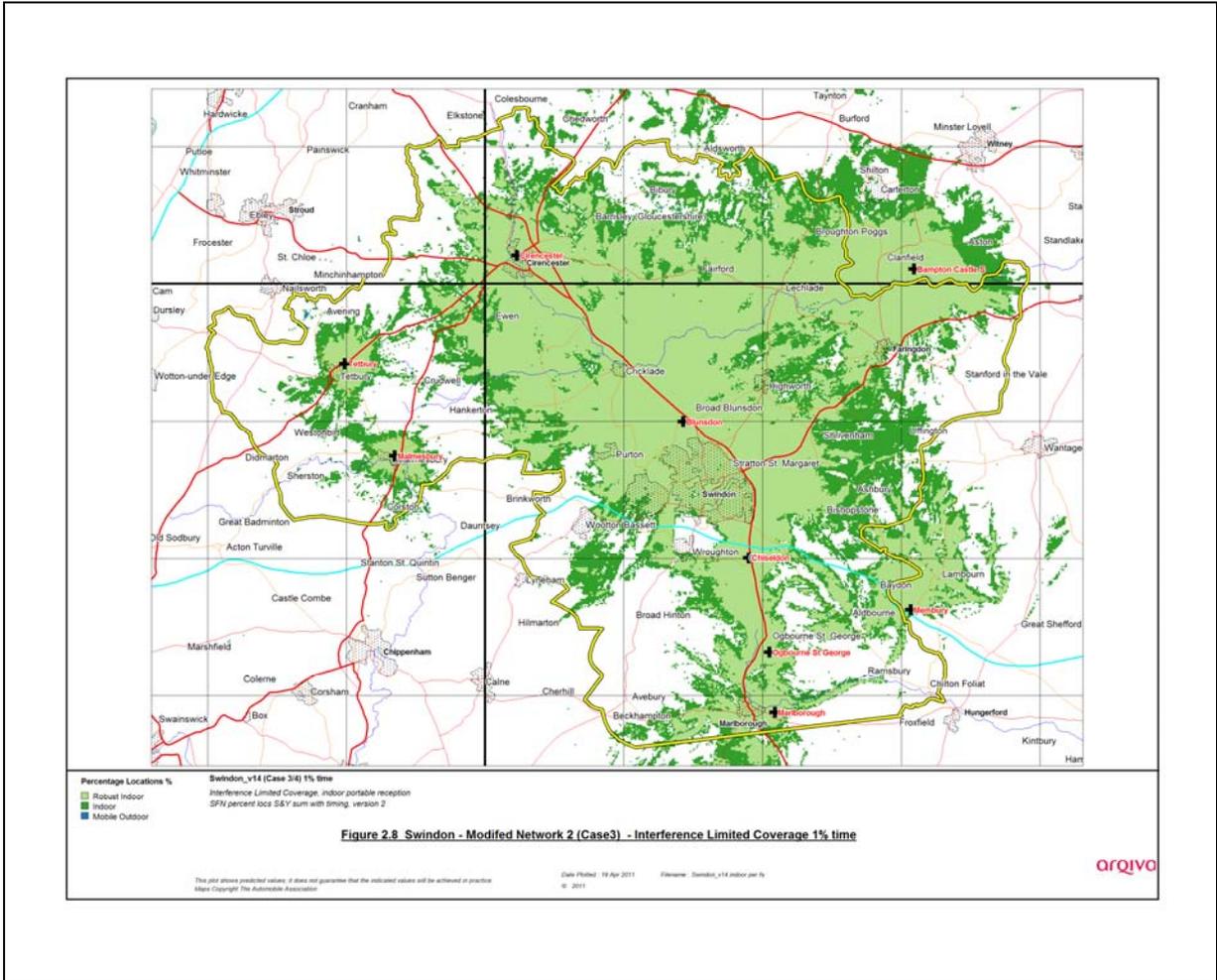


Figure 2.1.1: Swindon 11C Case 4

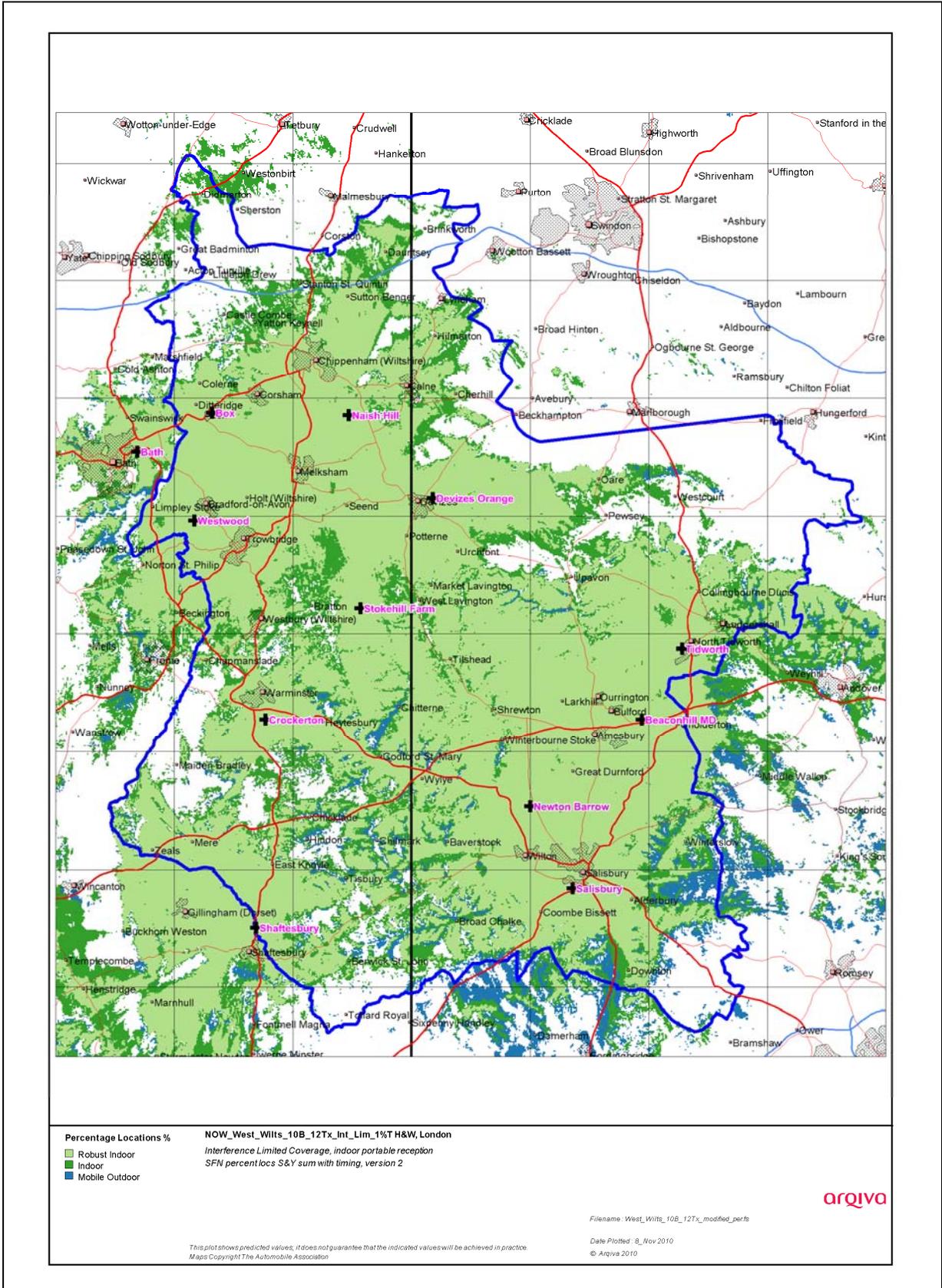


Figure 2.1.2: West Wilts & Salisbury 10B Case 4

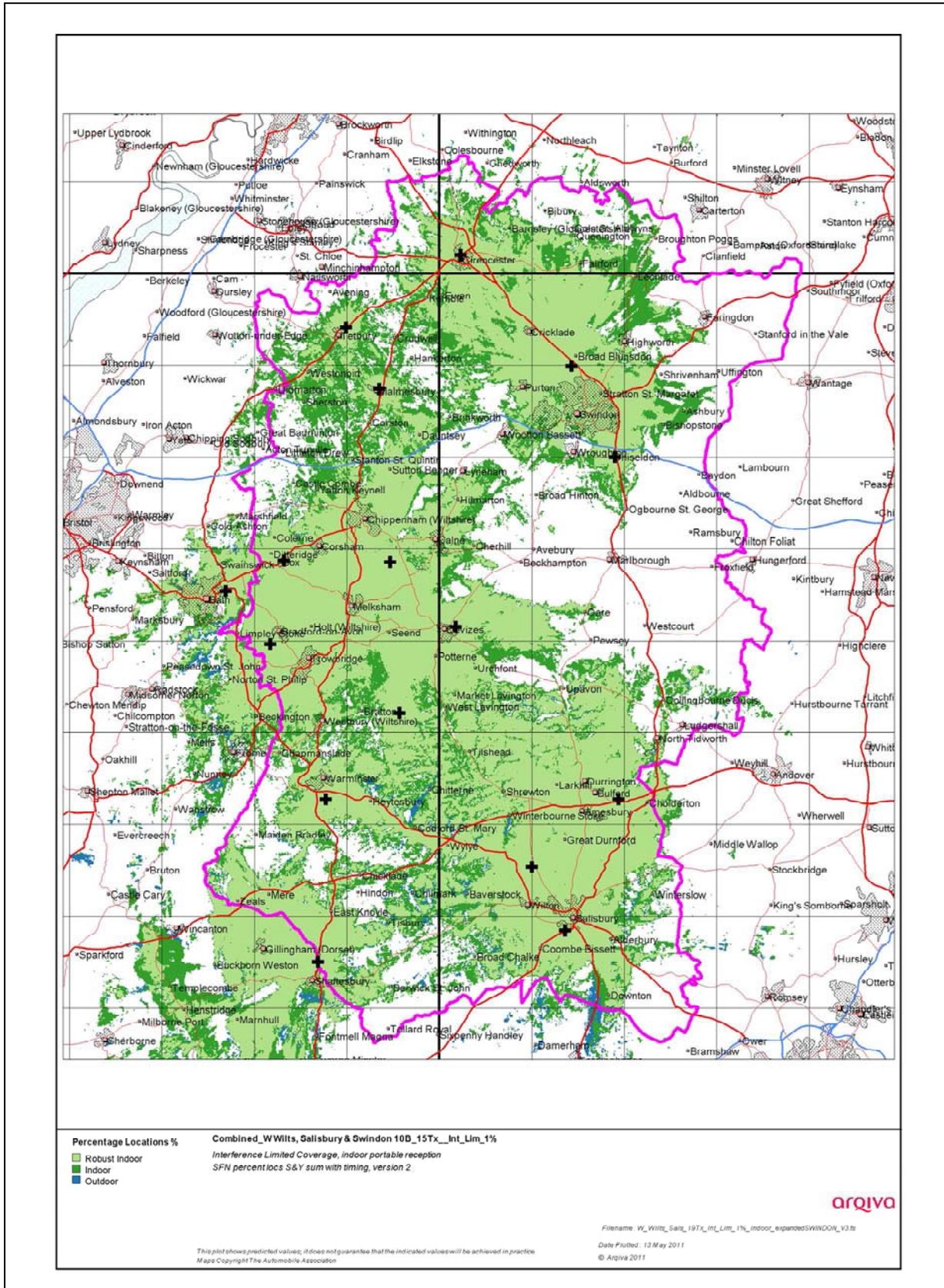


Figure 2.1.3: West Wilts & Salisbury plus Swindon 10B

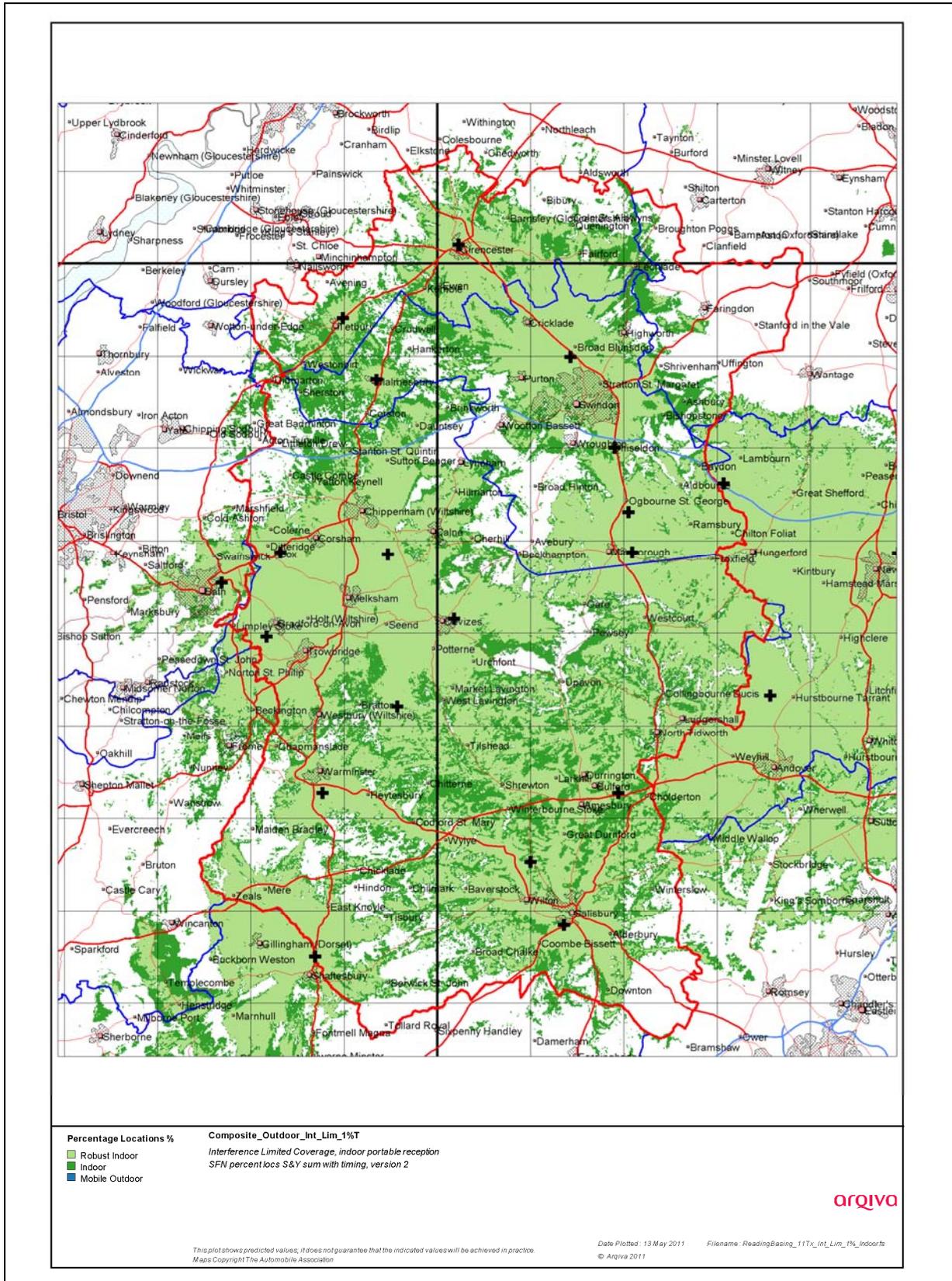


Figure 2.1.4: Composite of West Wilts & Salisbury plus Salisbury & Extended Reading and Basingstoke

