DIGITAL RADIO PLANNING

Digital radio planning – some history

Previous Planning

- Analogue transmissions
- Fixed rooftop reception
- Assignment based
  - Transmitter parameters must be known
- Result
  - complex conference planning
  - easy implementation

Digital Radio

- New technology
  - OFDM
- mobile service
- SFNs
  - network gain
- Allotment planning
  - Transmitter parameters do not need to be known
- Improved computer technology - computers can be used to help devise a ‘plan’
- Result
  - less complex conference planning
  - Implementation more complex

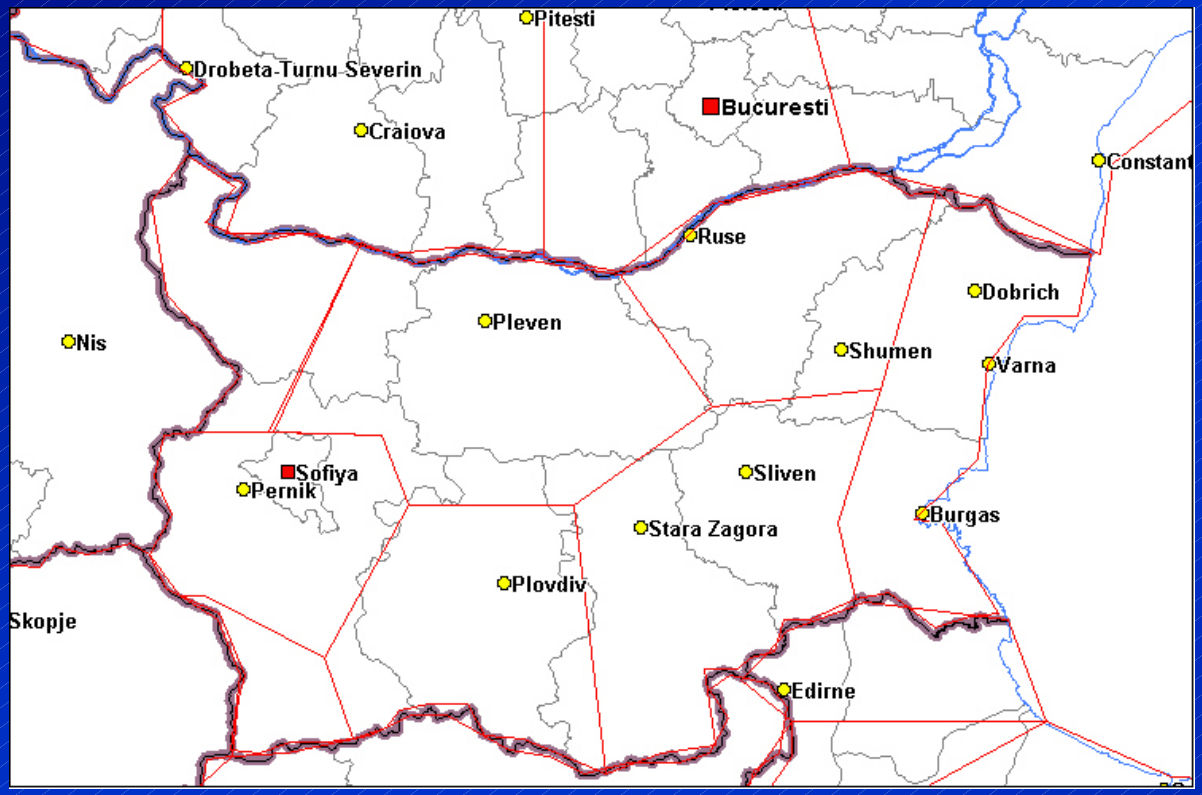
Planning meetings for T-DAB

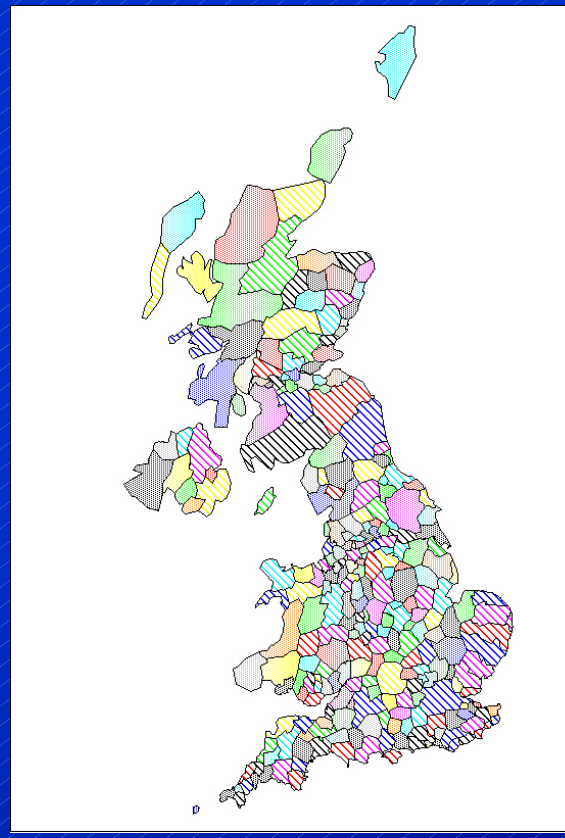
- **Wiesbaden 1995**
  - VHF Band III & L Band (1.5 GHz)
  - 2 networks, 1st & 2nd Priorities
- **Bonn 1996**
  - Implementation
- Additions to Wiesbaden Agreement
- **Maastricht 2002**
  - L Band Only,
  - 1 network, third priority
- **RRC-04 & 06**

What does allotment planning comprise?

- Decide your new requirements
  - the areas you want to serve - described as a series of test points
  - the type of service (DAB / DVB-T, fixed, mobile, portable indoor etc)
  - a preferred frequency or range if desired
- Identify other services which need to be taken into account
- Choose your reference network
  - taking into account the requirements for the type of service
- Calculate compatibility
  - to other new requirements
  - to other services which must be protected
- Assign frequencies
  - the synthesis

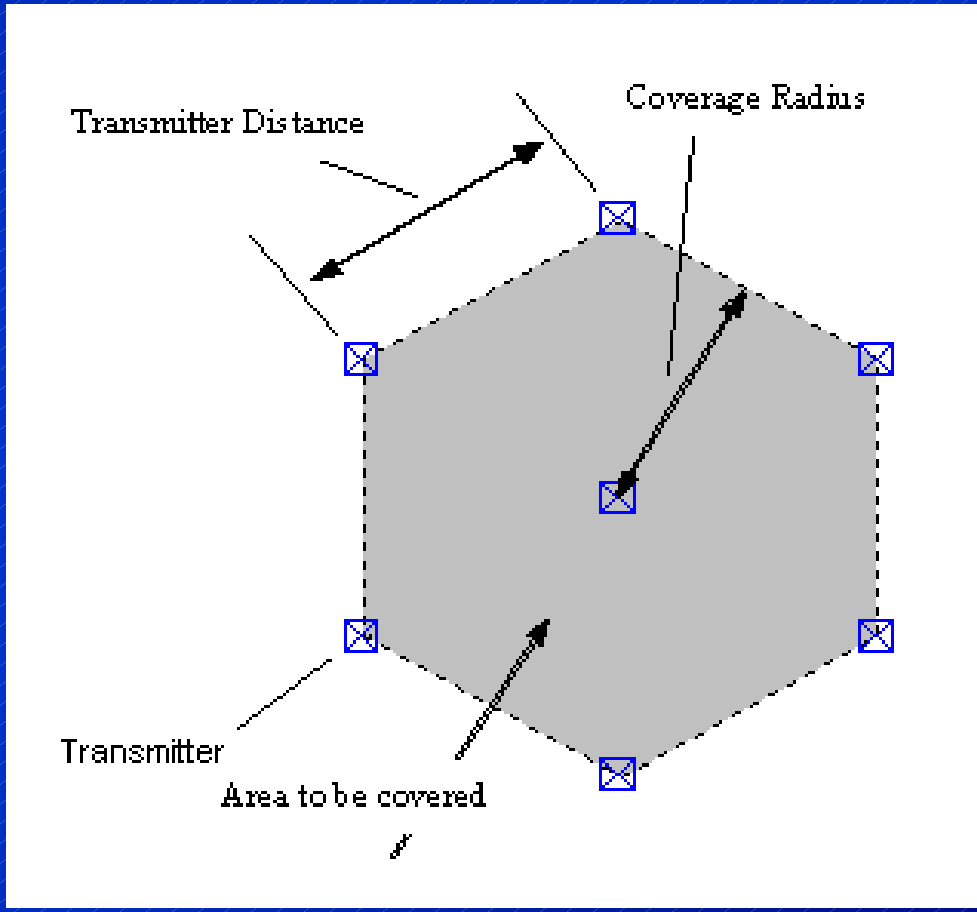
Choose your requirements



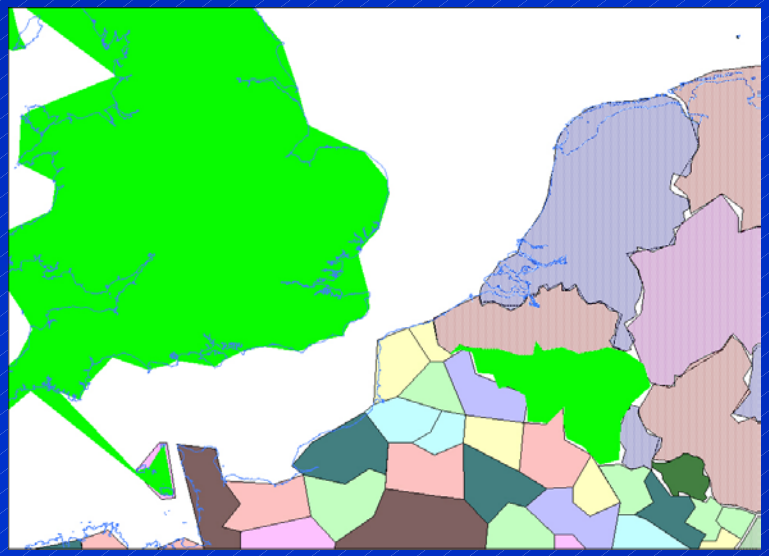


Compatibility Calculation (simplified)

- It is necessary to know which requirements will not work together.
- Reference Networks
  - Closed (shown here)
  - Open or semi-closed
- outgoing interference potential is characterised by the RN
- which is then used to assess compatibility by treating it as an interfering source
- Field strength calculation using Rec. 1546

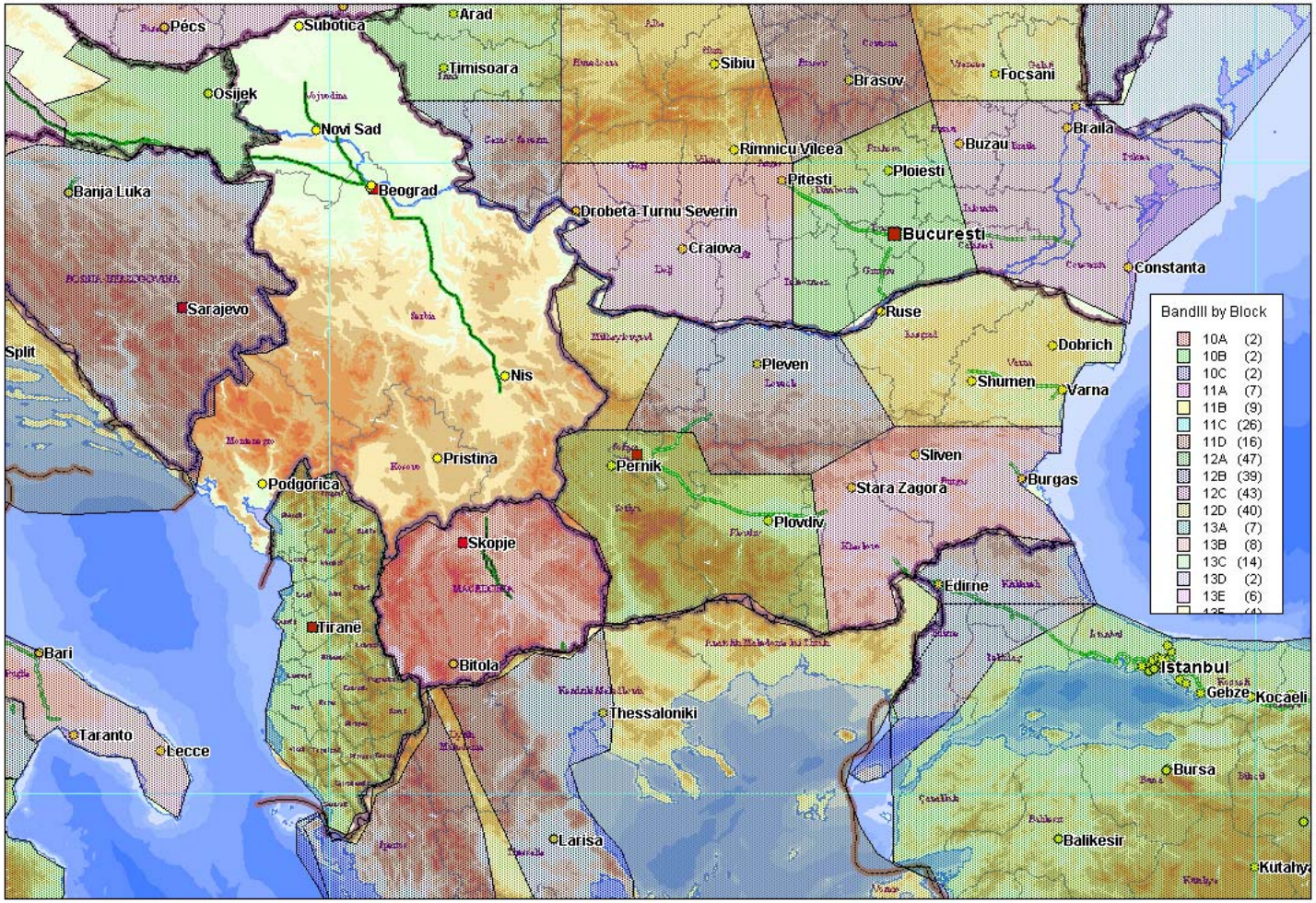


Compatibility & Synthesis



- Calculate compatibility
  - Other services
  - From each allotment area to all other allotment areas
- Use a synthesis program to try and fit frequencies to areas
  - Compatibility
  - Preferences
- Special Agreements between Administrations

Band III Allotments (from Wiesbaden)



Implementation (Bonn 1996)

- Simple Rule
  - the real transmitter network should cause no more interference than a reference network.
  - A ‘threshold’ value for maximum interfering field strength is calculated and agreed for the required service

- Test Points
  - the reference network is used to calculate the position of ‘calculation test points’
  - the total interfering field strength from the real network at those test points is calculated according to set rules
  - If the total interfering field strength of the real network is below the threshold value, then no further co-ordination is required.
  - If the total interfering field strength of the real network exceeds the threshold value – then bilateral negotiations are required

Bonn Summation

- The power sum is obtained as follows:
  - starting with the highest interfering source, the power values equivalent to the interfering field strengths are added, one after the other;
  - at each summation, the result is compared to the previous one;
  - if the increase in power is greater than or equal to 0.5 dB, the summation process continues and the next interfering transmitter is taken into account as well;
  - if the increase in power would have been less than 0.5 dB, the summation process is stopped and 0.5 dB is added instead, giving the result of the power sum.
- The final 0.5 dB is used to represent all the remaining interfering transmitter, which each contribute less than 0.5 dB.

Example

- For a single calculation test point, with a T-DAB allotment converted into a network of 6 assignments, Transmitters 1 to 6, the power summation process would be as detailed below:
- Note: The first stage of the summation process is to sort the transmitters in order of decreasing equivalent field strength
- The corresponding power factor, power summation and conversion back to the resulting equivalent field strength are calculated
- Note: transmitter 6 does not feature directly in the calculation.

Tx	Equivalent Field strength E_n (dBµV/m)	Corresponding Power Factor P_r	Progressive Power Sum $\sum_p$	Corresponding Equivalent Field Strength E_{ps} (dBµV/m)	Increase (dB)	Comment	Resulting Equivalent Field Strength (dBµV/m)
Tx 3	13.55	22.65	22.65	13.55		Continue summation	13.55
Tx 4	12.73	18.75	41.40	16.17	2.62	Increase due to this Tx will be more than 0.5 dB, so continue.	16.17
Tx 2	11.88	15.42	56.81	17.54	1.37	Increase due to this Tx will be more than 0.5 dB, so continue.	17.54
Tx 5	11.21	13.21	70.03	18.45	0.91	Increase due to this Tx will be more than 0.5 dB, so continue.	18.95
Tx 1	8.31	6.78	76.80	18.85	0.40	Increase due to this Tx will be less than 0.5 dB, so add 0.5 dB and stop summation.	19.45

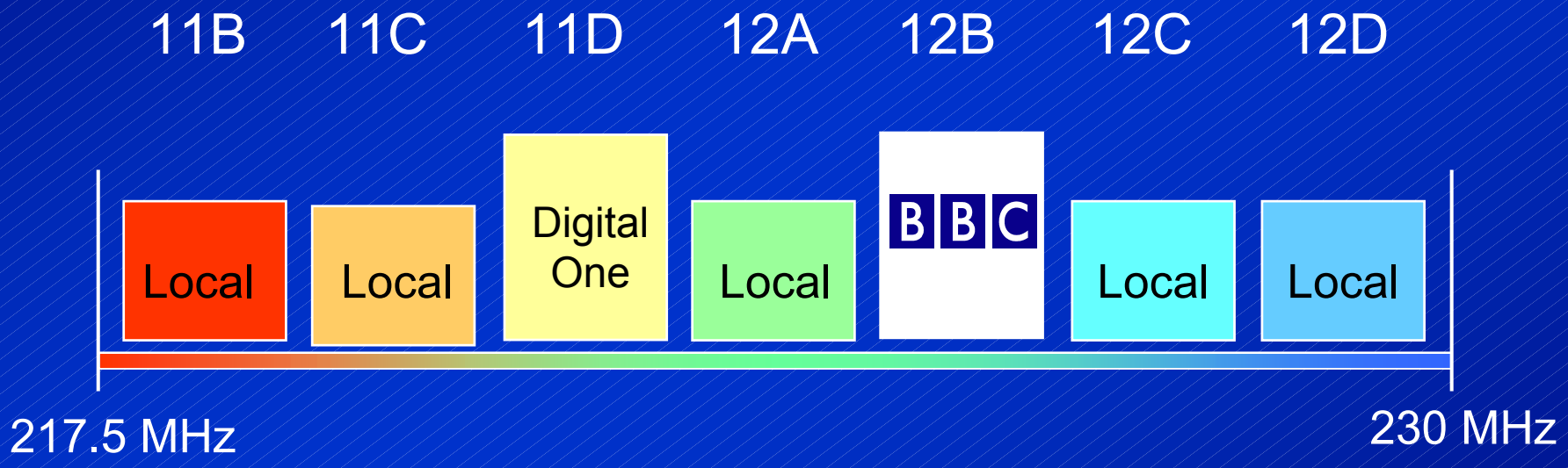
The next step for T-DAB (and DVB-T)

- RRC-06
- Bands III
  - T-DAB
  - DVB-T
- Bands IV & V
  - DVB-T only
- Will be a mixture of allotment planning & assignment planning
- Requirements for new services need to be prepared
- Requirements for the protection of existing services need to be prepared
- Sharing criteria for DVB-T and T-DAB in Band III have been documented in the report of the 1st session
- RPCs, Reference Networks and sharing parameters for other services also all documented in the report of the 1st session

