Site-investigation and landfill characterisation by airborne geophysics

David Beamish

Geological Survey of Finland

SUOMEN ILMAILUOPISTO
FINNISH AVIATION ACADEMY

British Geological Survey

Why landfills?

- Potential sources of pollution
  - migration pathways in the subsurface
  - source-pathway-receptor model

- Methane emissions and climate change
  - Landfills are main contributor (40%) to UK methane release
  - Methane is 21 times more powerful than CO_2 as a greenhouse gas
  - They are a significant factor in UK reduced emission targets

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Outline

- Principally considering subsurface electrical conductivity
  - It's a 'new information' data set
  - Ignoring main geological discoveries (regional scale)
  - Concentrating on environmental information at scale of ~1 to 3 km
  - Simple mapping information and subsurface volumetric information
- From geophysical perspective (without technical site-information)
  - 1 active quarry
  - 1 sewage works
  - 5 landfills

subsurface electrical conductivity depends on:

Geology (solid component)

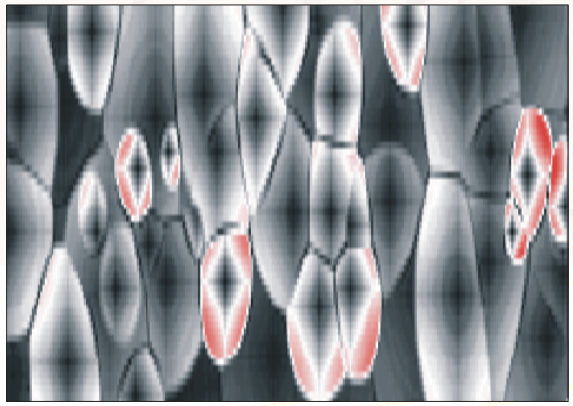
- porosity (i.e. void space)
- mineralogical associations (e.g. clays)

Geology

Pore water geochemistry

- ionic concentration & mobility
- (e.g. Na^+, $SO4^-$, Cl^-, K^+, and $NO3^-$ groups)
- No geochemical discrimination…
- it measures only Total Dissolved Solids

Pore fluids



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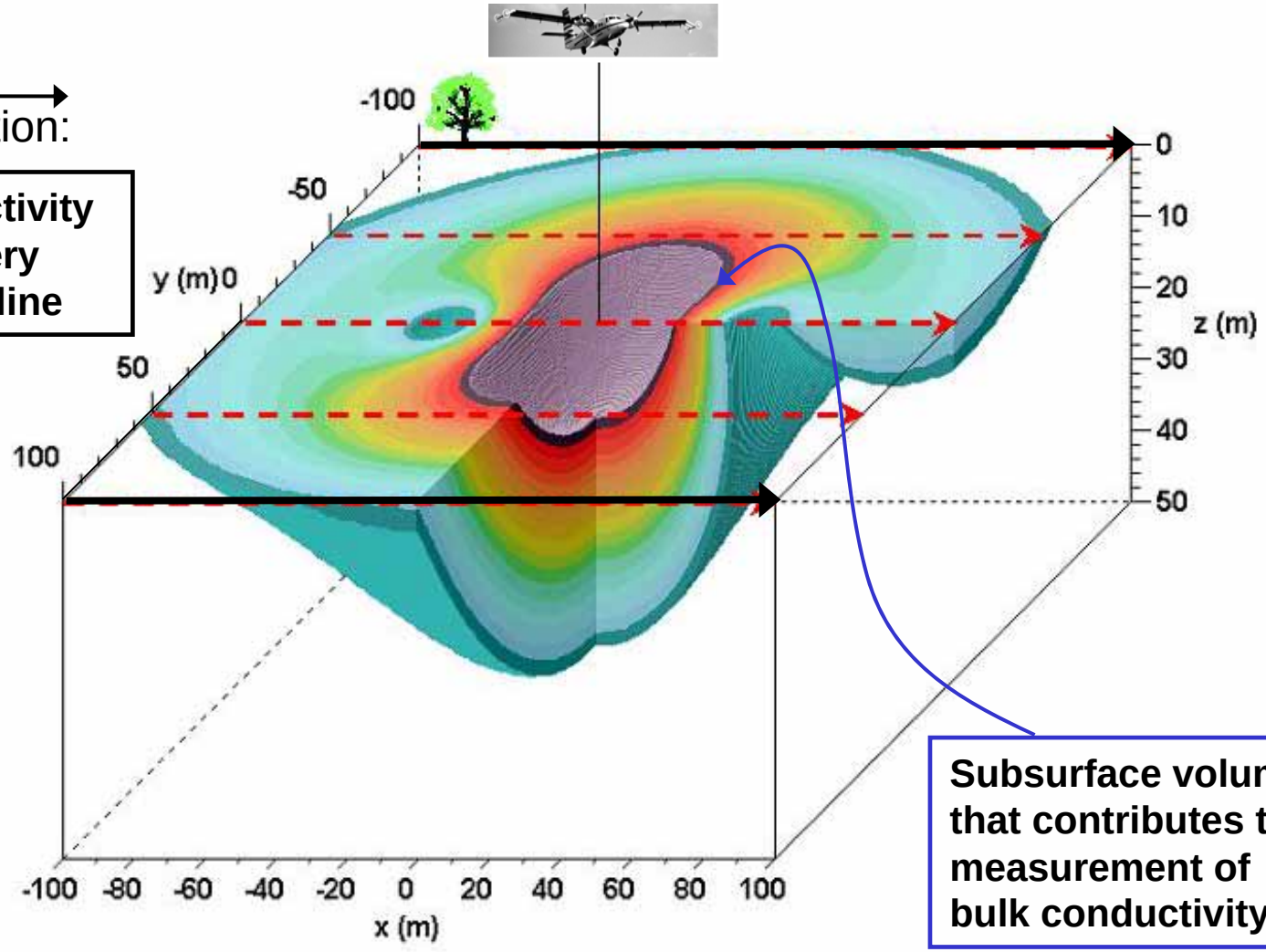
Demonstrating the electromagnetic footprint

Flight direction:

Bulk conductivity sampled every ~15m along line



Subsurface volume that contributes to measurement of bulk conductivity

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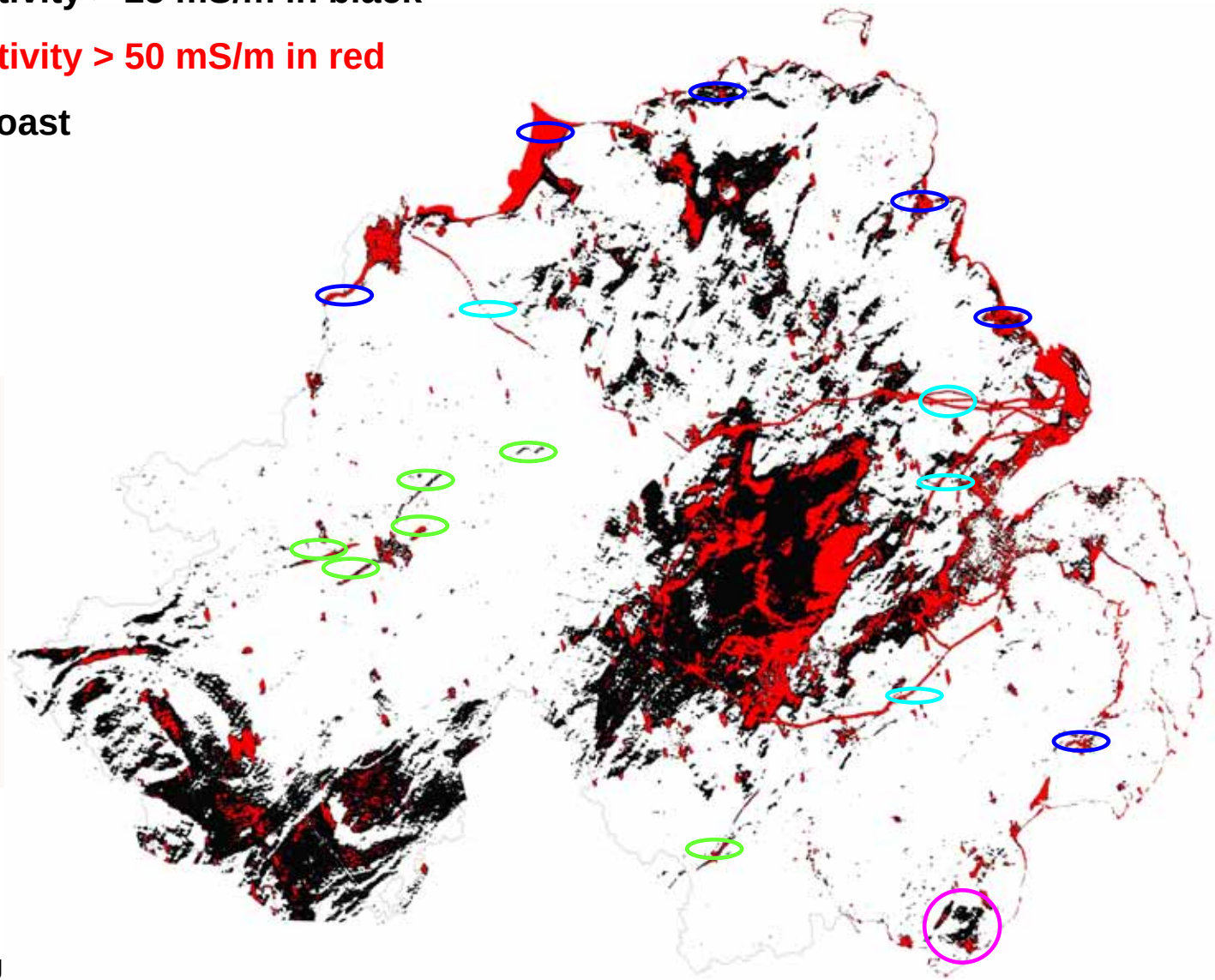
- conductivity > 25 mS/m in black
- conductivity > 50 mS/m in red
- cut at coast