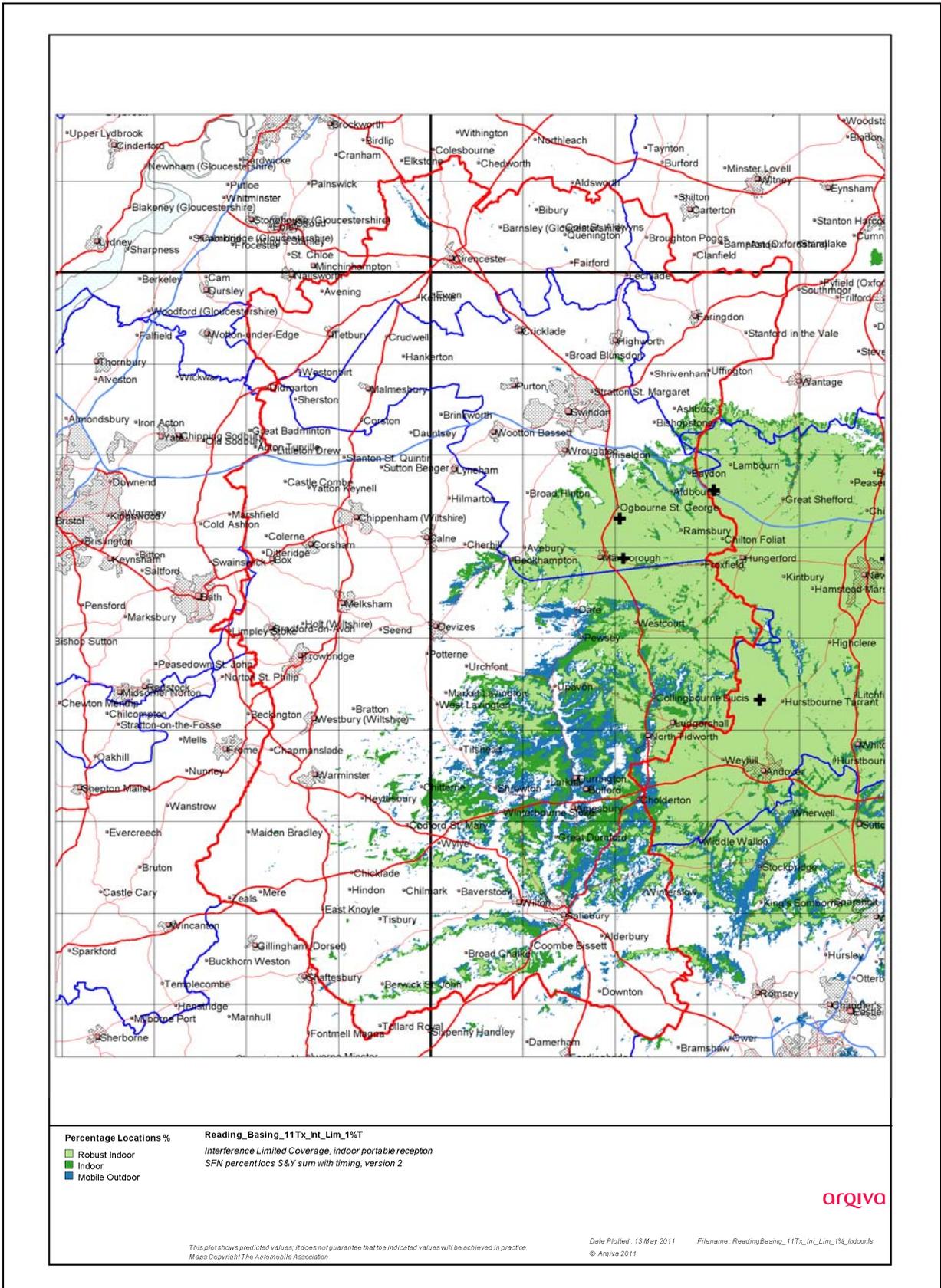


Figure 2.1.5: Extended Reading & Basingstoke on 12D

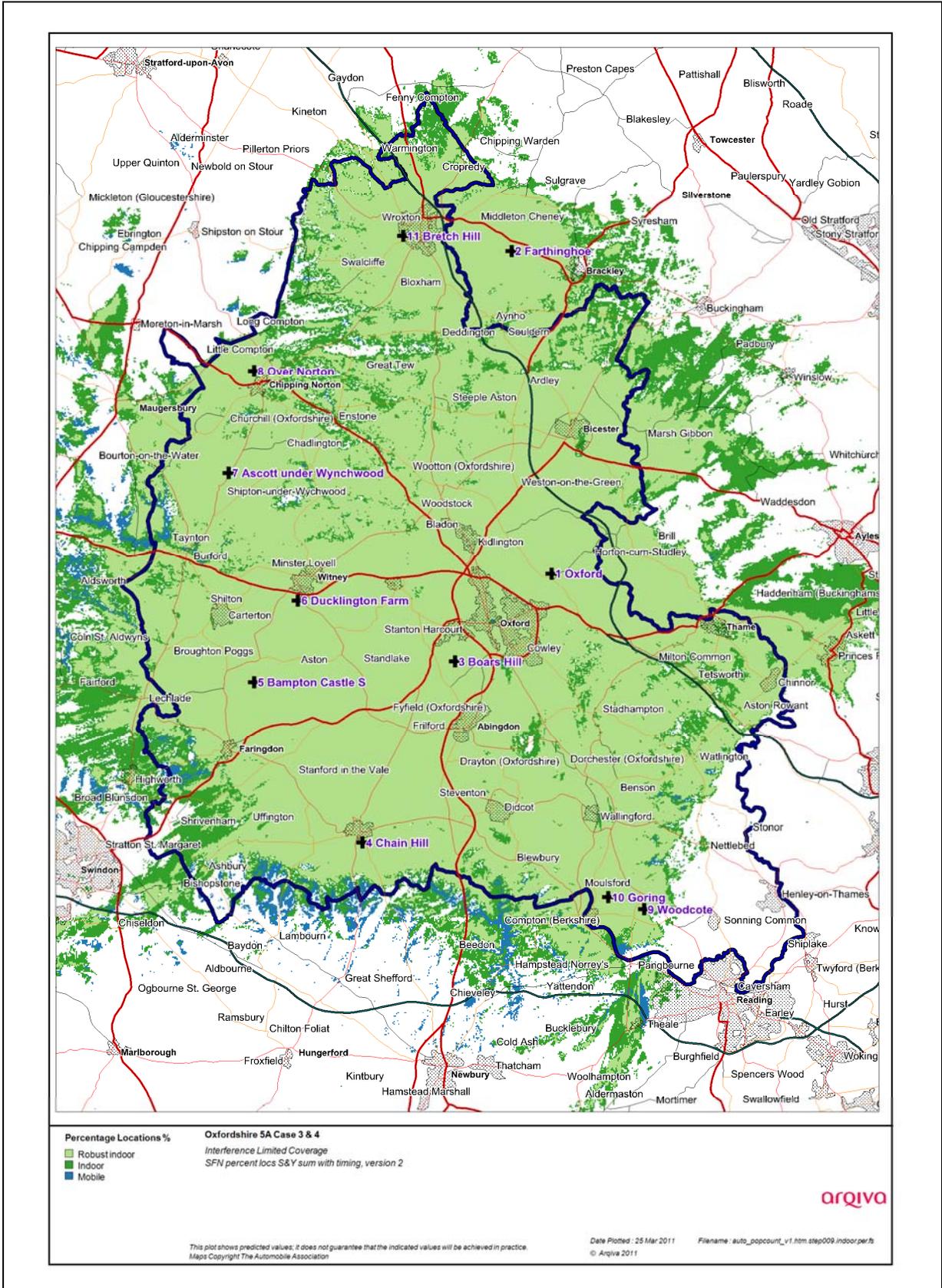


Figure 2.1.6: Oxfordshire 5A Case 4

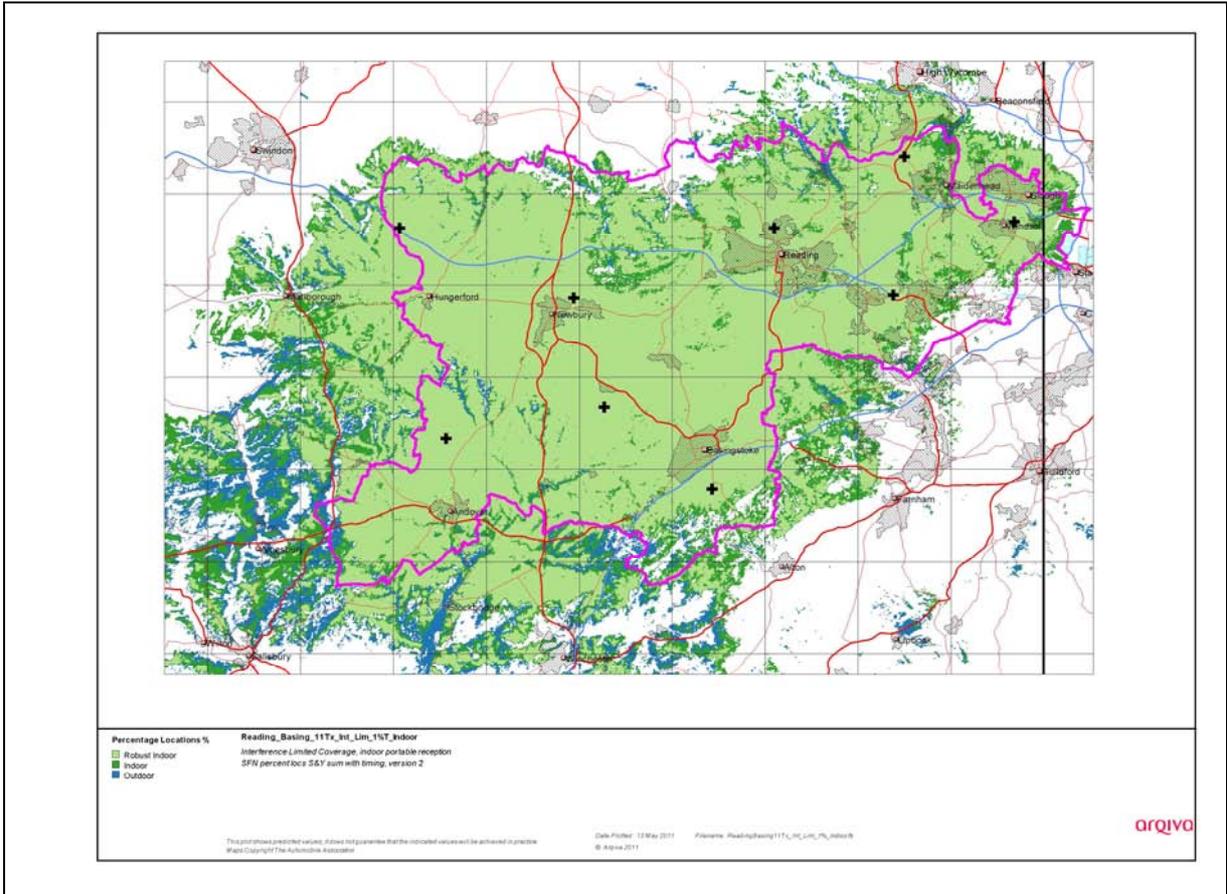


Figure 2.1.7: Reading & Basingstoke 12D Case 4

Table 2-1. Population coverage proportional indoor 1% time interference

Total Swindon : 143,661

Total West Wilts &amp; Salisbury: 177,926

Total Combined: 321,059

Site scenario	Interference limited coverage within editorial area	Percentage of editorial area
Swindon case 4 11C	125,468	87.34%
West Wilts & Salisbury 10B	159,437	89.6%
Combined West & Salisbury 10B plus Swindon 11C	284,905	88.7%
Combined West & Salisbury plus Swindon 10B	267,635	*83.36%

Table 2-2. Road coverage proportional indoor 1% time interference

Total Swindon : 332km

Total West Wilts &amp; Salisbury: 690km

Total Combined: 954km

Site scenario	Interference limited coverage road coverage within editorial area	Percentage of roads within editorial area
Swindon case 4 11C	178km	53.57%
West Wilts & Salisbury 10B	498km	72.12%
Combined West & Salisbury 10B plus Swindon 11C	676km	70.80%
Combined West & Salisbury plus Swindon 10B	544km	* 57.04%

\*Note the combined figures for 10B of Swindon and West Wilts do not include any population or road coverage proposed from Reading & Basingstoke and Oxfordshire. This solution also removes three transmitters. It may also be possible to remove a further two transmitters if a road test is carried out. If these overlapping coverage's are included the population and more particularly road coverage would improve significantly. In summary whilst the coverage allocated to the extended 10B goes down this is compensated for changes to Reading & Basingstoke and potentially saving 3-5 transmitters.

## 2.2 Bournemouth

The proposal is to replace 11B with 12A. There is no significant impact on London (Switch) or any of the regional multiplexes. The case 4 coverage on 11B is shown in figure 2.2.1 the coverage of Bournemouth for the same case 4 transmitters is shown in figure 2.2.2.