BBC DAB National Network Expansion Implementation Issues

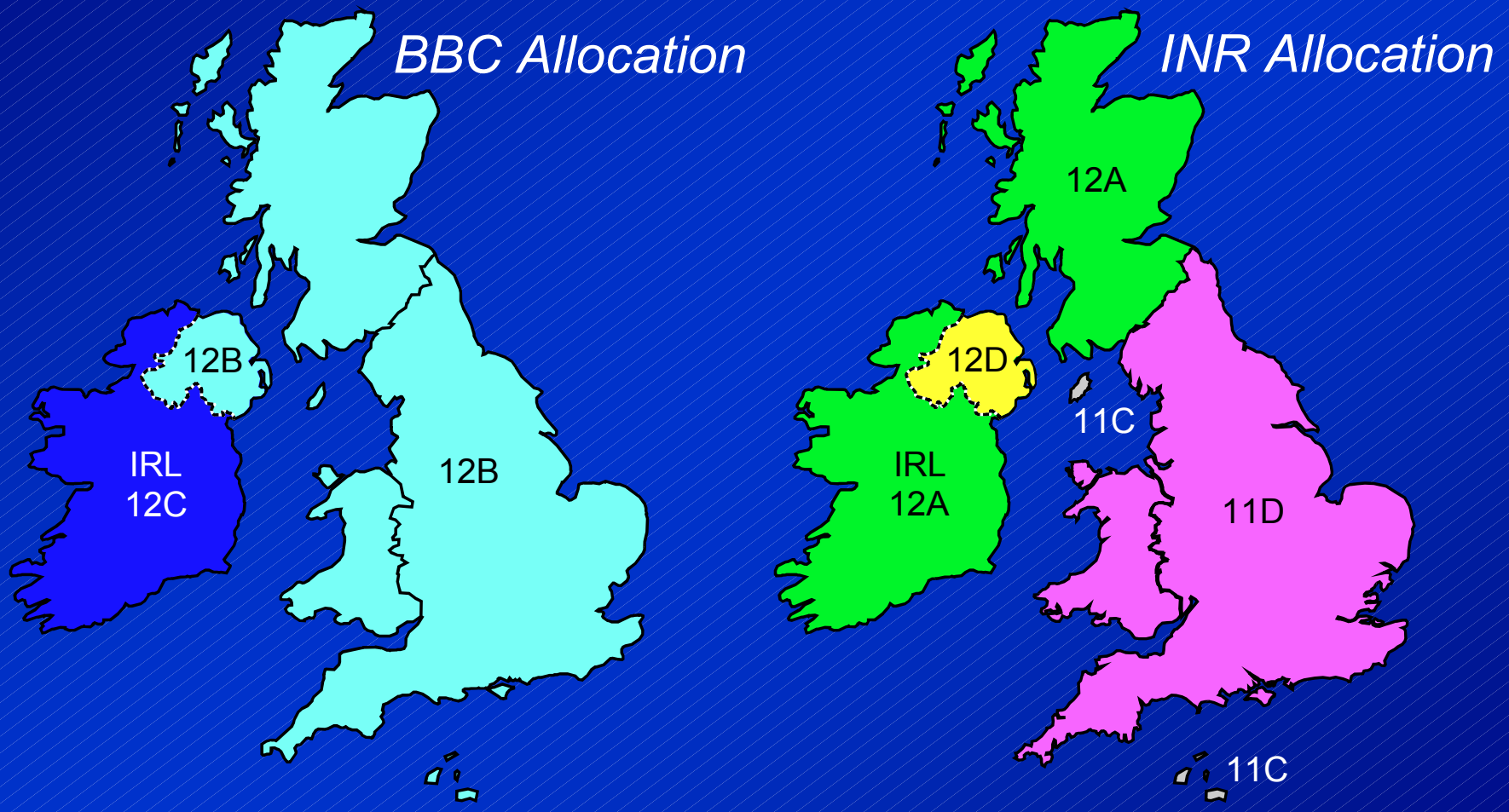
2003 - 2004

Band III T-DAB frequency spectrum used in England and Wales

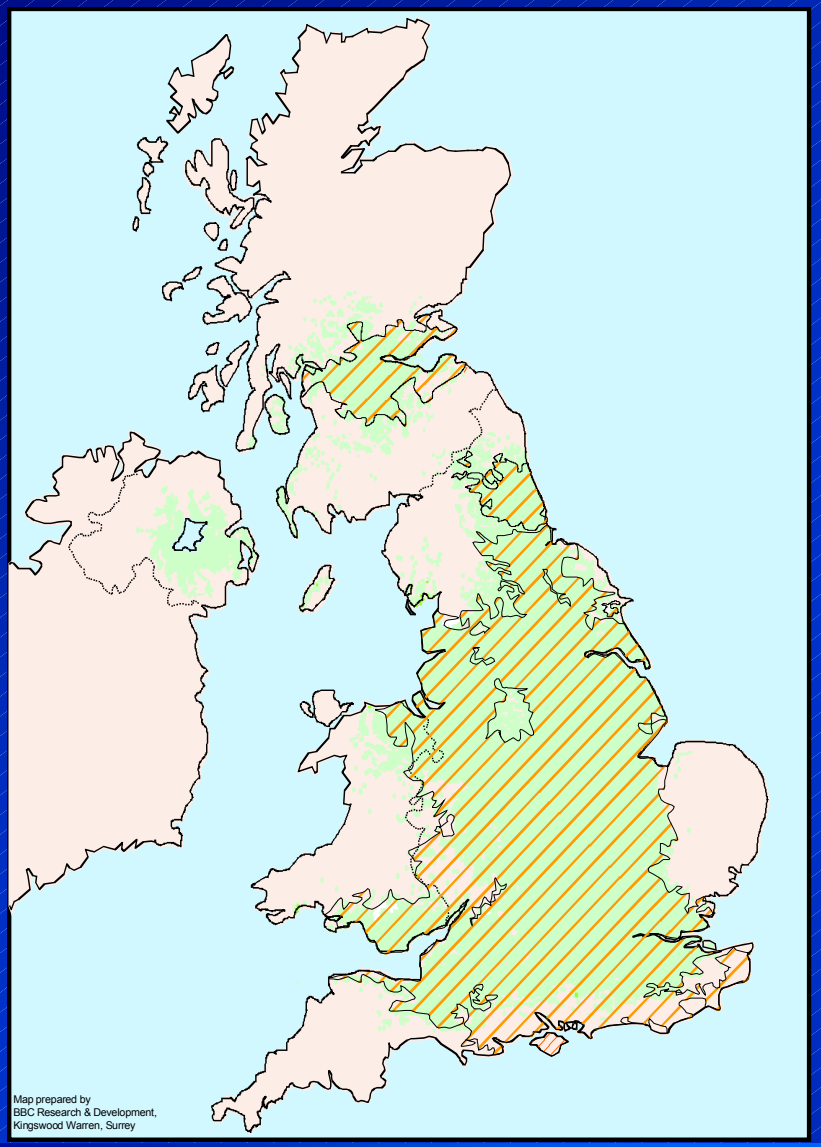


5 Blocks used for UK local & regional services

T-DAB national channel allocation in the UK and Ireland



Digital Radio: national networks

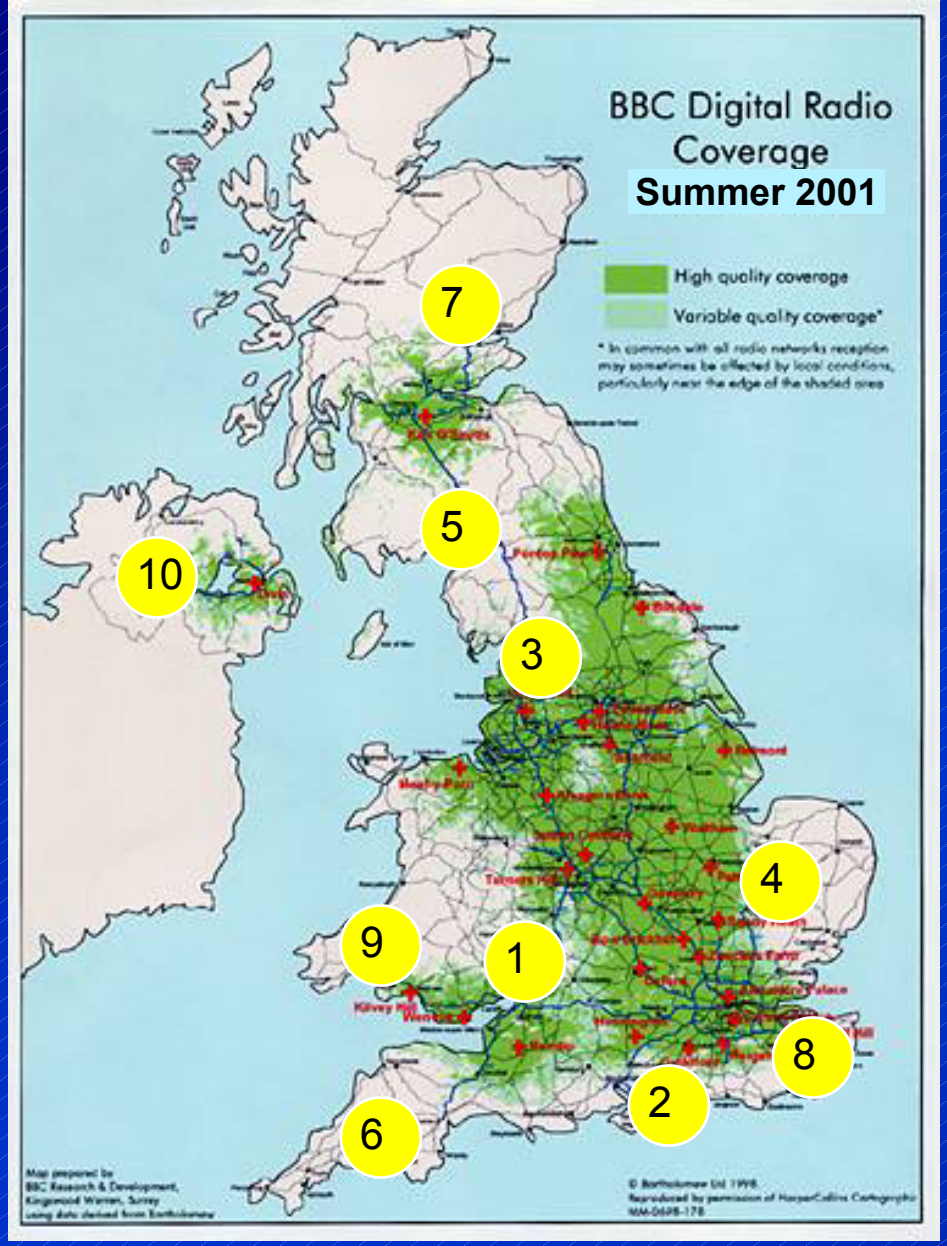


- By Autumn 2001, the BBC network consisted of 32 transmitting stations serving 65% of the UK population
- Digital One had declared a target of 85% coverage of GB by end of 2002
- The BBC has now declared a target of 85% coverage of UK
- BBC's current expansion is 40 additional stations by end of 2004, giving 85% of UK coverage

Autumn 2001 figures

BBC
32 stations, 65% of UK

Digital One (INR)
51 stations, 82% of GB



BBC Digital Radio targets for coverage extension to 85% of the UK population

- 1 M5/M4 corridor
- 2 South coast
- 3 Pennine belt
- 4 East Anglia
- 5 M6/A74 corridor
- 6 SW England
- 7 Scotland
- 8 Kent
- 9 Wales
- 10 Northern Ireland

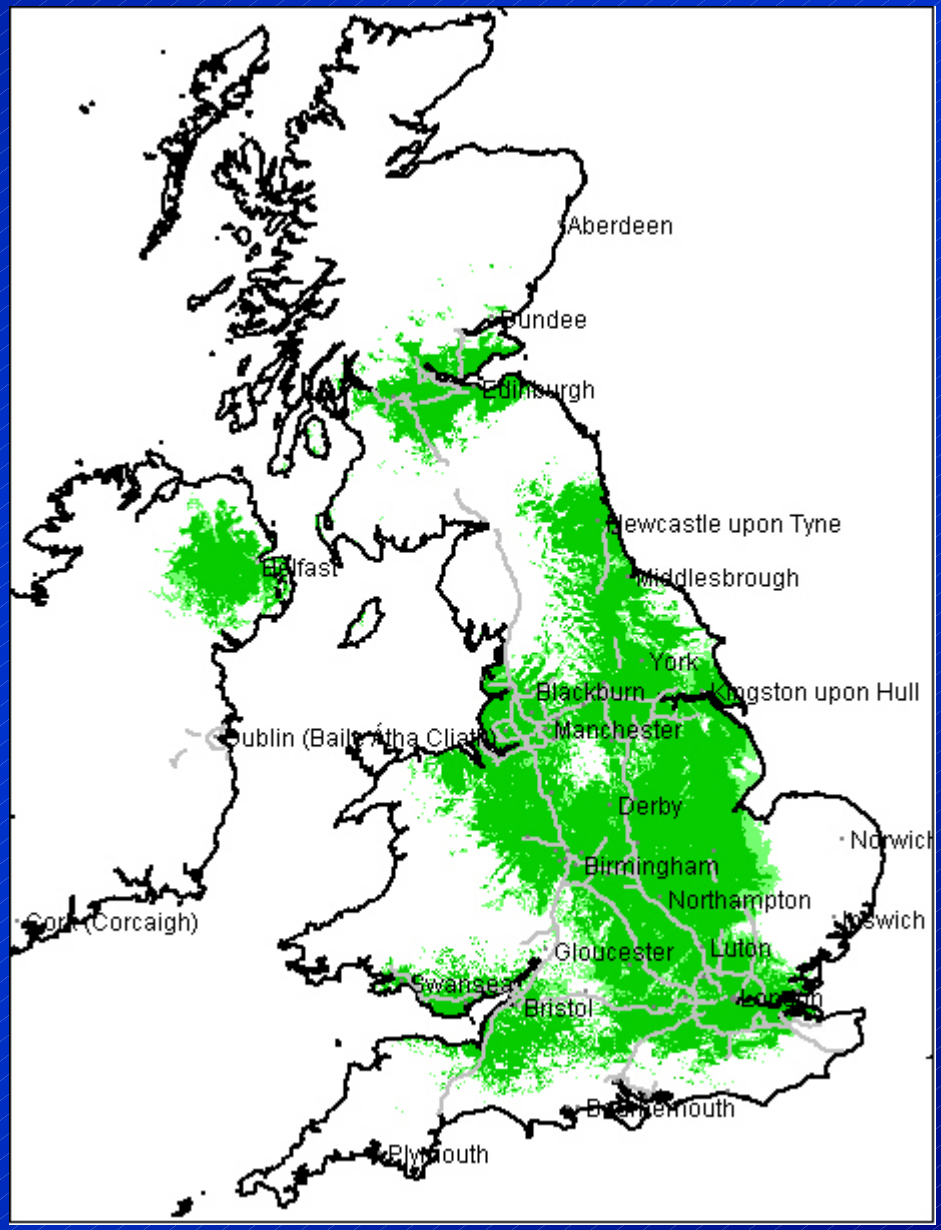
Existing Coverage

2003

High quality coverage

Variable quality coverage*

*In common with all radio networks, reception may Sometimes be affected by local conditions, Particularly near the edge of the shaded area



This map shows predicted coverage, actual coverage may differ.

Consolidation phase

2003 - 4

High quality coverage

Variable quality coverage*

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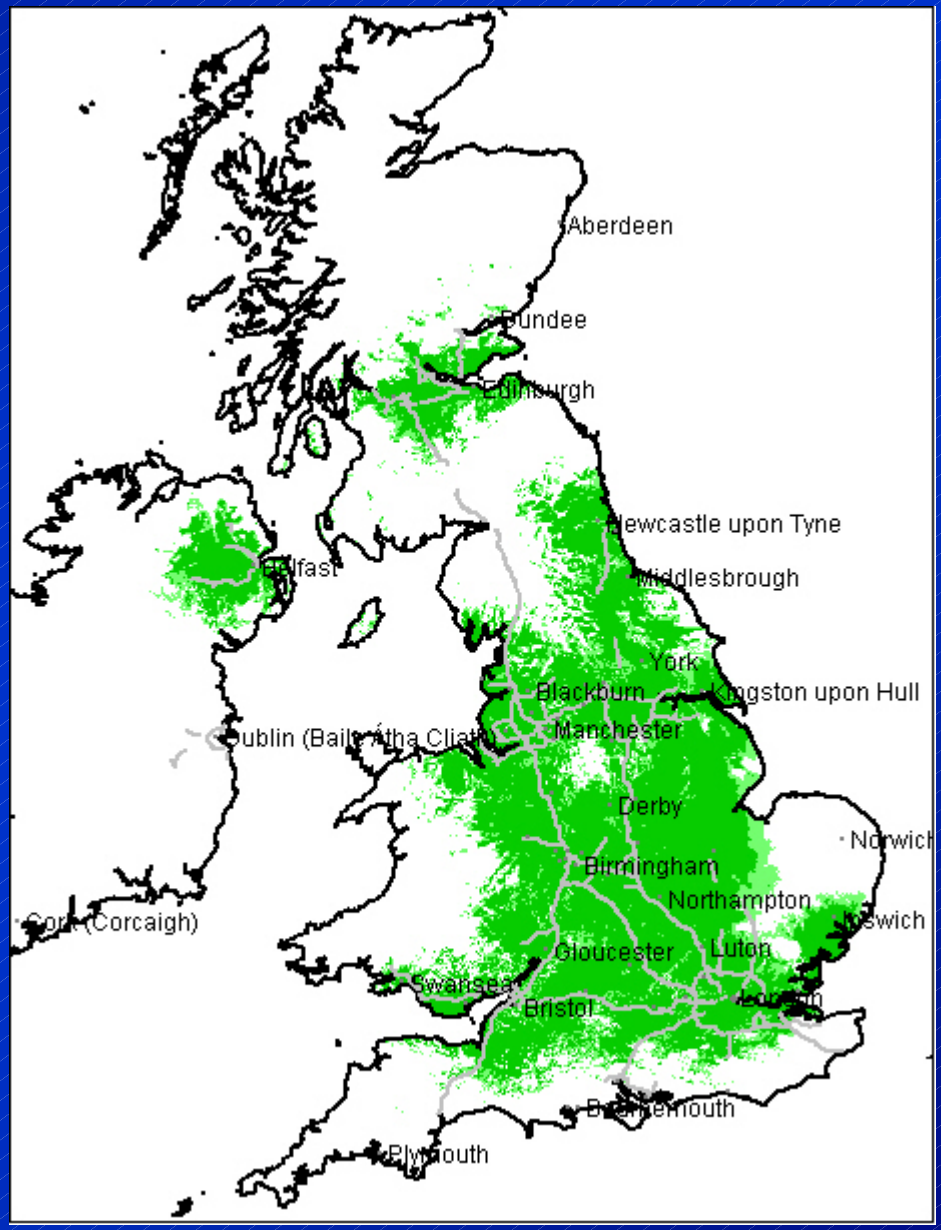

Note: commissioning dates of individual transmitters will vary. This map shows predicted coverage, actual coverage may differ.

