A Green Spine for England

Water, Power, Transport, Communications

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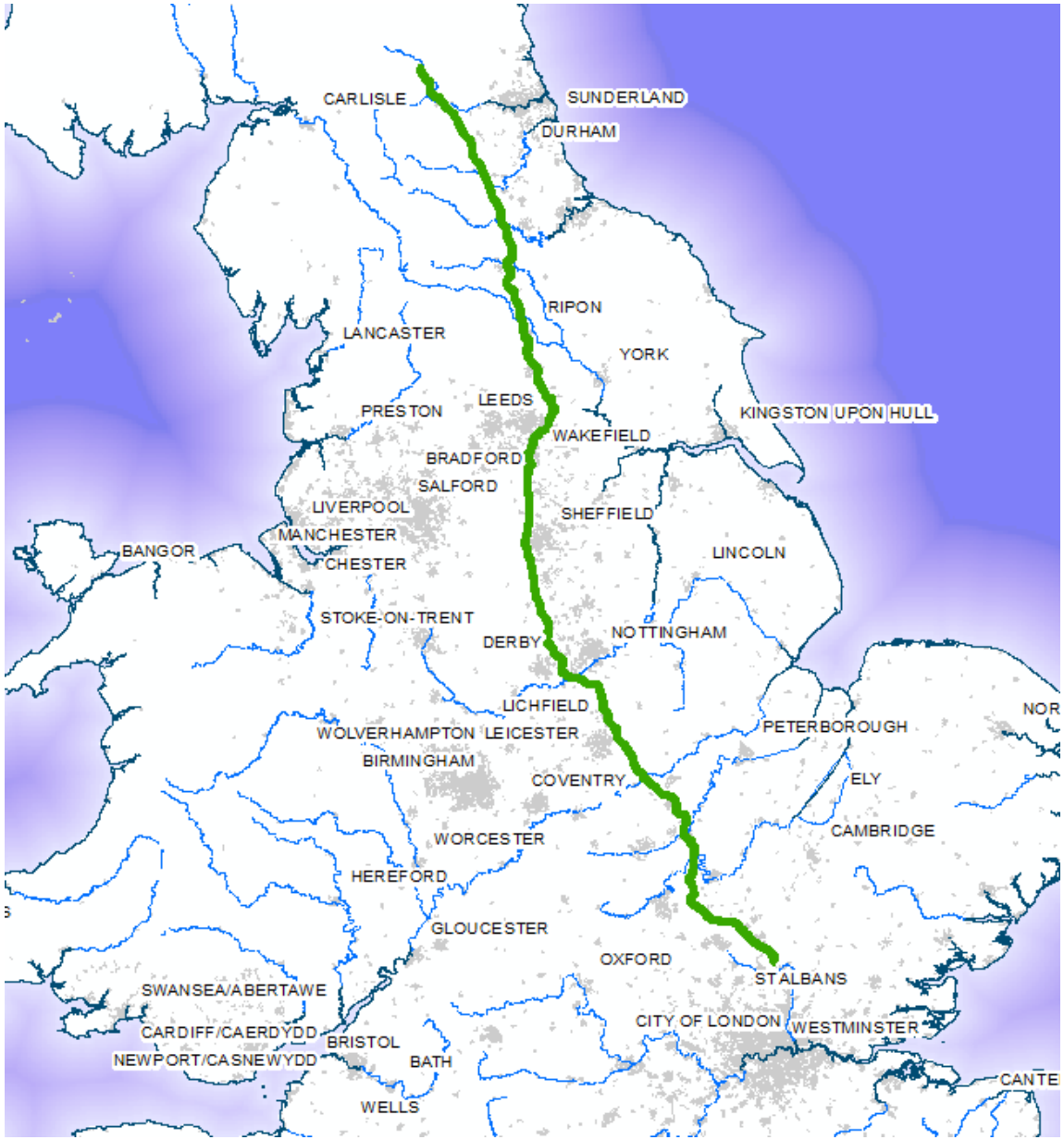
The Big Idea



Not

But

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Origins

THE GRAND CONTOUR CANAL PROPOSALS IN 1942

In the 1930s, engineer John Pownall spotted what all the early canal and railway builders - James Brindley, George Rennie, George Stephenson – knew, that at about 300ft above sea level there is a "natural canal line". It wiggles across the country, avoiding most obstacles. In 1942, Pownall propounded the Grand Contour Canal. It was to be 100ft wide and 17ft deep.

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Why?

- Water storage and supply
- Power transmission
- Transportation
- Communications
- District heating
- Uplift in land values
- Leisure and tourism
- Opportunities for regeneration