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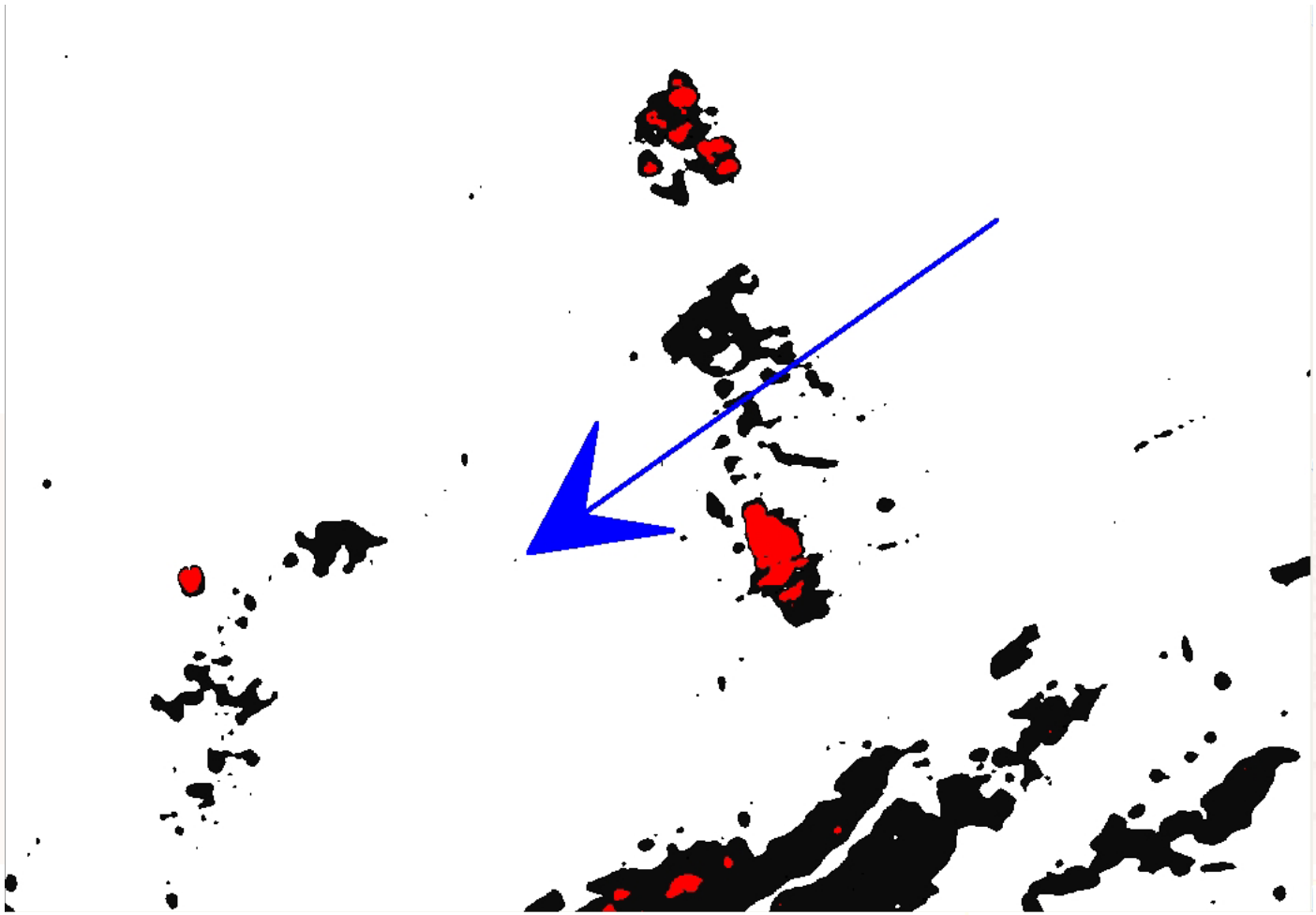

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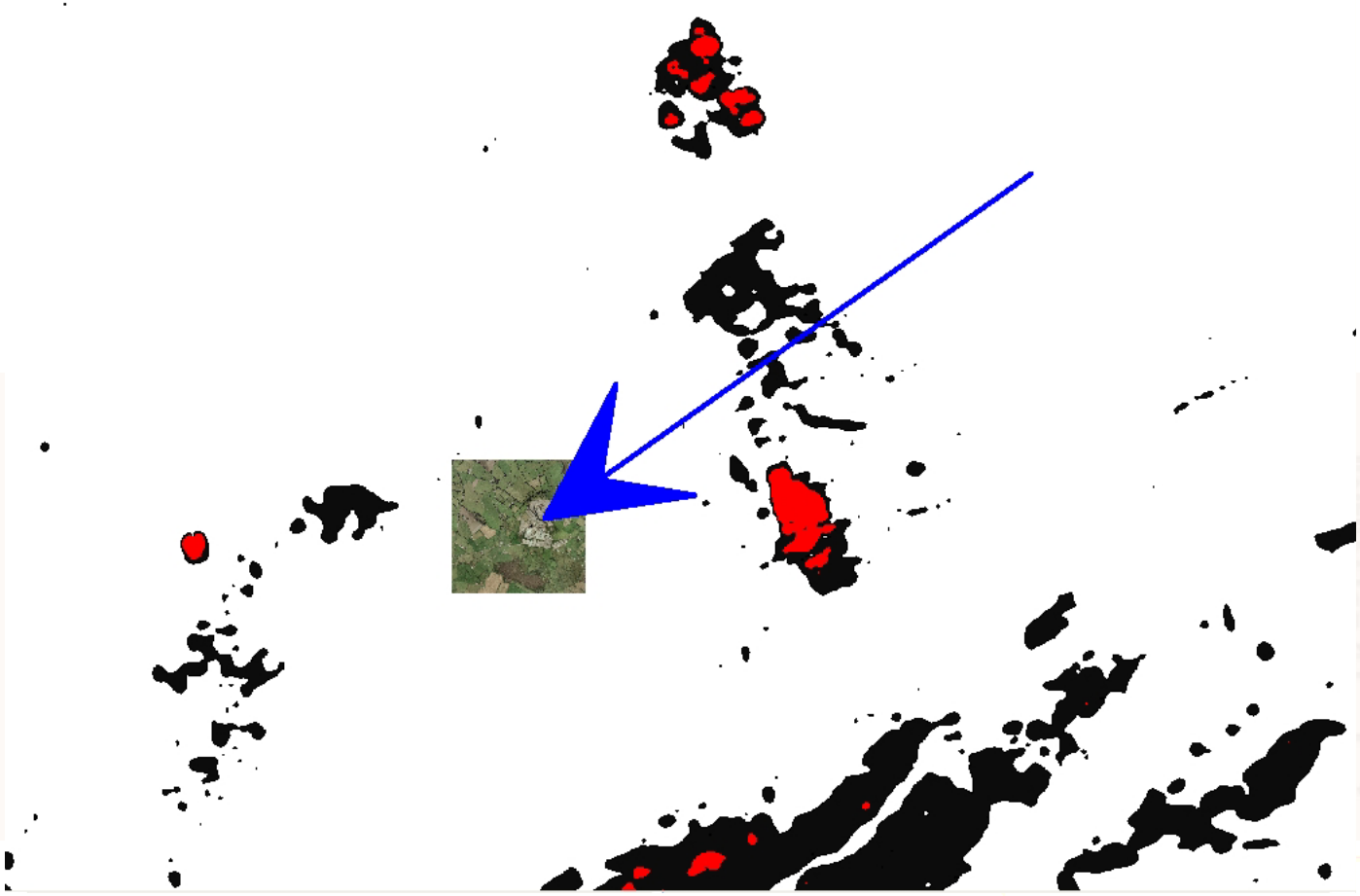