Expansion into South East England

2003 - 4

High quality coverage

Variable quality coverage*

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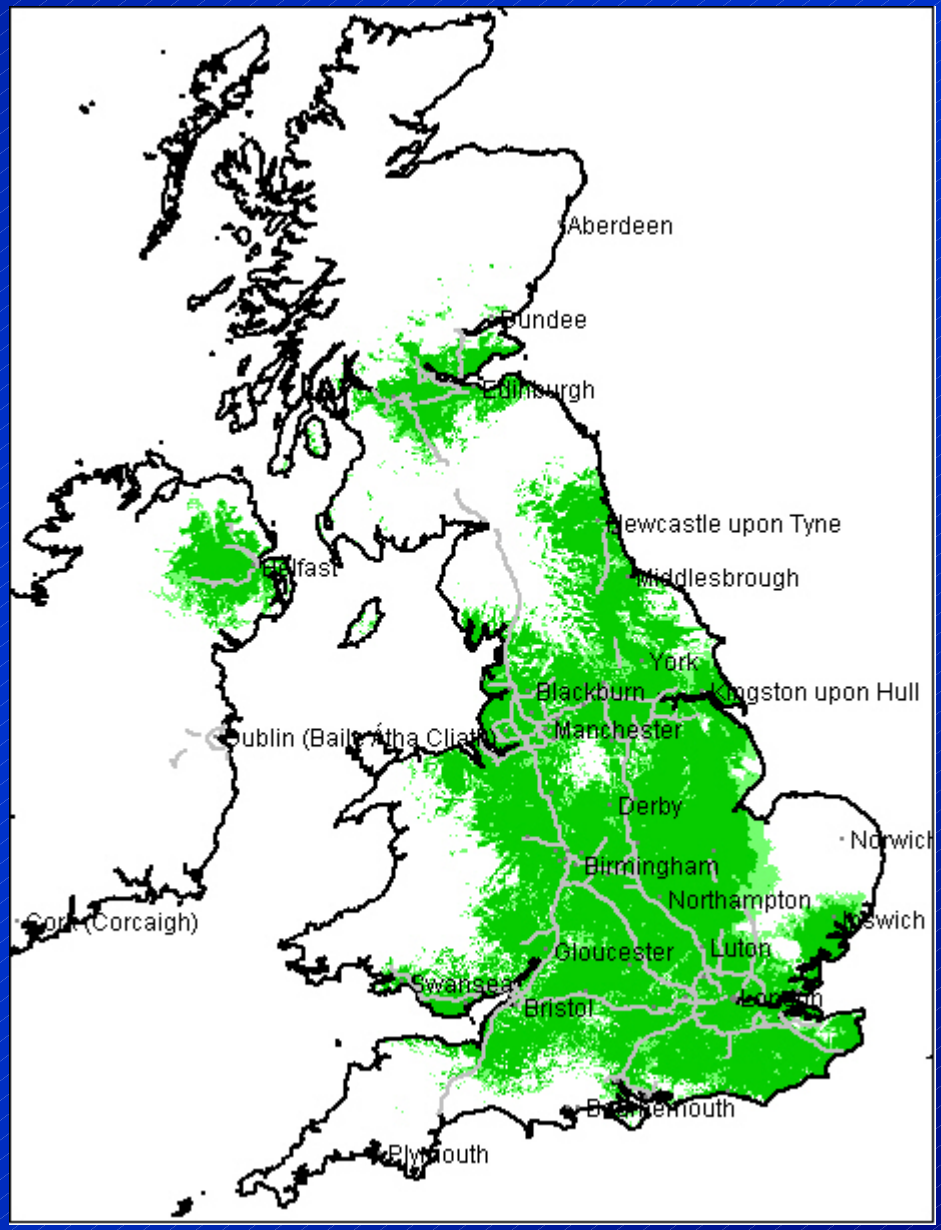

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Expansion into East Anglia

2003 - 4

High quality coverage

Variable quality coverage*

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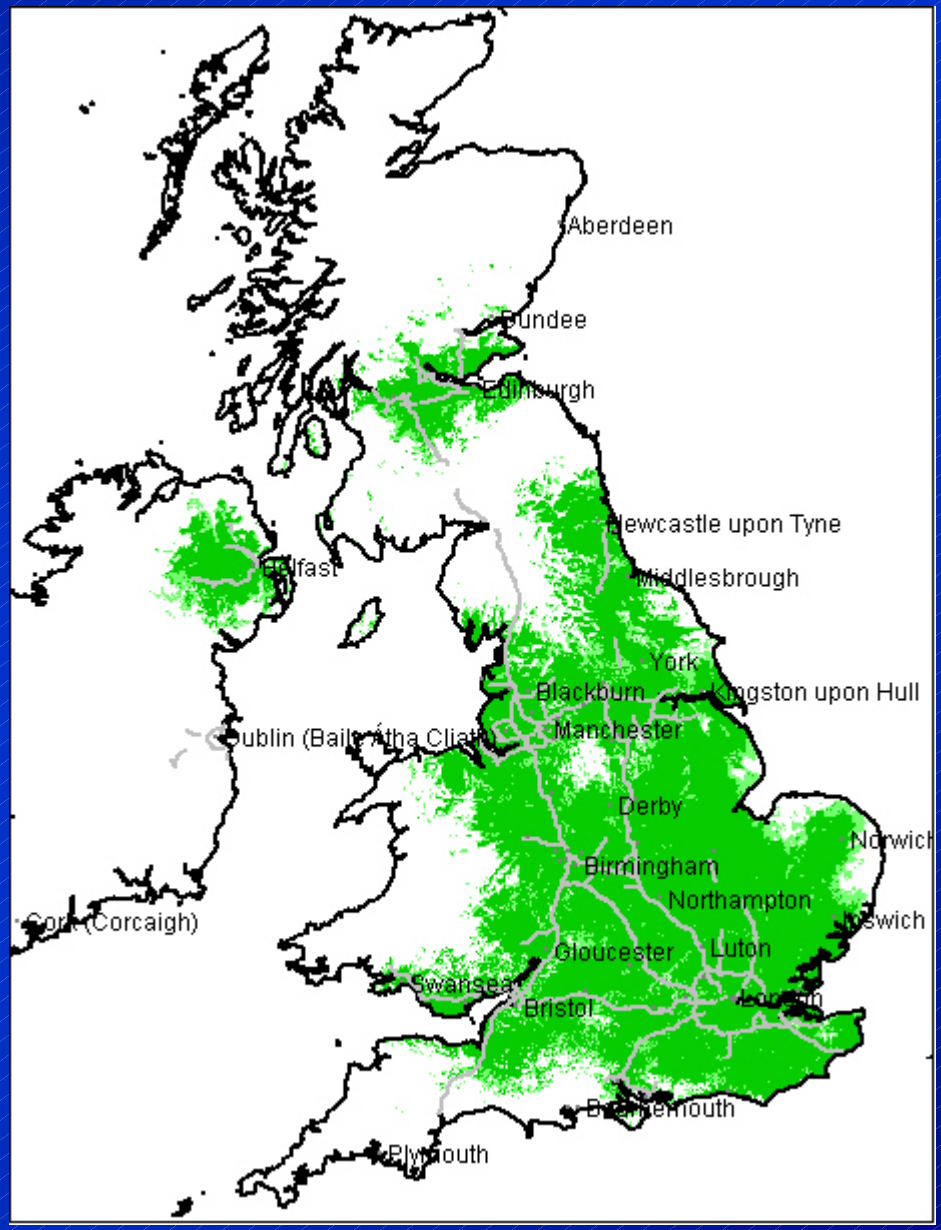

Note: commissioning dates of individual transmitters will vary. This map shows predicted coverage, actual coverage may differ.

Expansion into South West England

2003 - 4

High quality coverage

Variable quality coverage*

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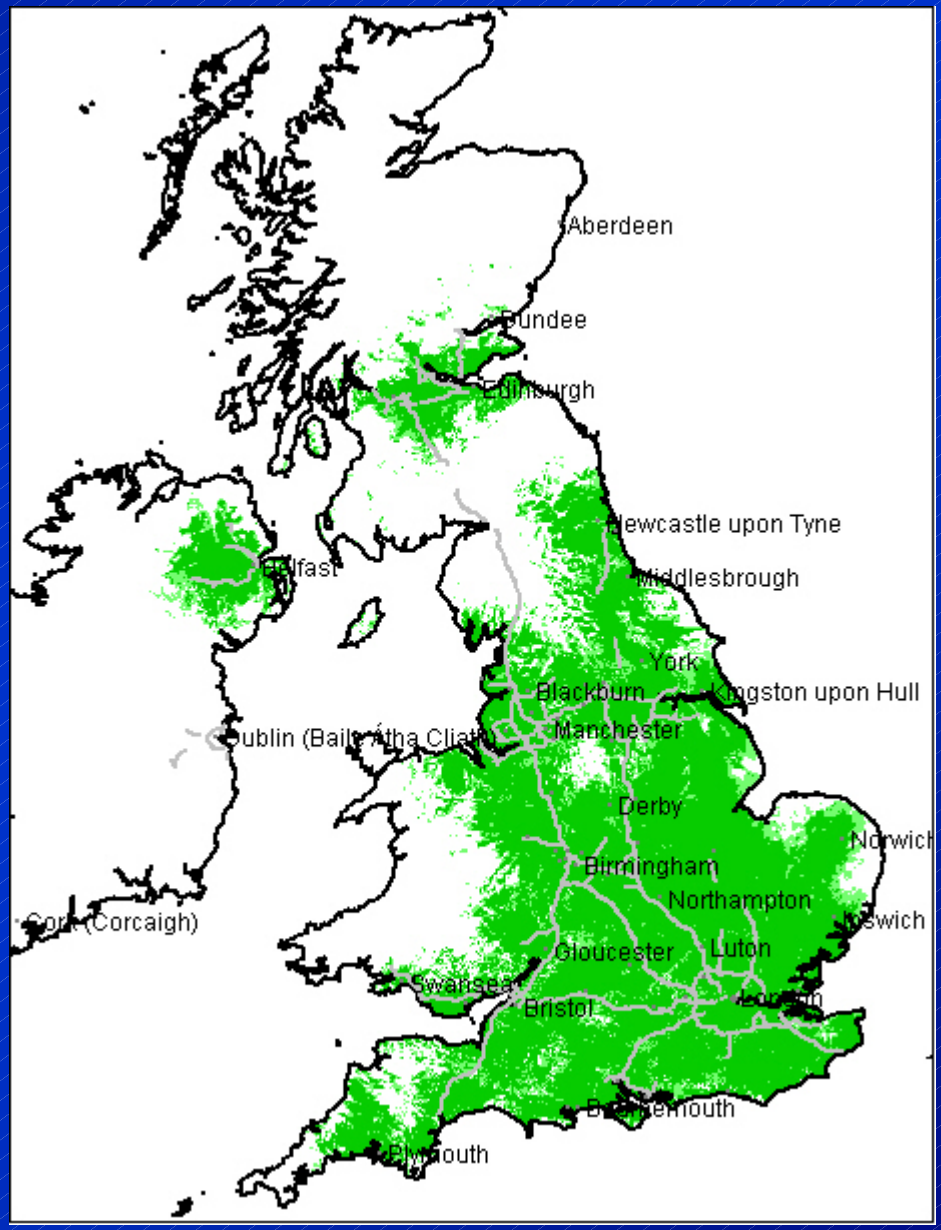

Note: commissioning dates of individual transmitters will vary. This map shows predicted coverage, actual coverage may differ.

Expansion into North West England

2003 - 4

High quality coverage

Variable quality coverage*

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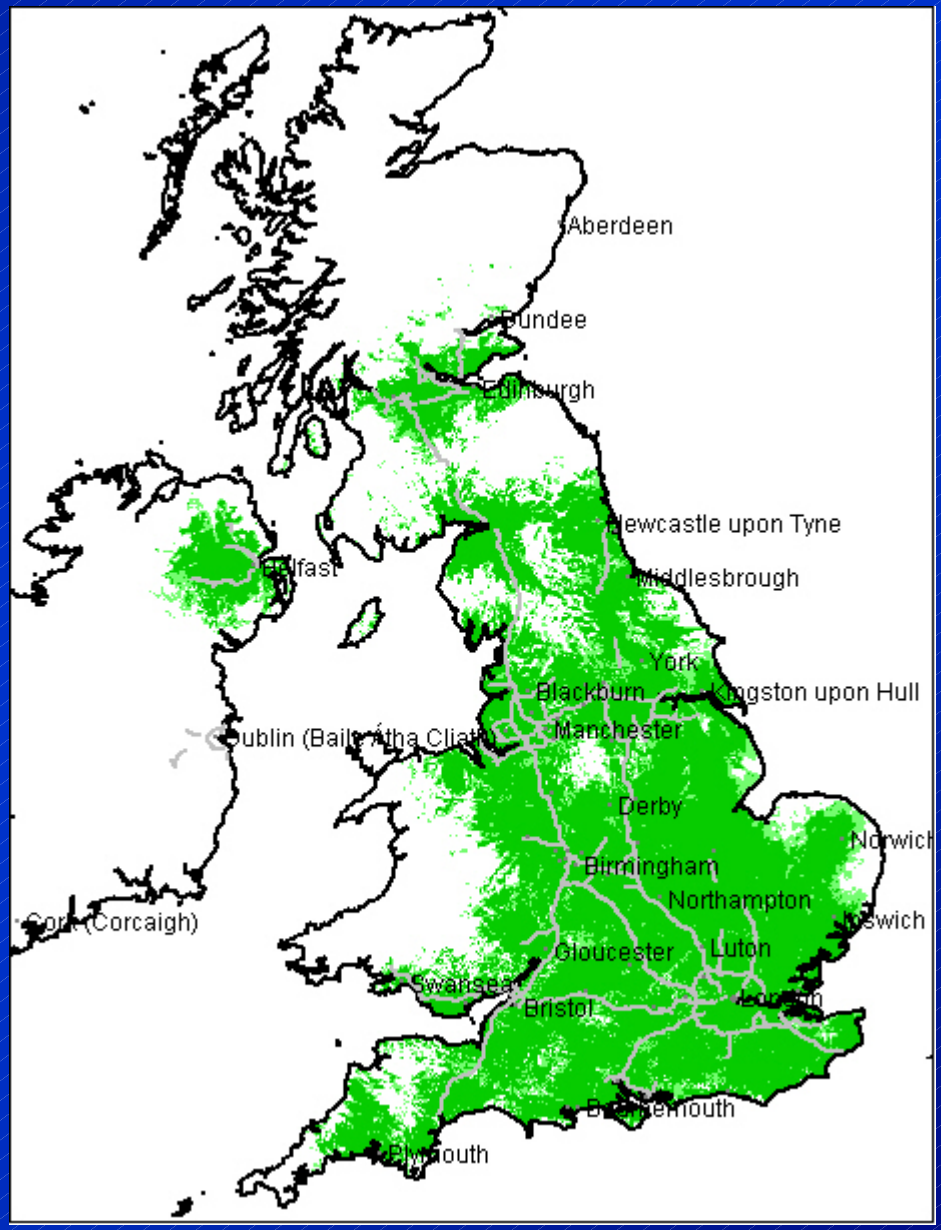

Note: commissioning dates of individual transmitters will vary. This map shows predicted coverage, actual coverage may differ.

Expansion into Scotland

2003 - 4

High quality coverage

Variable quality coverage*

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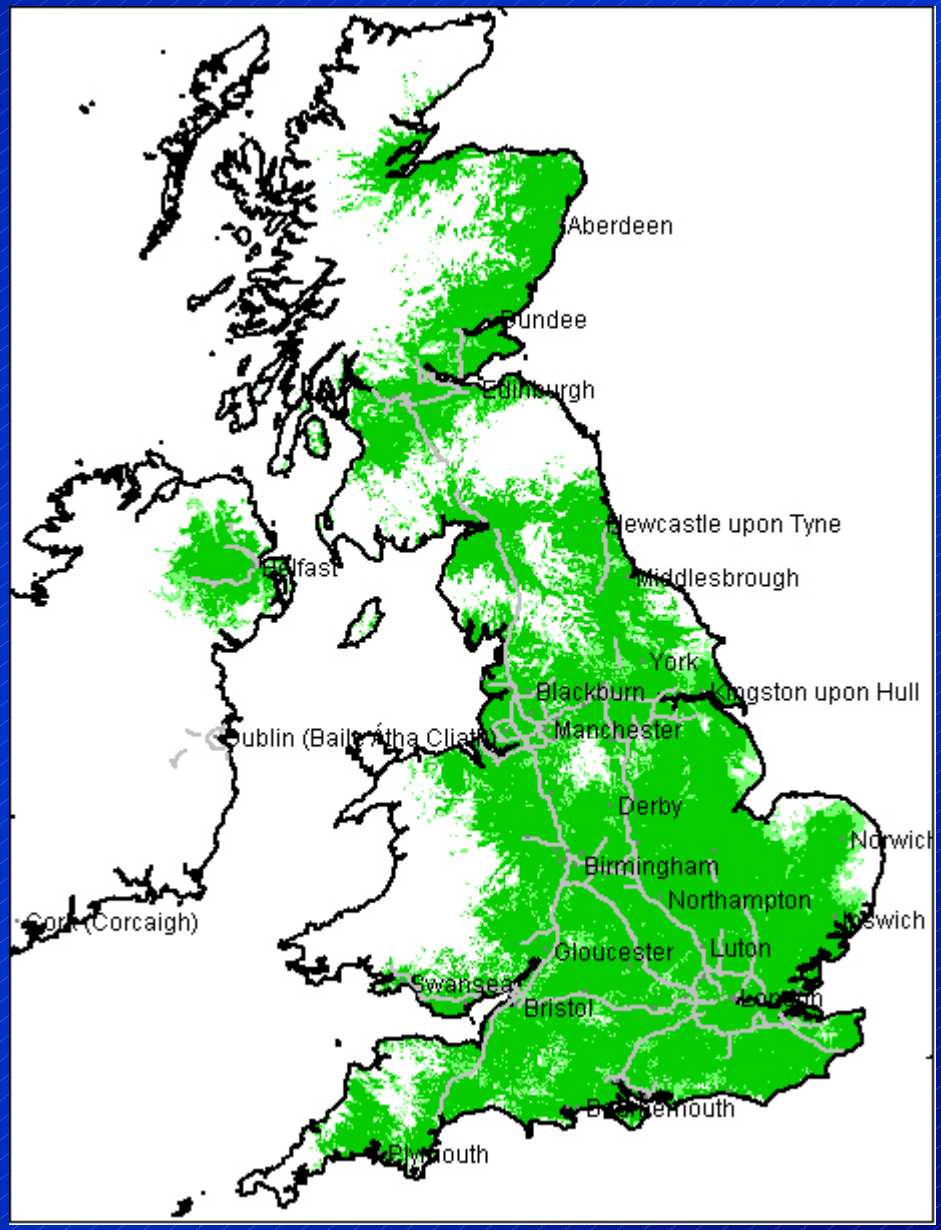


Note: commissioning dates of individual transmitters will vary. This map shows predicted coverage, actual coverage may differ.

Planning Considerations for an SFN

- When Single Frequency Networks are being planned particular parameters should be taken into consideration. These are:

- Transmitter synchronisation & timing
  - Not just same frequency, need same content
- Summation of field strengths & network gain
  - Multiple signals at a given receiving location (within the guard interval) can result in an increase in the wanted fields strength
- Maximum transmitter distance & self-interference
  - Signals from adjacent transmitters should ideally arrive within the guard interval – or self interference efects may result

Timing Issues

Adding Lancaster & Morecambe Bay to the BBC National Network SFN

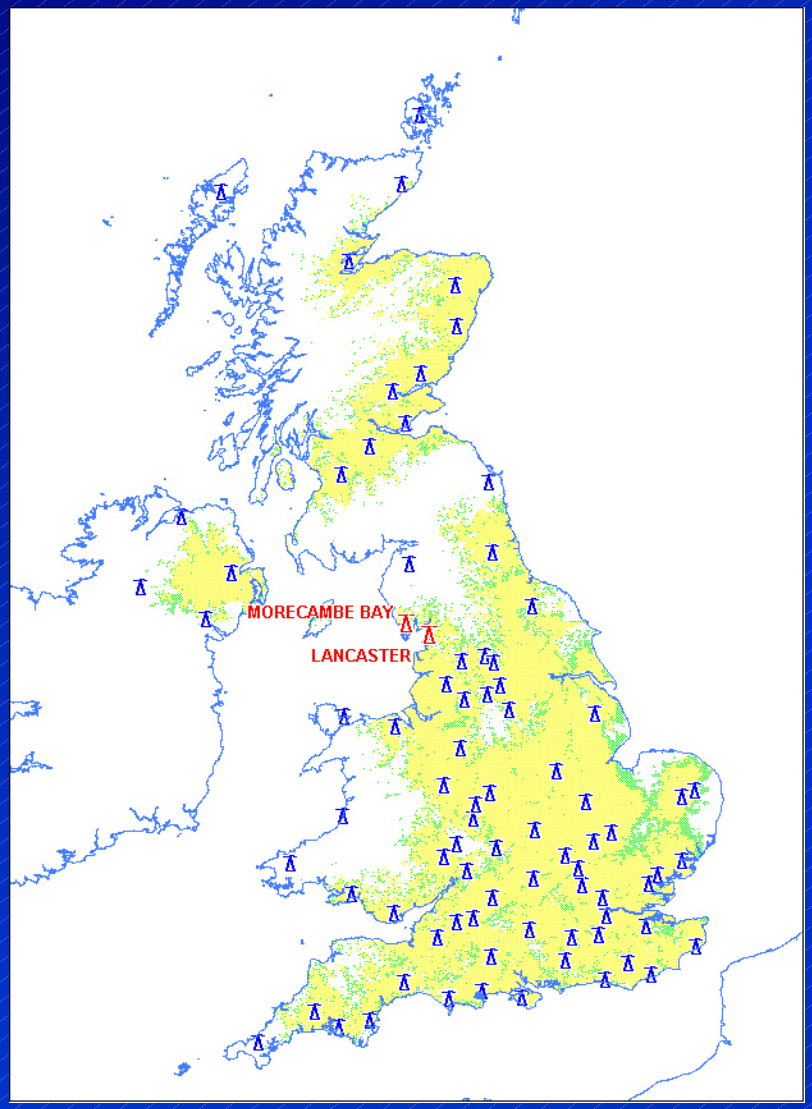
- Lancaster 2 kW e.r.p. nominally omni-directional
- Network synchronized time is 800 μsecs

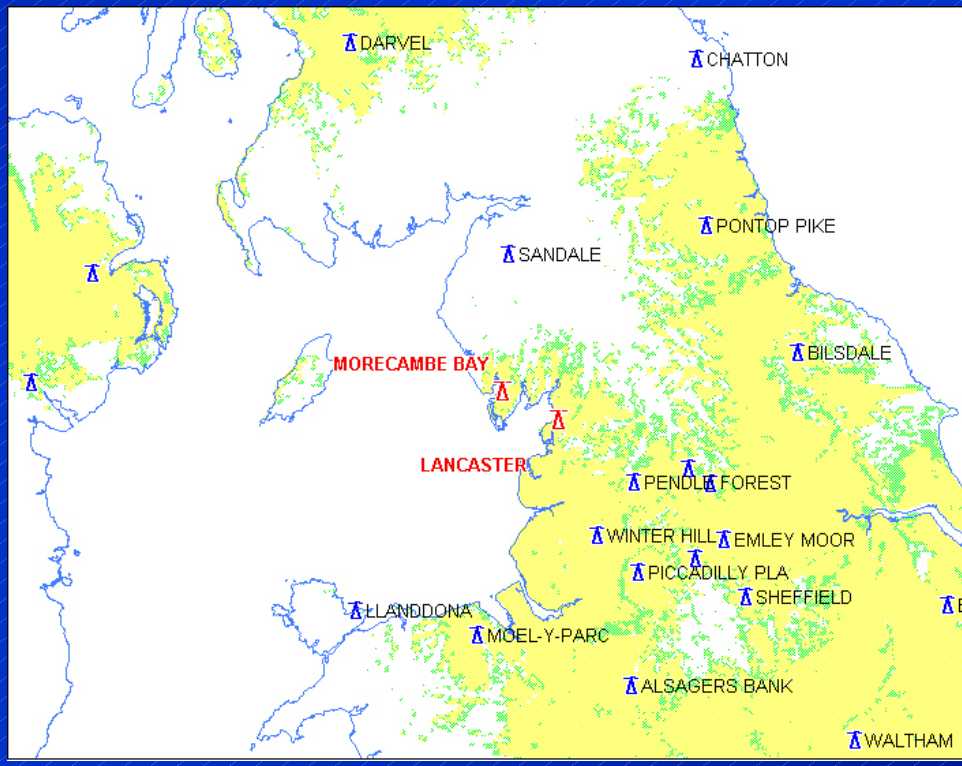
Map Colours

- Green, areas that improve substantially
- Grey, areas that improve ‘a bit’ (should be light green)
- Light Blue, areas that do not change
- Light red, areas that get ‘a bit ‘ worse
- Dark Red, areas that get ‘a lot’ worse