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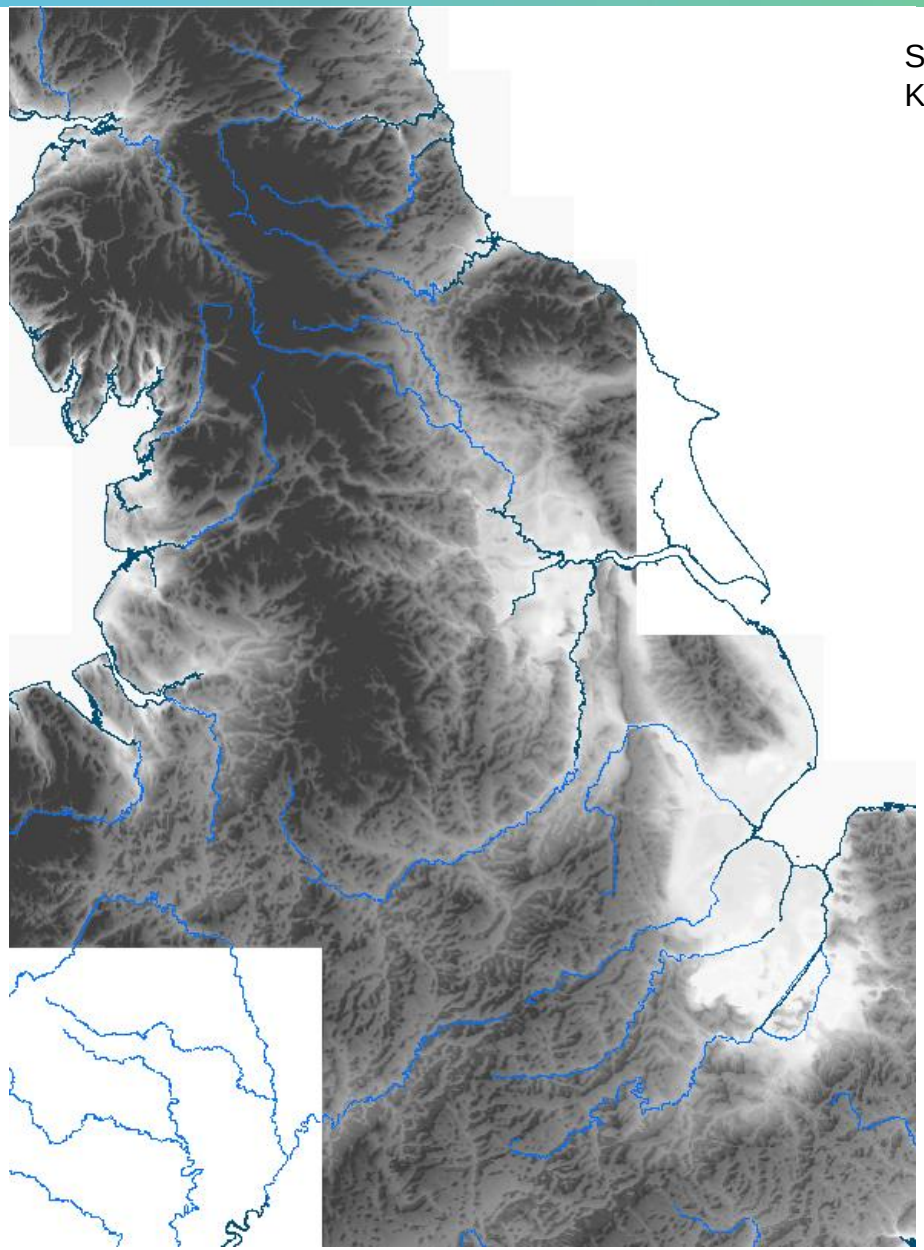
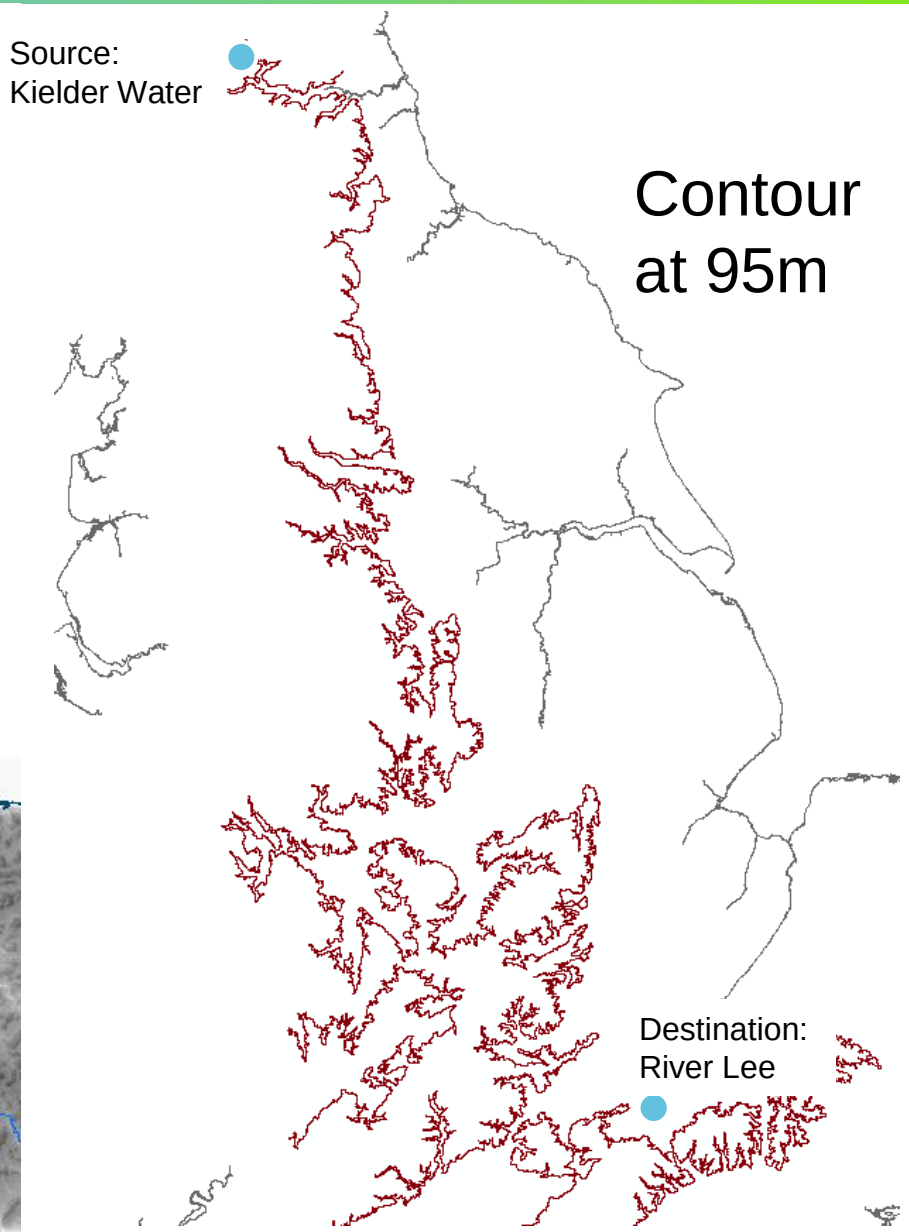
The Continuous Contour – Is It Real? YES!

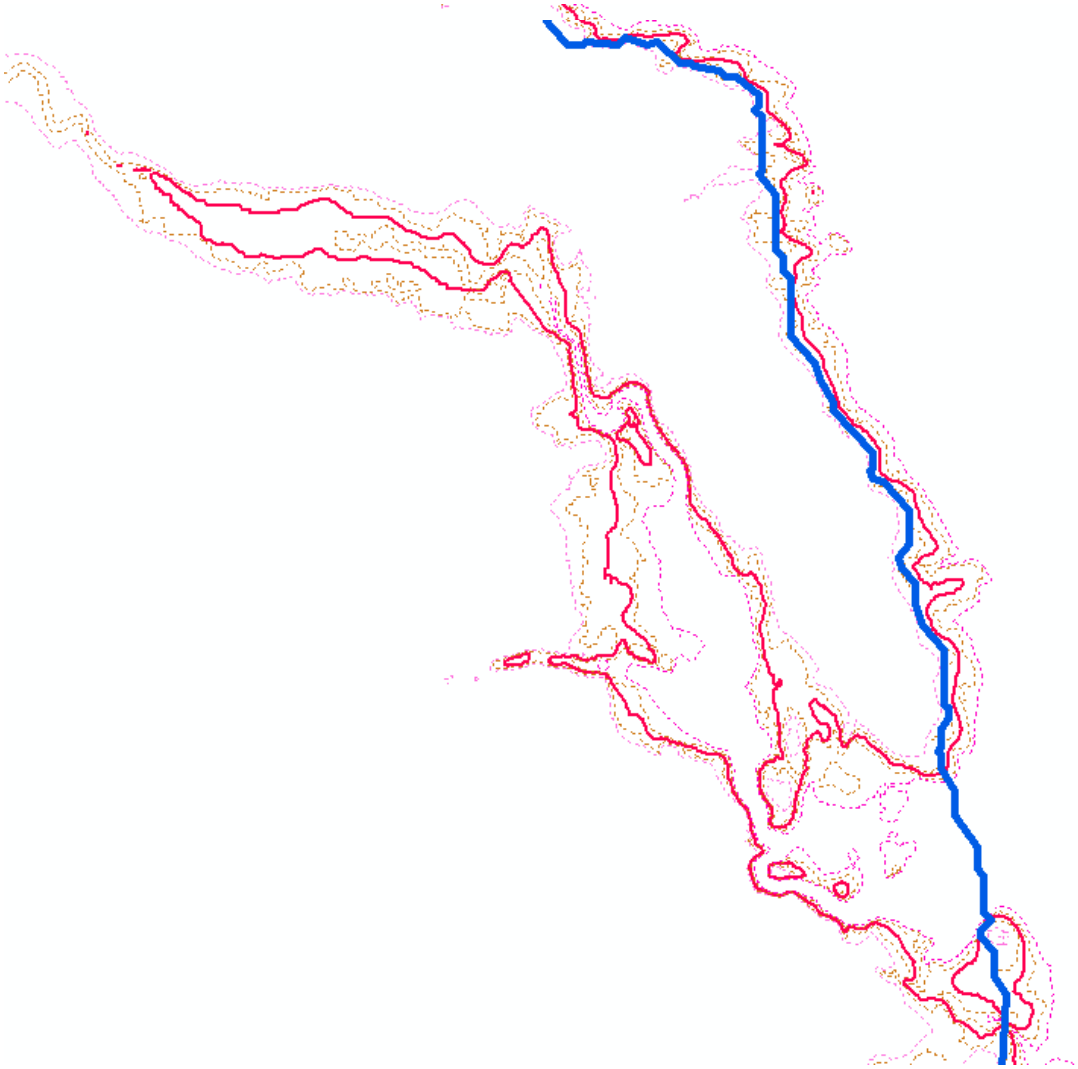




Balancing Length and Cost

- Although we want the canal to follow the contour as much as possible, in some cases it would be cheaper to construct a more direct route