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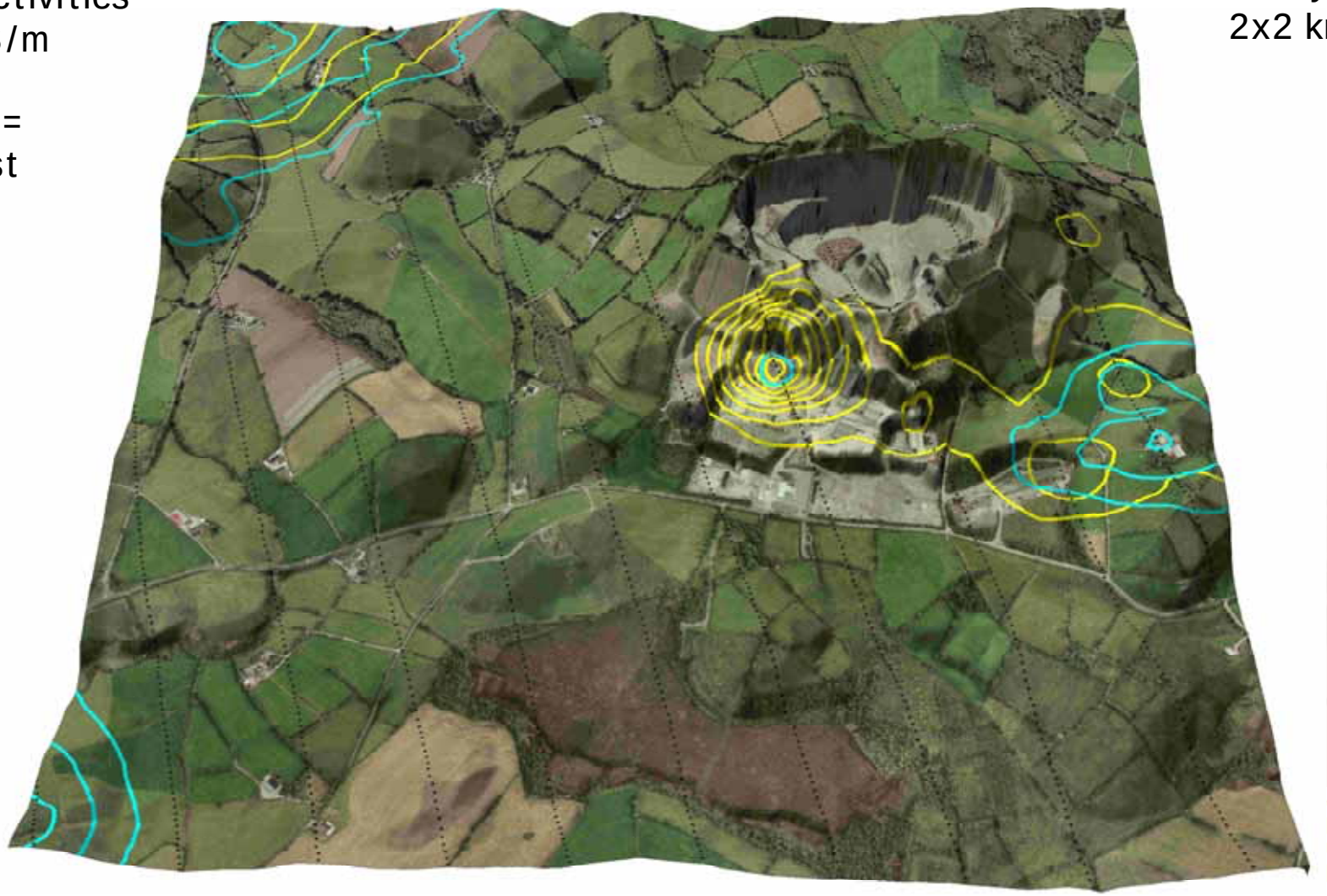
Conductivities
> 5 mS/m

Yellow = deepest



Study area
2x2 km

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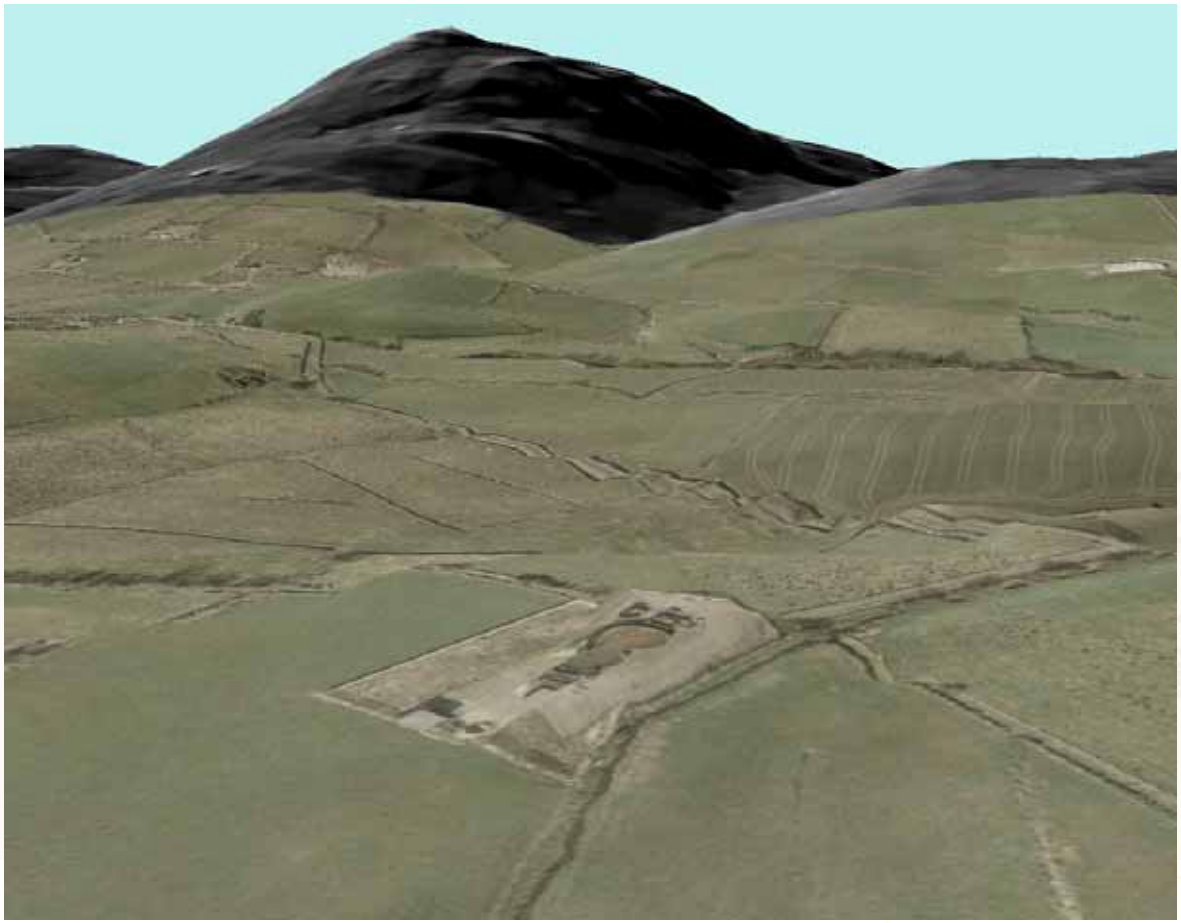
Target sewage works (north of Killeter)