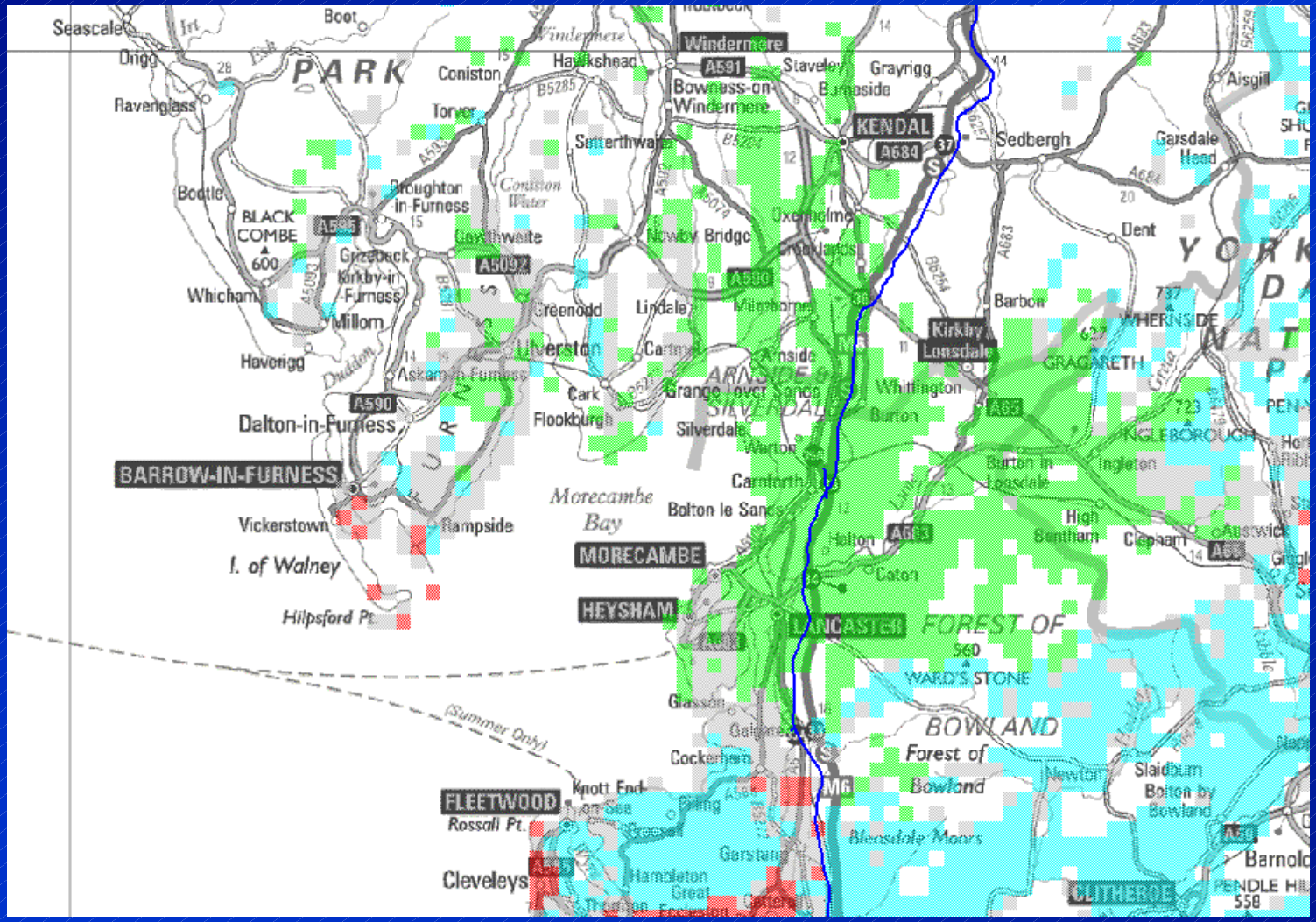
- Note that these colours only denote change, they give no indication of whether an area is served or unserved!

UK Map with transmitters





Lancaster 750 µs



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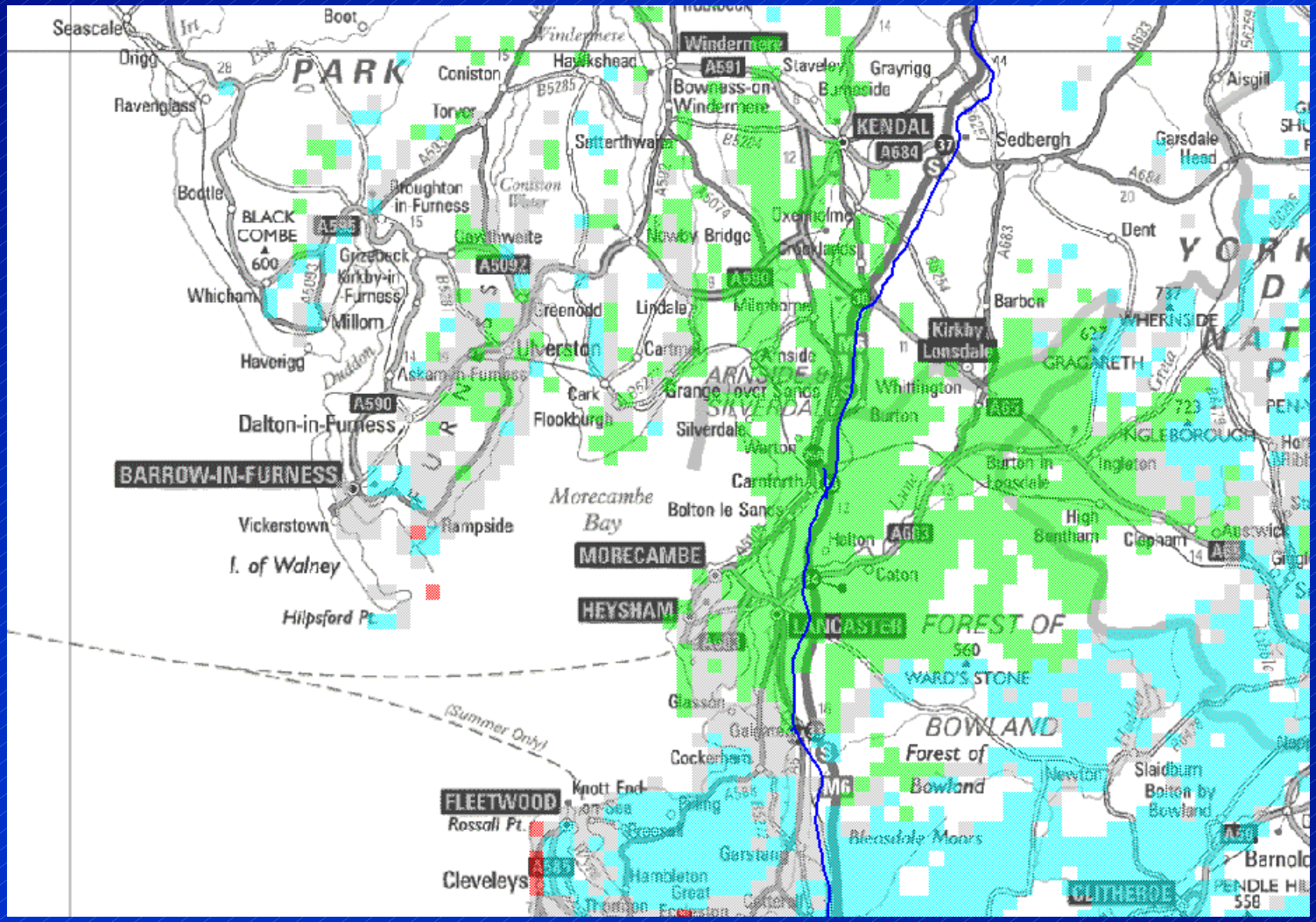
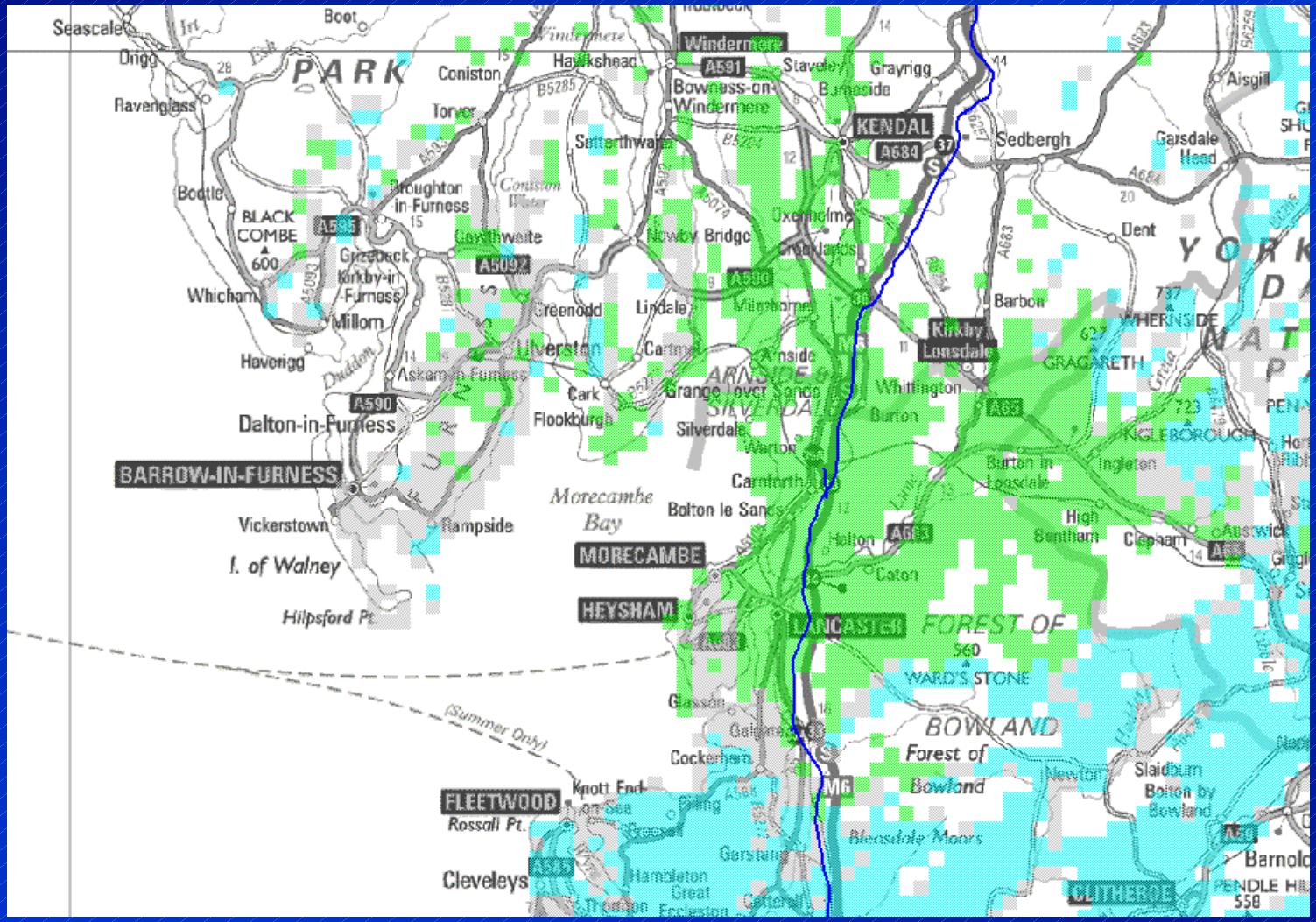
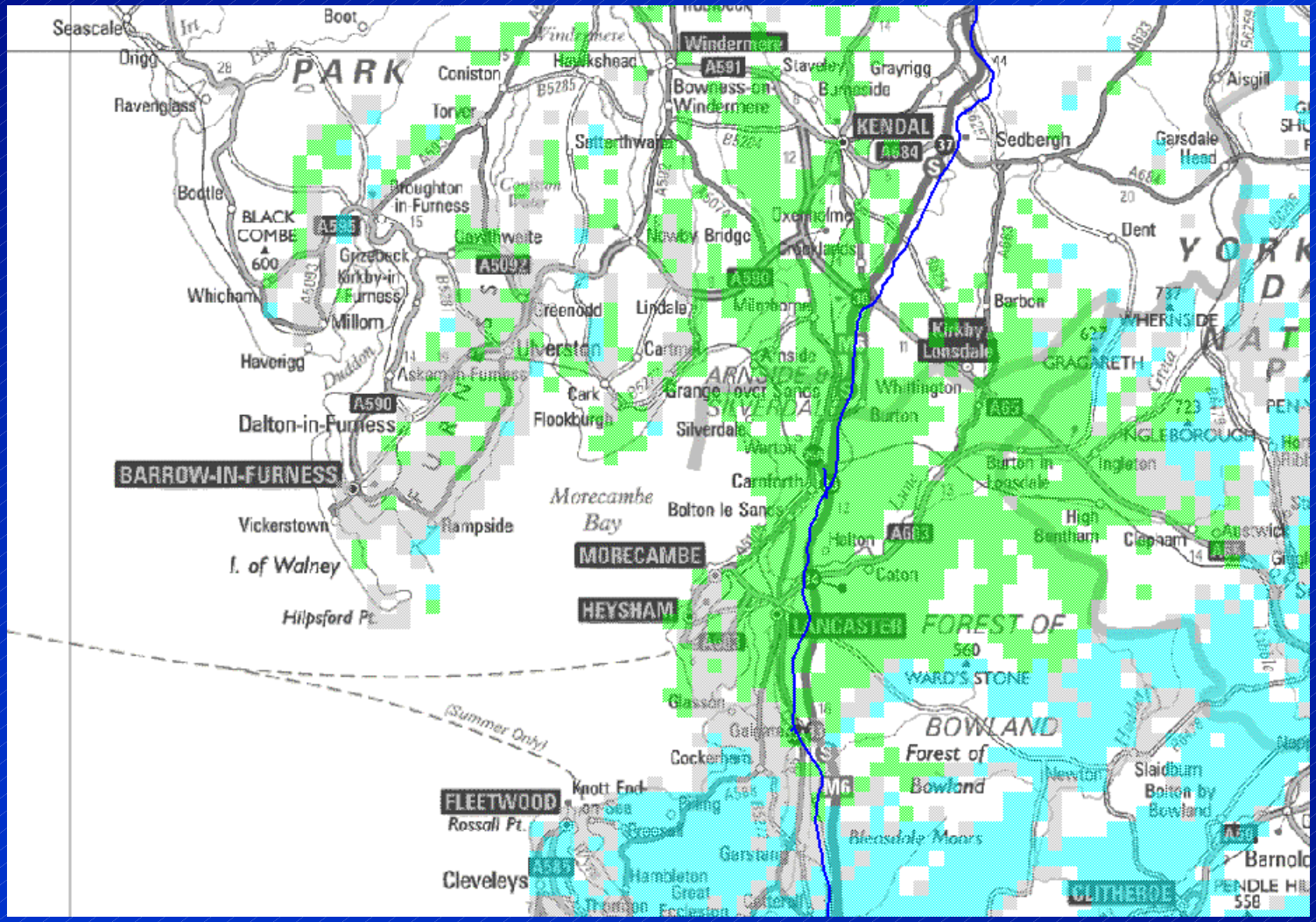