- Key to analysis was forming an algorithm that takes account of varying cost based on change in formation level



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Least Cost Path Model

- The user creates just the start and end points for the route, on the same contour
- Model uses start height to assess relative cost of route with reference to altitude and existing infrastructure constraints
- Path is one cell wide and is the cheapest route relative to the cost units defined by the original cost raster
- This is converted to a line feature for further analysis

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Raster Maths

- For each route calculated the reference height is set, i.e. the contour we want to follow (95m in the example below)
- Calculate a new raster, which is the height <u>difference</u> from the reference height
- Calculate the <u>cost factor</u>, from our parameters

88	90	94	96	98
90	95	97	99	100
94	97	97	99	105
96	99	99	105	110
98	100	105	110	110

-7	-5	-1	1	3
-5	0	2	4	5
-1	2	2	4	10
1	4	4	10	15
3	5	10	15	15

2	2	1	1	2
2	1	1	2	2
1	1	1	2	2
1	2	2	2	5
2	2	2	5	5

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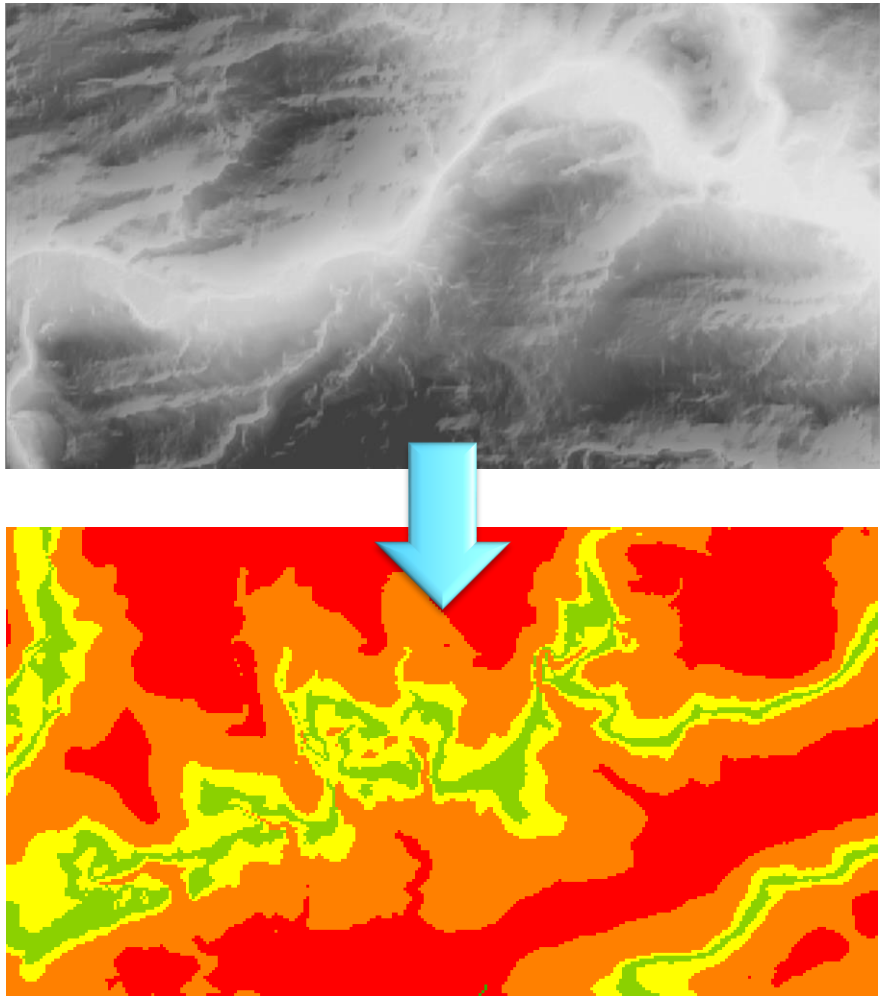
Altitude as Cost

- For each route, a new cost surface is calculated based on the reference height
- Using just this surface would give us the cheapest route corridor if there were no other constraints



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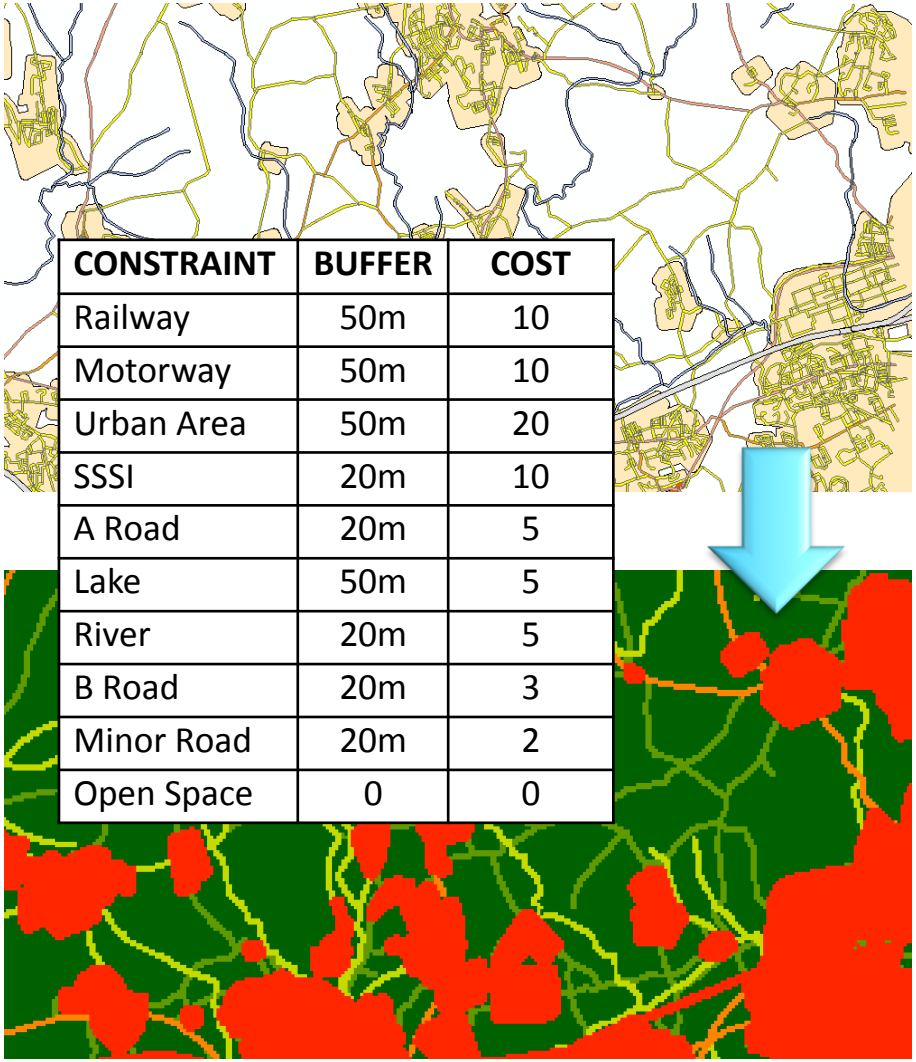
Constraints as Costs