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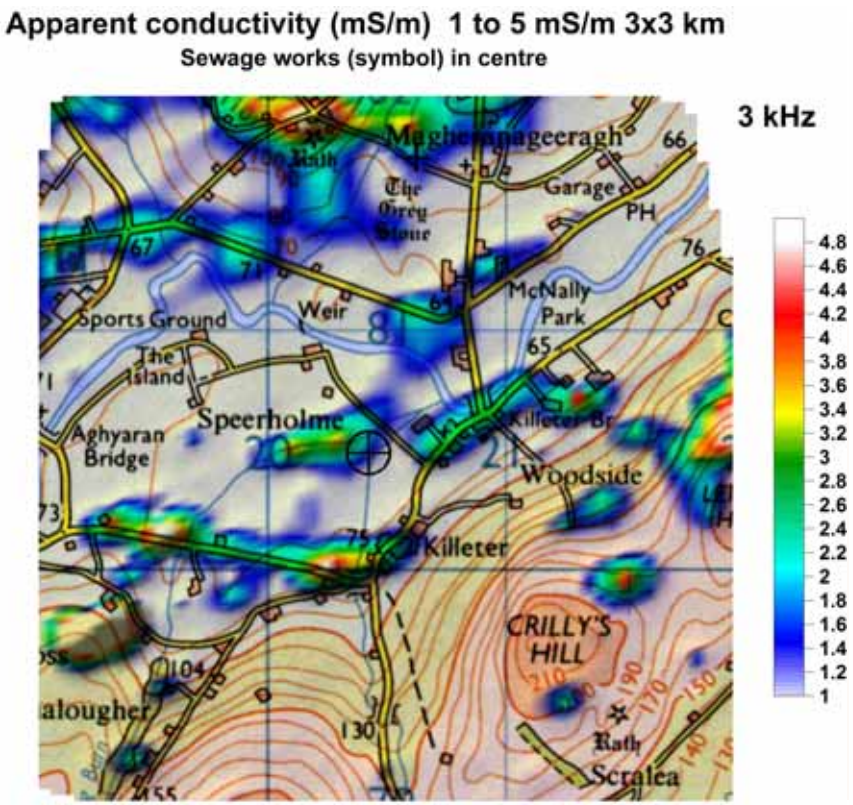
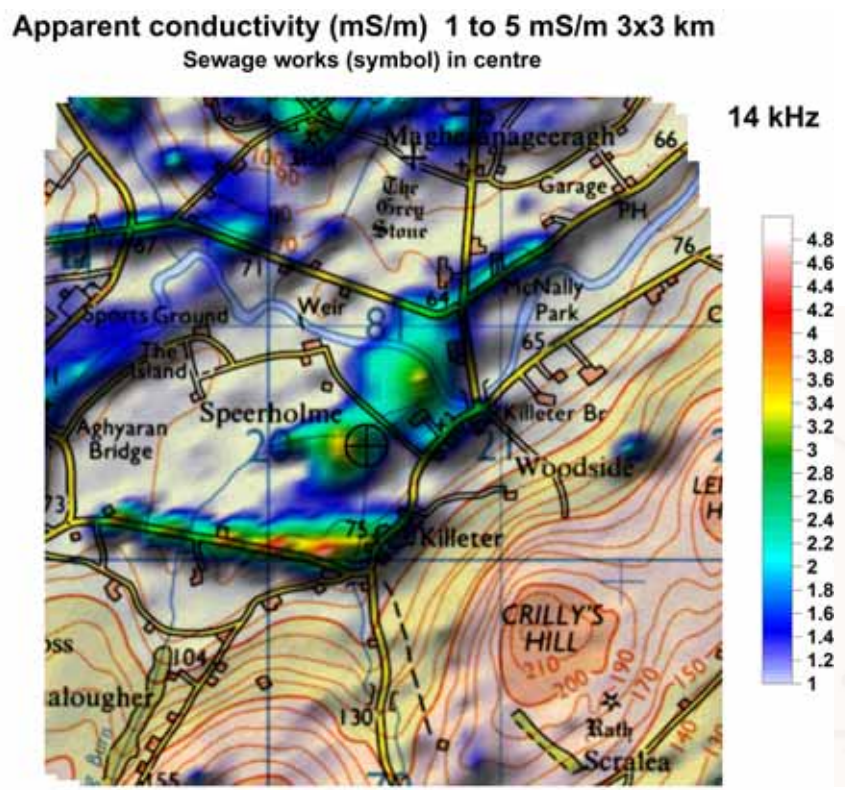
Demonstrating low amplitude conductivity mapping (1 to 5)

Study area
3x3 km



deeper



shallower

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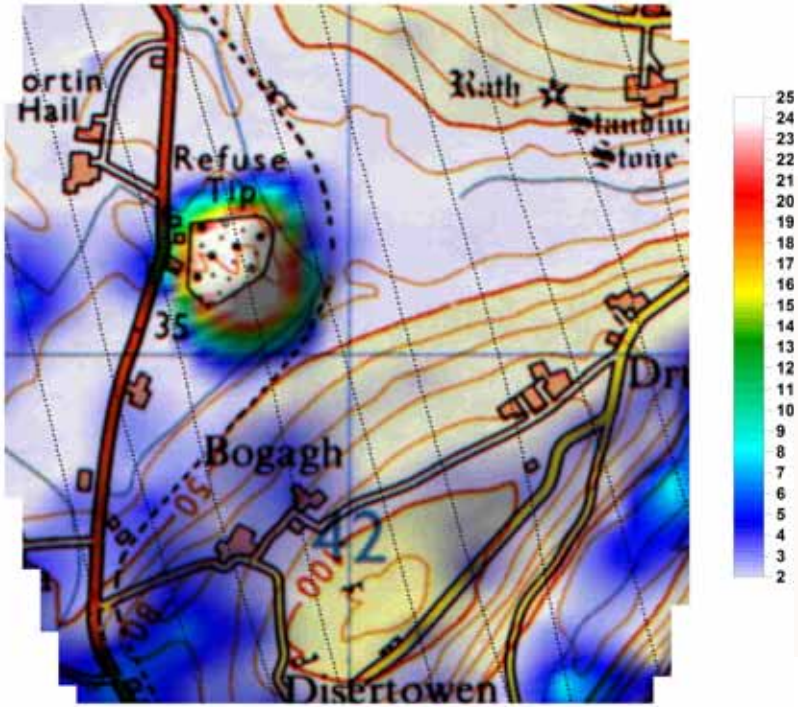
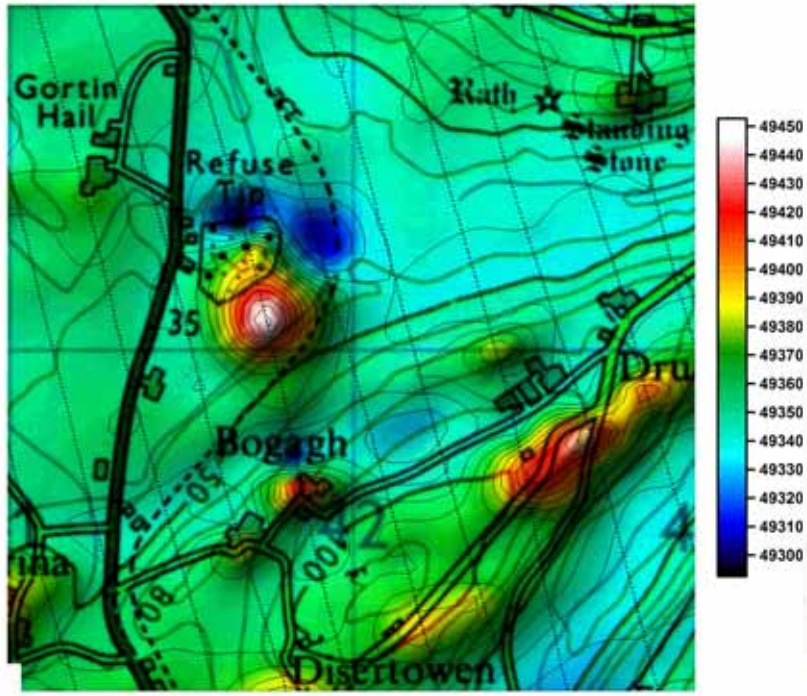
Study area
2x2 km

Demonstrating landfill anomaly confined to ~1 flight line



Conductivity > 2 mS/m



Magnetic field

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Strabane : Refuse tip
adjacent to river Finn/border