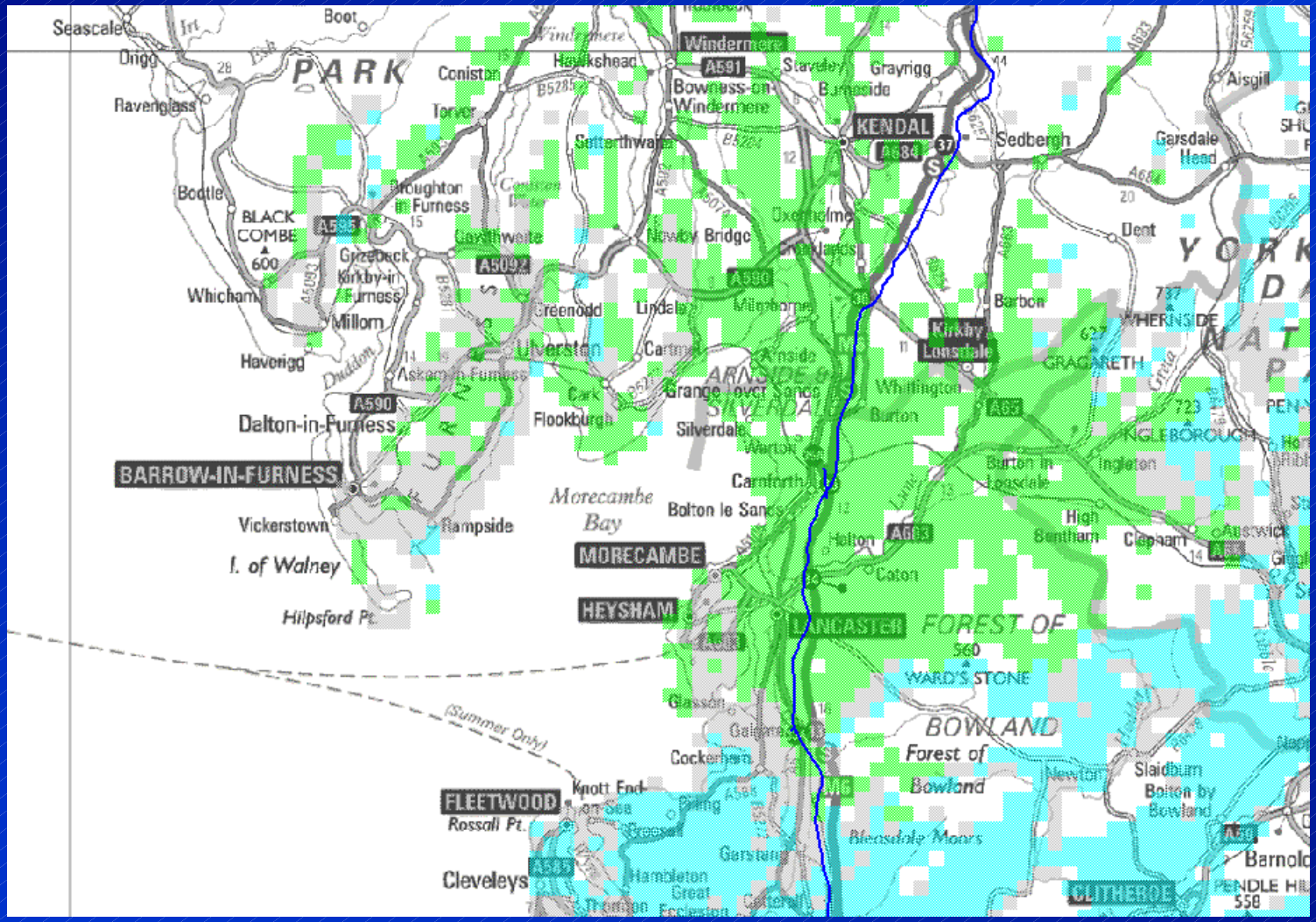
Lancaster 800 µs



Lancaster 825 µs



Lancaster 850 µs



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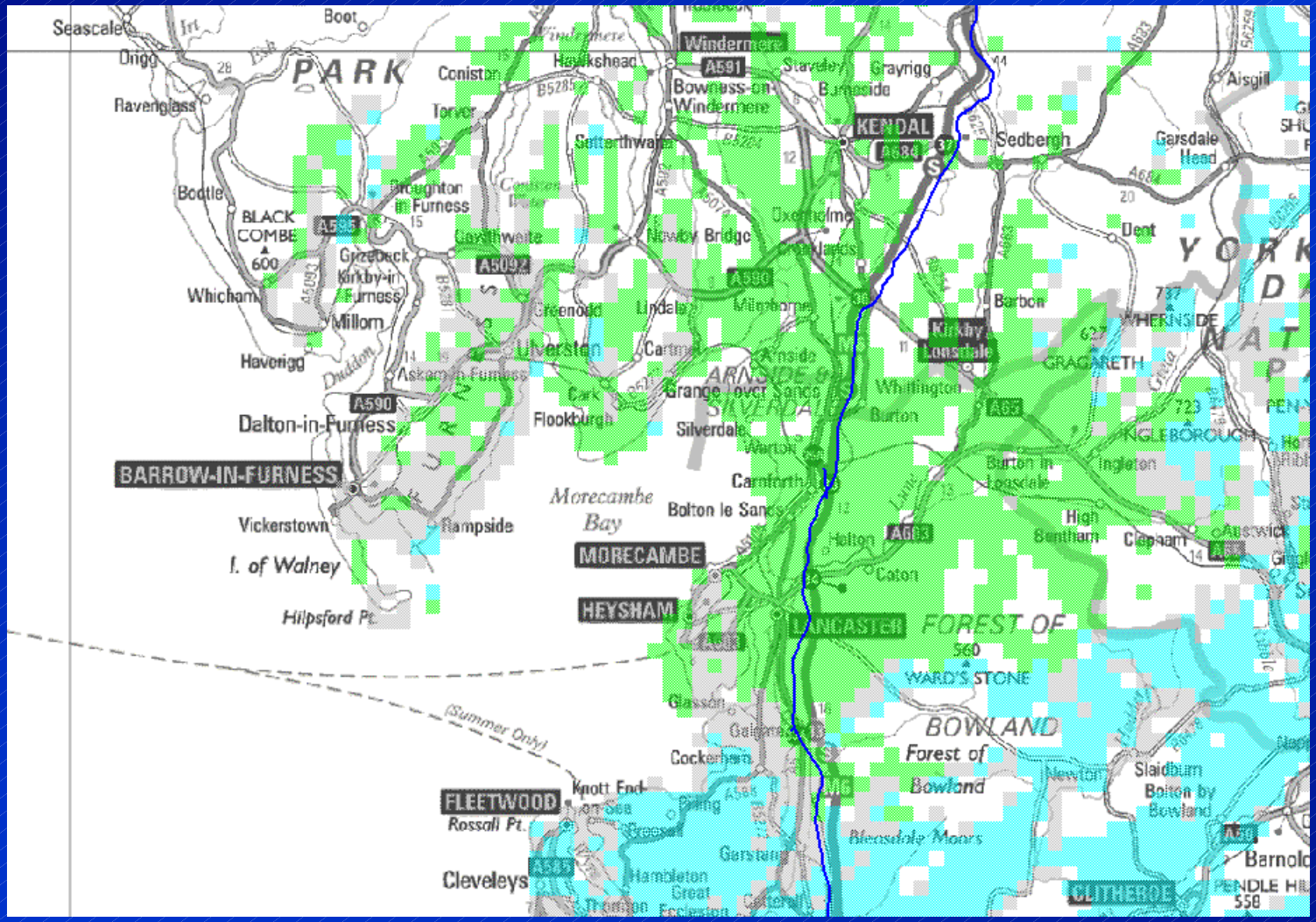
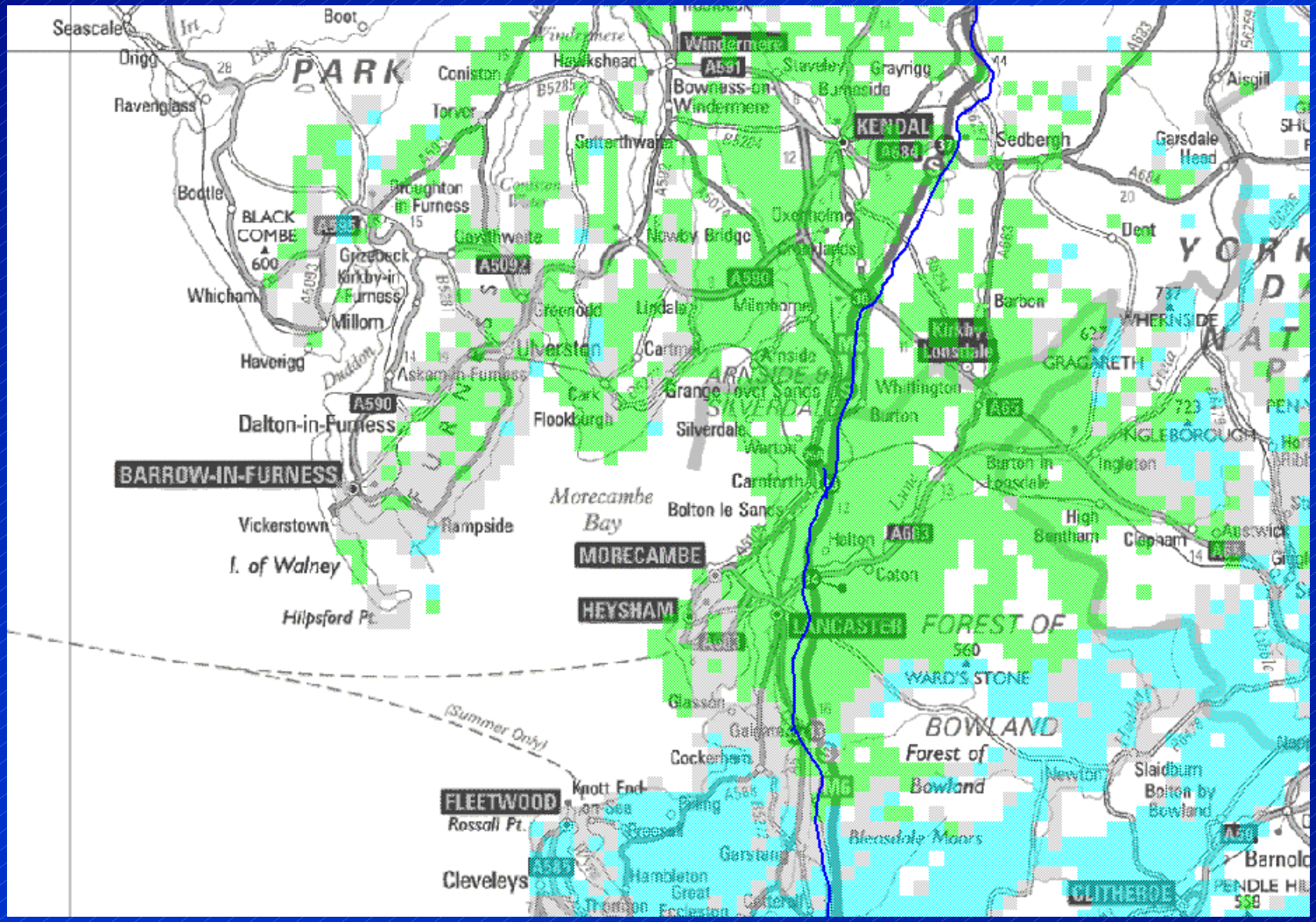


Lancaster 900 µs



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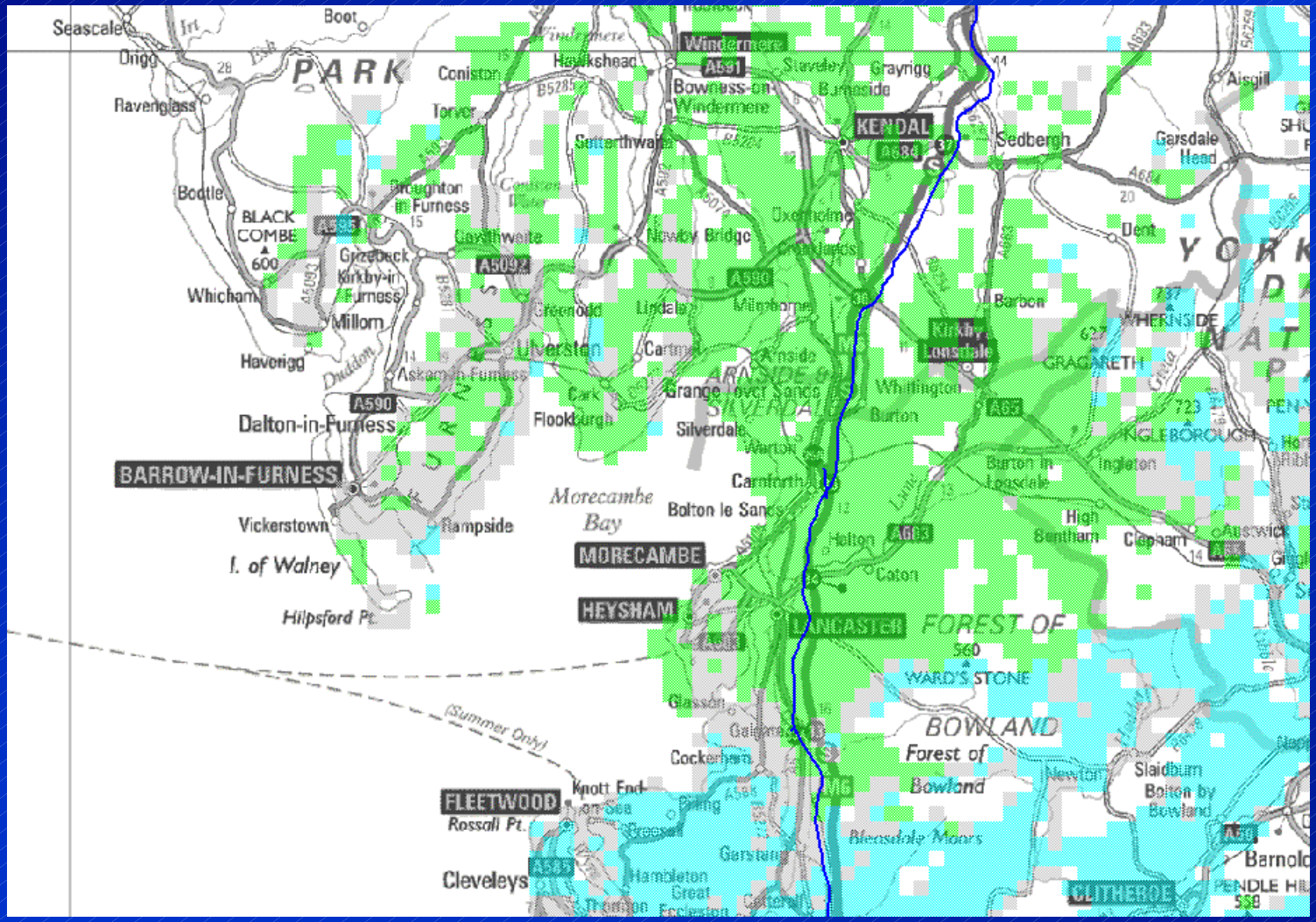

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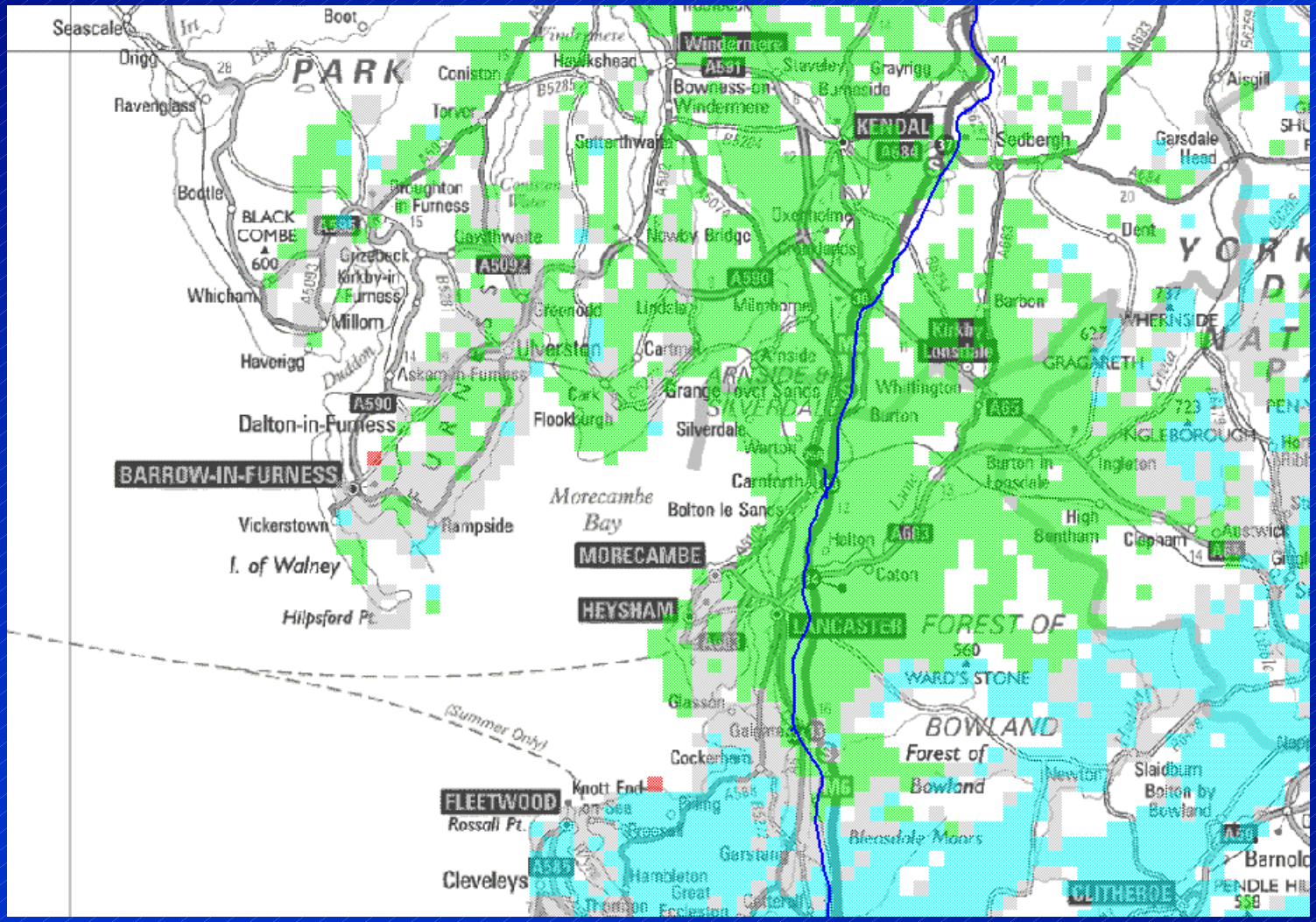

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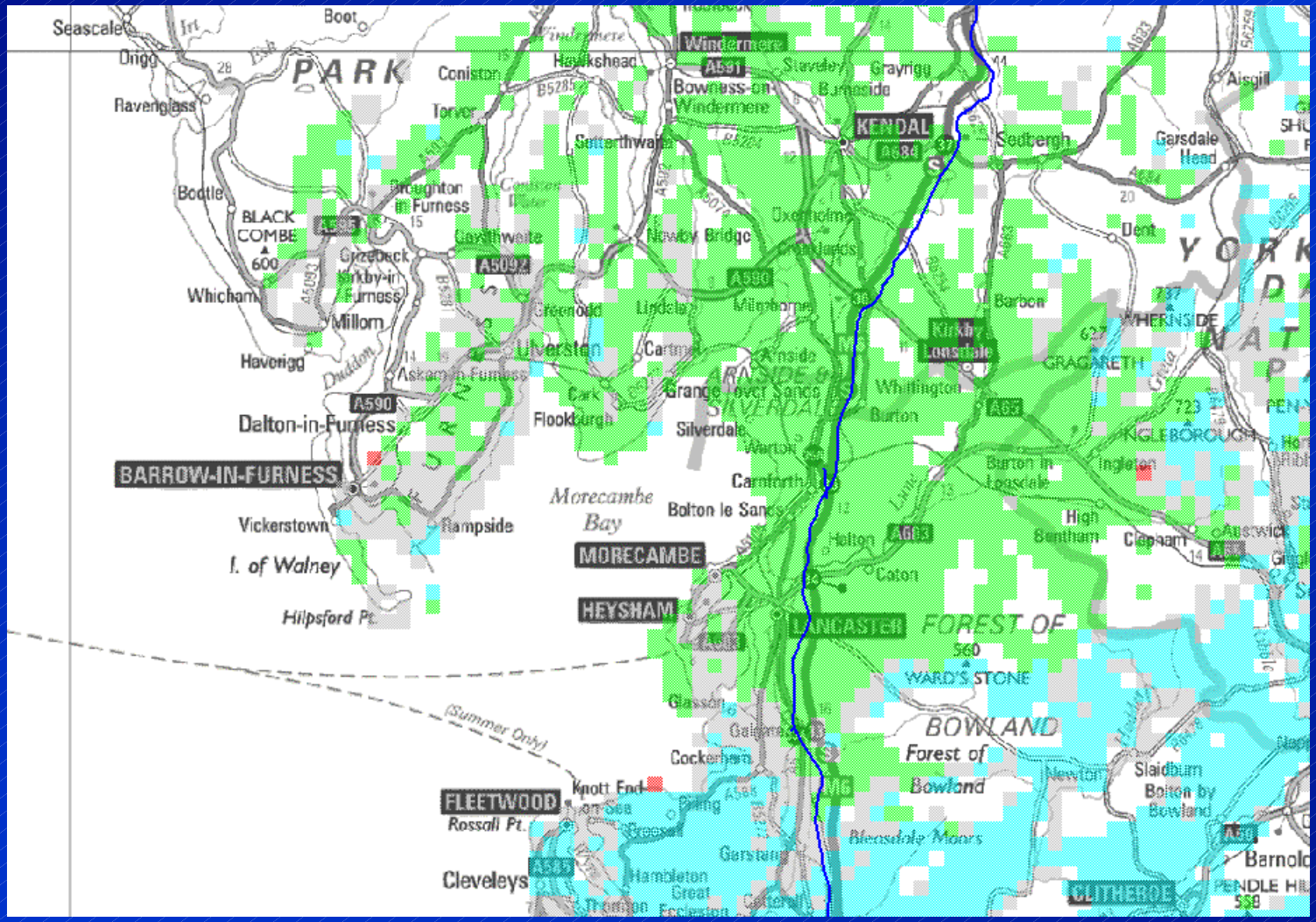
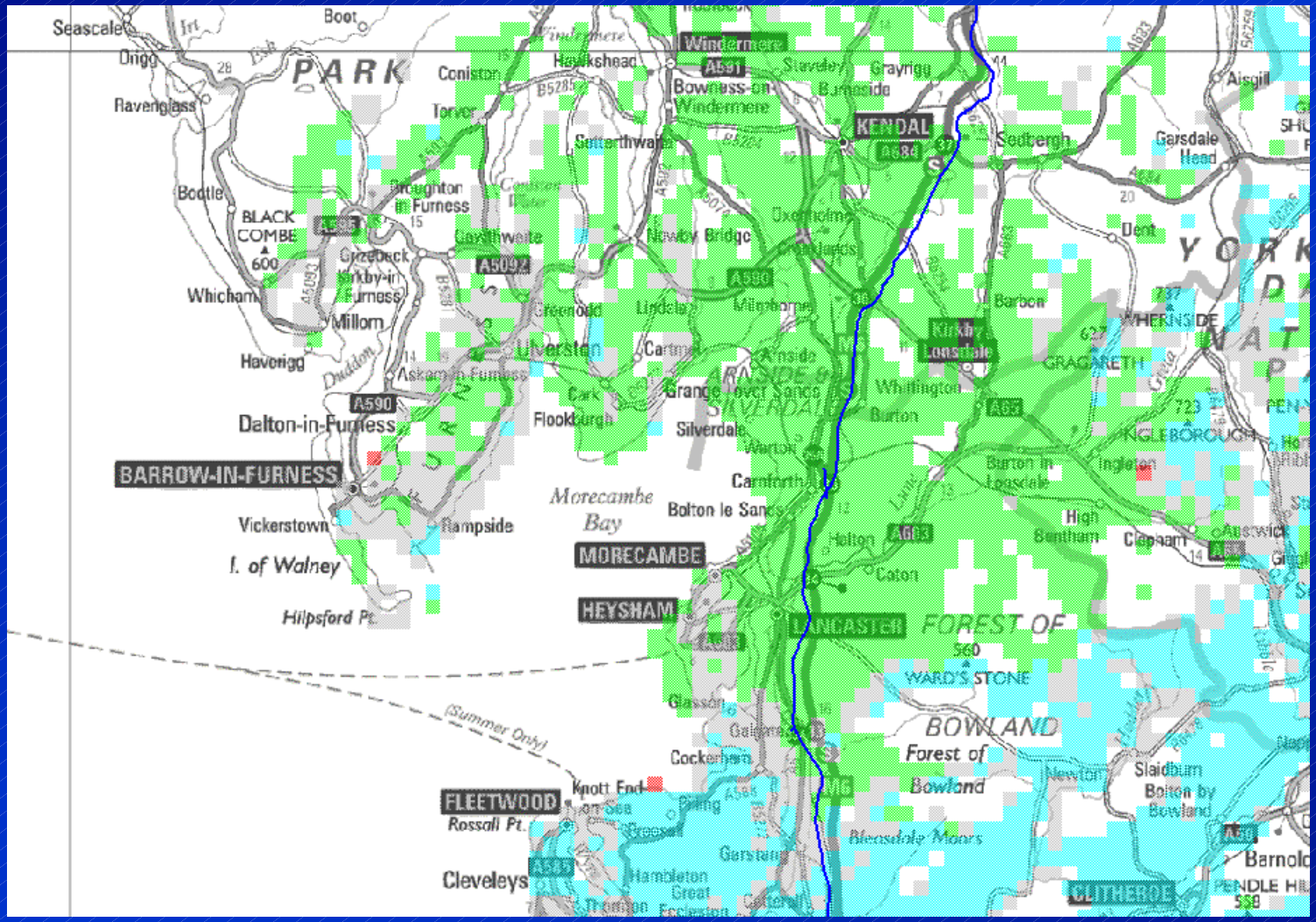