The removal of Bournemouth from 11B results in a gain of coverage for Sussex of ~1% indoor and ~4.5% roads and for Bristol & Bath it is ~2% indoor and ~9.3% roads. As part of this review document Leicester is planned to move away from block 11B, giving a further improvement in road coverage for Bristol & Bath of ~0.4%. Note this is a major re-allocation and will have an impact on France and therefore will have to be negotiated with France, France does not have to accept this change of allocation.

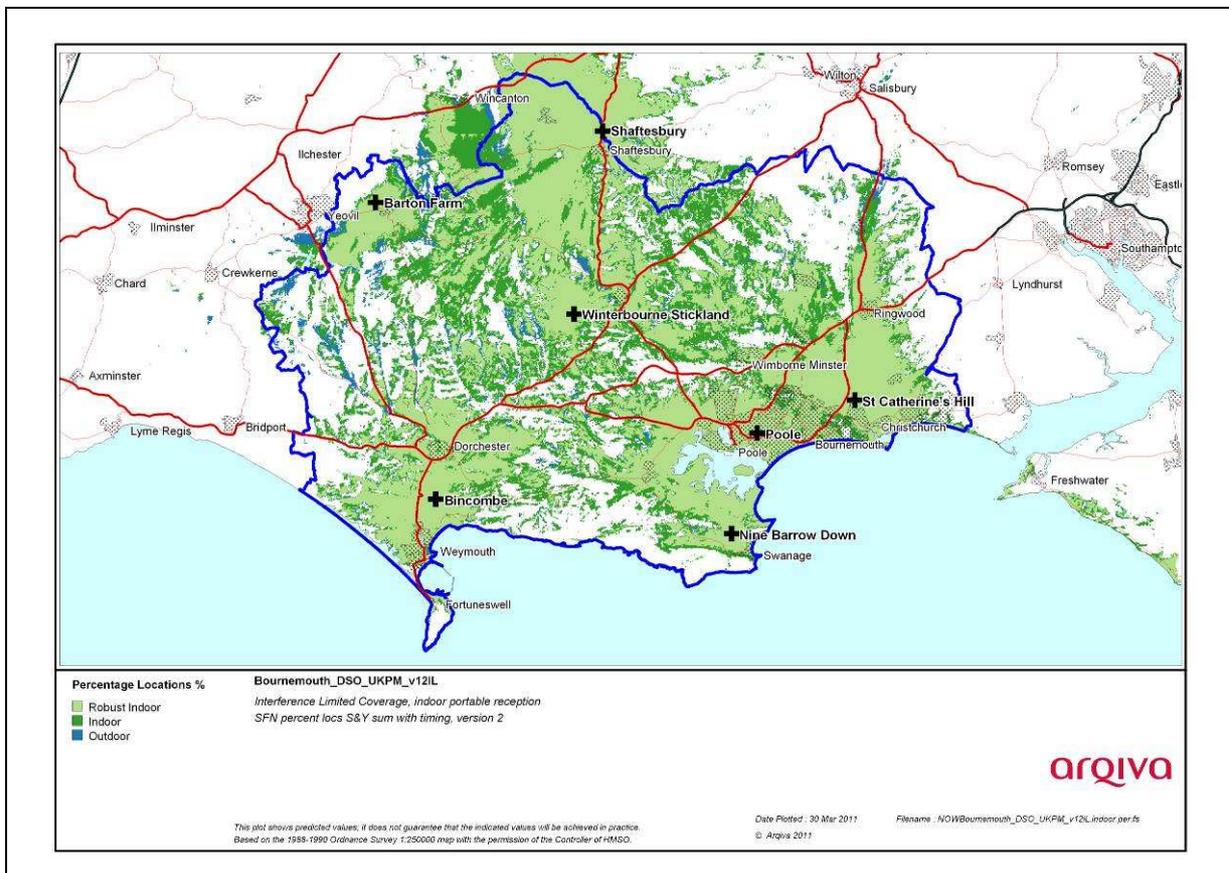


Figure 2.2.1: Bournemouth 11B Case 4

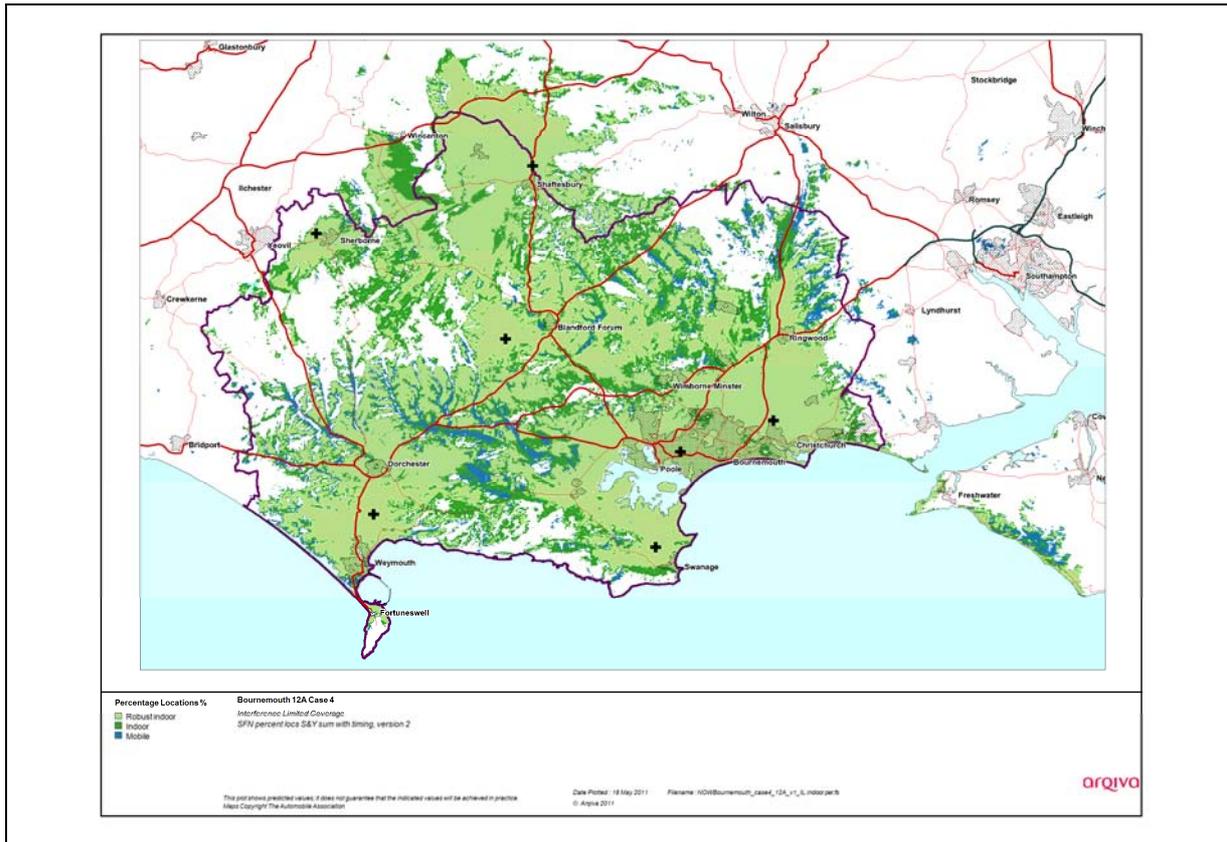


Figure 2.2.2: Bournemouth 12A Case 4

The population and road coverage improvement is shown in table 2.2.1 and 2.2.2

Table 2.2.1: Total pop: 356,346

Site scenario	Interference limited coverage within editorial area	Percentage of editorial area
11B Case 4	299,235	84.0%
Case 4 12A	318,245	89.3%

Table 2.2.2. Road coverage 99% location 99%Time: Total roads 531 km

Site scenario	Total road length in km	Percentage of roads within editorial area
11B Case 4	317	59.8%
Case 4 12A	450	84.9%

## 2.3 Peterborough

Peterborough on 12D has a significant impact on Essex and is itself severely interference limited, requiring a large number of transmitters to try and fill the multiplex, with less than optimal road coverage. The proposal is to merge Peterborough with Cambridge on Block 11C. This has the effect of removing interference to other 12D blocks notably Essex, and to a lesser extent Reading & Basingstoke. The effect of this change is to put more interference into other 11C blocks, this change only really affects South Yorkshire to any significant degree. This change is also made assuming that Swindon moves off of Block 11C. The combined coverage of this change for Peterborough and Cambridge is significant, particularly for the Peterborough part of the combined area. Because of the improved interference situation, it may be possible to review the number of transmission sites required for the combined multiplex. This should be reviewed at the earliest opportunity should these proposals be accepted.

The impact to South Yorkshire is primarily road coverage in the eastern part of the editorial area. Much of this 'lost' coverage is in areas not contiguously covered and in an overlap with Lincolnshire and Humberside. It is therefore not considered too serious a loss of coverage.

Figure 2.3.1 shows the coverage of Peterborough on block 12D, figure 2.3.2 shows the coverage of Cambridge on block 11C, figure 2.3.3 shows the combined coverage of Cambridge and Peterborough on Block 11C. Figure 2.3.4 shows the improved coverage of Essex and figure 2.3.5 shows the impacted coverage of South Yorkshire. Figure 2.3.6 show the coverage of Coventry.

The impact of the proposed changes on both 11C and 12D in terms of indoor and road coverage are detailed in tables 2.3.1 and 2.3.2.