Strabane : concrete works

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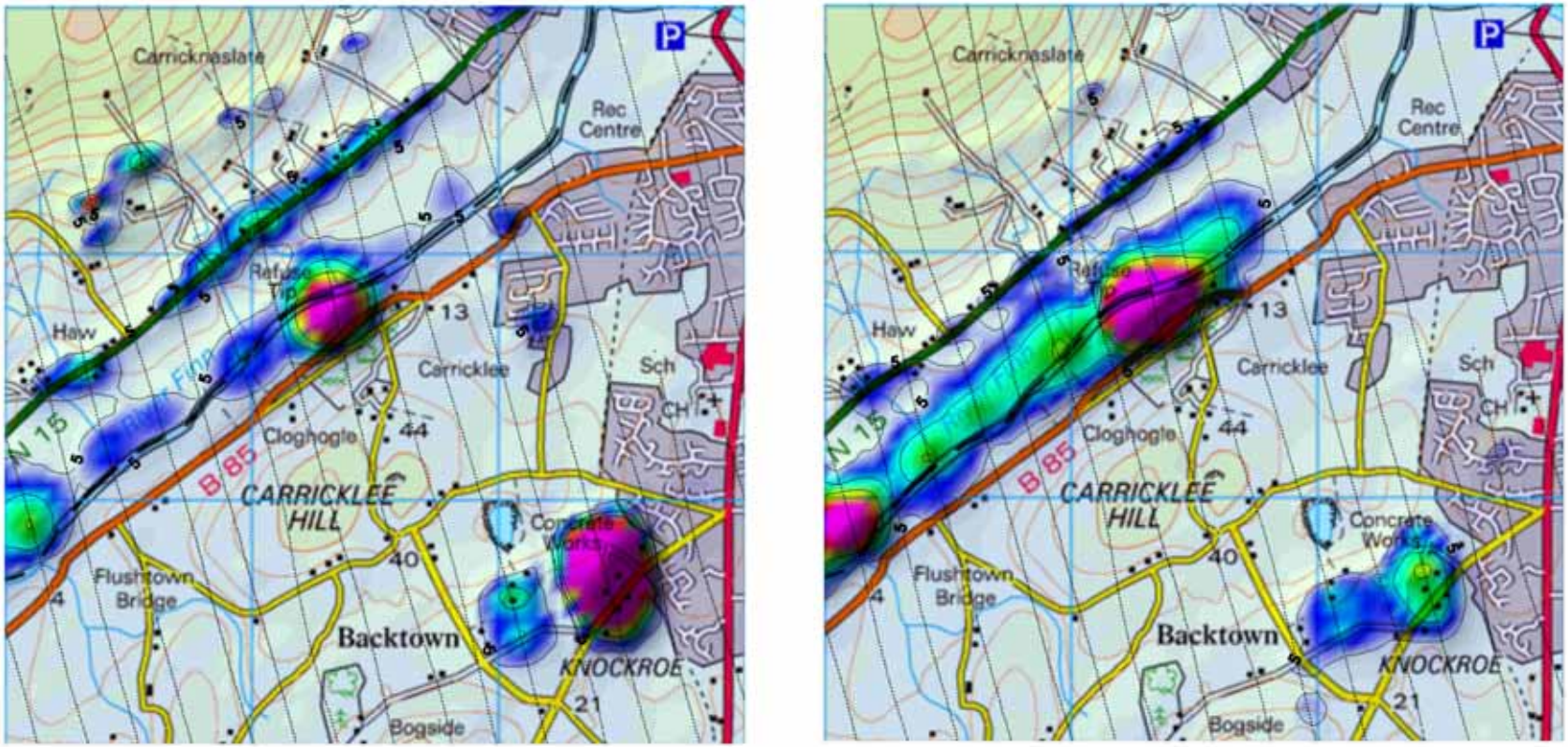
Study area
3x3 km

Demonstrating landfill anomaly with extensive plume



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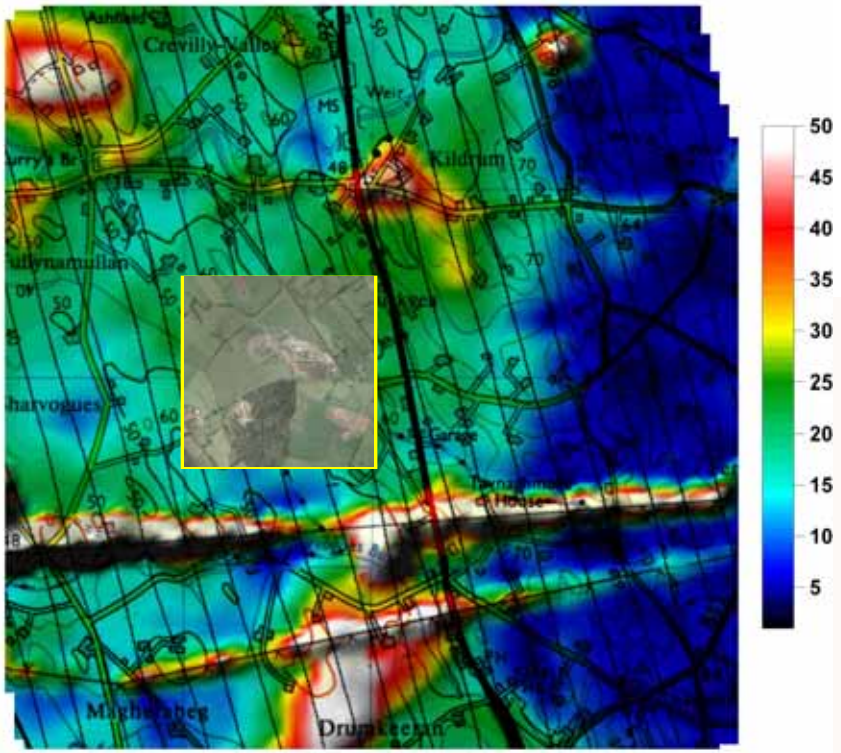
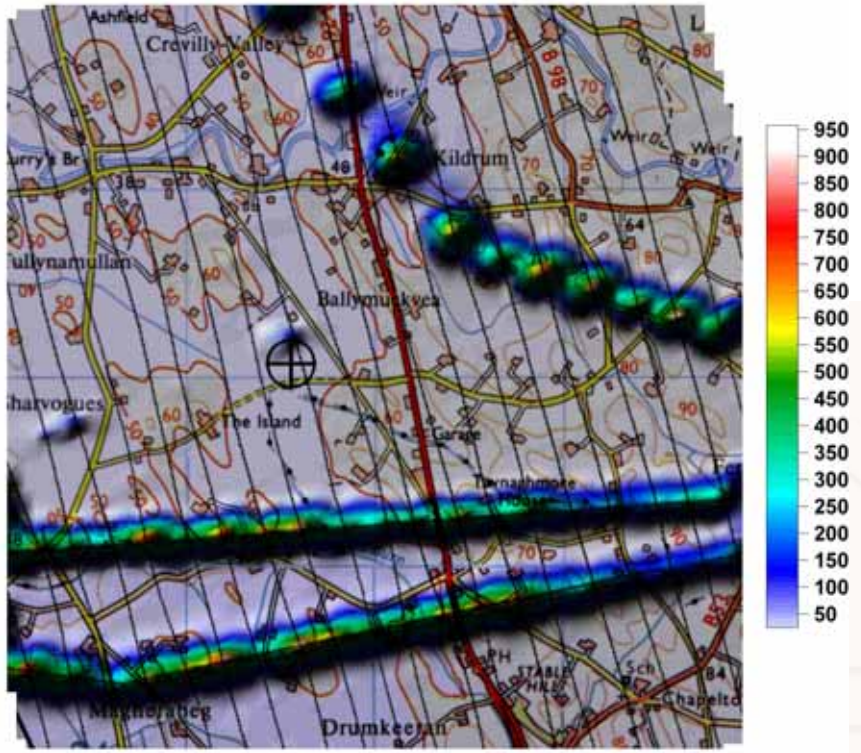
Study area
4x4 km