Lancaster 1000 µs

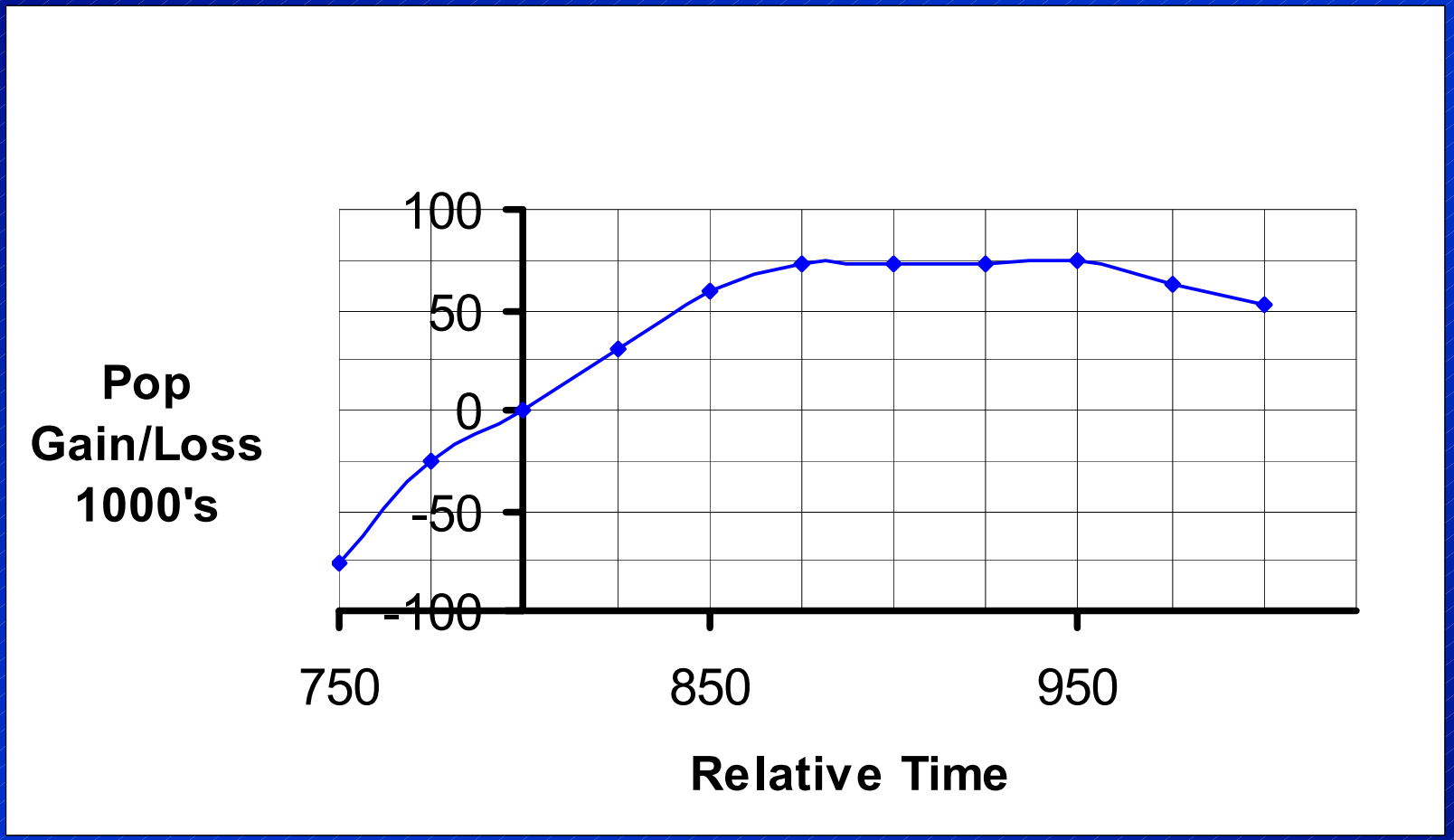


Evaluation

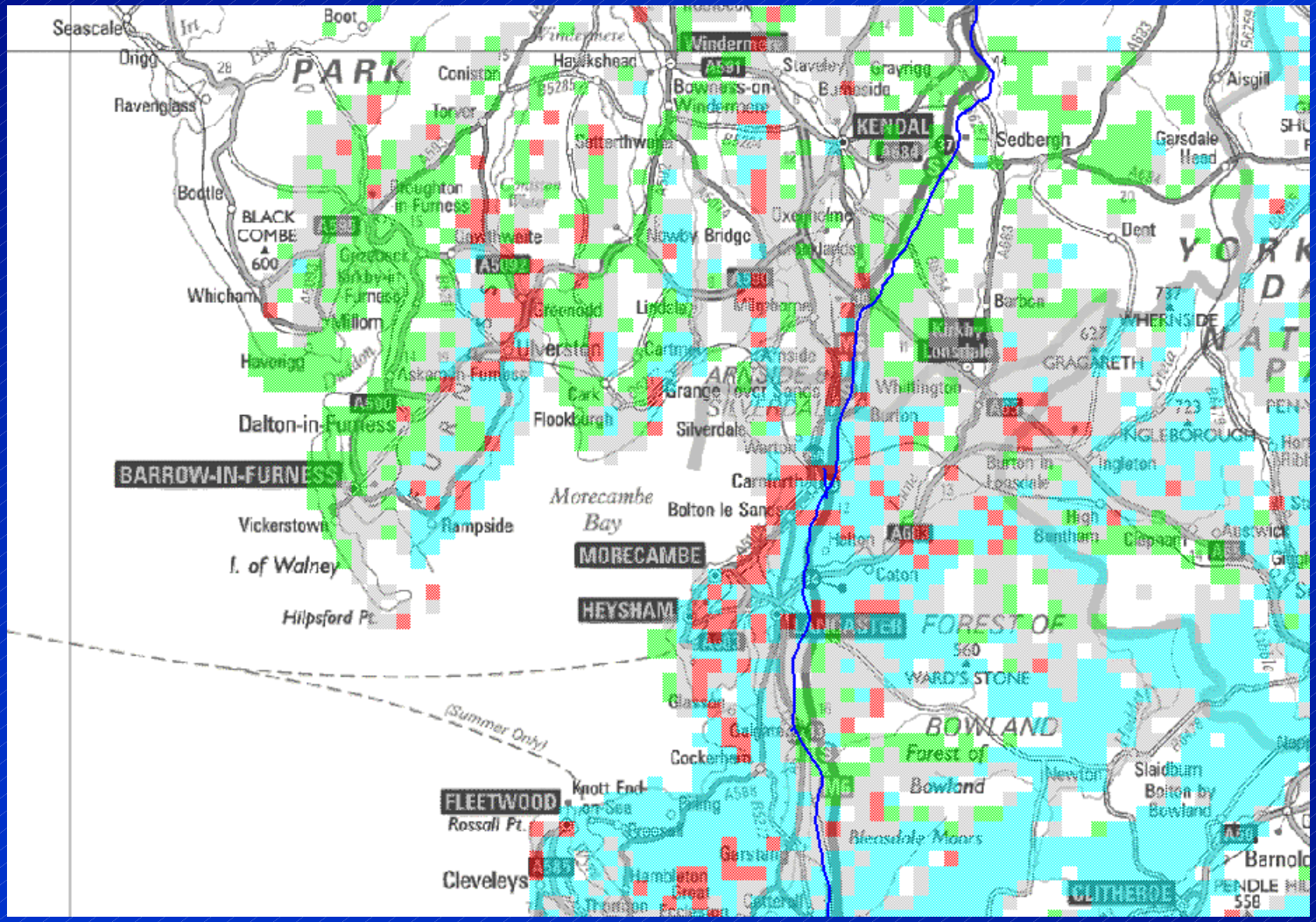
- Populations can be assessed for each of the foregoing maps

- It should be noted that these maps have not been calculated for the whole country, only for a limited area around service area of this transmitter.
- Therefore we need to look at the changes rather than absolute population figures, by relating everything to the situation for a co-timed network.
- We can then see how the extra population gained varies with relative timing of the Lancaster transmitter

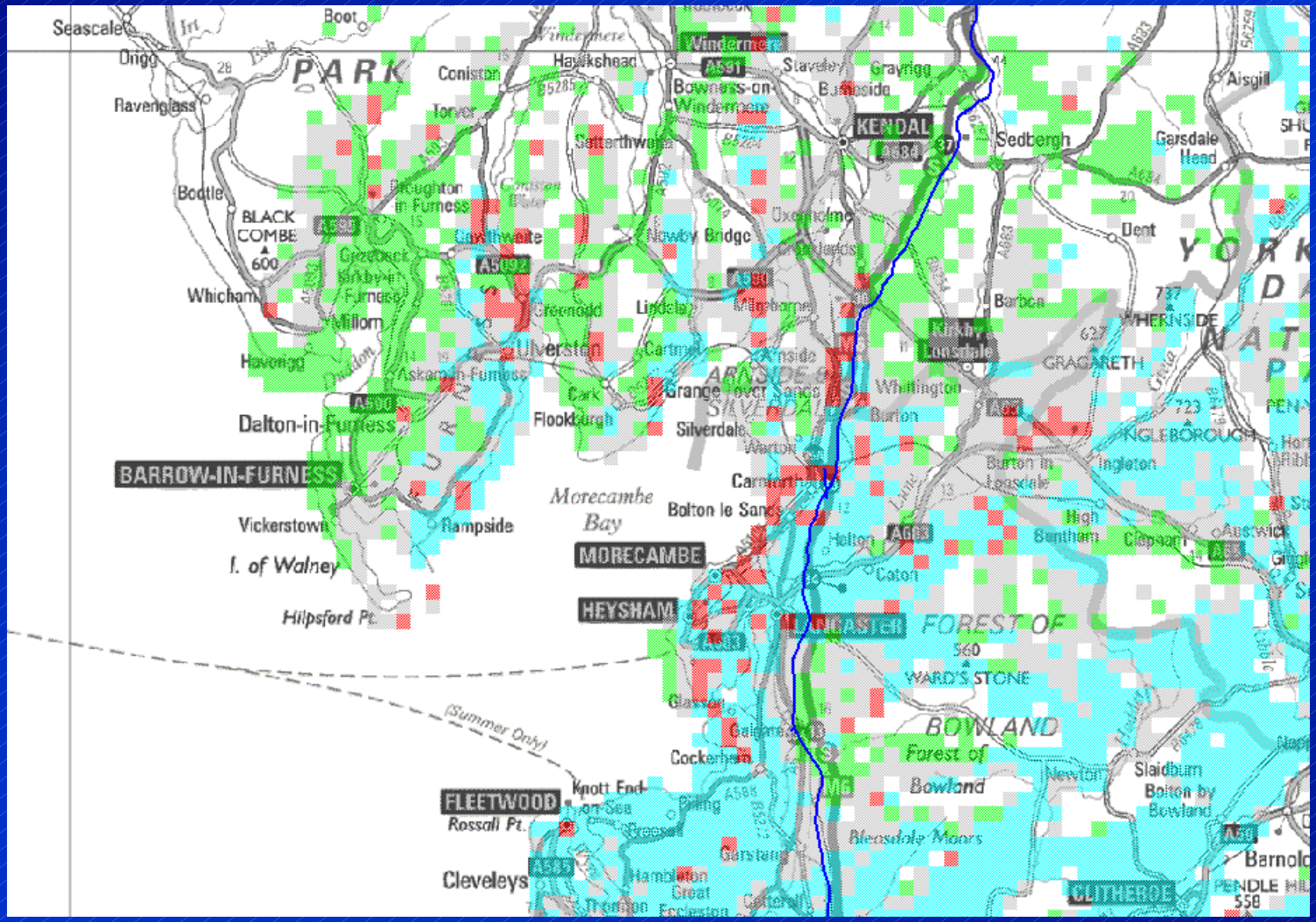
Population Gain for Lancaster



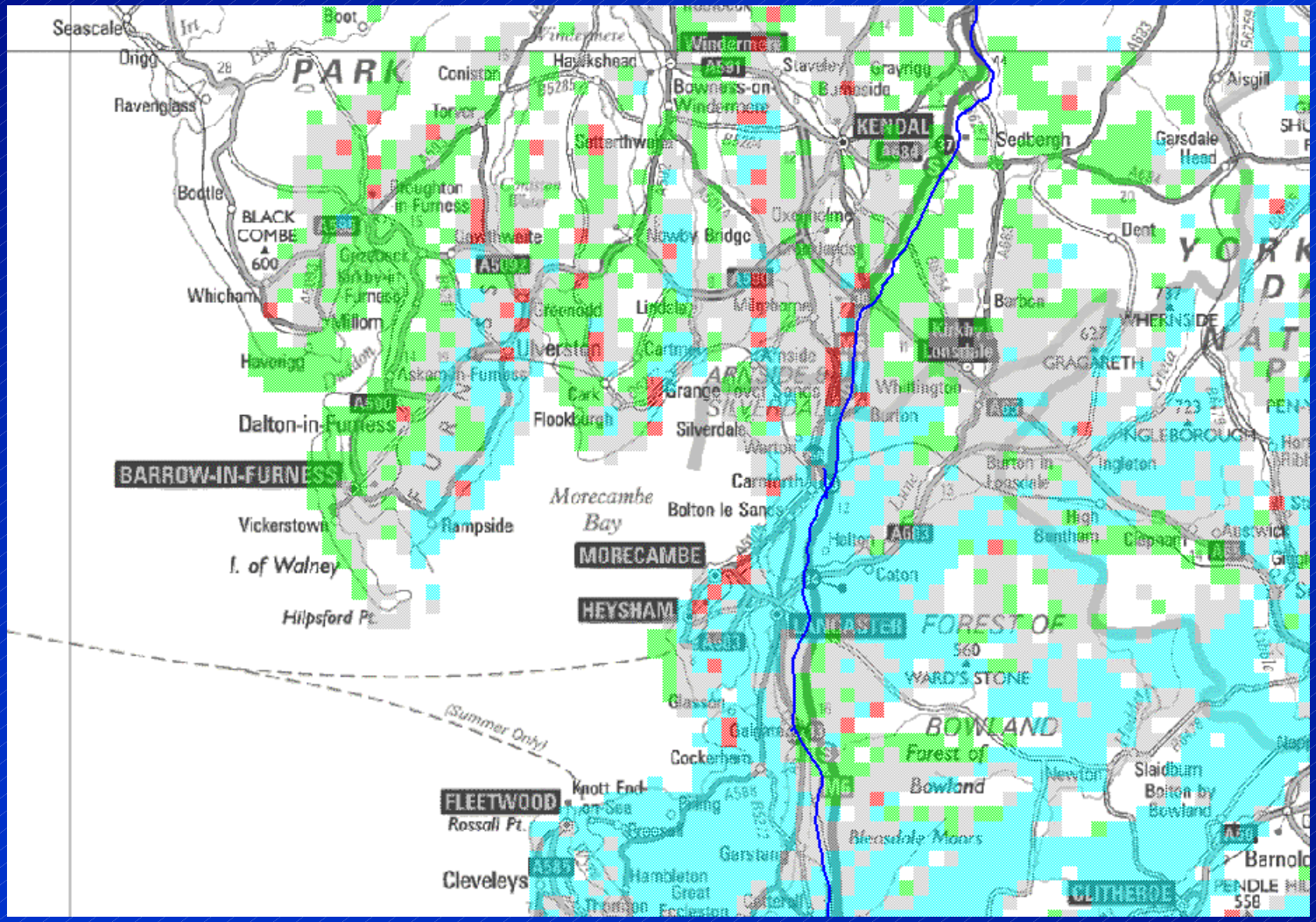
Morecambe Bay 750 µs, (Lancaster at 900 µs)



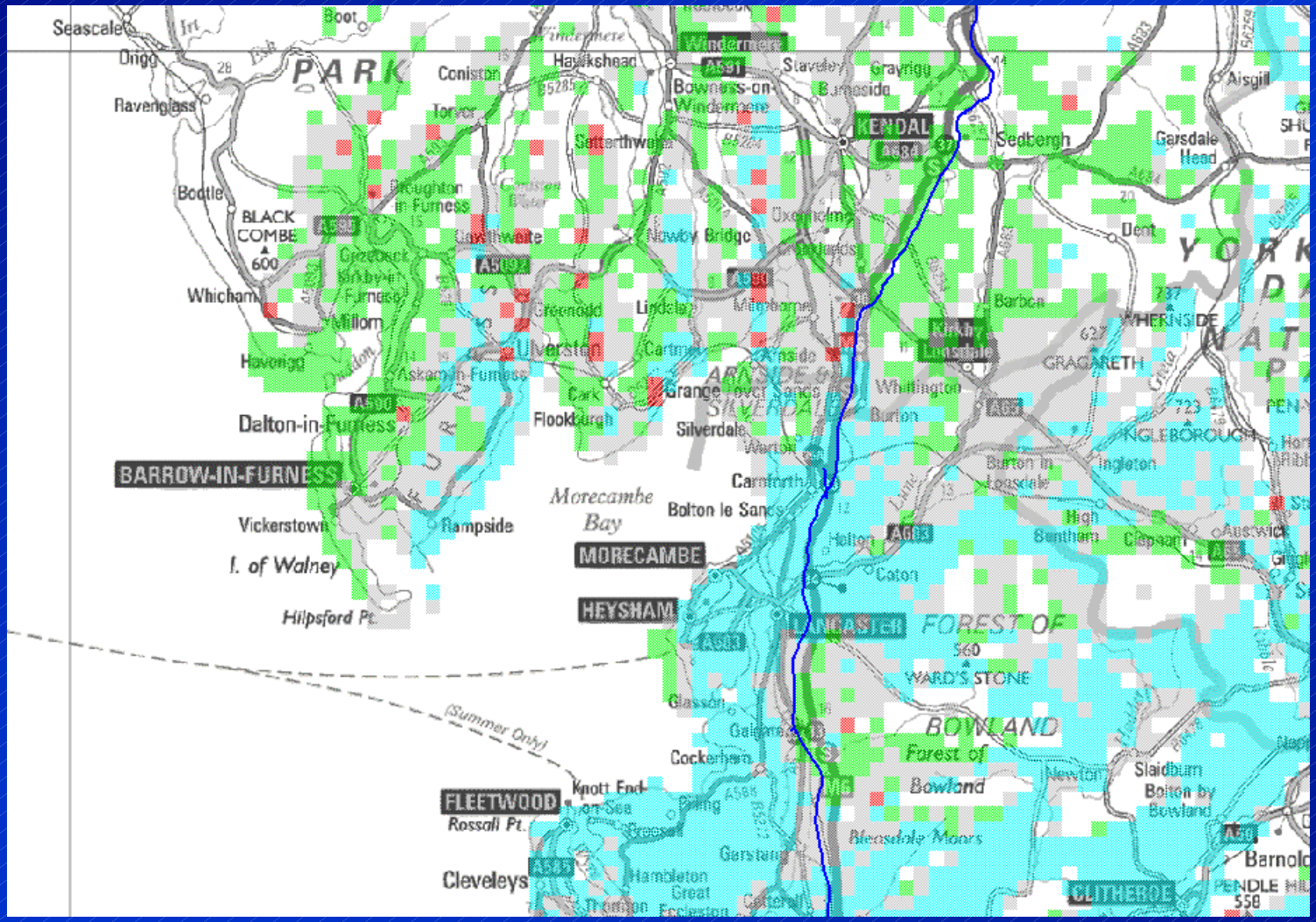
Morecambe Bay 775 µs, (Lancaster at 900 µs)