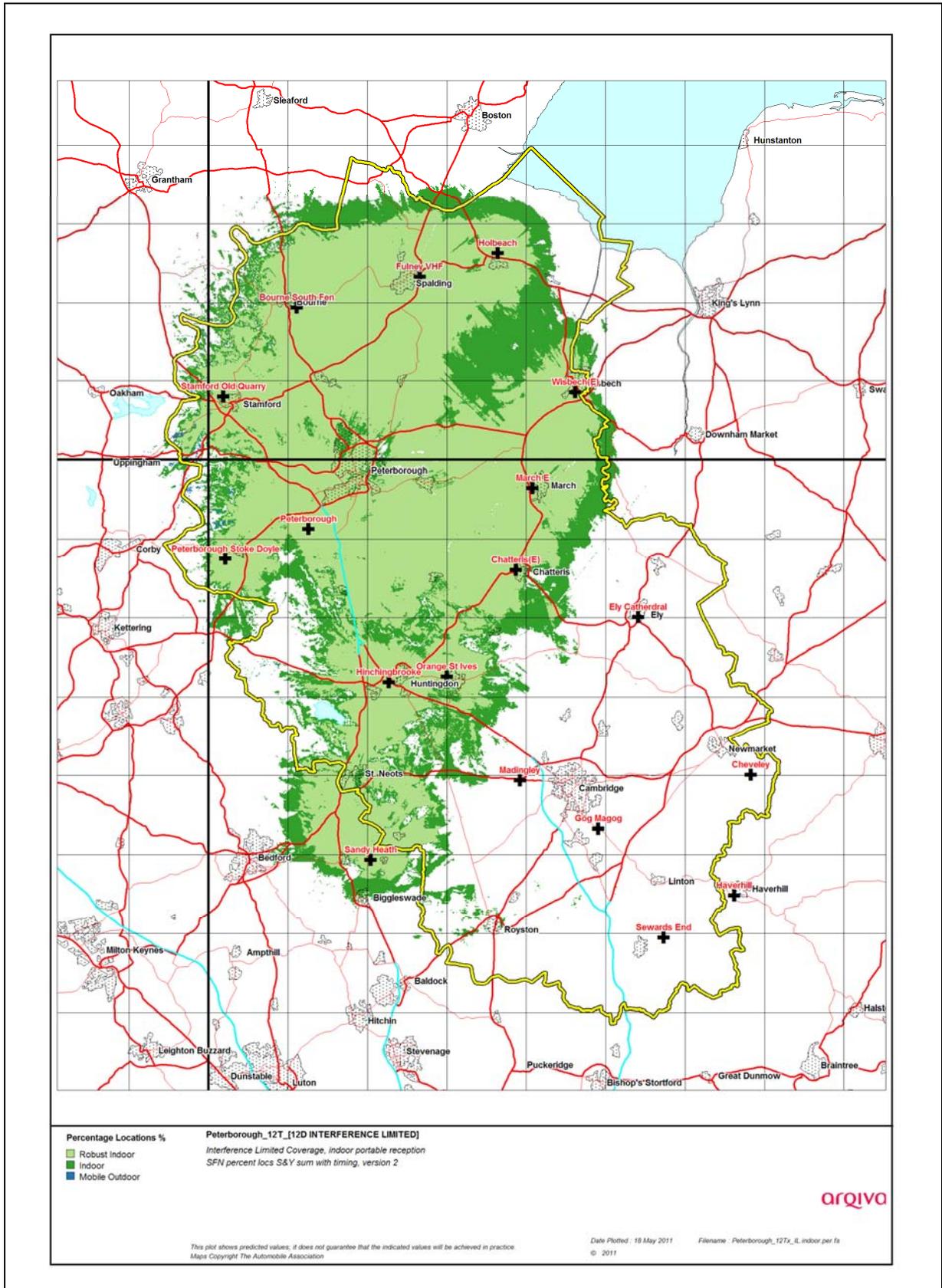


Figure 2.3.1: Peterborough 12D Case 4

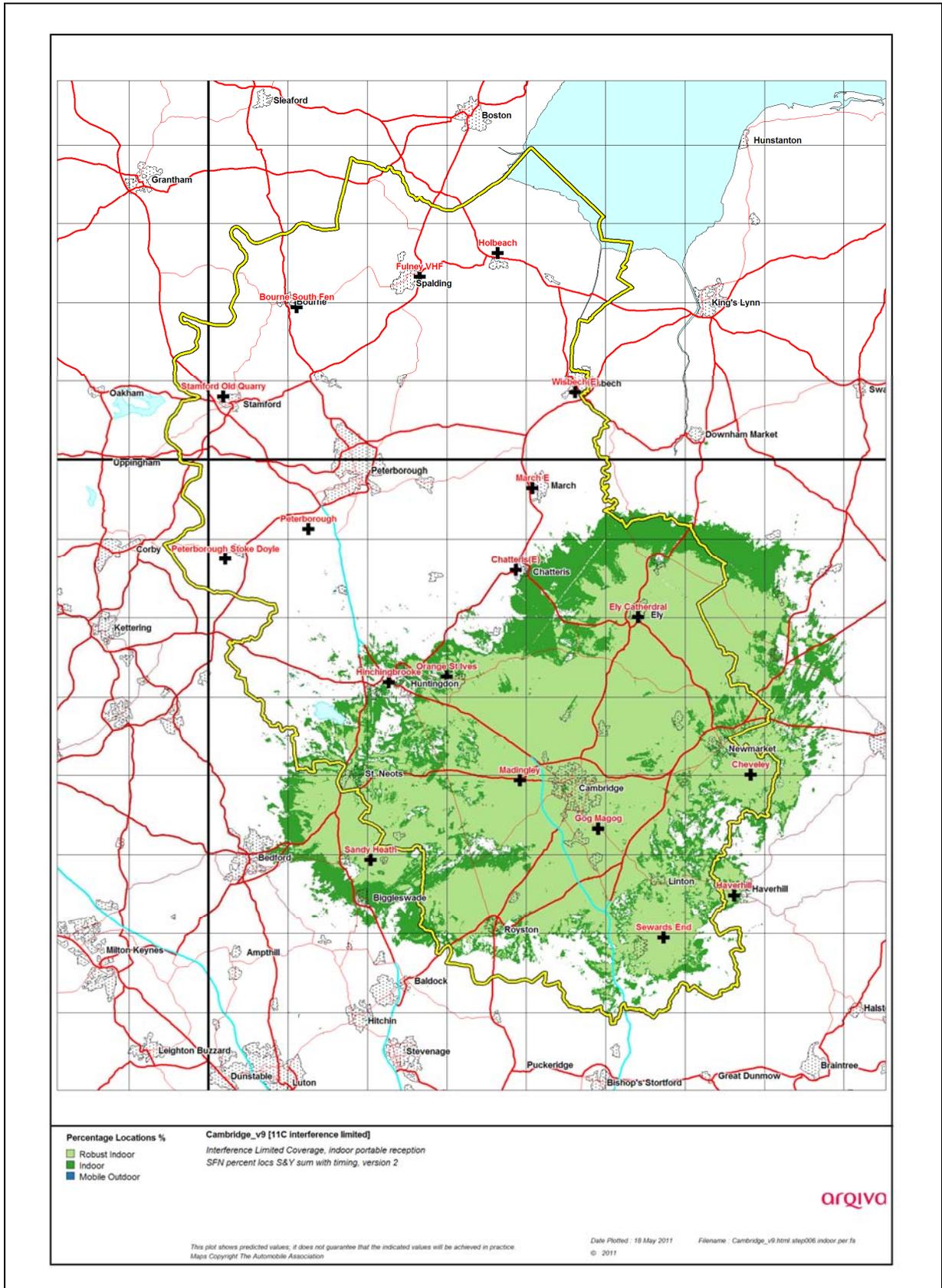


Figure 2.3.2: Cambridge Case 4 11C

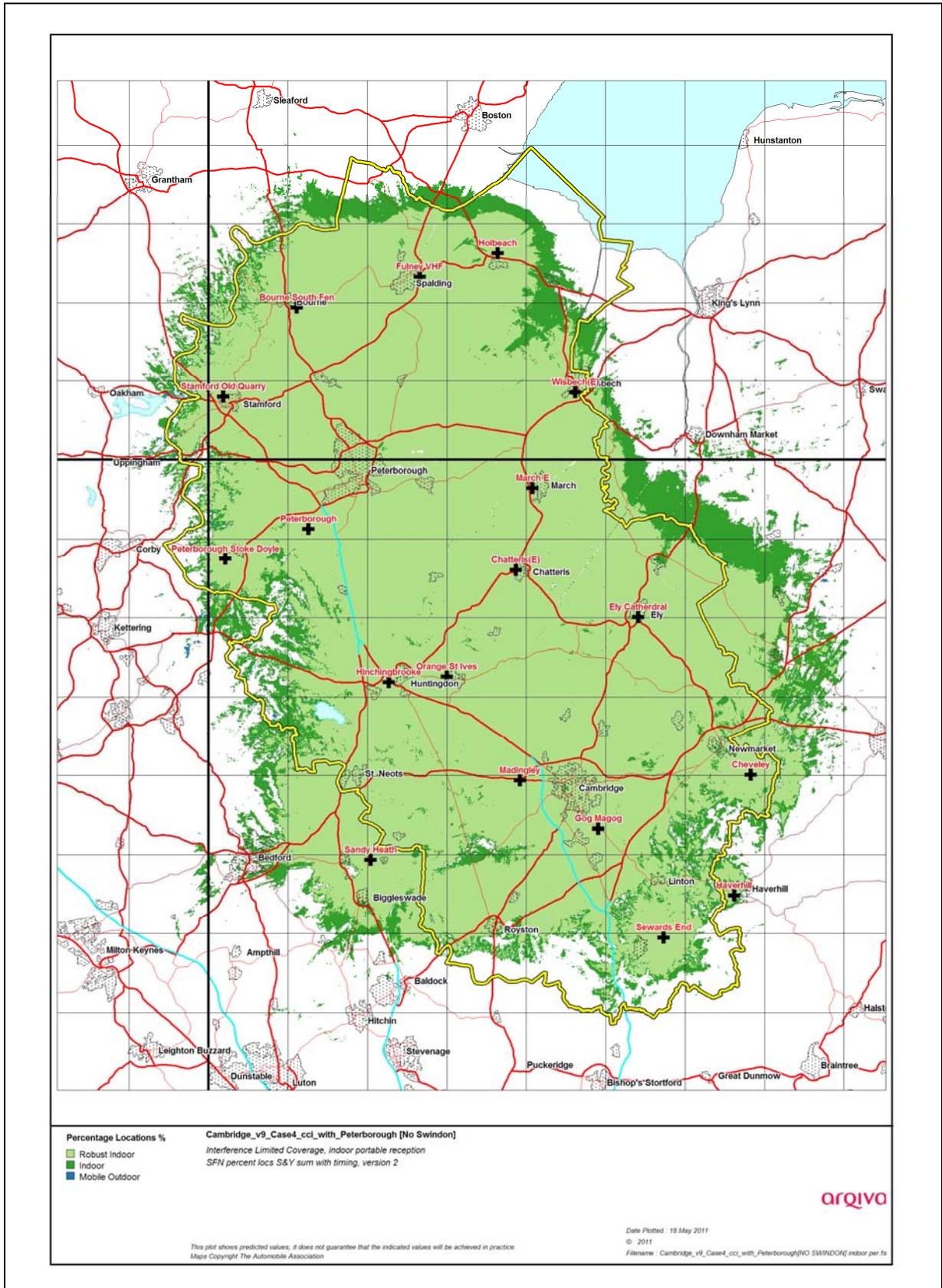


Figure 2.3.3: Combined Peterborough and Cambridge on 11C

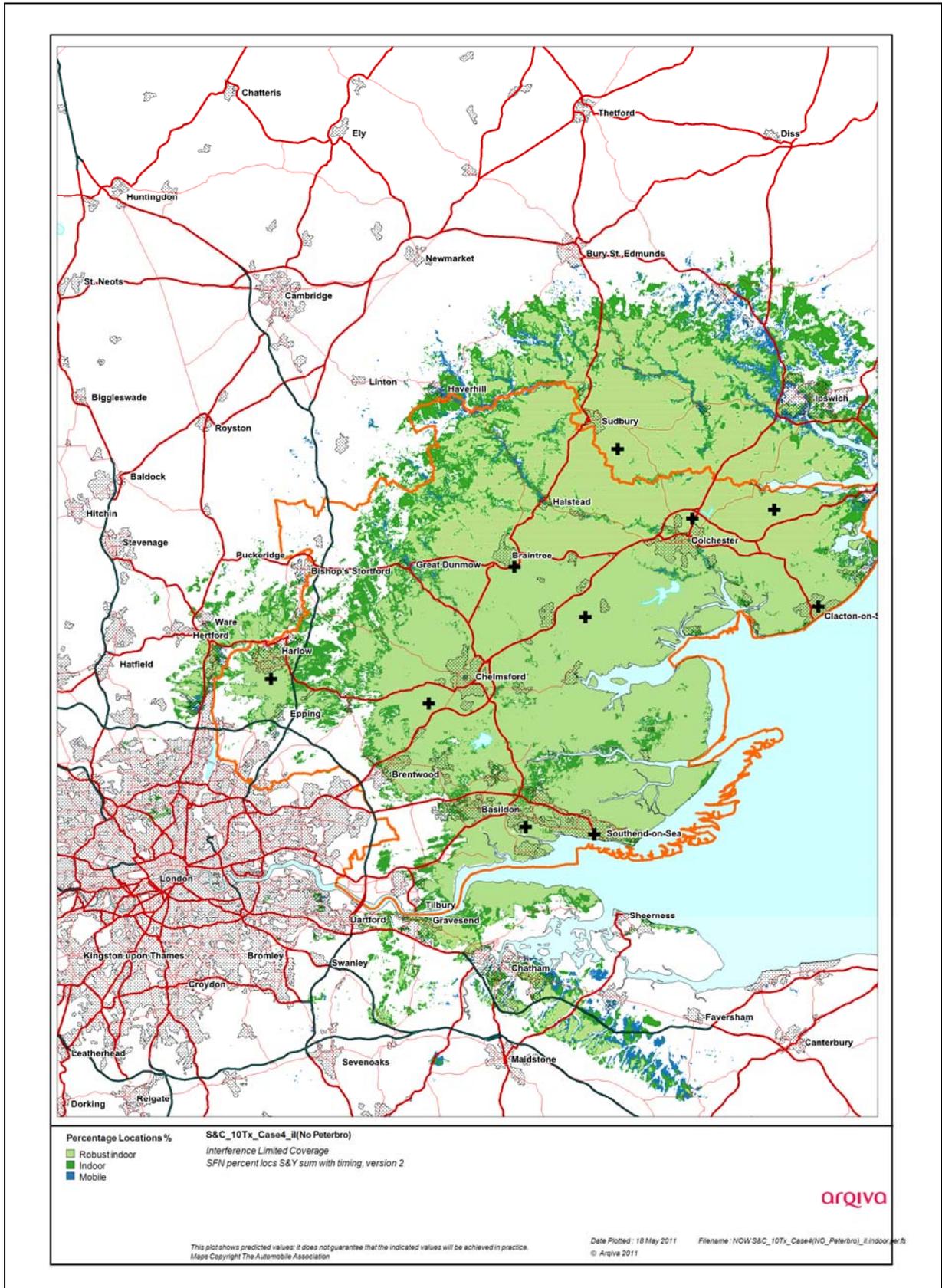


Figure 2.3.4: Essex (Southend & Chelmsford) on 12D with Peterborough removed and new editorial area.