- Create a cost surface for constraints
- Buffer each constraint to make a polygon
- Convert polygons to raster, where the value in each pixel is the penalty cost for construction



CONSTRAINT	BUFFER	COST
Railway	50m	10
Motorway	50m	10
Urban Area	50m	20
SSSI	20m	10
A Road	20m	5
Lake	50m	5
River	20m	5
B Road	20m	3
Minor Road	20m	2
Open Space	0	0

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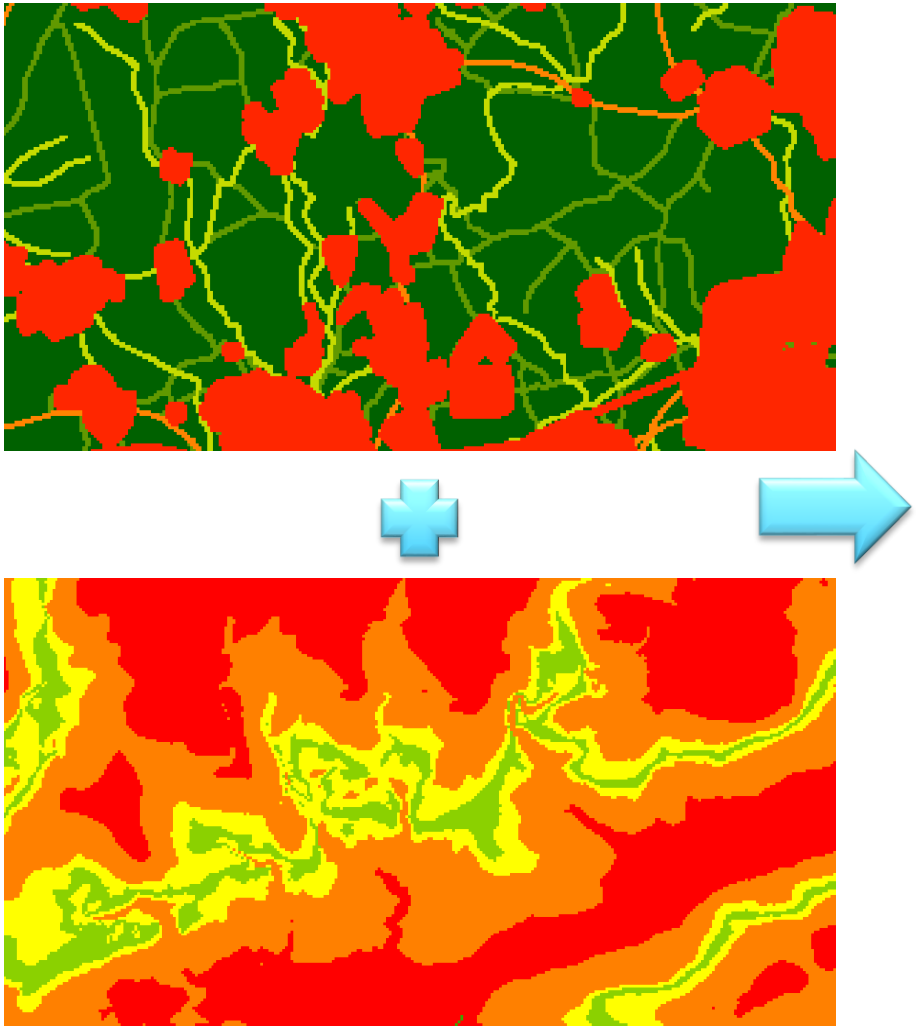
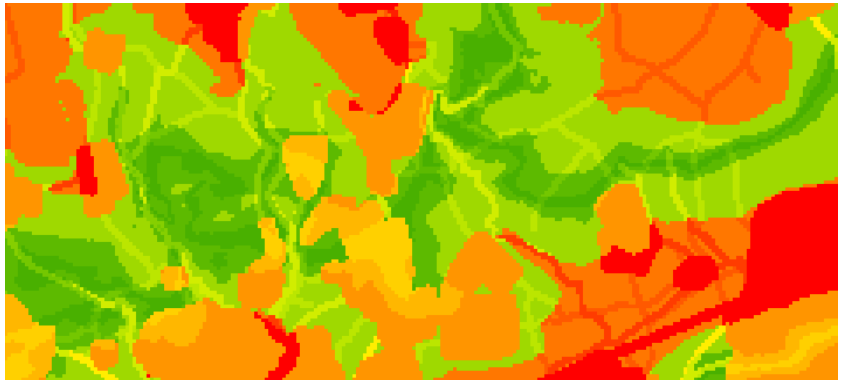
Combined Cost Surface



- Both of our cost surfaces represent costs on the same scale



- The rasters can be added together to create a combined cost surface

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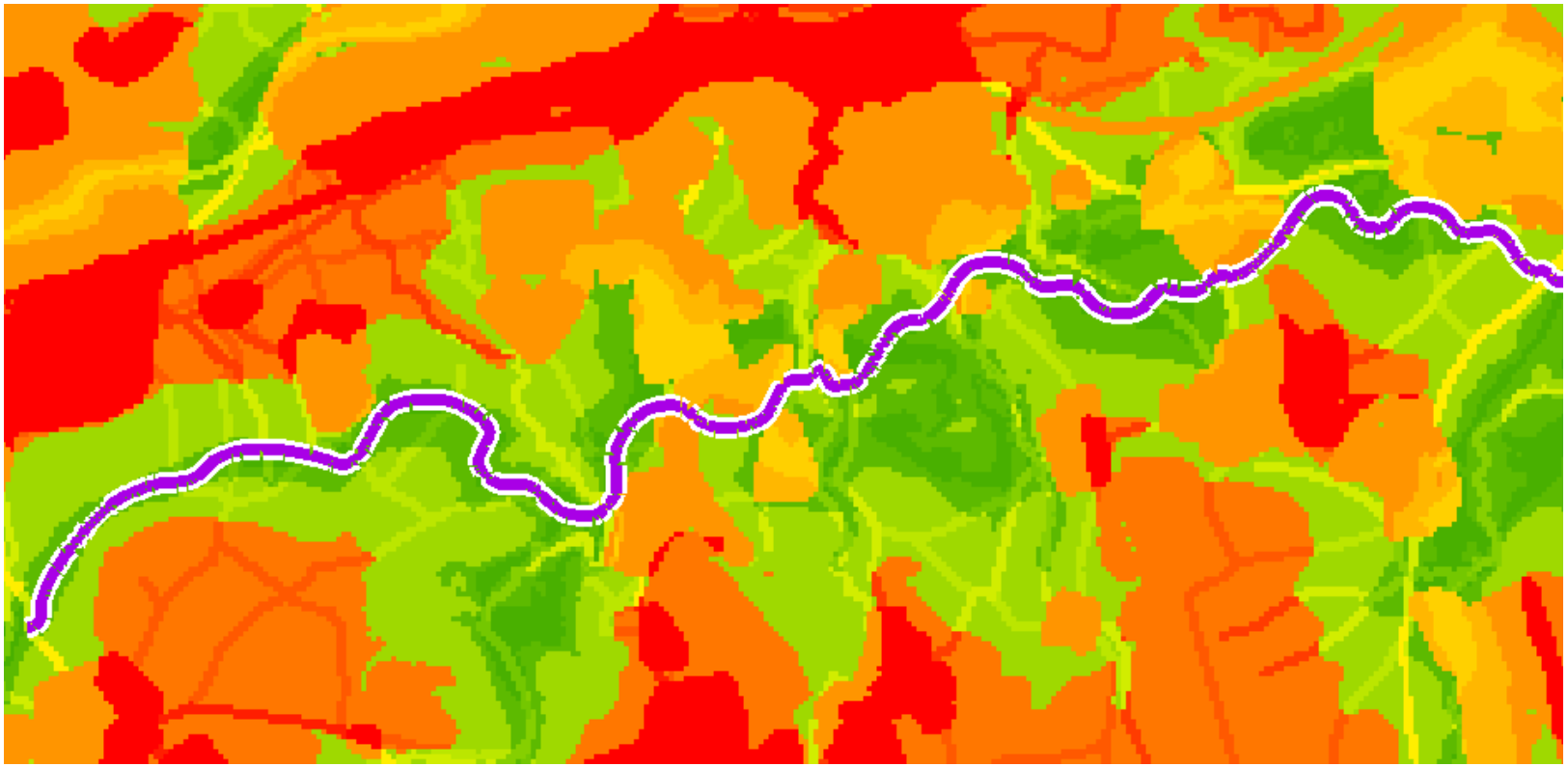
Least Cost Path