Demonstrating more extensive landfill anomaly with high conductivity



conductivity



Power-line monitor

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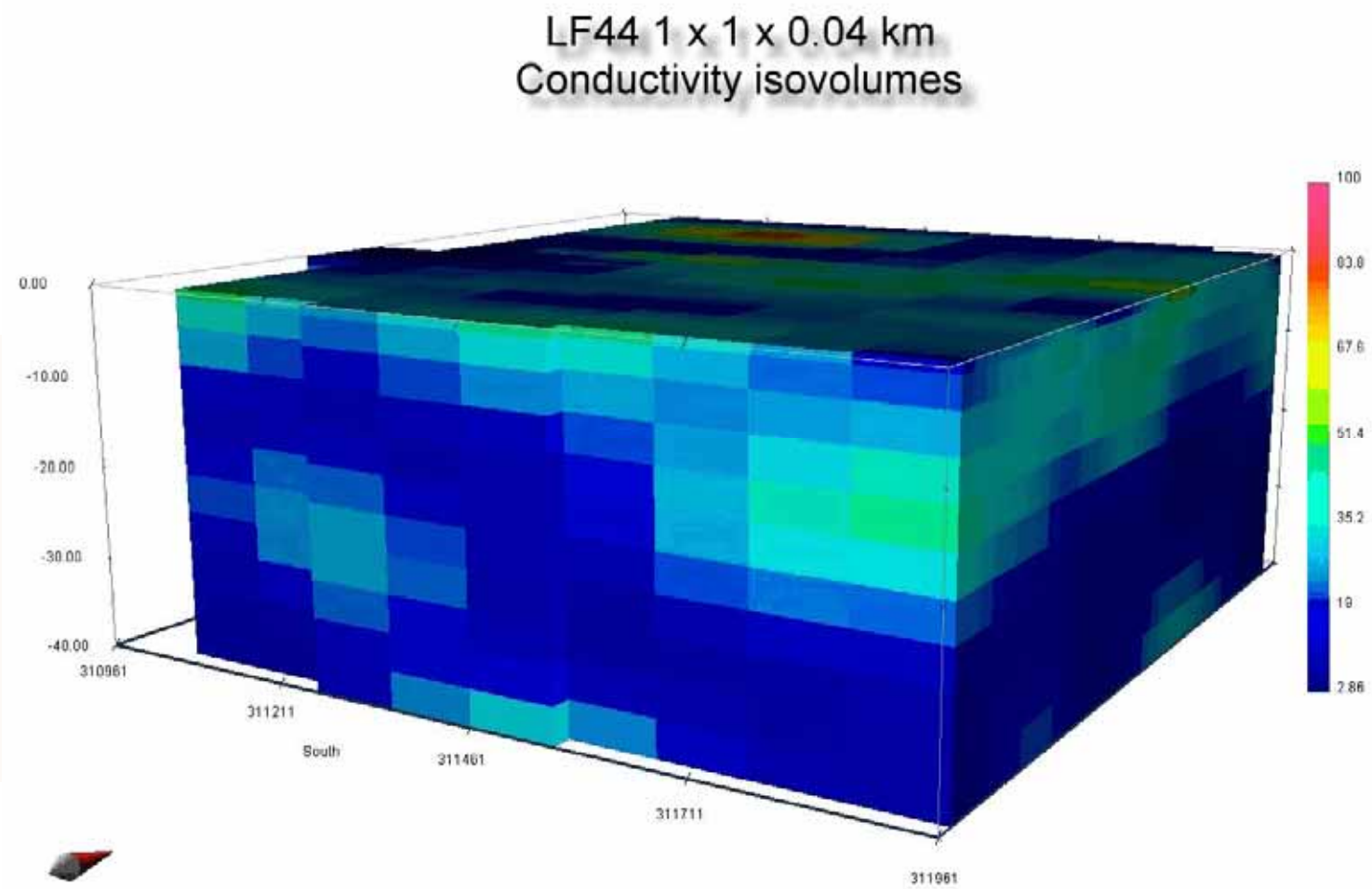
Demonstrating volumetric subsurface (to 40 m) information



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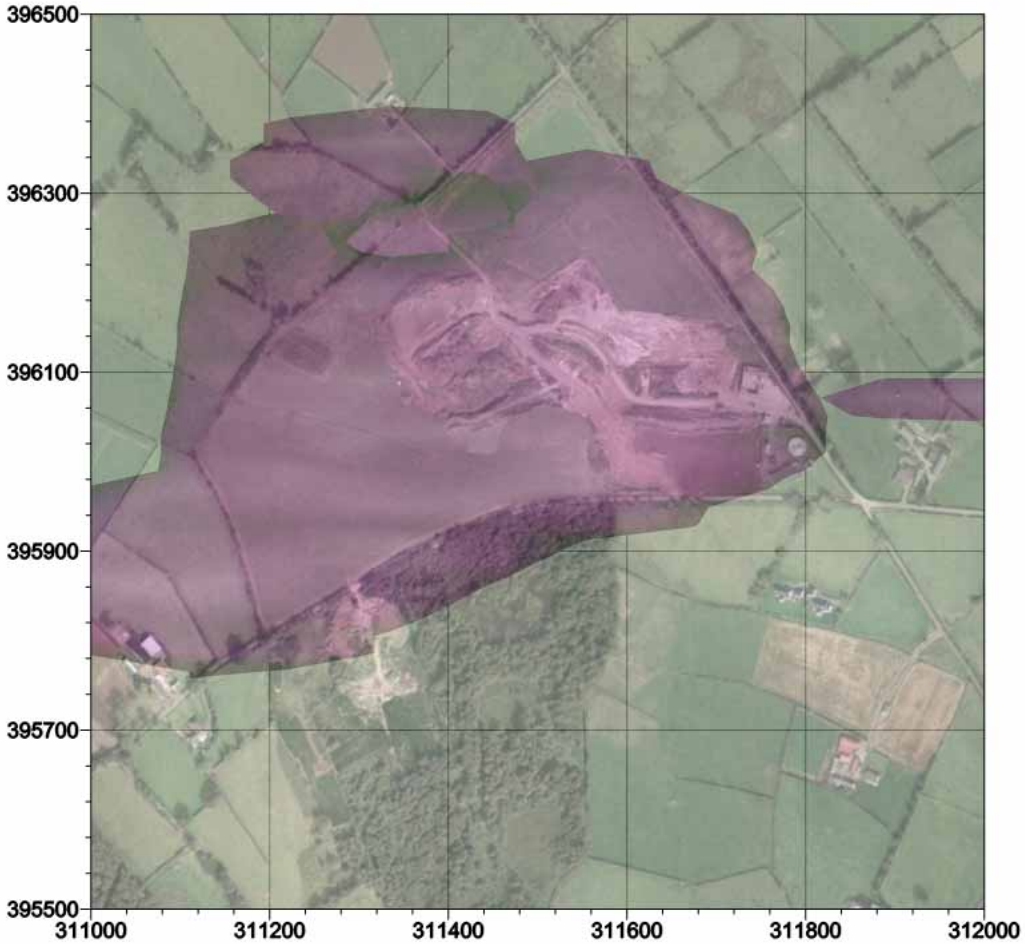
Study area
1x1 km

Demonstrating the 3D conductivity distribution beneath the site



> 80 mS/m

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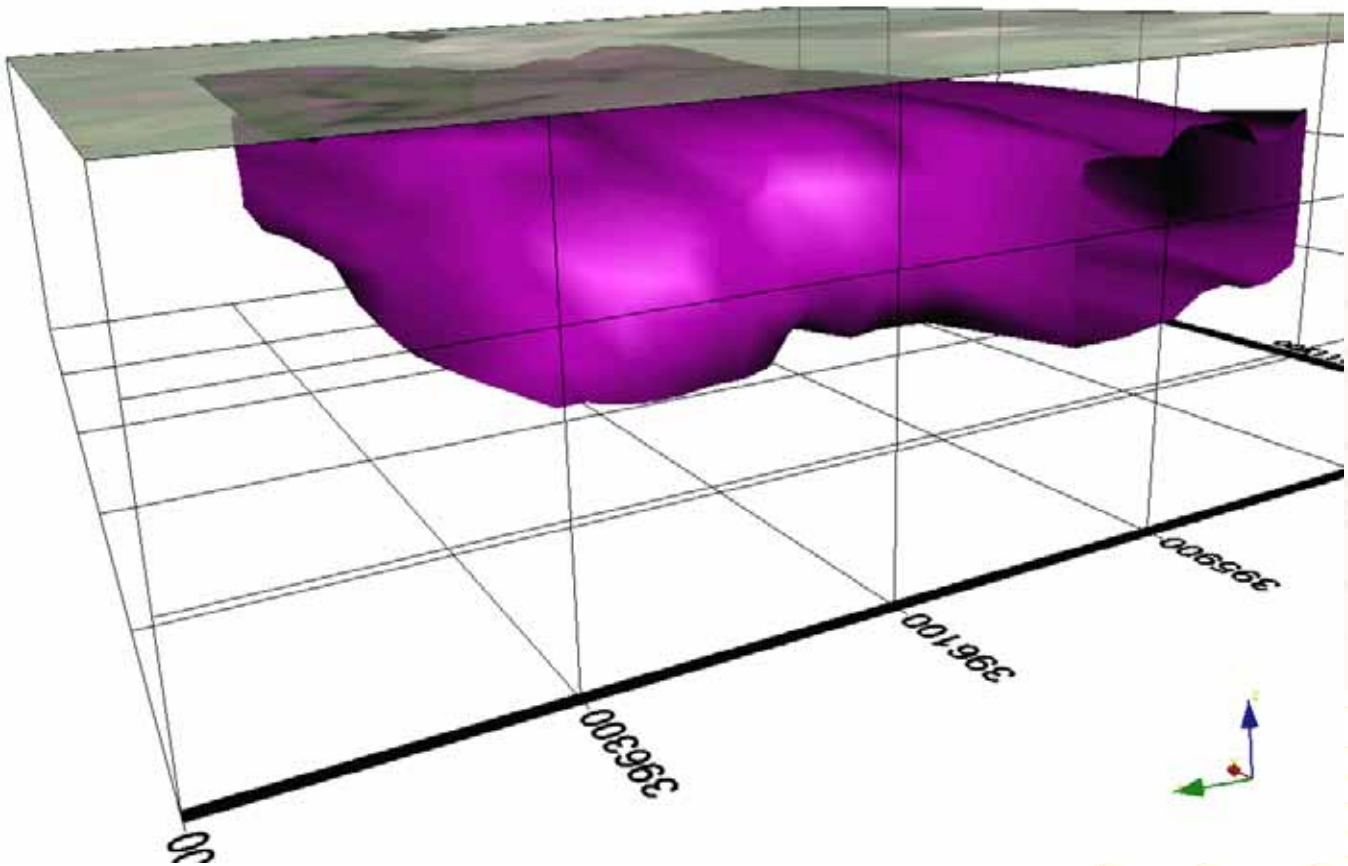
Demonstrating subsurface conductivities > 55 mS/m (to 30 m)