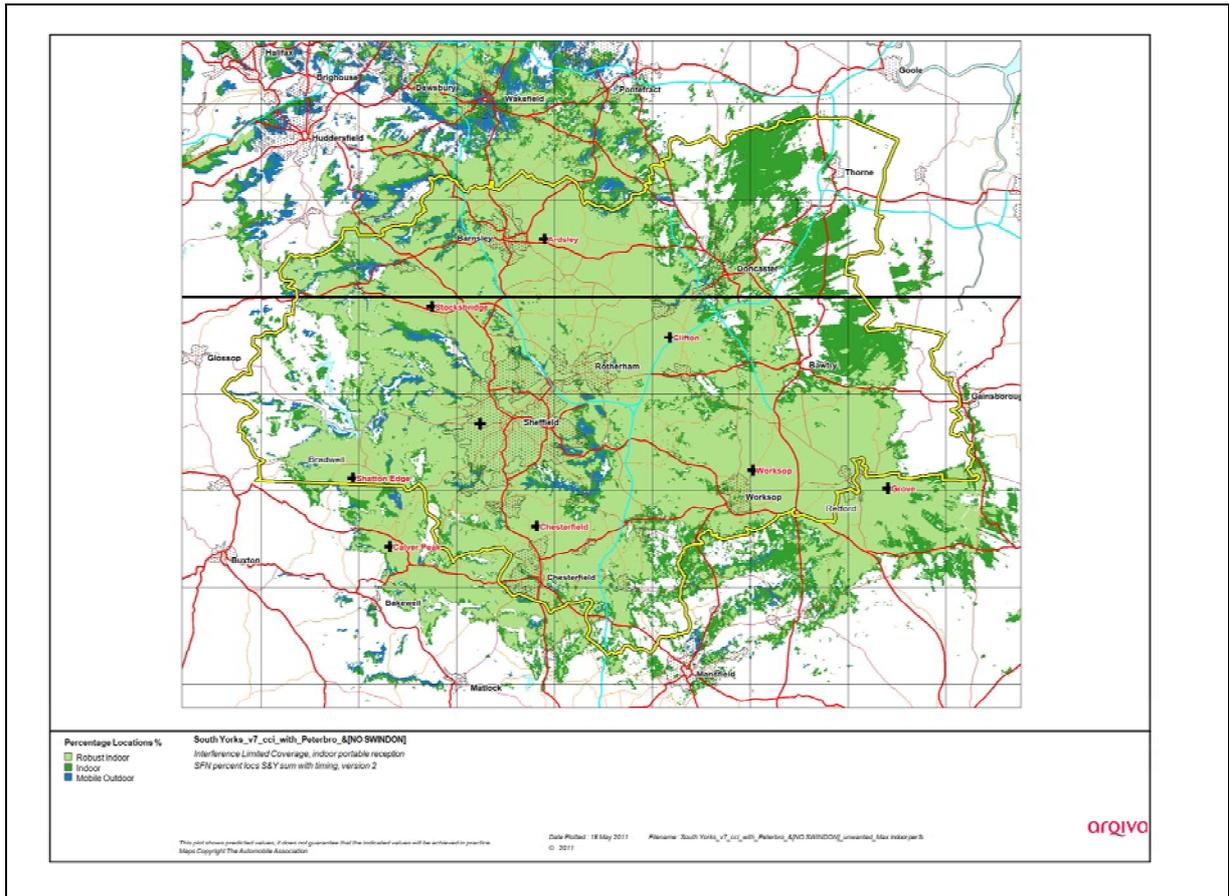


Figure 2.3.5: South Yorkshire 11C with merged Cambridge and Peterborough

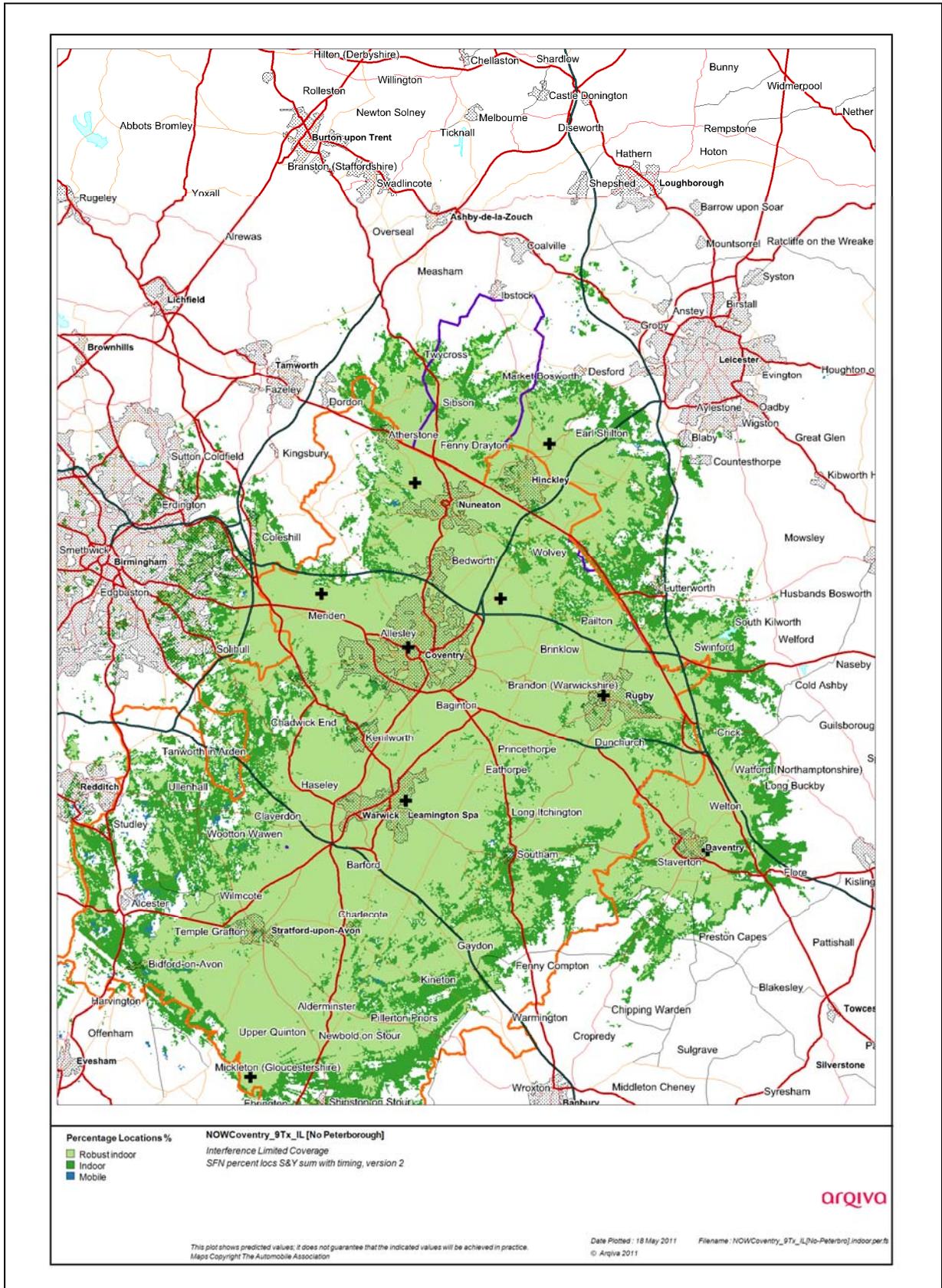


Figure 2.3.6: Coventry on 12D with Peterborough removed

Due to the complex nature and the interactions of 11C with many other multiplexes and the impact of removing 11C from Swindon a matrix table is shown below to summarise all the 11C changes.

	Cambridge Case 4		Cambridge Case 4 plus Peterborough		Change in pop	Change in Roads	Cambridge Case 4 plus Peterborough WITH NO SWINDON		Change in pop	Change in Roads
	% Pop	% Roads	% Pop	% Roads			% Pop	% Roads		
Cambridge editorial area (limited by proposed 11C)	90.54%	92.50%	98.78%	94.56%	8.24%	2.06%				
Peterborough Editorial area (limited by proposed 11C)			97.26%	91.04						
Combined Editorial area (limited by proposed 11C)			97.82%	90.49%			98.81%	94.70%	0.99%	4.21%
Effect on other 11 C Multiplexes										
	Populations without Peterborough on 11C		Populations WITH Peterborough on 11C		Percentage Loss due to Peterborough on 11C		Populations WITH Peterborough on 11C WITH NO SWINDON			
South Yorkshire	91.6	84.7	89.15	77.59	-2.45	-7.11	89.19	77.64	0.04	0.05
Kent	84.25	74.04	83.34	73.5	-0.91	-0.54	83.37	73.51	0.03	0.01
South Hampshire	96.1	86.9	96.13	86.89	0.03	-0.01	96.23	87.22	0.1	0.33
Swindon	87.34	53.57	86.14	50.43	-1.2	-3.14	-	-	-	
Birmingham	94.08	80.9	93.35	79.85	-0.73	-1.05	94.36	81.53	1.01	1.68
	Current Cardiff Case 4						Cardiff case 4 - with no Swindon interference			
Cardiff & Newort	82.49	67.91	-	-	-	-	83.18	68.83	0.69	0.92

A similar matrix for 12D is shown below:

#### Effect on 12 D Multiplexes of removing Peterborough from Block 12D

	Case 4 - including Peterborough co-block		Case 4 excluding Peterborough co-block		Change in pop	Change in Roads
	% Pop	% Roads	% Pop	% Roads		
Southend & Chelmsford (new editorial area)	75.98	57.88	79.11	65.35	3.13	7.47
Coventry (new editorial area)	93.57	75.96	93.96	76.86	0.39	0.9
Stoke	83.09	78.86	83.06	78.79	-0.03	-0.07
Reading and Basingstoke	95.03	90.38	95.1	90.65	0.07	0.27
Leeds	96.57	97.49	97.05	99.19	0.48	1.7

Peterborough on 12D coverage was: 92.97% indoor & 79.1% road coverage.

## 2.4 Leicester

This proposal is simple in concept but has significant impact on the frequency plan. It is proposed to replace 11B in Leicester with 10C from Northamptonshire in turn merging Northamptonshire with Herts Beds & Bucks on 10D. Therefore the analysis requires not only investigating removal of 11B from Leicester (which is all good) but impact of 10C in Leicester on other co-block multiplexes, and the use of a larger 10D allotment with the merged HBB and Northants allotment, (three block assessments). So this section will sub-divided into:

- Coverage of Leicester itself
- Impact of removal of Leicester on 11B to other multiplexes
- Impact on 10C multiplexes
- Coverage of merged Northants and HBB
- Impact on other 10D multiplexes.

### 2.4.1 Coverage of Leicester

The population and road coverage improvement is shown in table 2.4.1 and 2.4.2

Table 2.4.1: Total pop: 419,049

Site scenario	Interference limited coverage within editorial area	Percentage of editorial area	Percentage increase
11B Case 4	360,323	85.89%	-
Case 4 10C	379,638	90.59%	4.7%
Case 4 10C plus Waltham North	388,702	92.75%	6.9%

Table 2.4.2. Road coverage 99% location 99%Time: Total roads 670 km

Site scenario	Total road length in km	Percentage of roads within editorial area	Percentage increase
11B Case 4	364	54.26%	-
Case 4 10C	452	67.4%	13.14%
Case 4 10C plus Waltham North	570	85.1%	30.8%

Figure 2.4.1.1 shows the Case 4 coverage on 11B, figure 2.4.1.2 shows Case 4 coverage on 10C (excluding Waltham north) figure 2.4.1.3 shows the indoor coverage including Waltham North and figure 2.4.1.4 shows the mobile coverage (95-97; 97-99 and >99% locations).

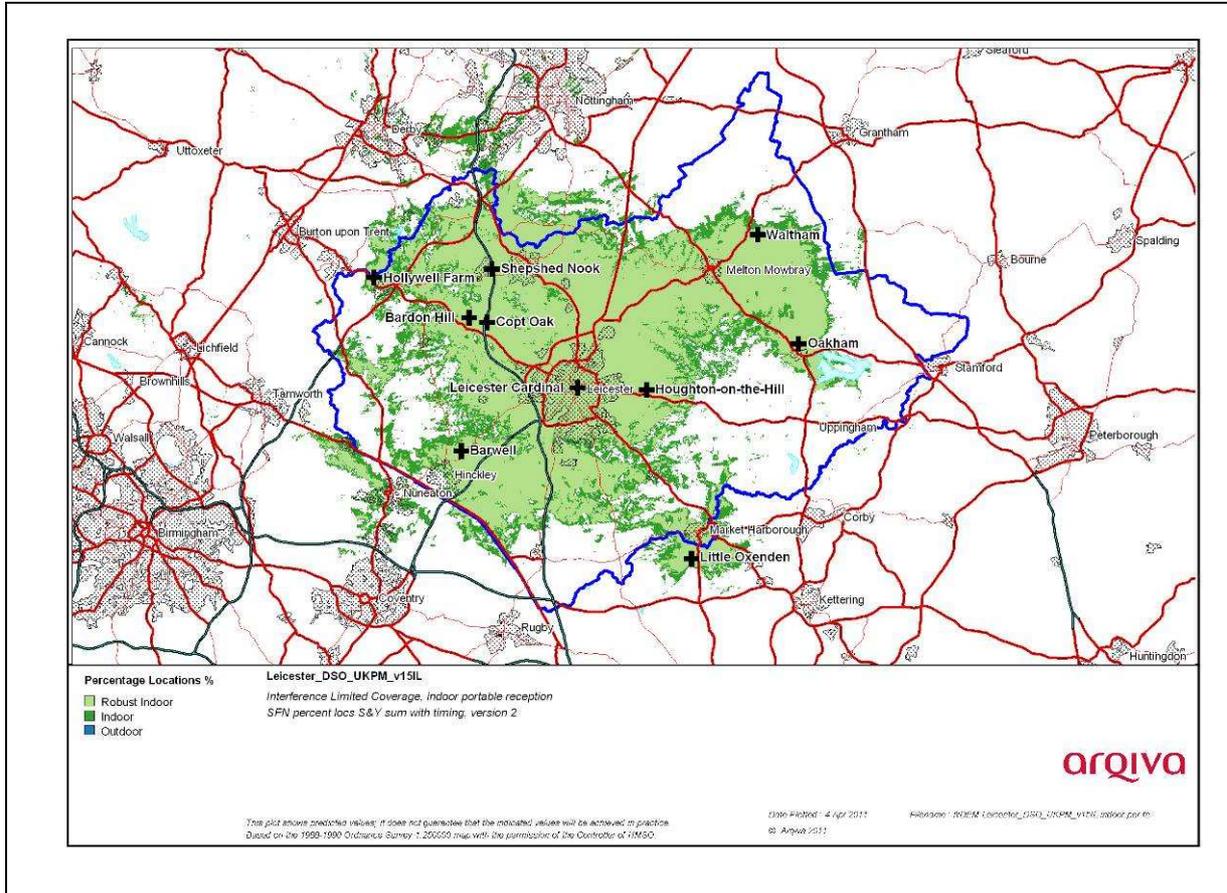


Figure 2.4.1.1: Case 4 11B Leicester

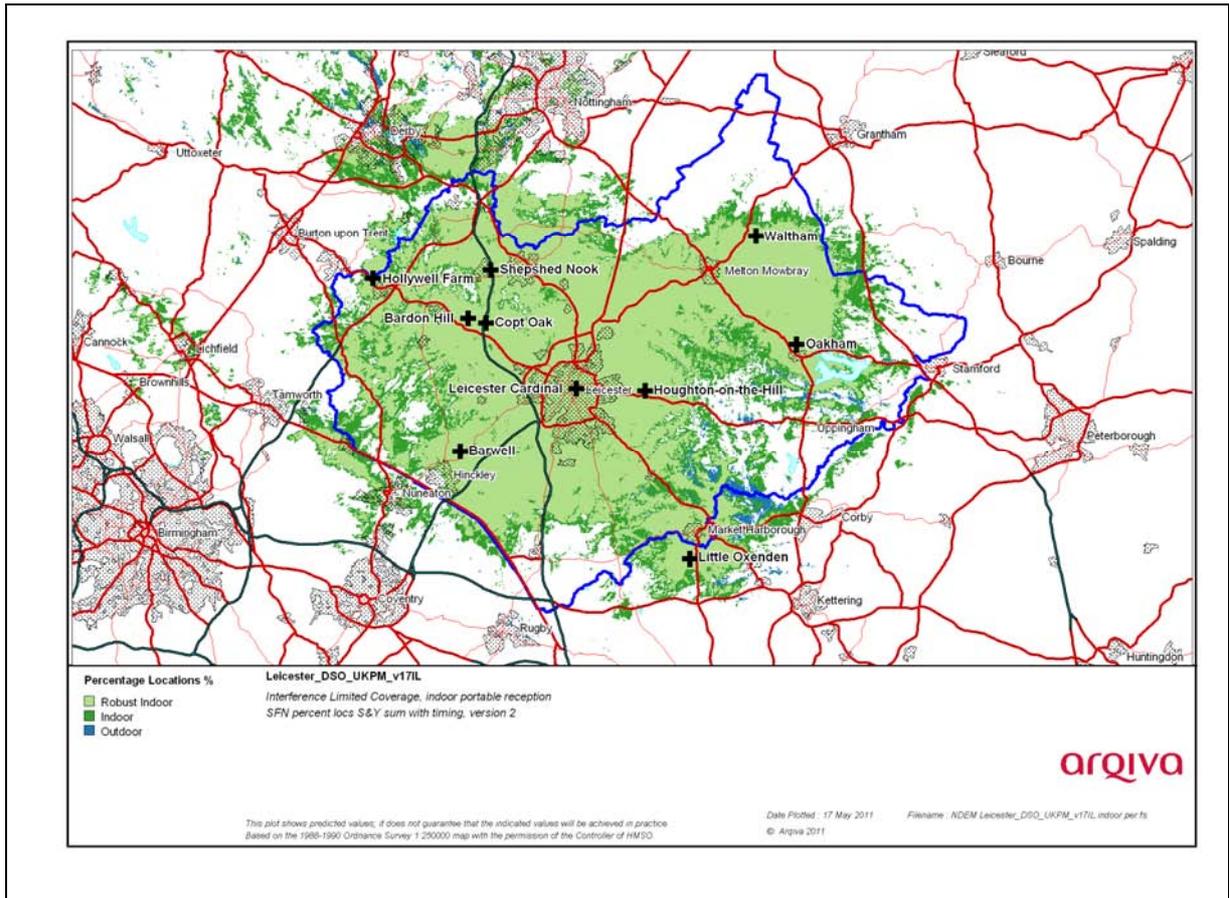


Figure 2.4.1.2: Leicester case 4 block 10C (no Waltham north)