The algorithm first finds a route from the source to the destination, and then re-calculates it in the reverse direction to minimise the cost



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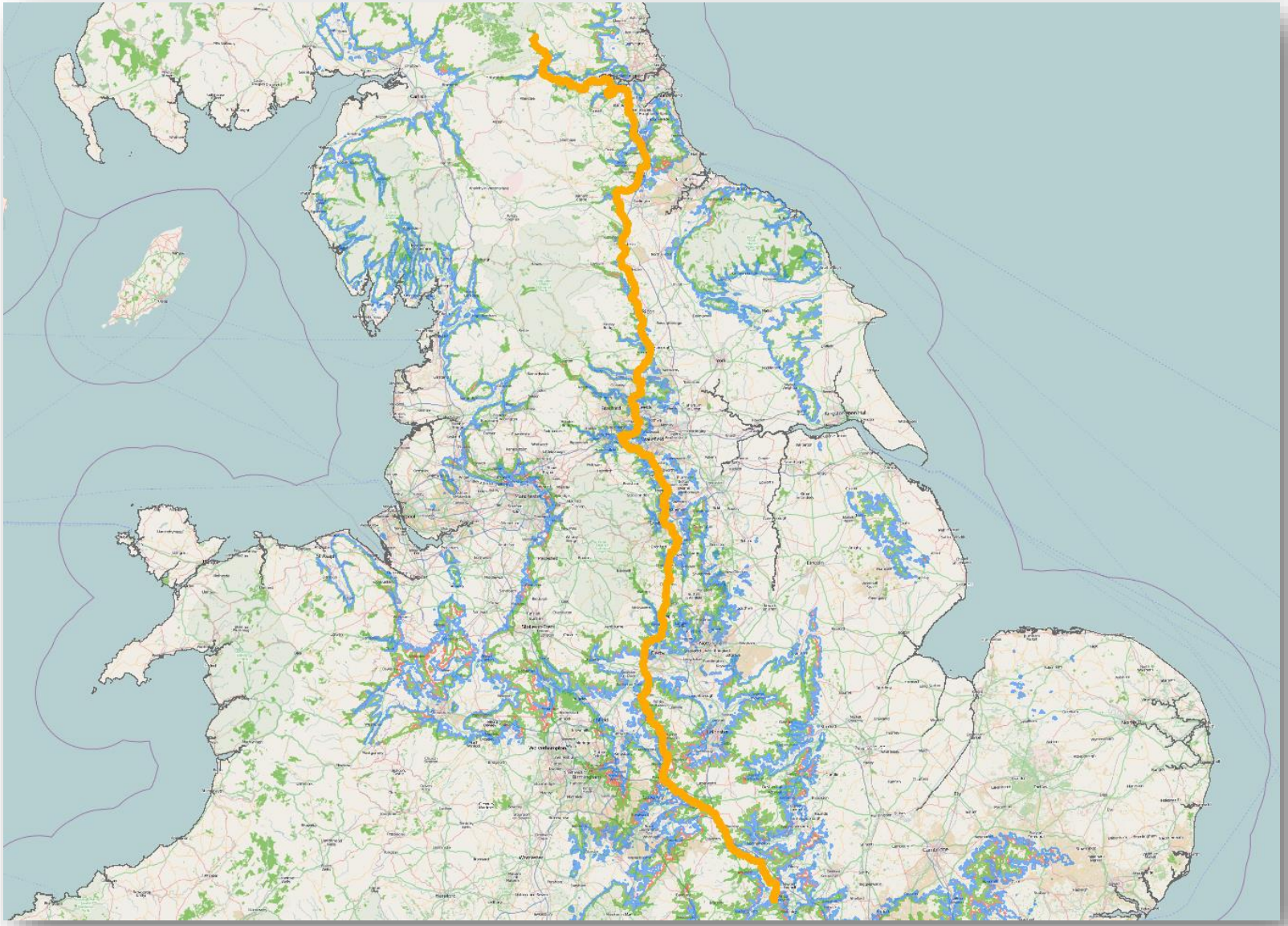
First Attempt – Least Cost Path Route