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Study area
3x2 km

Craigahullier landfill,
operating since 1998,
occupying a former quarry

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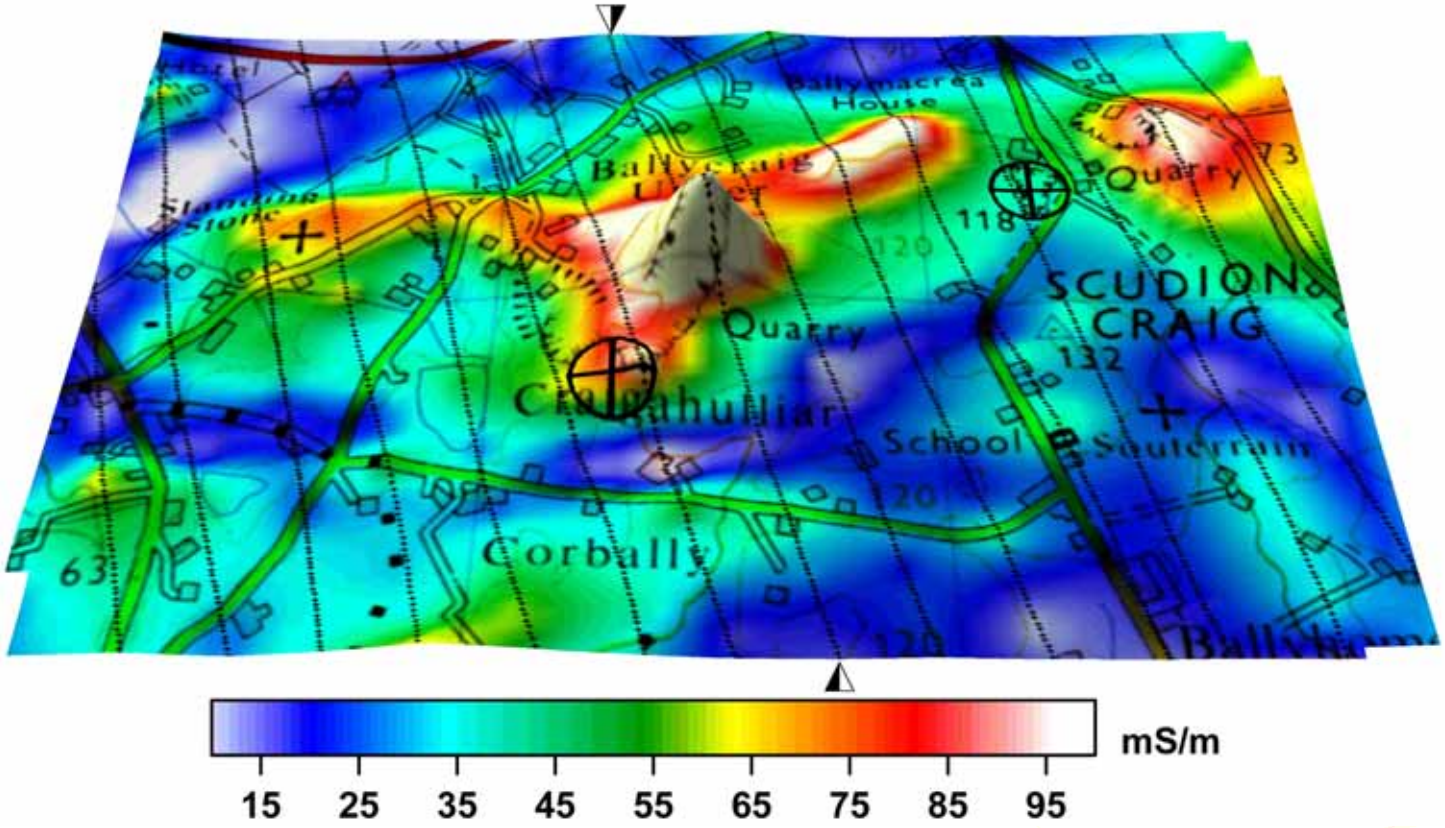
Demonstrating an engineered landfill in a complex setting

Study area
3x2 km

Largest landfill conductivities encountered (young reactive site)



3D perspective view of conductivity

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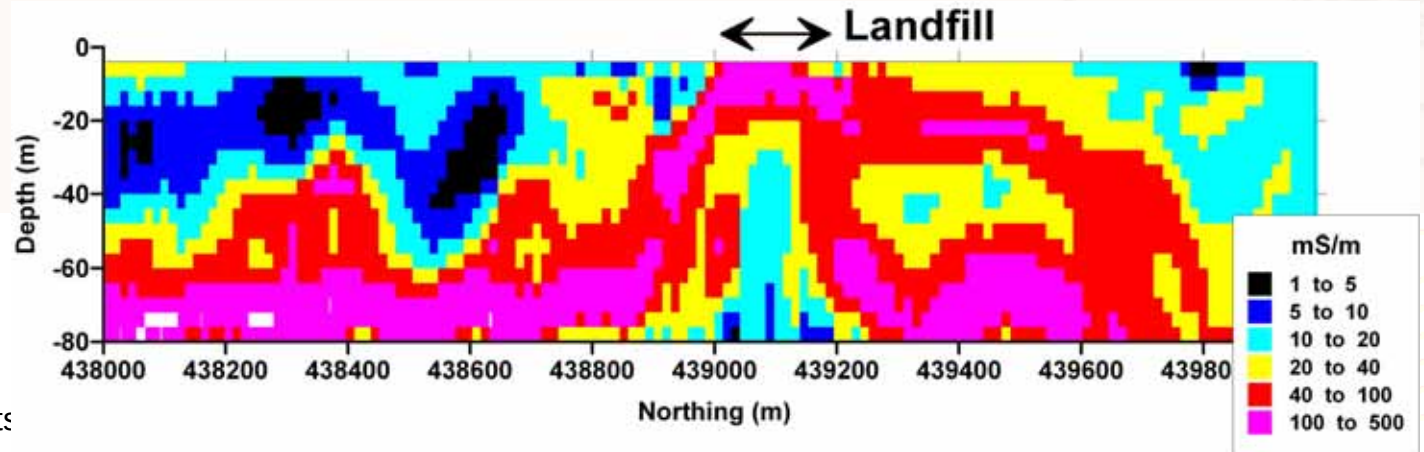
Detail. Largest amplitude response (pink contours) and line of cross-section