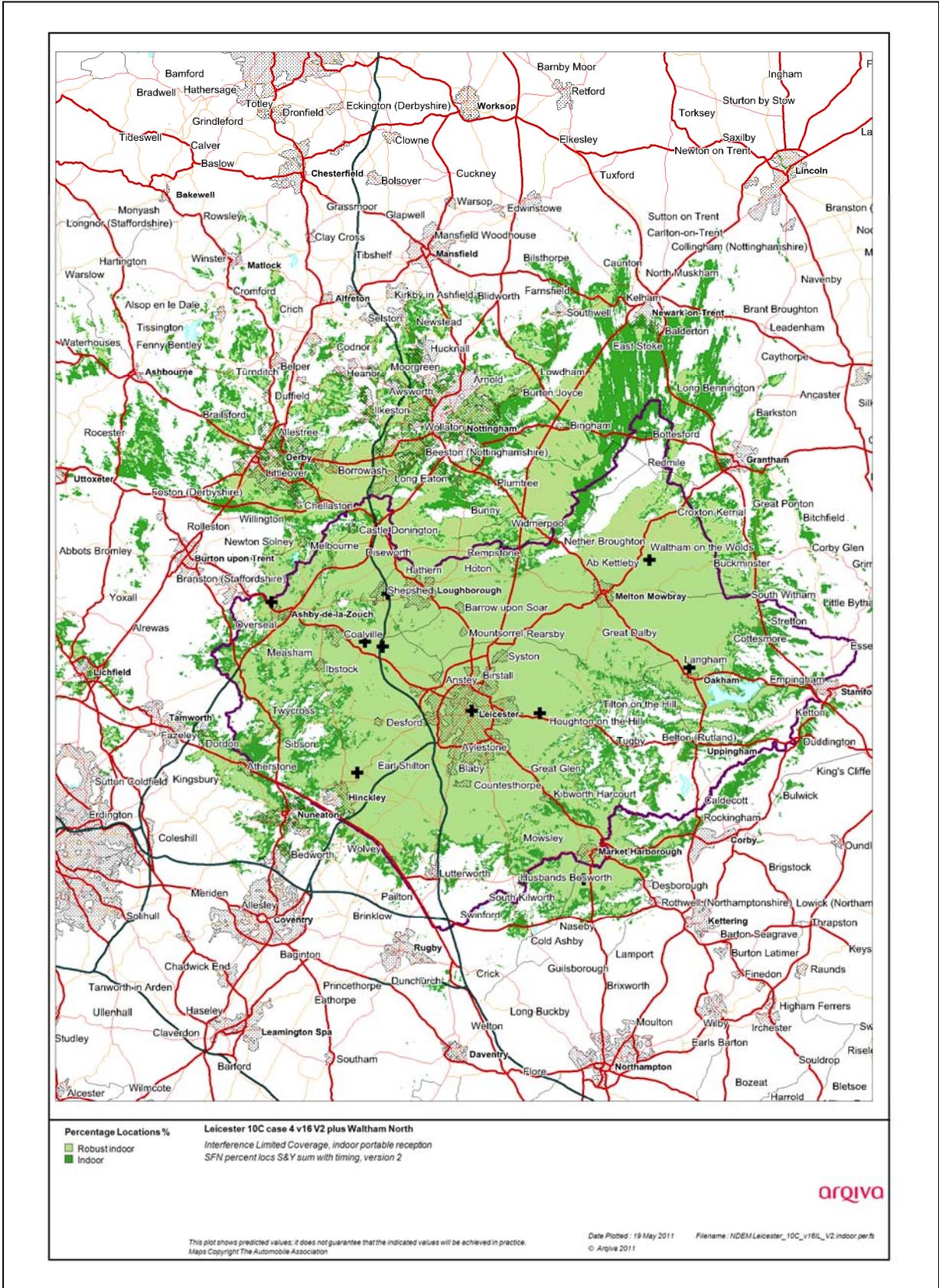


Figure 2.4.1.3: Leicester Case 4 block 10C indoor only

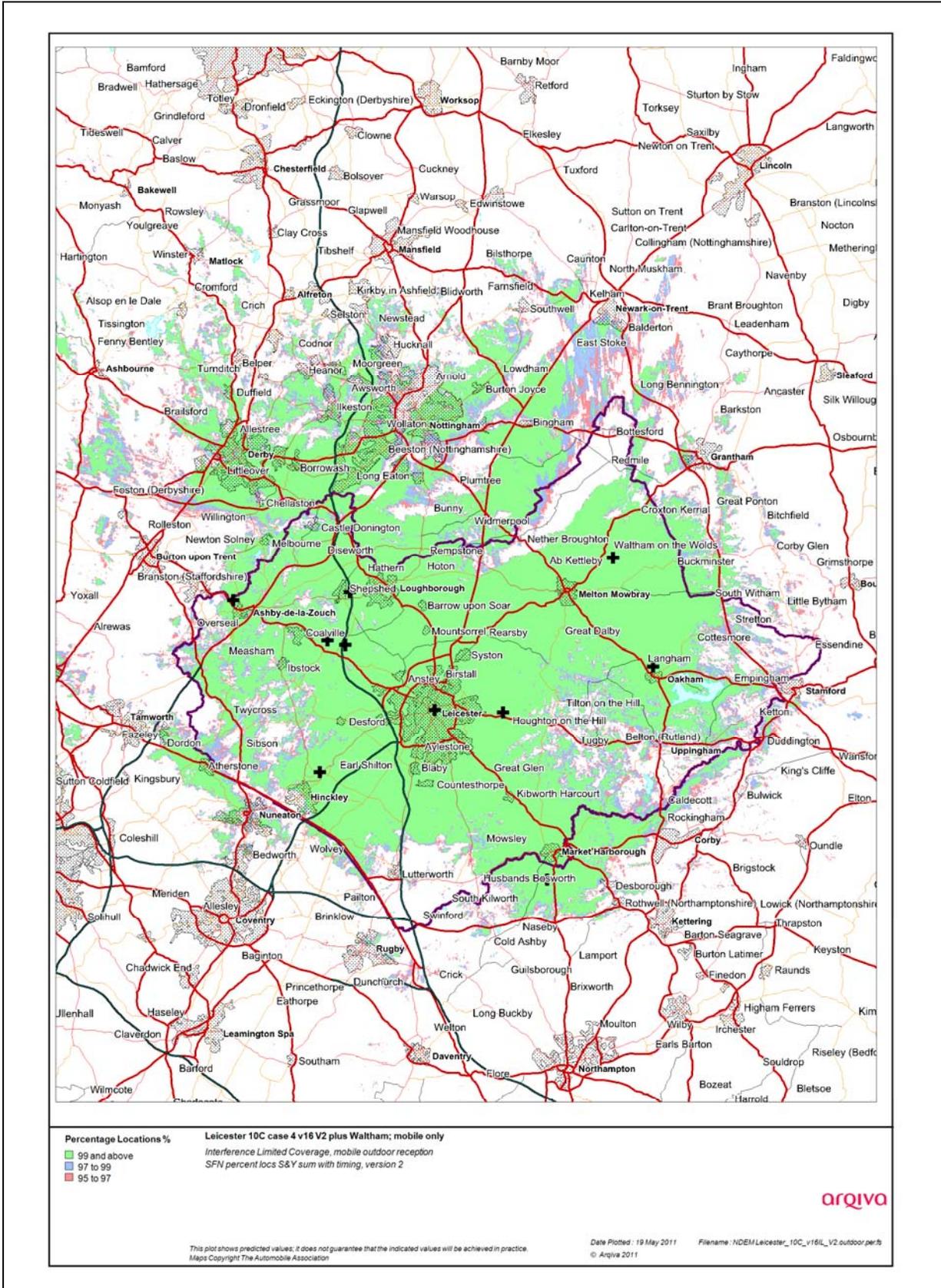


Figure 2.4.1.4: Leicester Case 4 block 10C mobile only

## 2.4.2 Impact of removing Leicester on other 11B multiplexes

As expected removing Leicester from 11B improves all other 11B multiplexes. This has a major impact on Wolverhampton and Norfolk and only minor improvements to Bristol & Bath and West Yorkshire (all other 11B show not significant improvements). The improvements to Norfolk are assuming the revised editorial area and Blythburgh removed. Wolverhampton assumes that Segdley Beacon replaces Wolverhampton Polytechnic.

The population and road coverage improvement for Norfolk is shown in table 2.4.3 and 2.4.4

Table 2.4.3: Total pop: 437,832

Site scenario	Interference limited coverage within editorial area	Percentage of editorial area	Percentage increase
Norfolk including Leicester	365,152	83.4%	
Norfolk excluding Leicester	388,130	88.7%	5.3%

Table 2.4.4. Road coverage 99% location 99%Time: Total roads 969 km

Site scenario	Total road length in km	Percentage of roads within editorial area	Percentage increase
Norfolk including Leicester	741	76.1%	
Norfolk excluding Leicester	932	96.0%	19.7%

The population and road coverage improvement for Wolverhampton is shown in table 2.4.5 and 2.4.6

Table 2.4.5: Total pop: 694,885

Site scenario	Interference limited coverage within editorial area	Percentage of editorial area	Percentage increase
Wolverhampton including Leicester	653,192	94.0%	
Wolverhampton excluding Leicester	674,418	97.1%	3.06%

Table 2.4.6: Road coverage 99% location 99%Time: Total roads 1117 km

Site scenario	Total road length in km	Percentage of roads within editorial area	Percentage increase
Wolverhampton including Leicester	908	81.3%	
Wolverhampton excluding Leicester	1,030	92.3%	10.95%

If only Leicester is removed from 11B then improvement to Bristol & Bath is 0.13% indoor and 0.84% mobile. West Yorkshire is 0.1% indoor and 0.2% mobile.

Figure 2.4.2.1 shows Norfolk case 4 with Leicester included, figure 2.4.2.2 shows Norfolk with Leicester excluded, figure 2.4.2.3 shows Wolverhampton with Leicester included and figure 2.4.2.4 shows Wolverhampton with Leicester excluded.

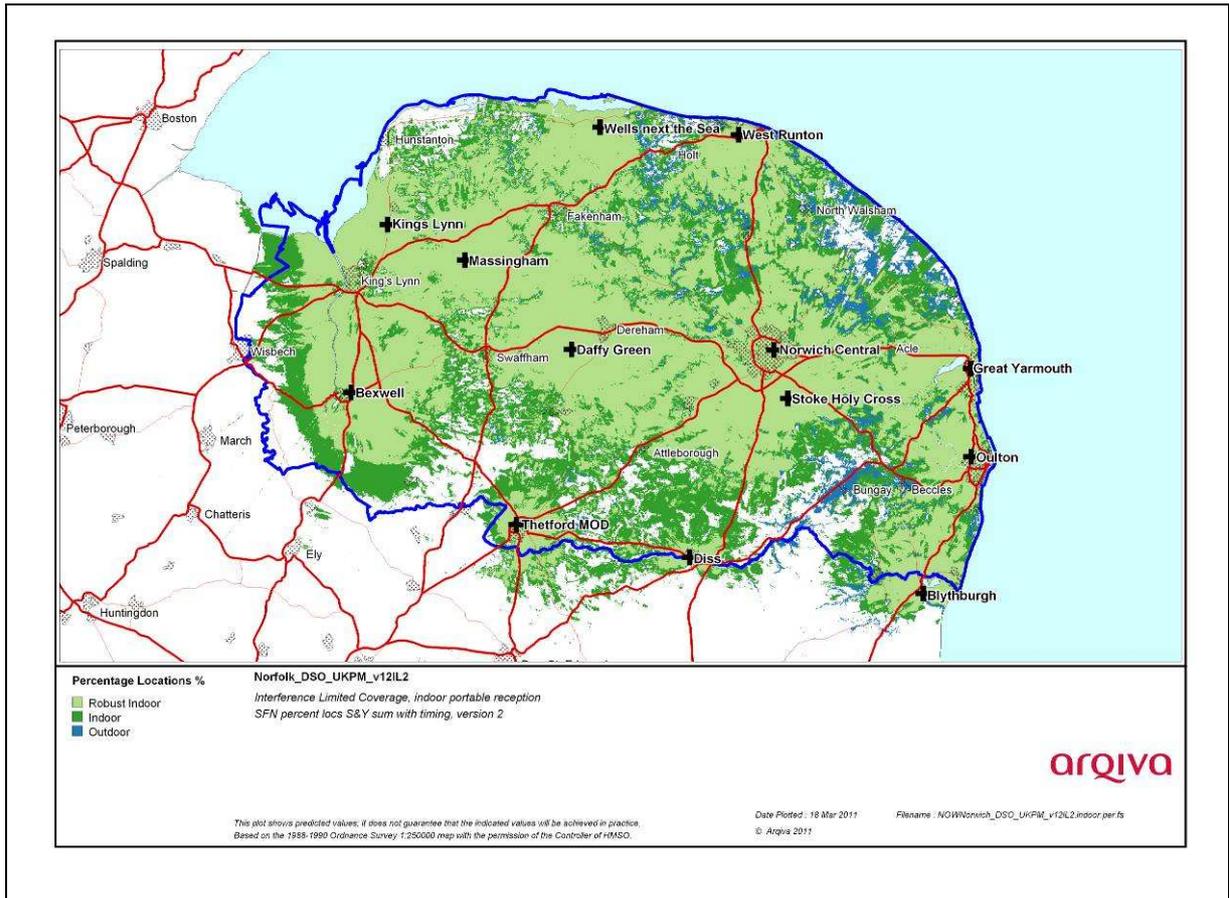


Figure 2.4.2.1: Norfolk Case 4 (old editorial area) includes Leicester

Note the populations given in this document refer to the revised editorial area with Blythburgh removed.