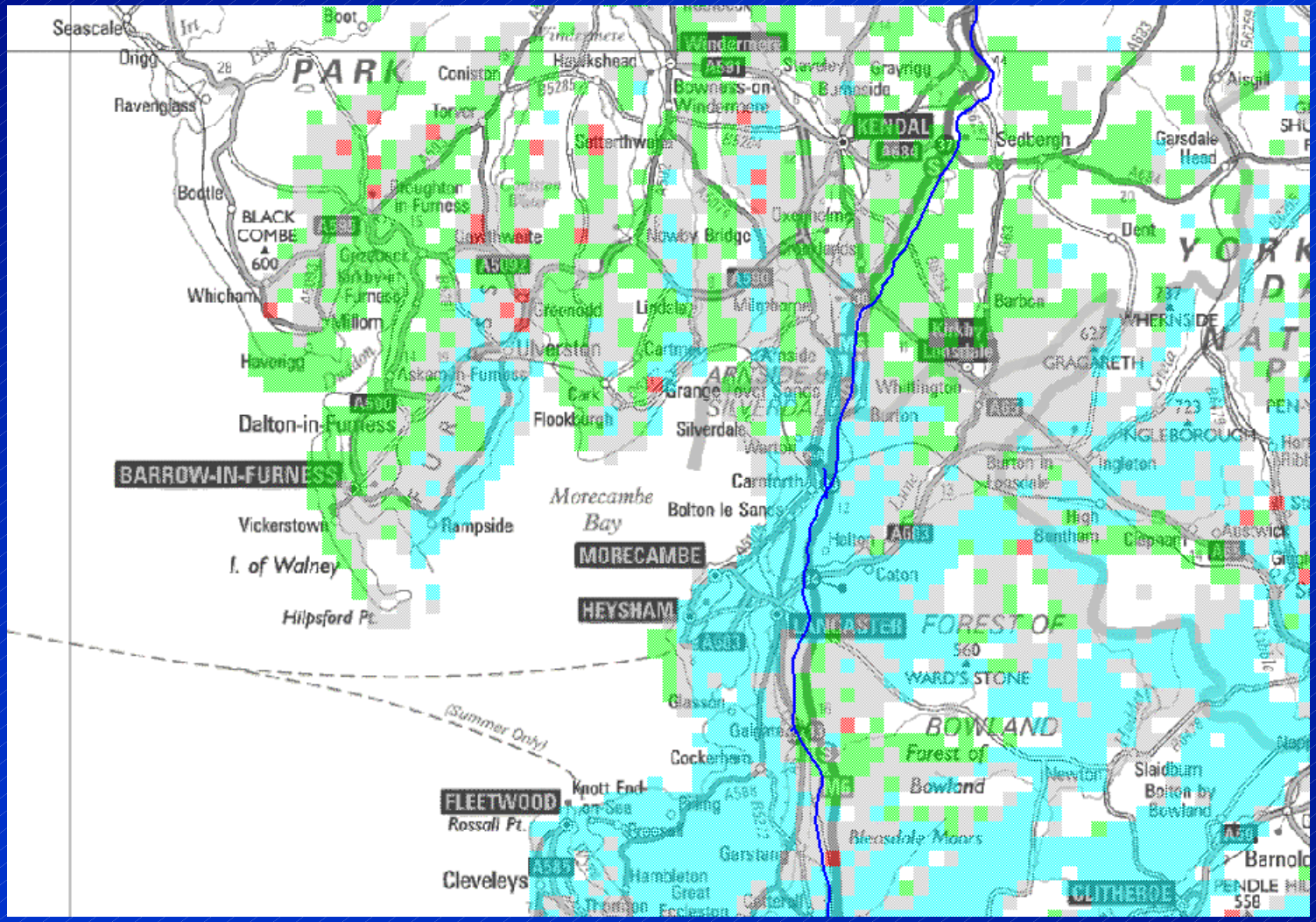
Morecambe Bay 800 µs, (Lancaster at 900 µs)



Morecambe Bay 825 µs, (Lancaster at 900 µs)



Morecambe Bay 850 µs, (Lancaster at 900 µs)



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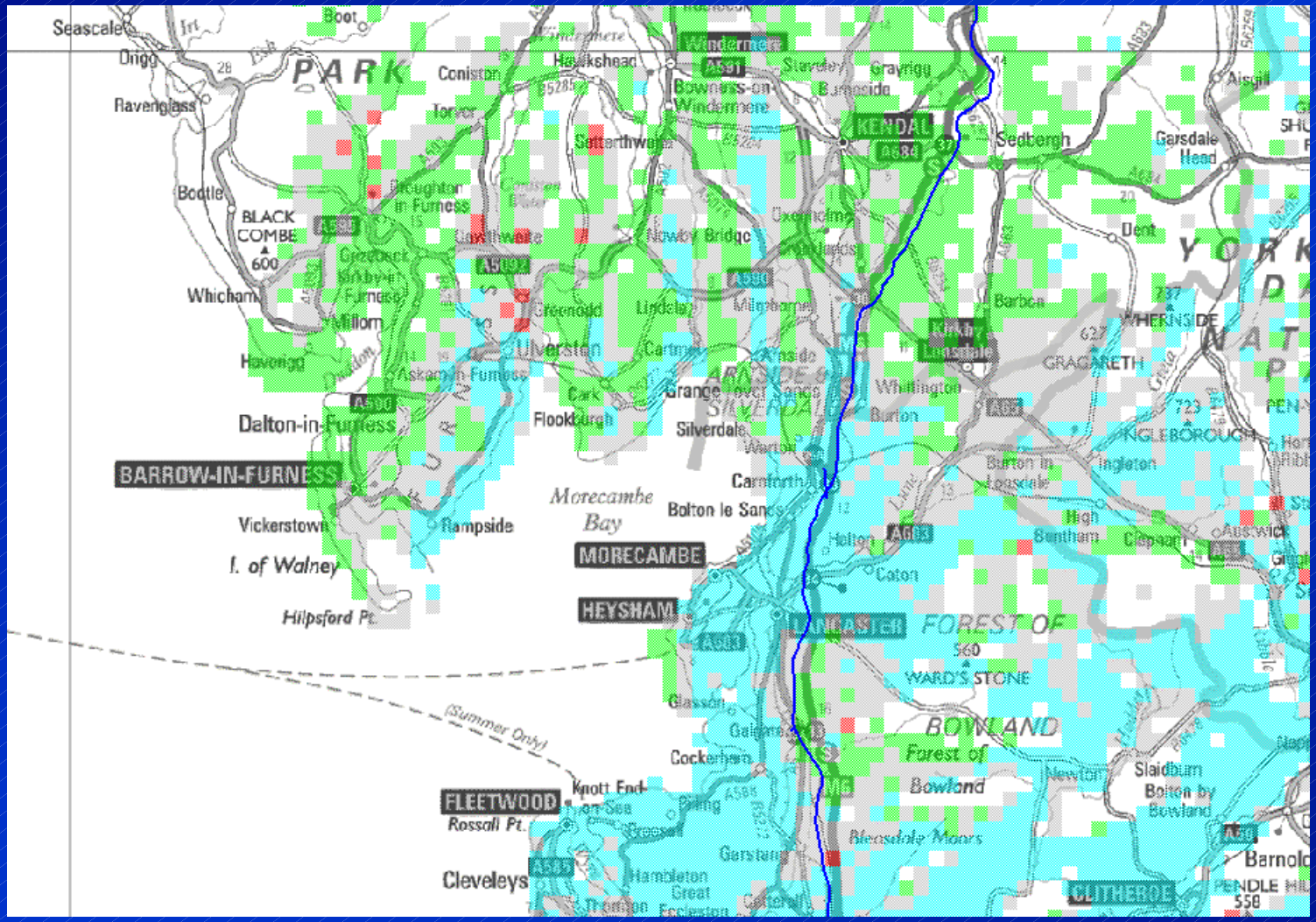
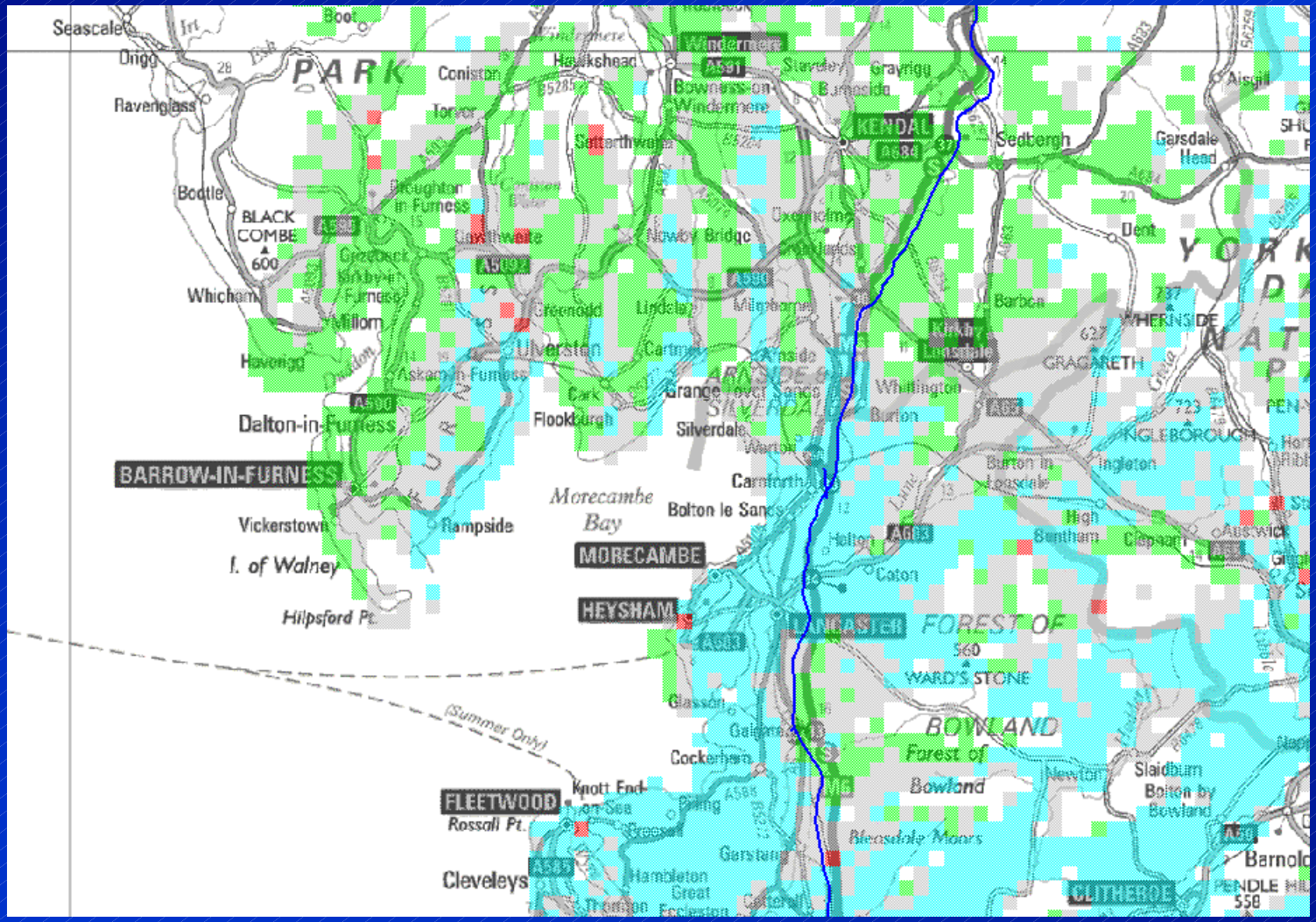


Morecambe Bay 900 µs, (Lancaster at 900 µs)



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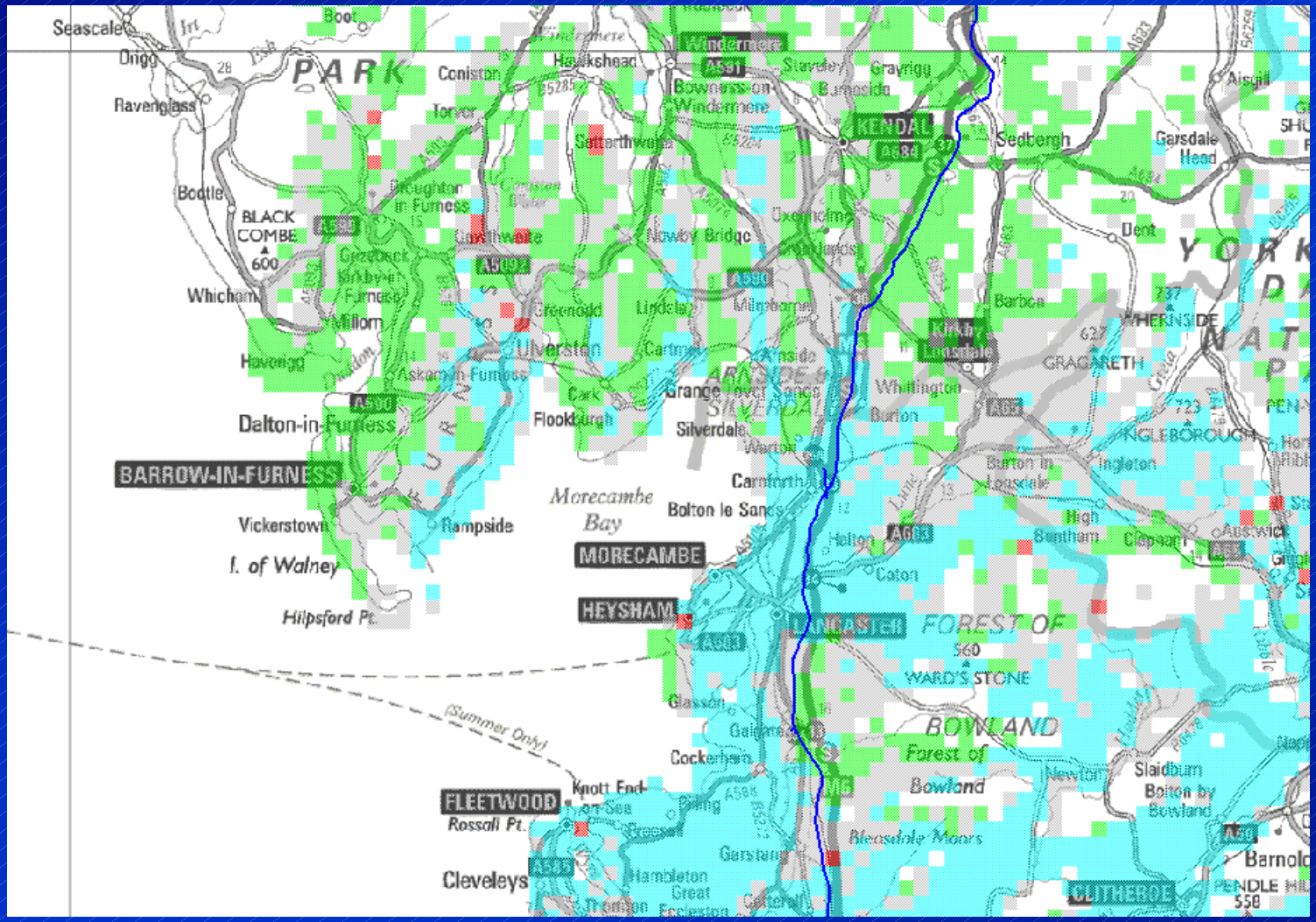

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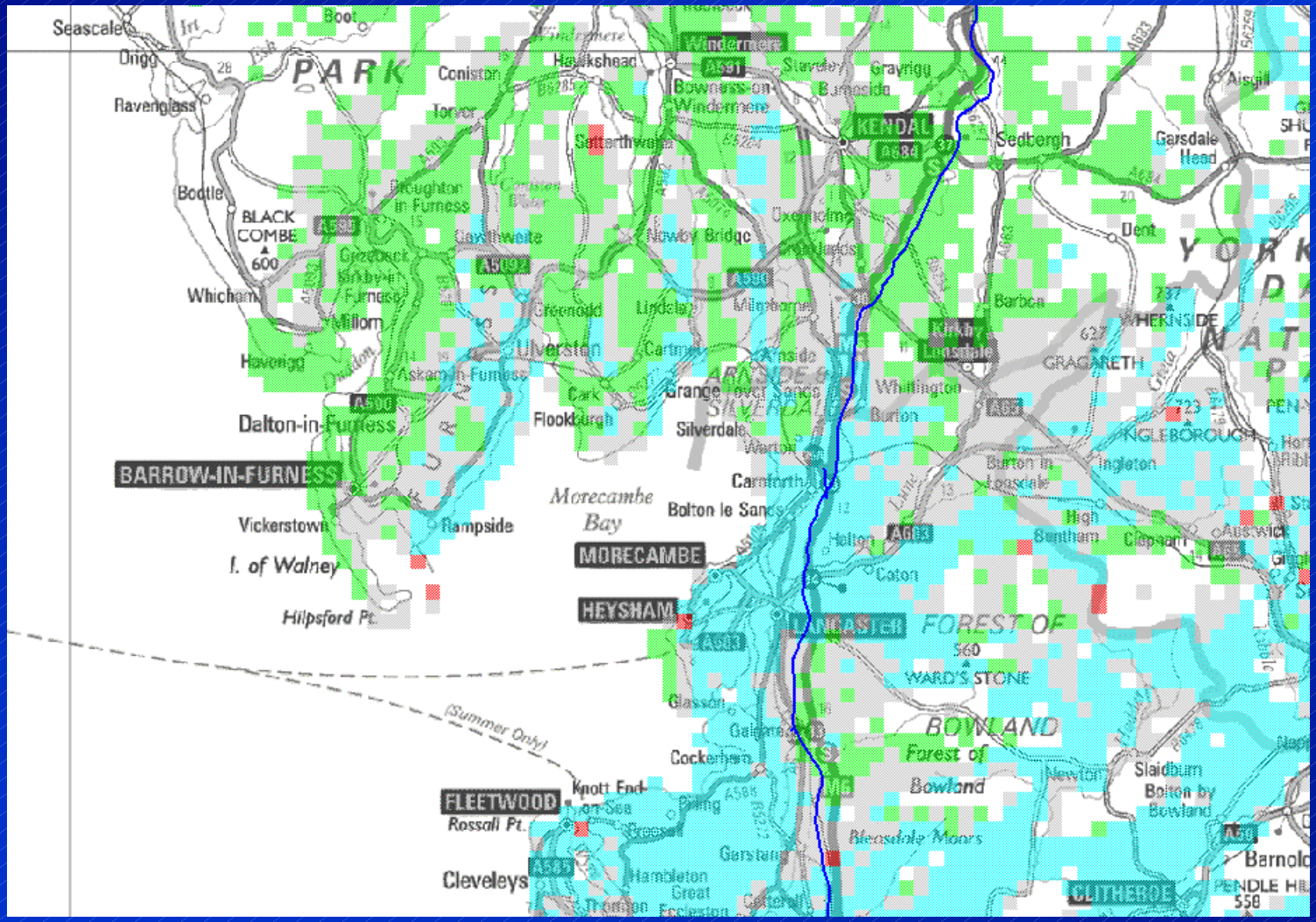