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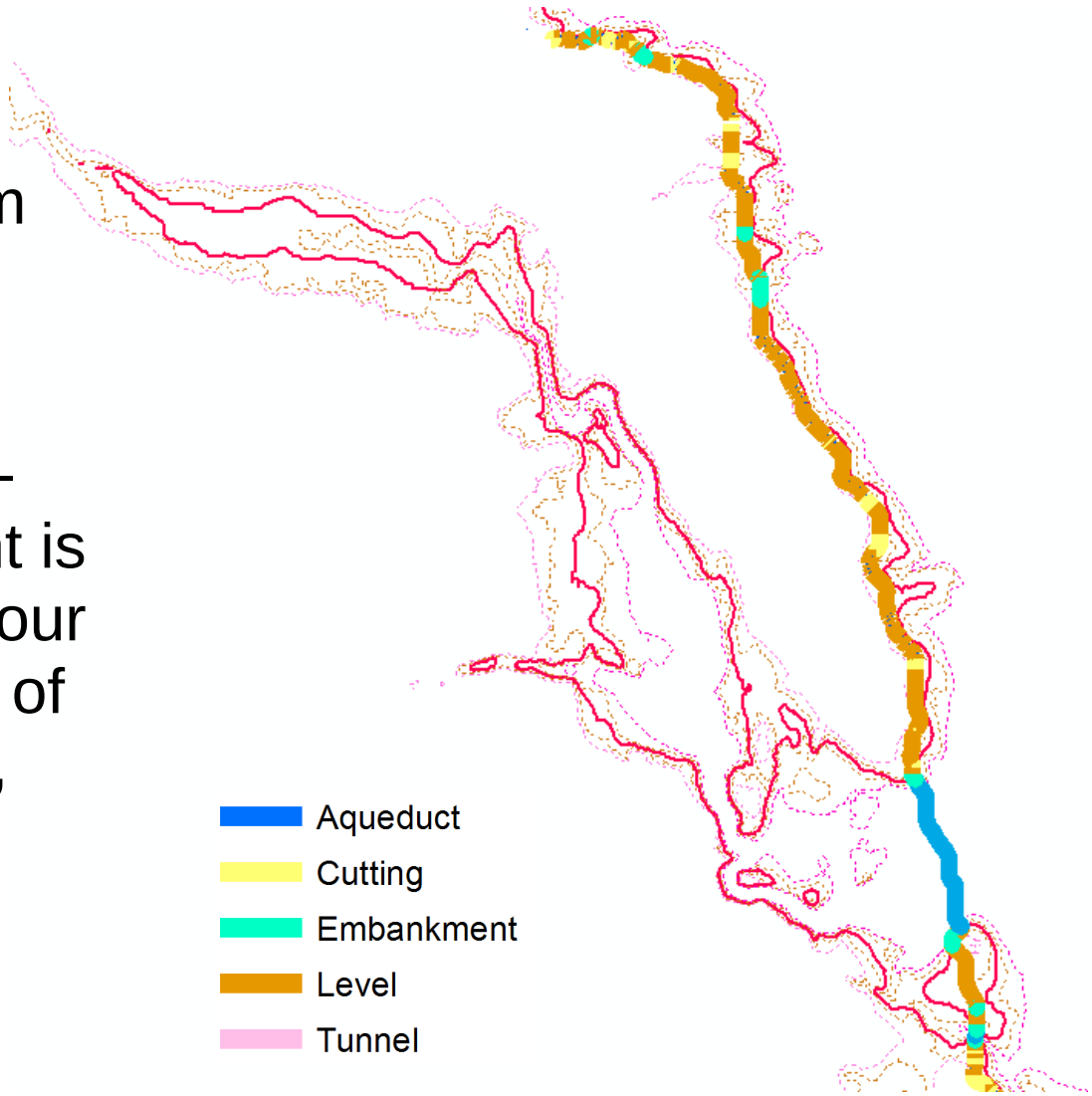
Construction Type

- The route is split in segments approx 50m long using the height raster
- The height at the mid-point of each segment is compared to the contour to determine the type of construction required, using the height/cost parameters



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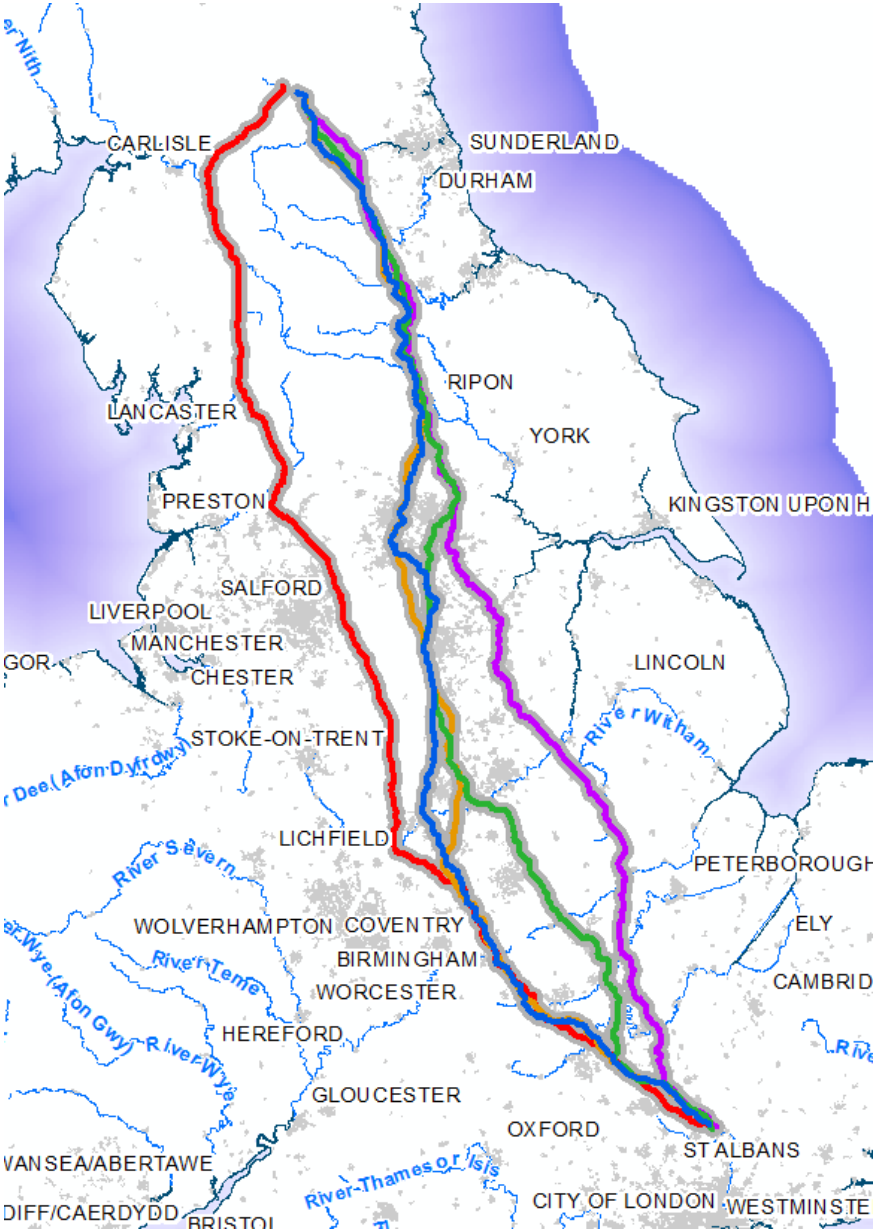
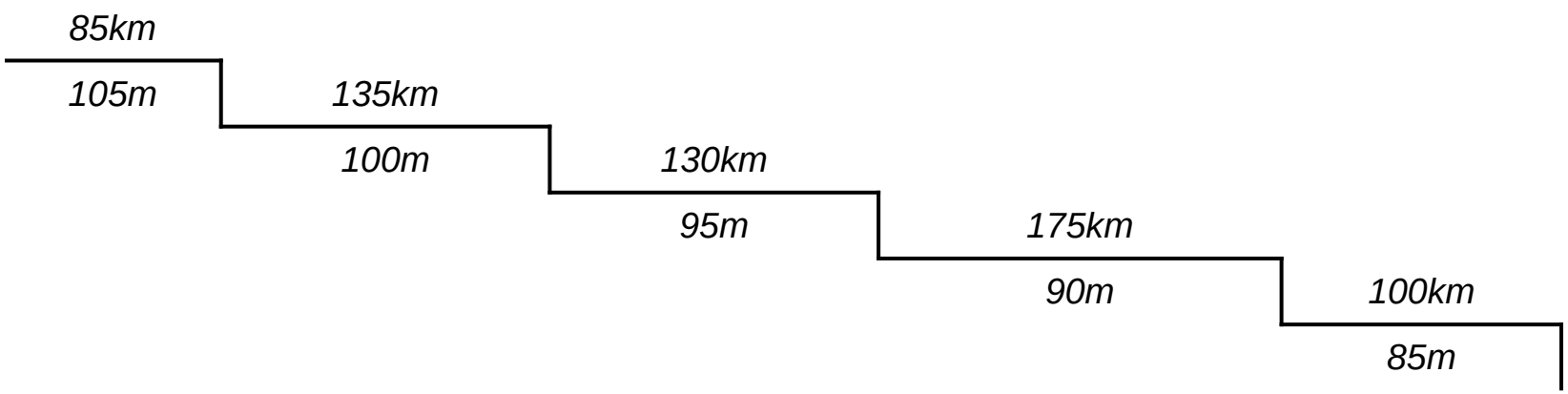
Route Options – Single Level