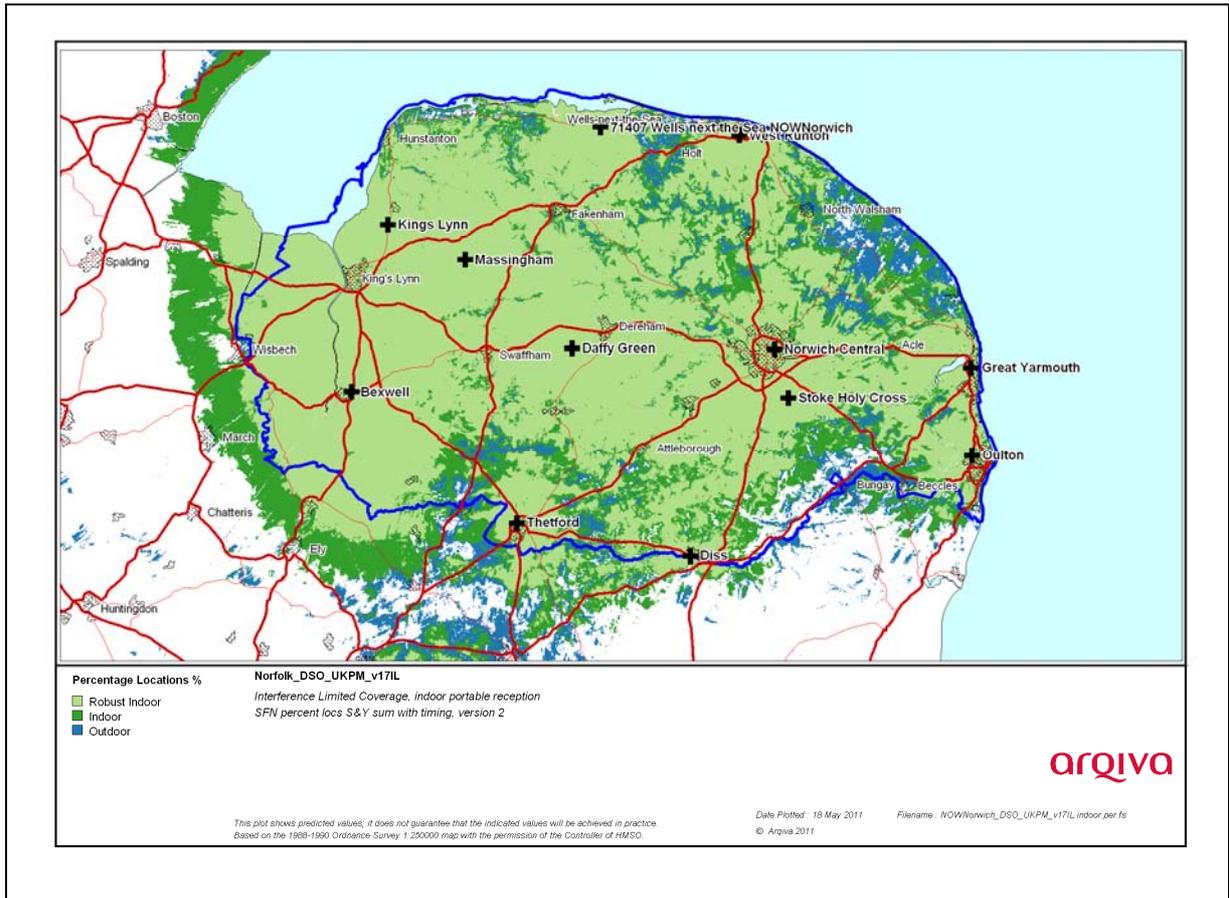


Figure 2.4.2.2: Norfolk case 4 with Leicester excluded (new editorial area)

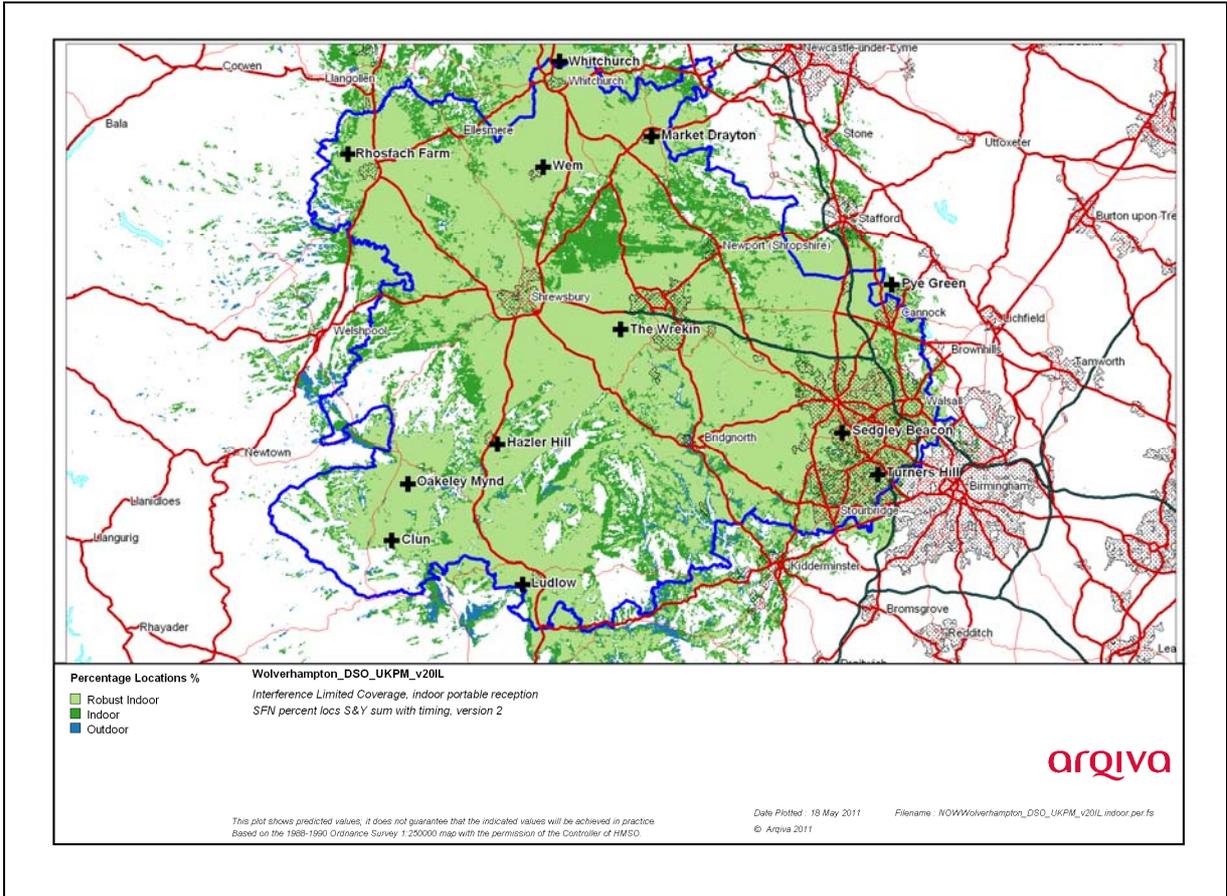


Figure 2.4.2.3: Wolverhampton with Leicester included

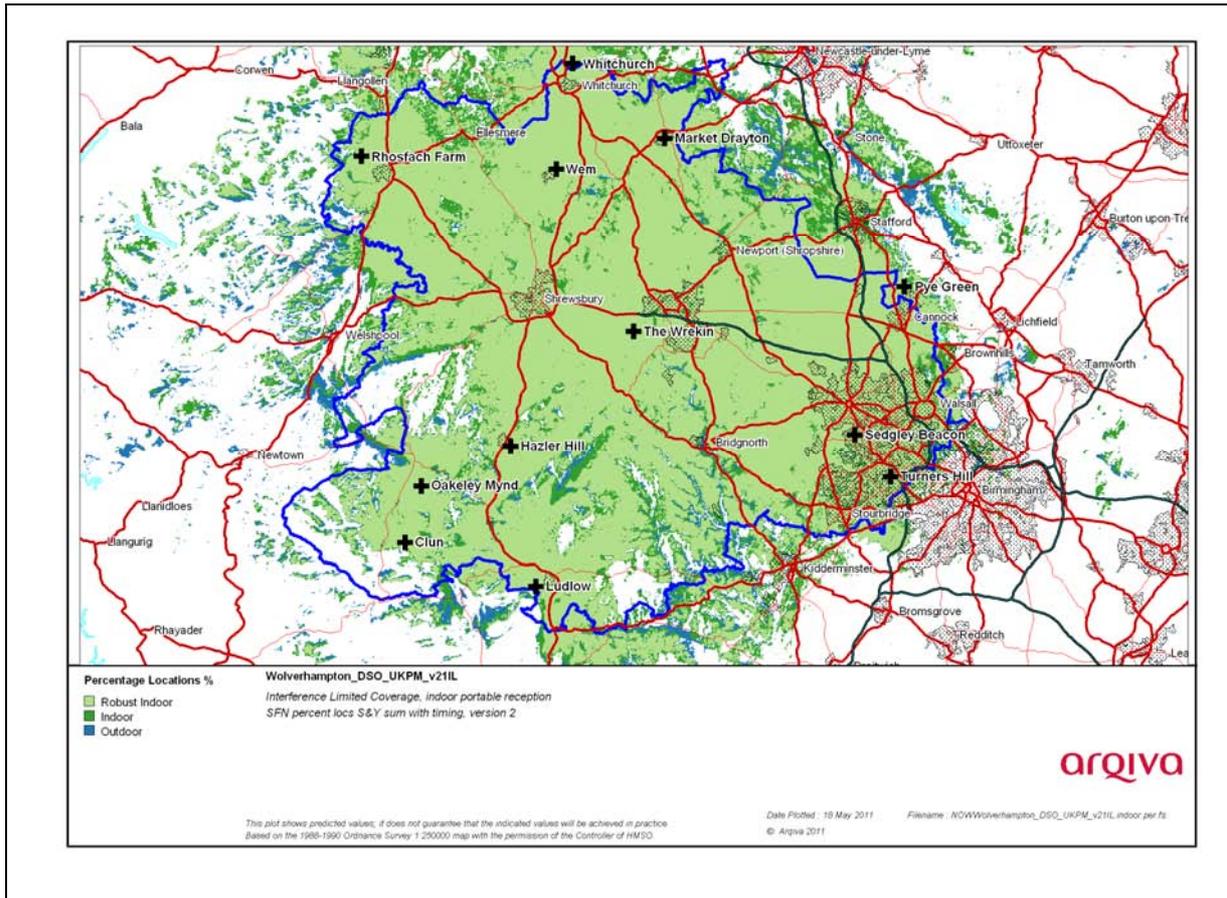


Figure 2.4.2.4: Wolverhampton case 4 excluding Leicester

### 2.4.3 Impact of Leicester on 10C to other multiplexes

This change in allocation affects North Yorks, Surrey, Gloucester and Liverpool. In summary there is a roughly neutral affect on Gloucester, a slight degradation of North Yorkshire and Liverpool and a significant improvement to Surrey. The impacts are summarised in the table 2.4.7 below:

Multiplex name	Indoor coverage before	Indoor coverage after	Percentage increase
North Yorkshire*	87.52%	86.37%	-1.15%
Liverpool*	95.19%	93.56%	-1.63%
Gloucester	85.80%	84.56%	-1.24%
Surrey*	84.55%	90.01%	5.46%

\*The population figures given are for the new editorial areas and assume that High Hunsley and Bridlington are removed from North Yorkshire. Also the coverage numbers for Liverpool are with High Hunsley and Bridlington removed (High Hunsely does have a significant impact on Liverpool and if included reduces indoor to 94.05% before. North Yorkshire numbers assume NO Waltham North if this is included if reduces North Yorkshire 8% indoor and 16% mobile.

Multiplex name	Mobile road coverage before	Mobile road coverage after	Percentage increase
North Yorkshire*	85.76%	82.98%	-2.78%
Liverpool*	90.76%	85.90%	-4.86%
Gloucester	71.82%	65.99%	-5.83%
Surrey*	83.42%	94.96%	11.54%

The coverage of Surrey mobile before and after is shown below in figures 2.4.3.1, 2.4.3.2 with figure 2.4.3.3 showing the mobile only coverage with Leicester replacing Northants.