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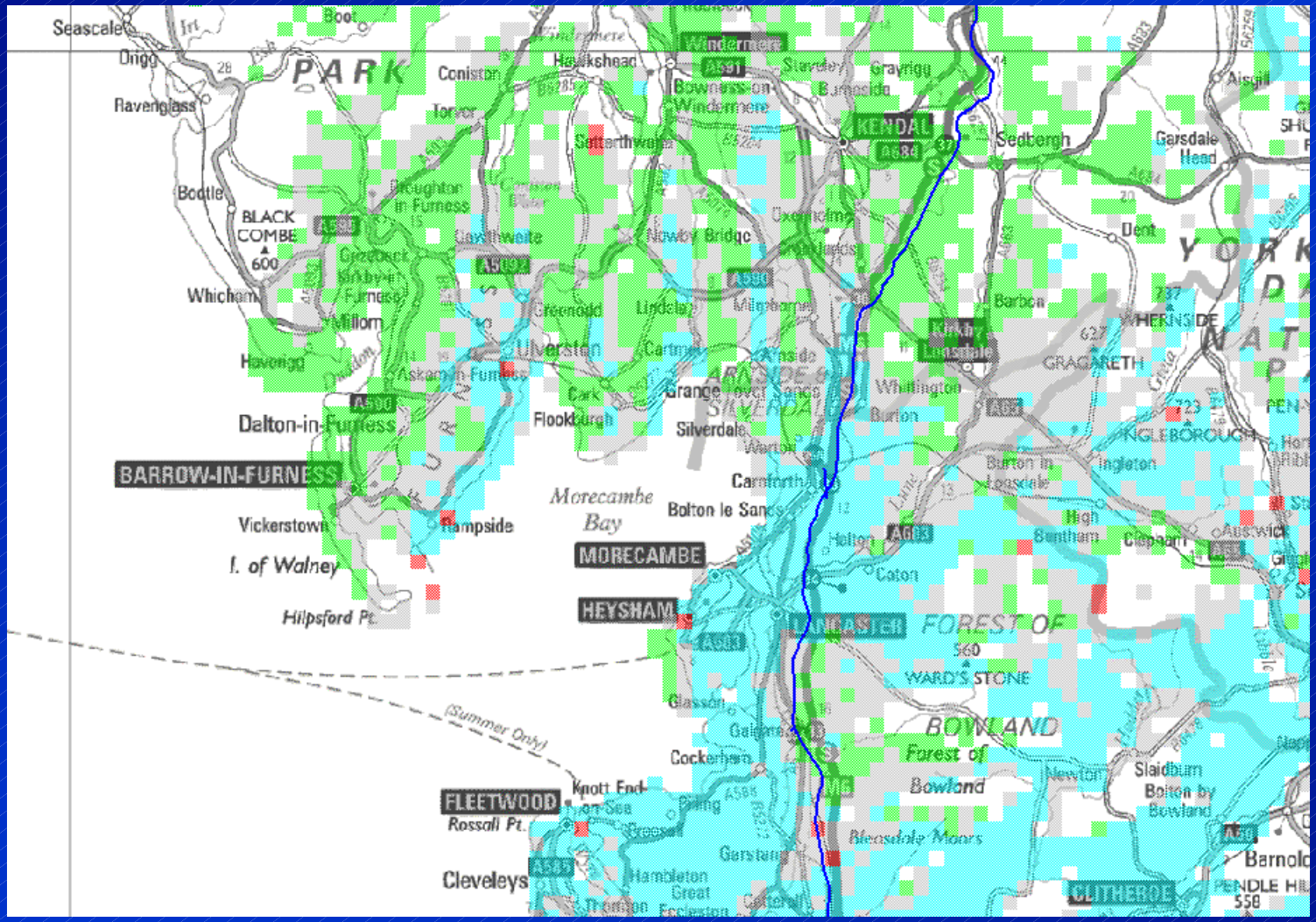
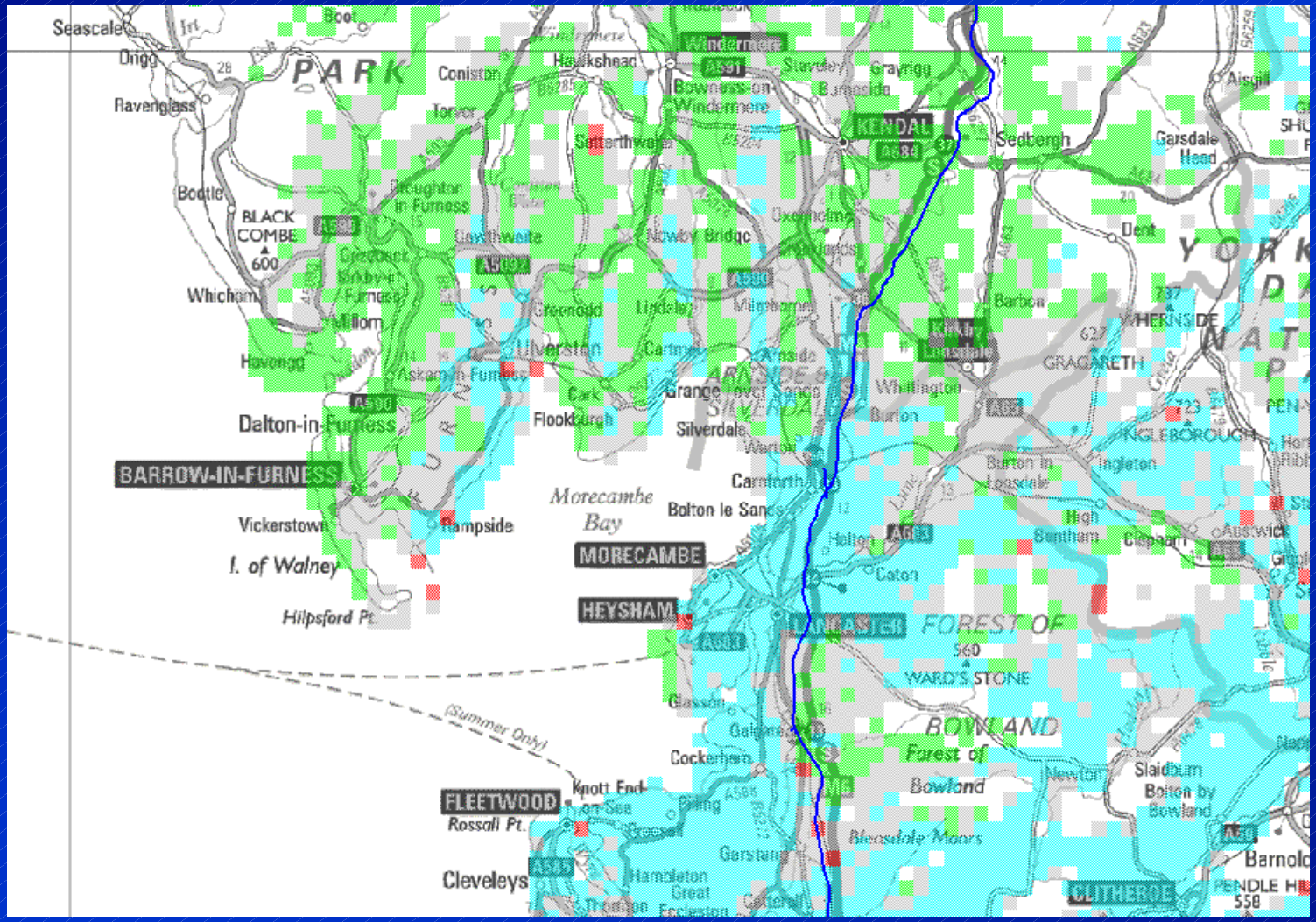
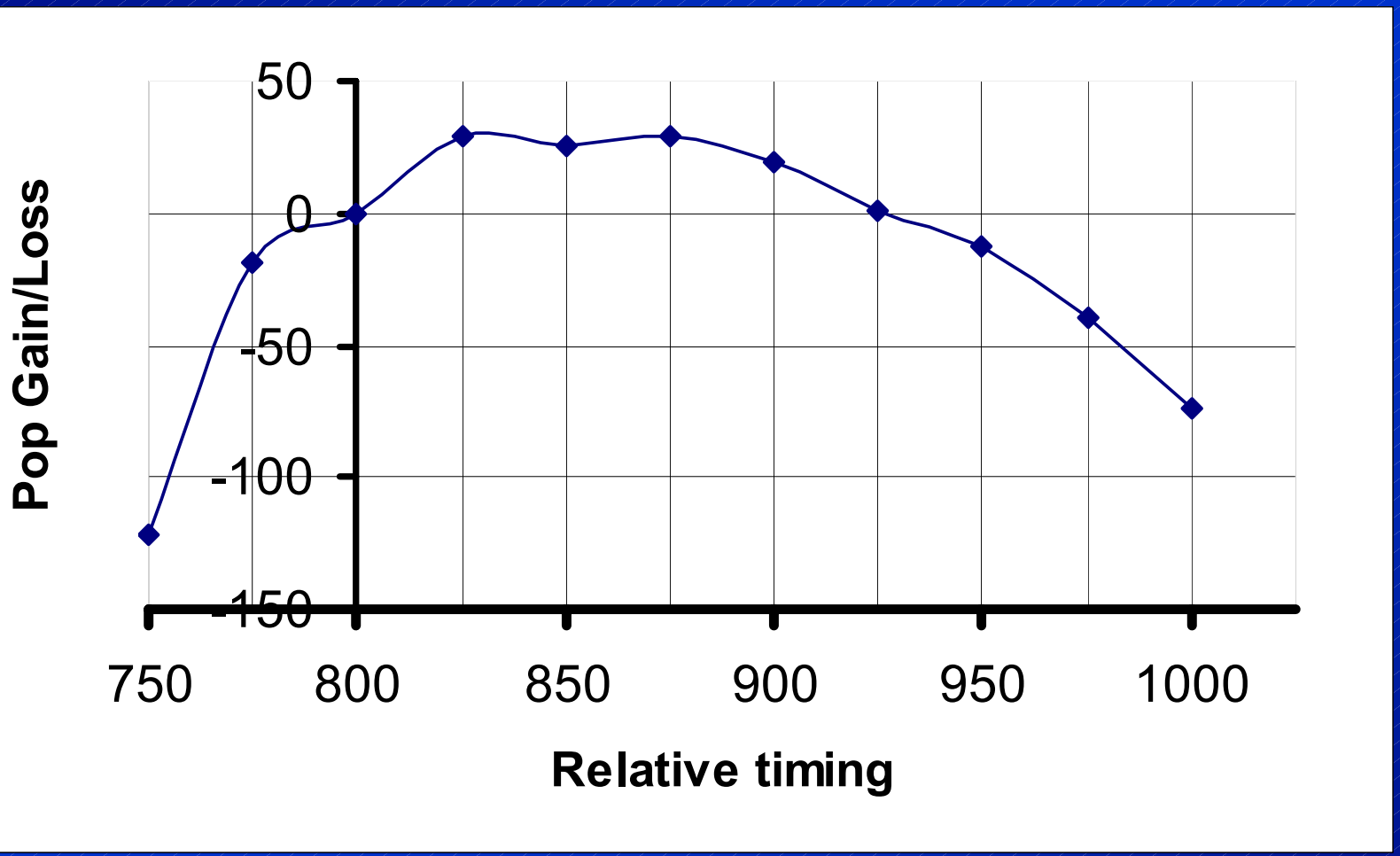


Morecambe Bay 1000 µs, (Lancaster at 900 µs)



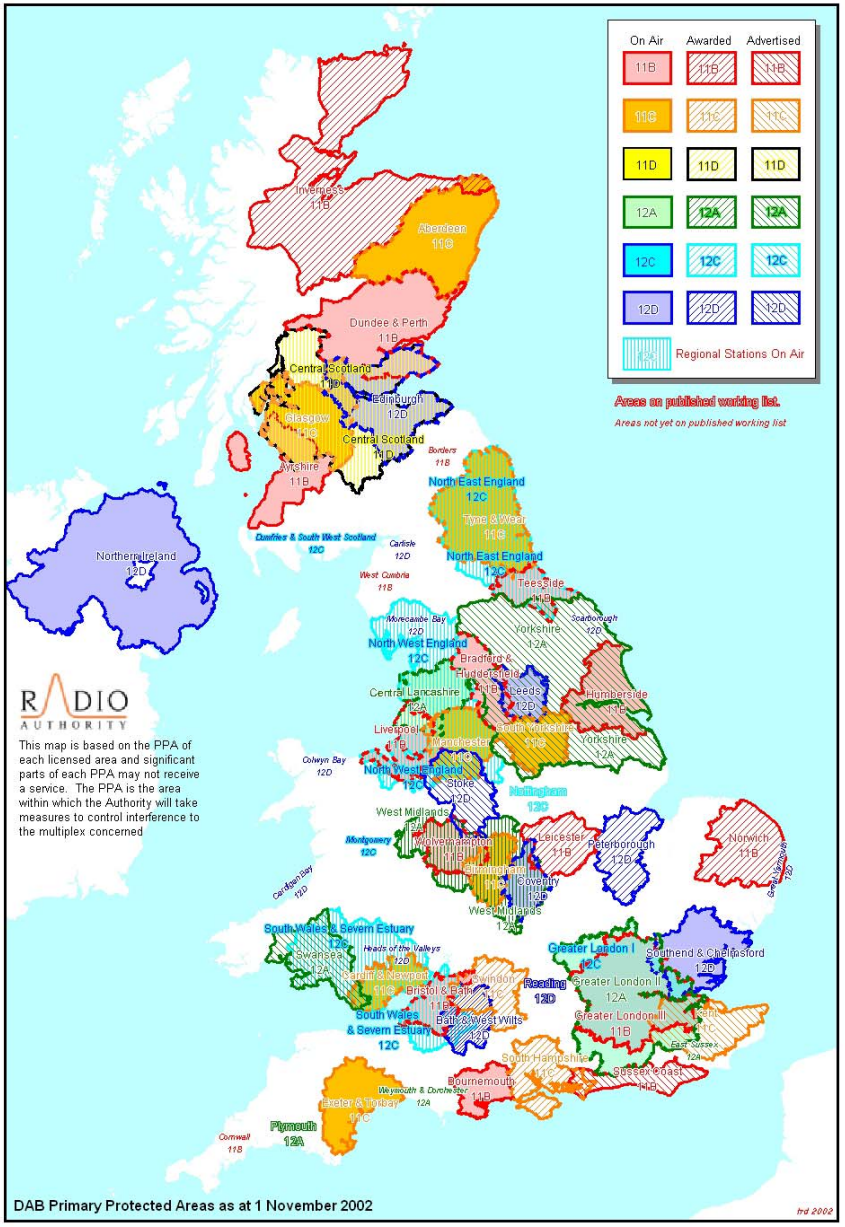
Population Gain for Morecambe



Adjacent Channel Issues

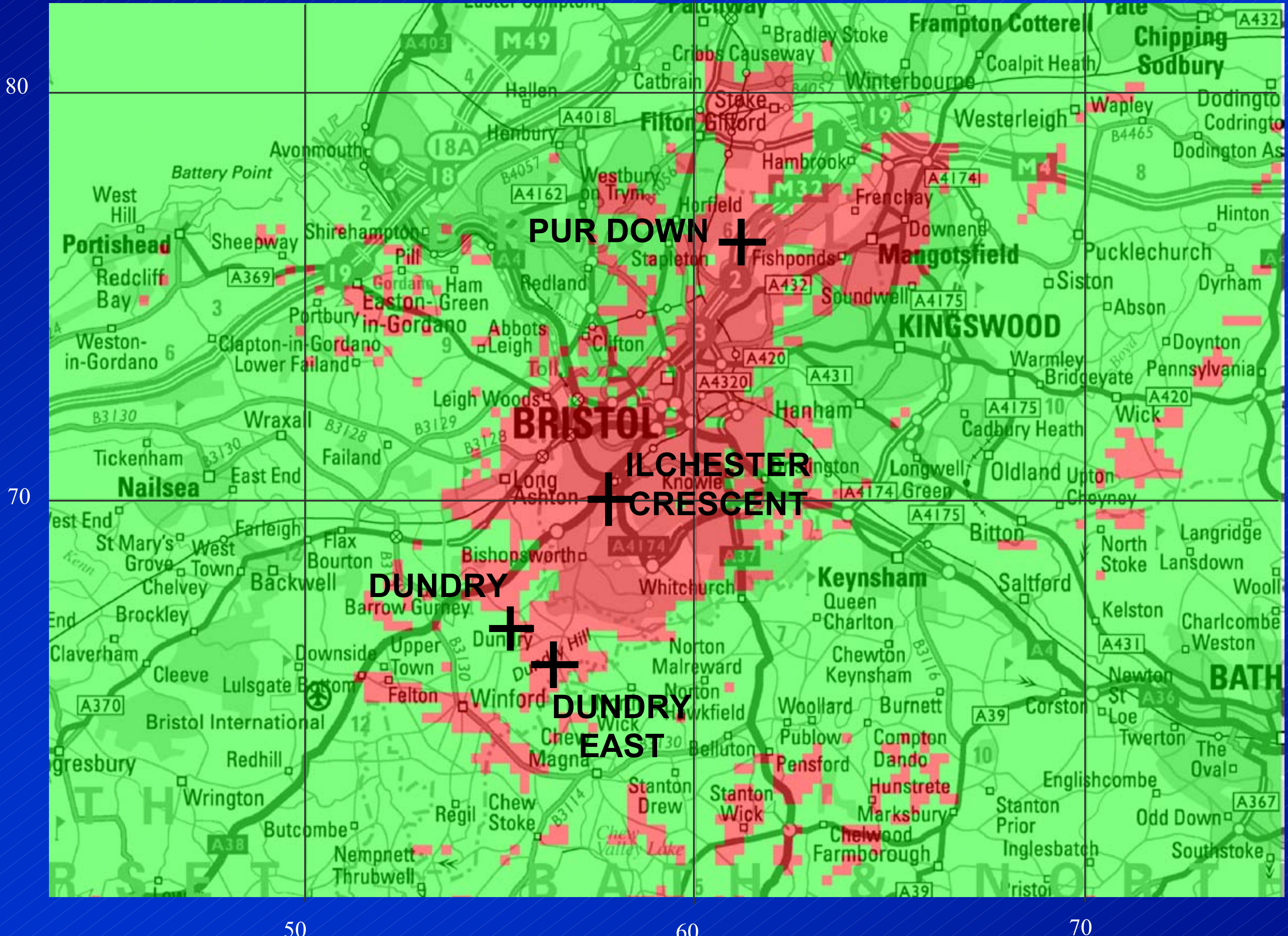
- Following WI95, the Radio Authority (now part of OFCOM) coordinated a series of regional and local networks.
- Two of the frequencies are upper and lower adjacent to the BBC National Network multiplex
- Where two adjacent channel multiplexes are not co-sited interference may result
- Rules have had to be agreed to minimise interference from those adjacent multiplexes to the BBC National Network and vice versa.
- Areas where the existing coverage is marginal are typically problematical.
- In some cases it is necessary to build ‘filler’ stations to restore lost coverage

Independent Local and Regional Networks

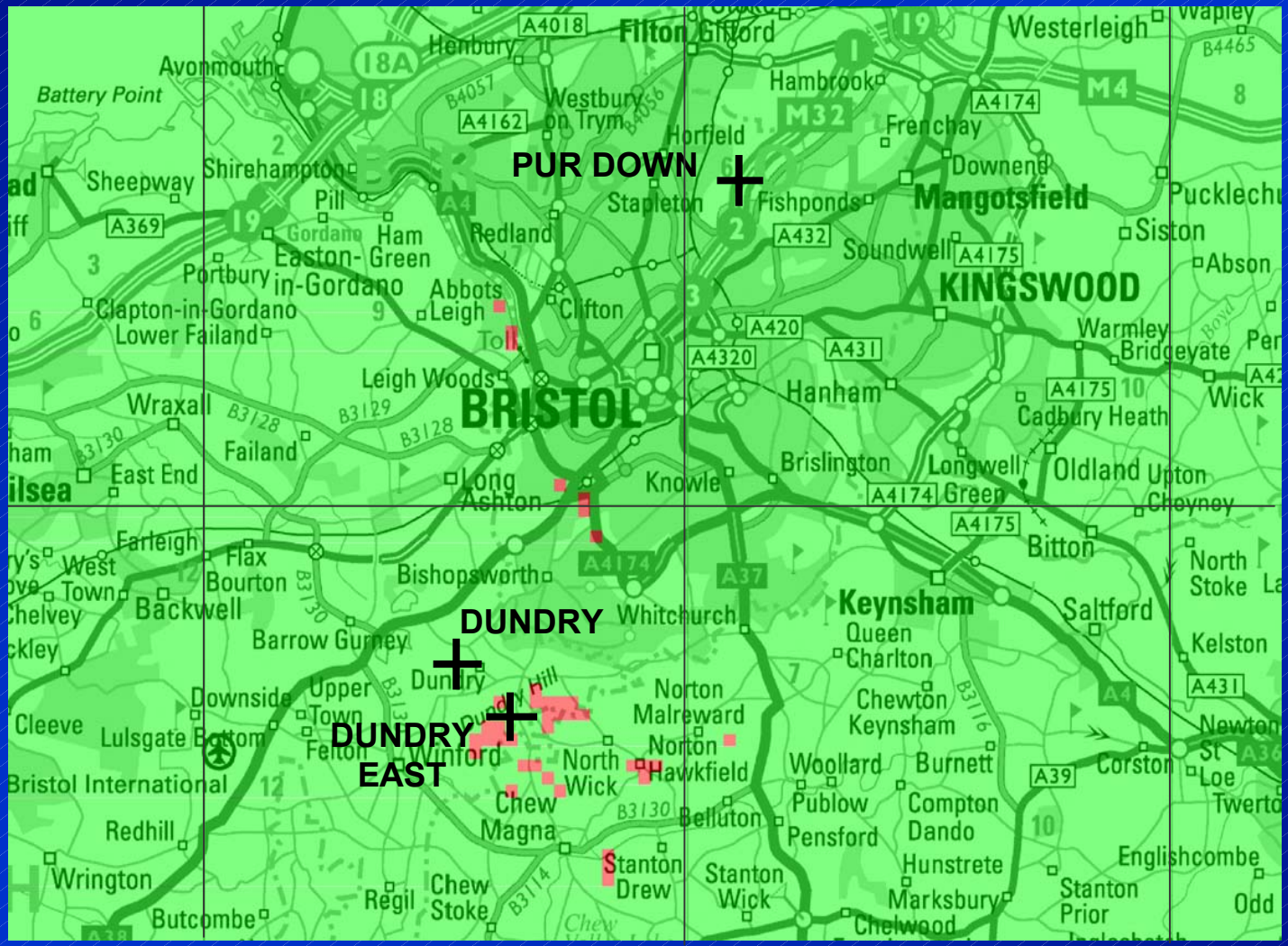


- Use the other 5 channels
- Protected Areas
- Possible interference

Adjacent Channel Interference



Solution to Adjacent Channel Problem



Conclusions

- Allotment planning gives flexibility in implementation and simplifies the conference planning process
- Administrations need to specify their requirements, but do not need to know their exact implementation details
- Rules need to be agreed to enable administrations to implement a real network without the need for further coordination

- Timing should be used in a SFN to optimise coverage by minimising self-interference within the network