- First task was to see if there was a range of contours that could each be used to create a route (75m/85m/95m/105m/115m)
- The range of cost factors for these runs was too small, resulting in a lot of tunnels, and some unrealistic options
- But it proved that there were options



Route Options – Changing Level

- Next set of runs used a more realistic scenario
- At 900 Mld, minimum of 12m difference in level across 625km required



- Canal divided into “pounds” at fixed levels, connected with 5m deep locks, creating a hydraulic gradient

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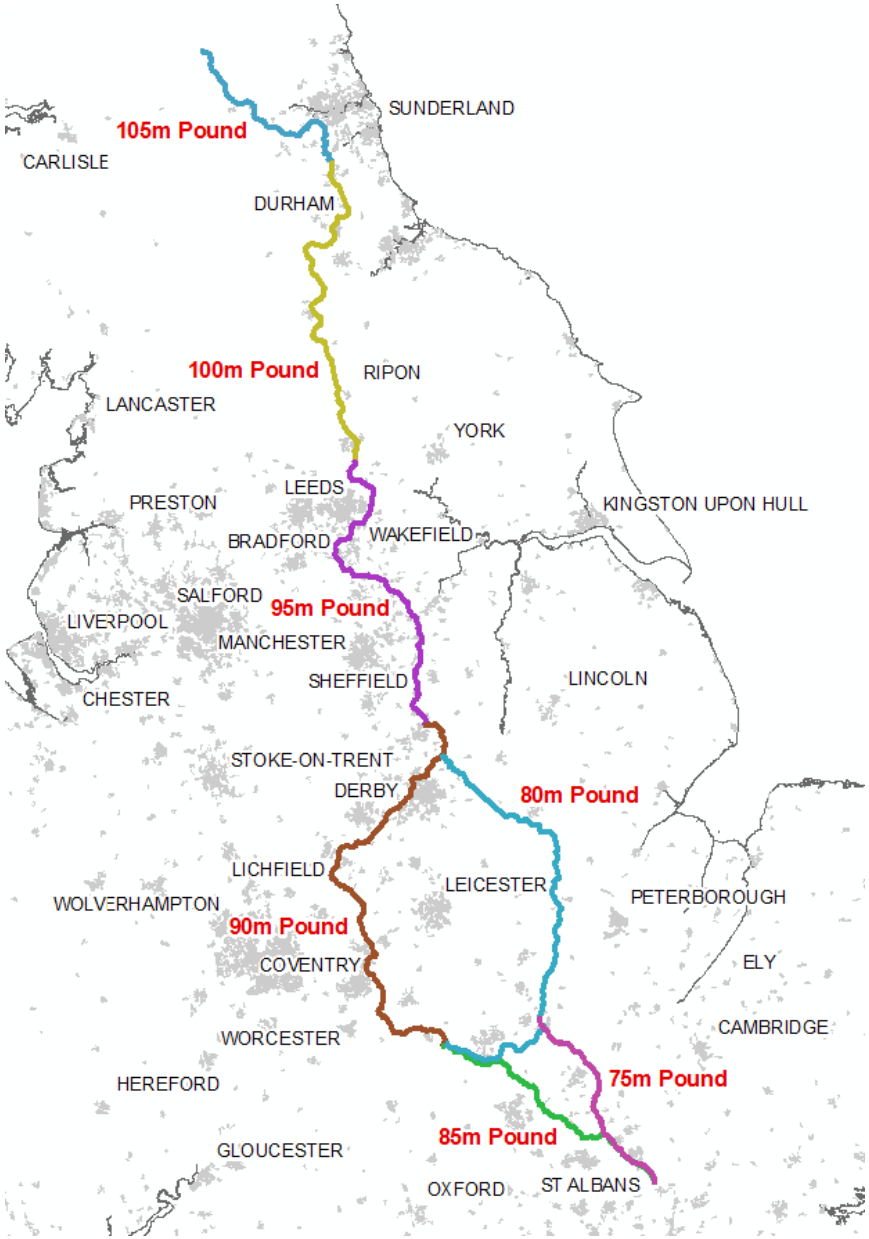
Route Options – Changing Level

- Better differentiation between relative construction costs
- Changed balance of construction away from tunnels and towards level sections along contours
- Alternative routes/levels for southern section investigated



Summary of Pound Based Route

The pound based approach creates a more feasible overall route, avoiding major conurbations and meeting most of the objectives

Aqueduct	Cutting	Embankment	Level	Tunnel	Total
143km	86km	66km	275km	56km	526km
22.9%	13.7%	10.6%	43.9%	8.9%	

With the revised cost factors there is still too much in tunnels or especially on aqueducts, but the overall balance of construction type is better than previous model runs