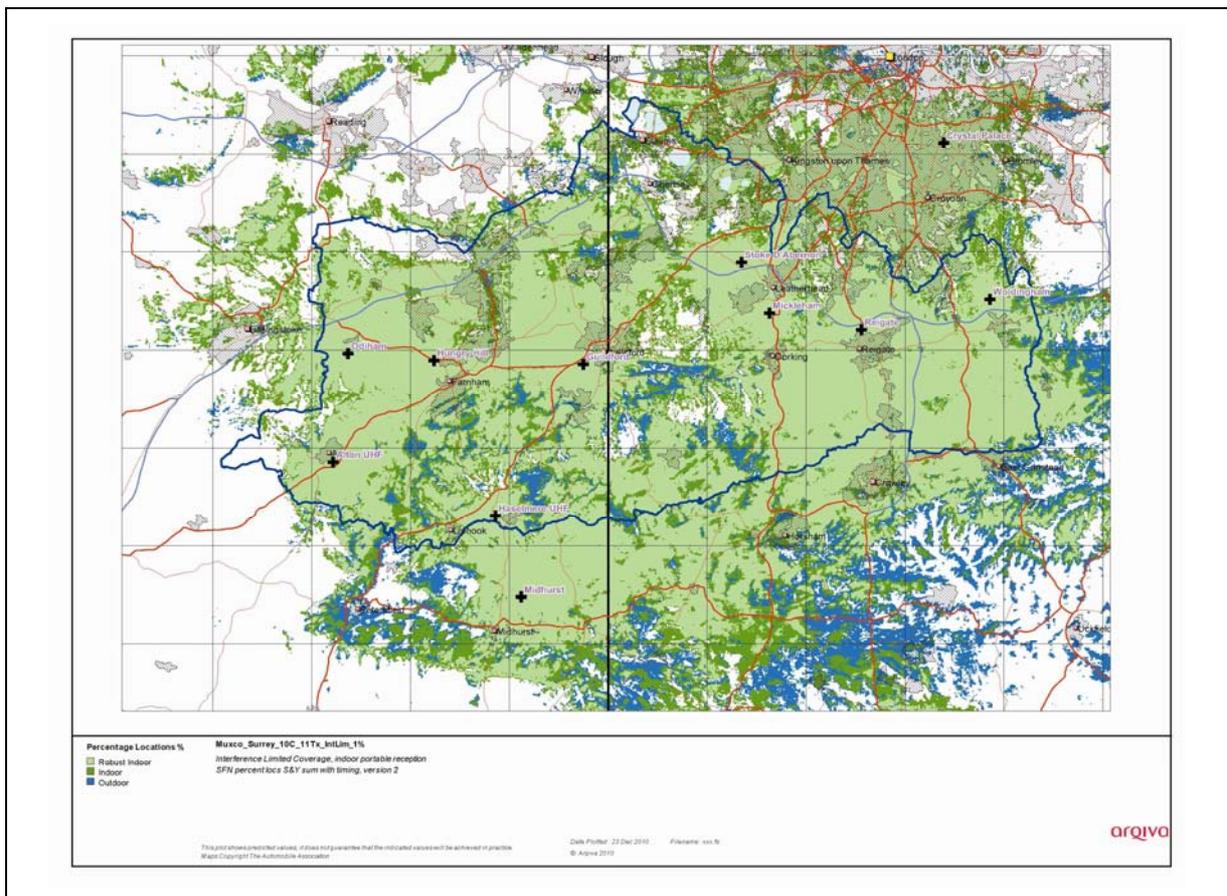


Figure 2.4.3.1: Surrey Case 4 new editorial area

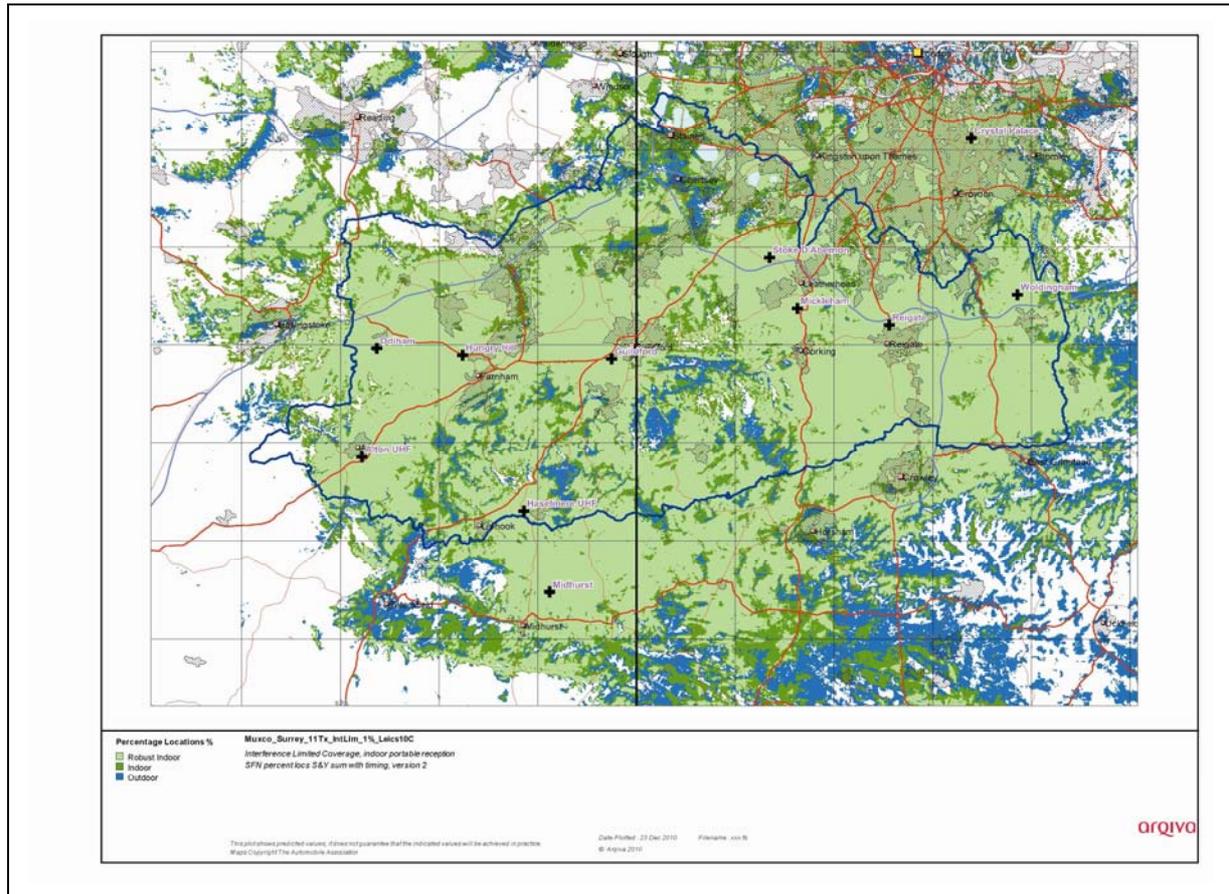


Figure 2.4.3.2: Surrey 10C with Leicester on 10C replacing Northants

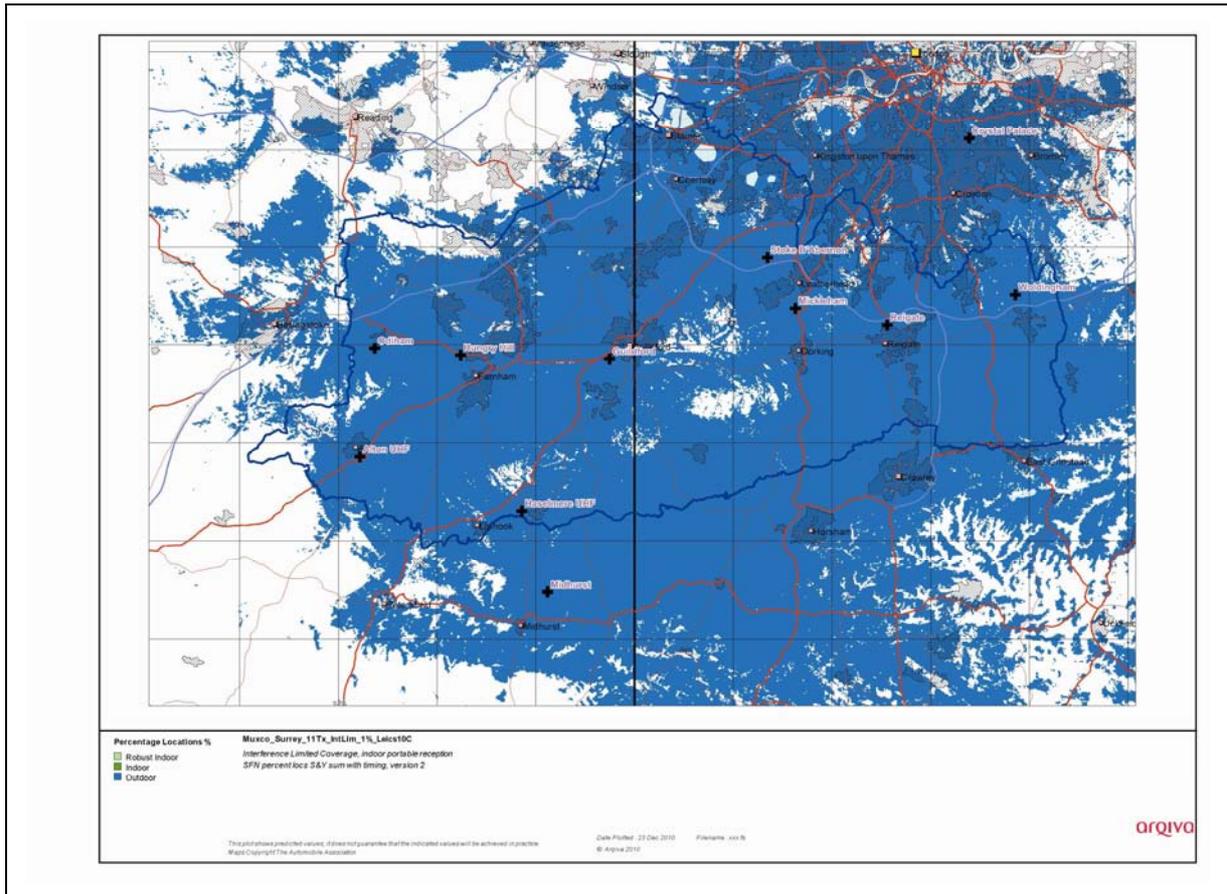


Figure 2.4.3.3: Surrey 10C mobile only with Leicester replacing Northants

### 2.4.4 Coverage of combined Herts Beds & Bucks and Northamptonshire on 10D

As a consequence of Leicester moving to block 10C it was necessary to merge HBB and Northants onto 10D. This merging seems to have worked reasonably well with good coverage in the combined area. Figure 2.4.4.1 shows the combined coverage. Coverage figures shown in table 2.4.8 and 2.4.9 are for the new editorial area. The area around Market Harborough is served by the Leicestershire multiplex.

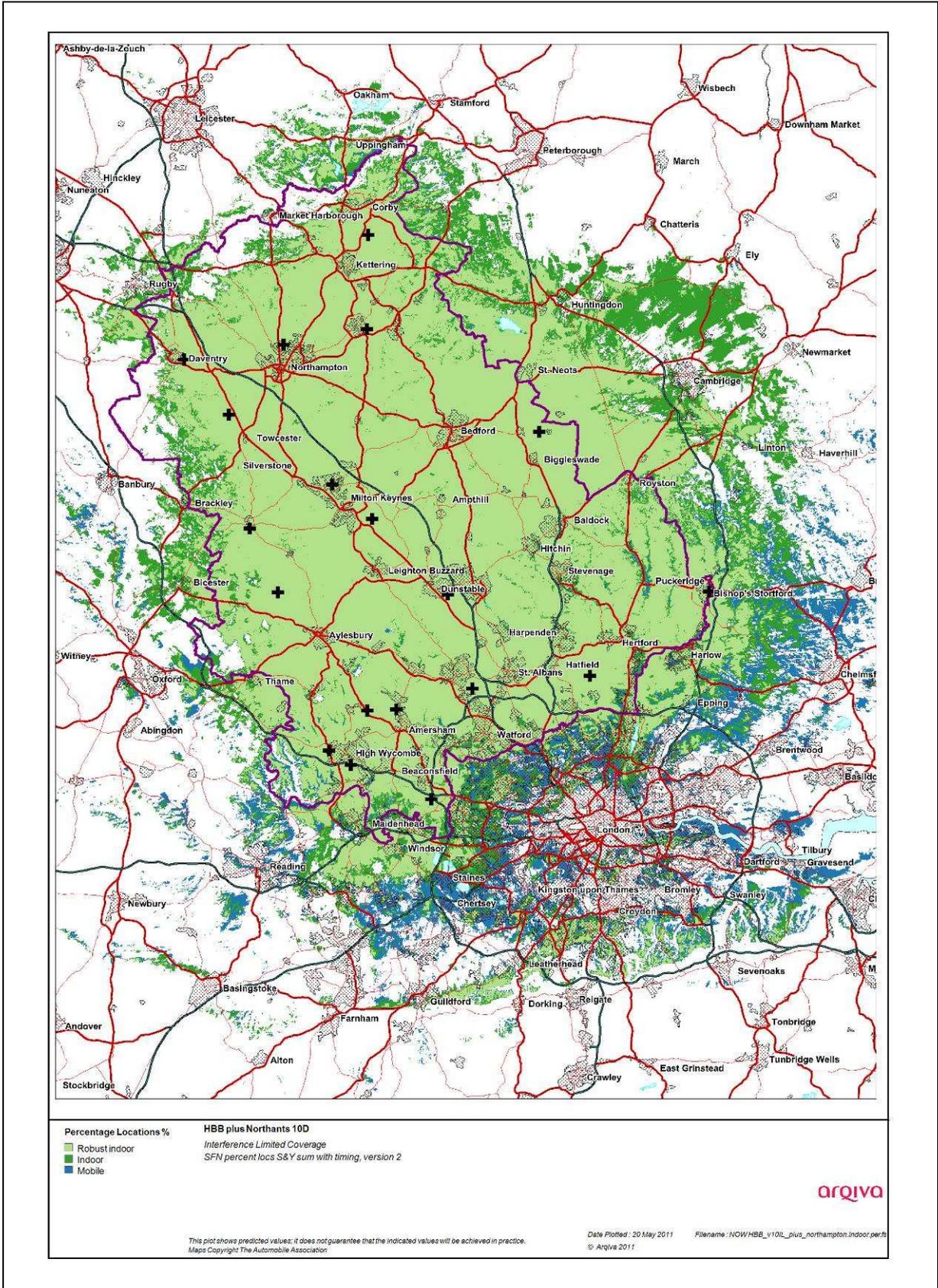


Figure 2.4.4.1: Combined HBB & Northants on 10D

The population coverage's of Herts Beds Bucks and Northampton have both combined and separate are given in tables 2.4.8 and 2.4.9 below:

Table 2.4.8. Population coverage proportional indoor 1% time interference

Total Northants: 282,428

Total Herts Beds & Bucks: 1,033,017

Total Combined: 1,315,475

Site scenario	Interference limited coverage within editorial area	Percentage of editorial area
Northants 10C only	258,875	91.7%
HBB 10D only	1,007,741	97.6%
HBB + Northants 10D	1,281,450	97.4%

Table 2.4.9. Road coverage proportional indoor 1% time interference

Total Northants: 667km

Total HBB: 1,480km

Total Combined: 2147km

Site scenario	Interference limited coverage road coverage within editorial area	Percentage of roads within editorial area
Northants 10C	497	74.6%
HBB 10D only	1,448	97.8%
HBB + Northants 10D	1,999	93.1%

## 2.4.5 Impact of combined HBB and Northants on other 10D multiplexes

There are a number of multiplexes on 10D but only one is affected by the proposed merger. Humberside is slightly affected with a reduction of indoor coverage of 1.6% and mobile coverage of 3.3%.