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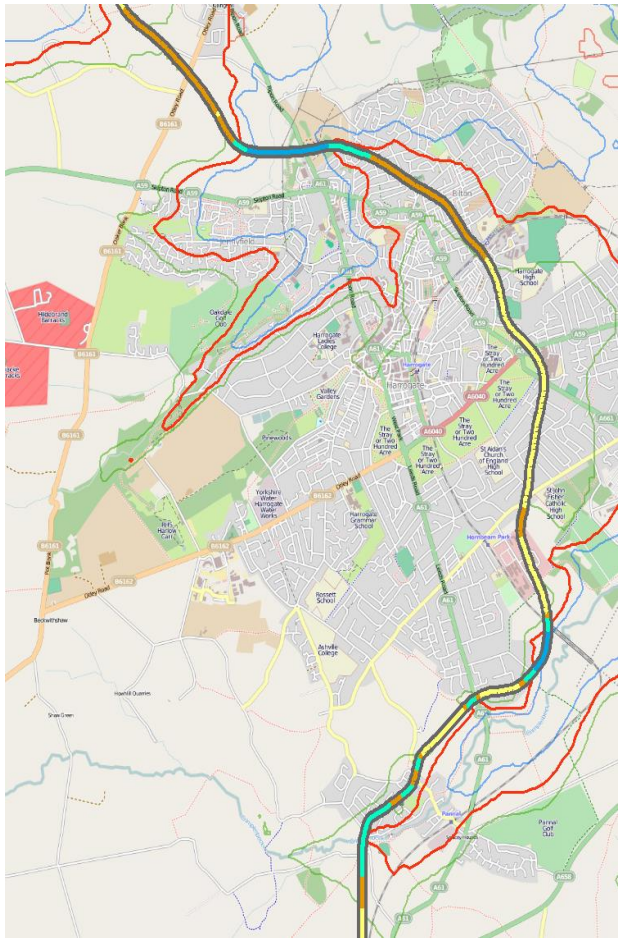
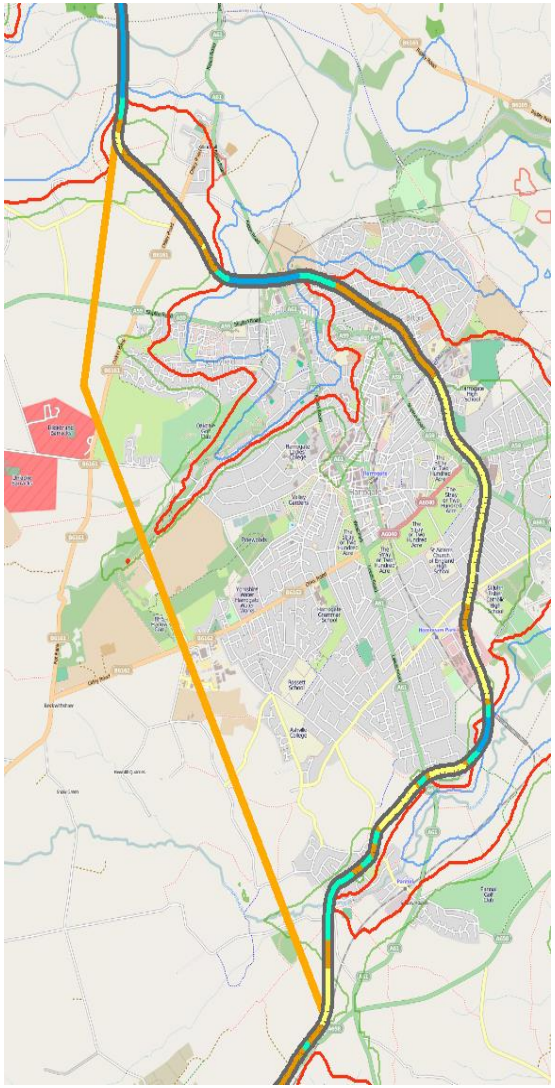
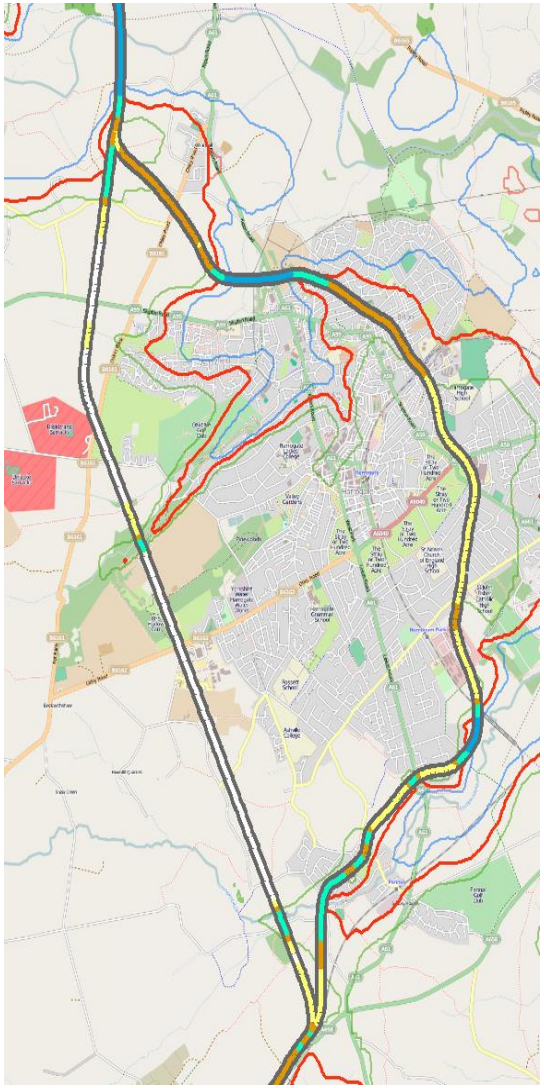
Manual Alternates







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Conclusions

- There is a potential route for the Canal
- Geo-processing models can be re-run with different parameters construction type and cost
- More detailed costs and specific routes need investigation
- The business case is not yet made
  - Is there a credible economic case?
  - How does it compare to other major infrastructure schemes?
- Using ArcGIS for route testing provides an efficient, multi-criteria optimisation with instant visualisation

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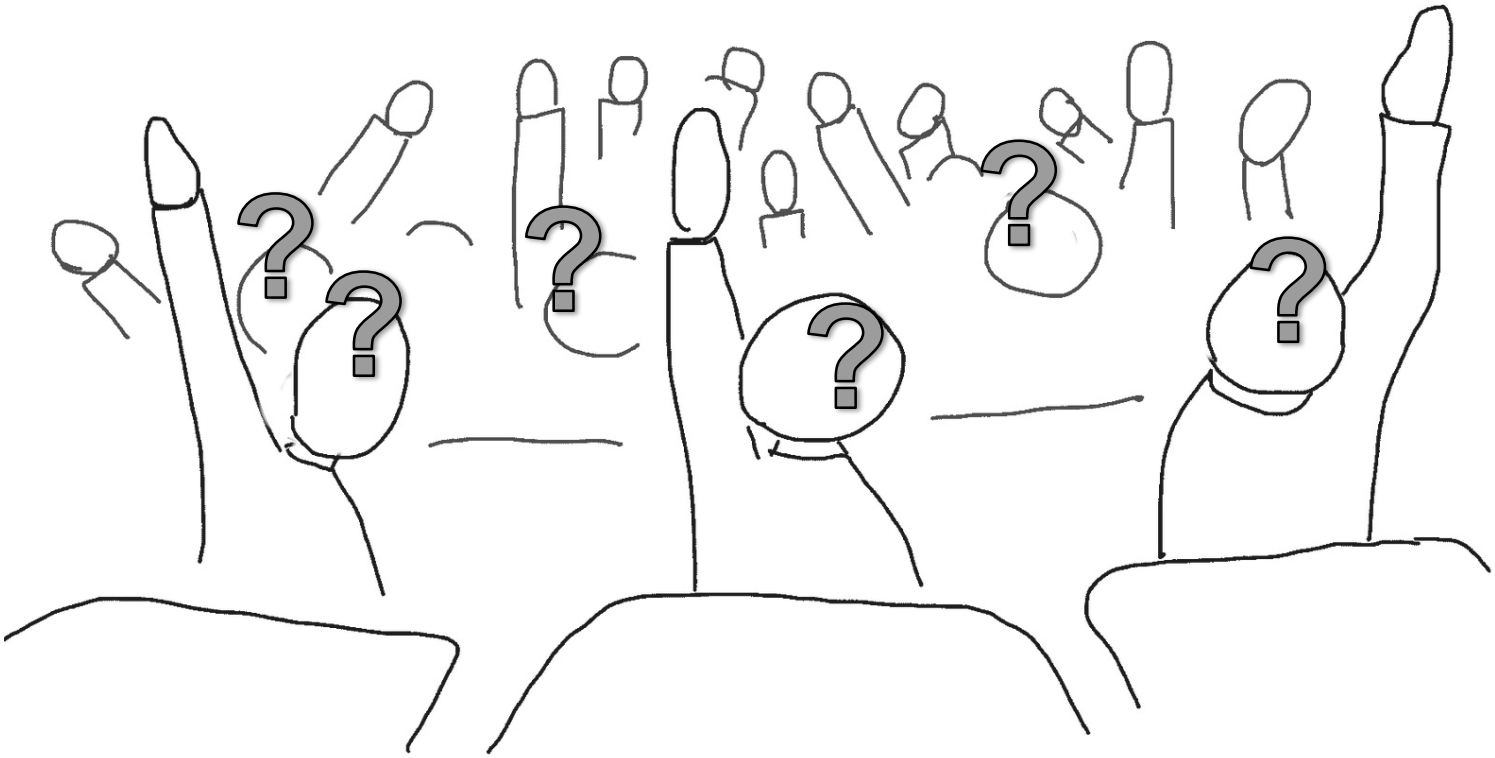
Any Questions?



Thank you for listening

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