2 km conductivity cross-section across landfill



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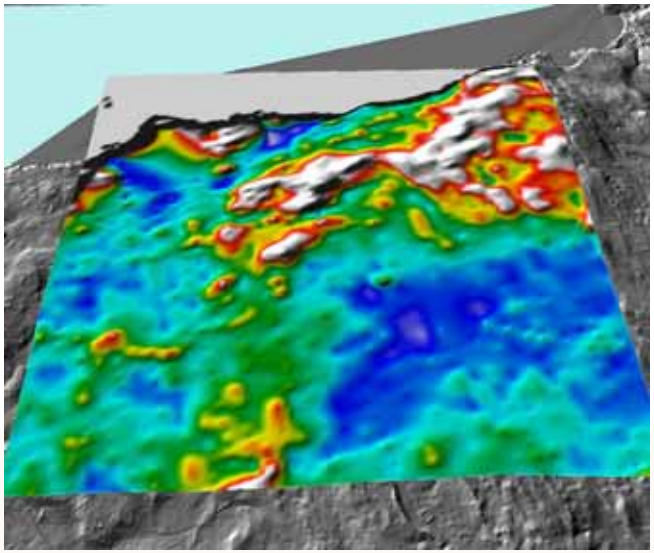
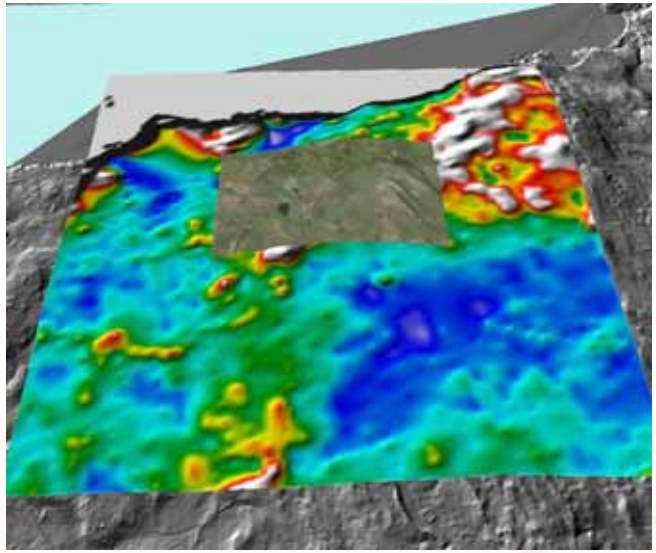
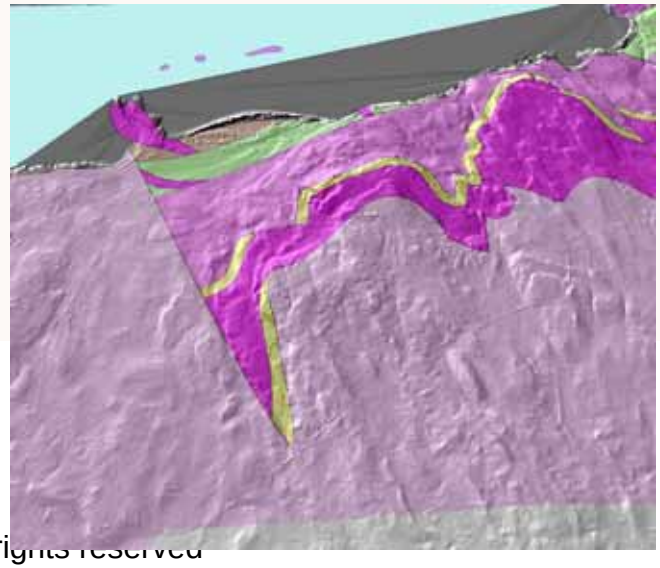
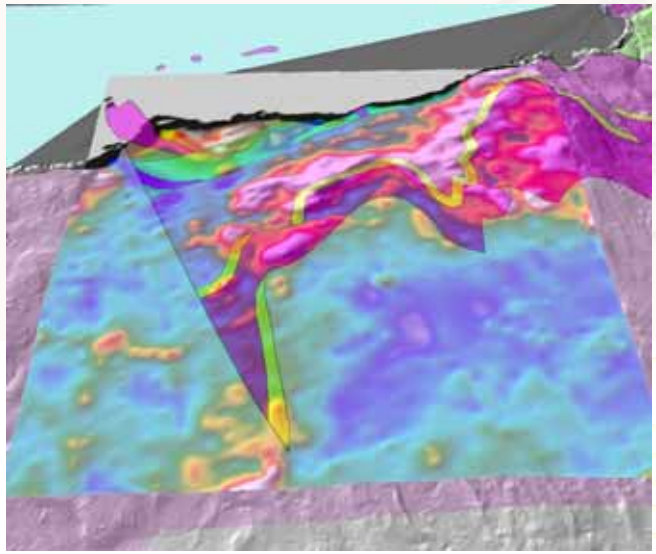
Demonstrating regional scale of saline intrusion and likely geological control





Study area
7x7 km





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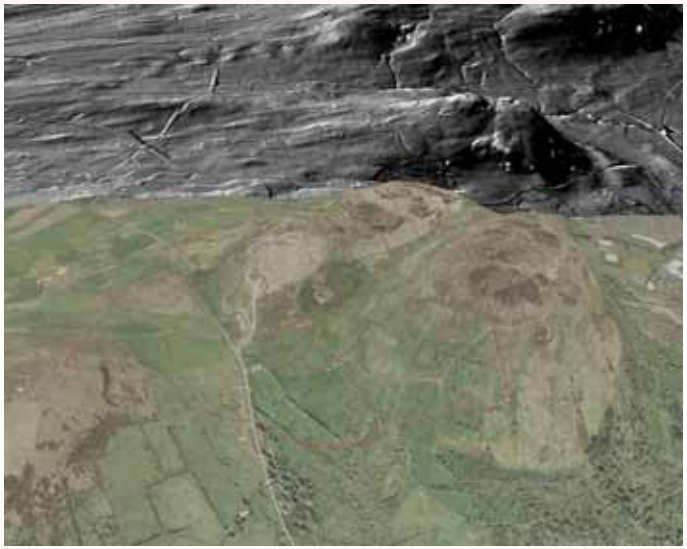
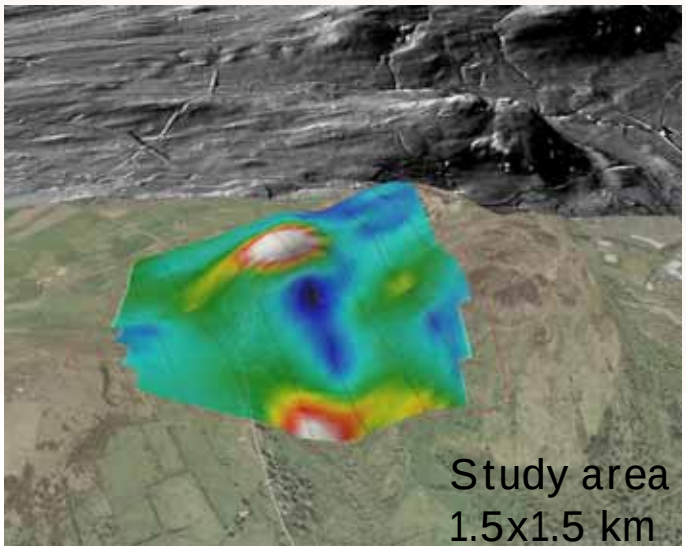
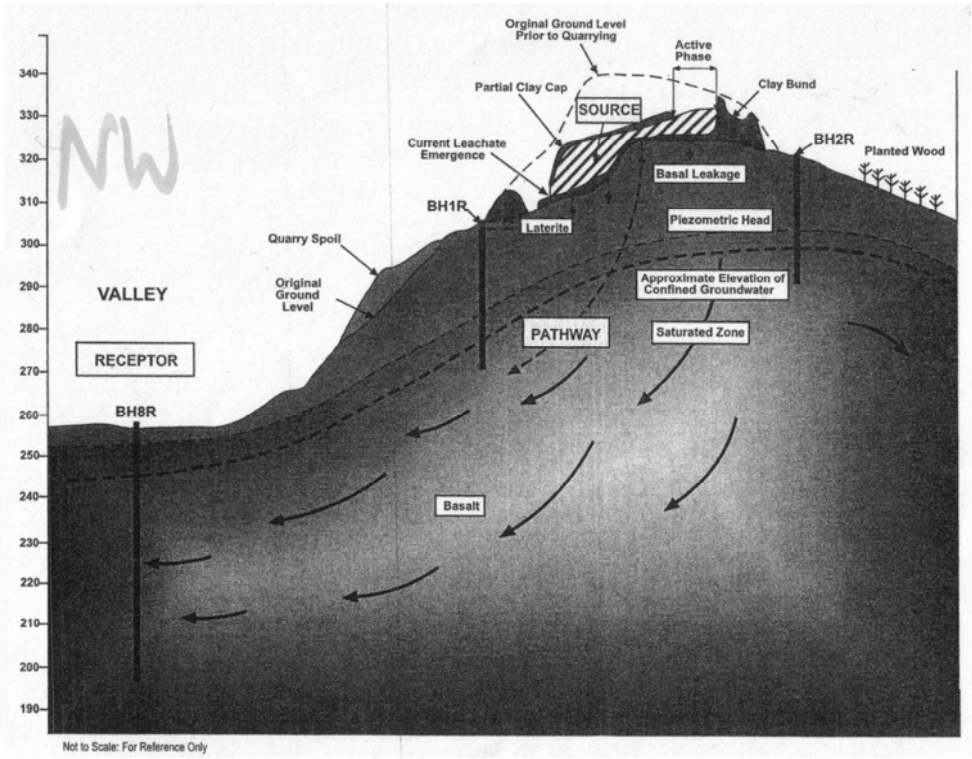




Hightown/Belfast Hills Landfill



Conceptual hydrogeological flow model

(Site Conditioning Plan Report/Site Permit, White Young Green for Macwill Services Ltd)

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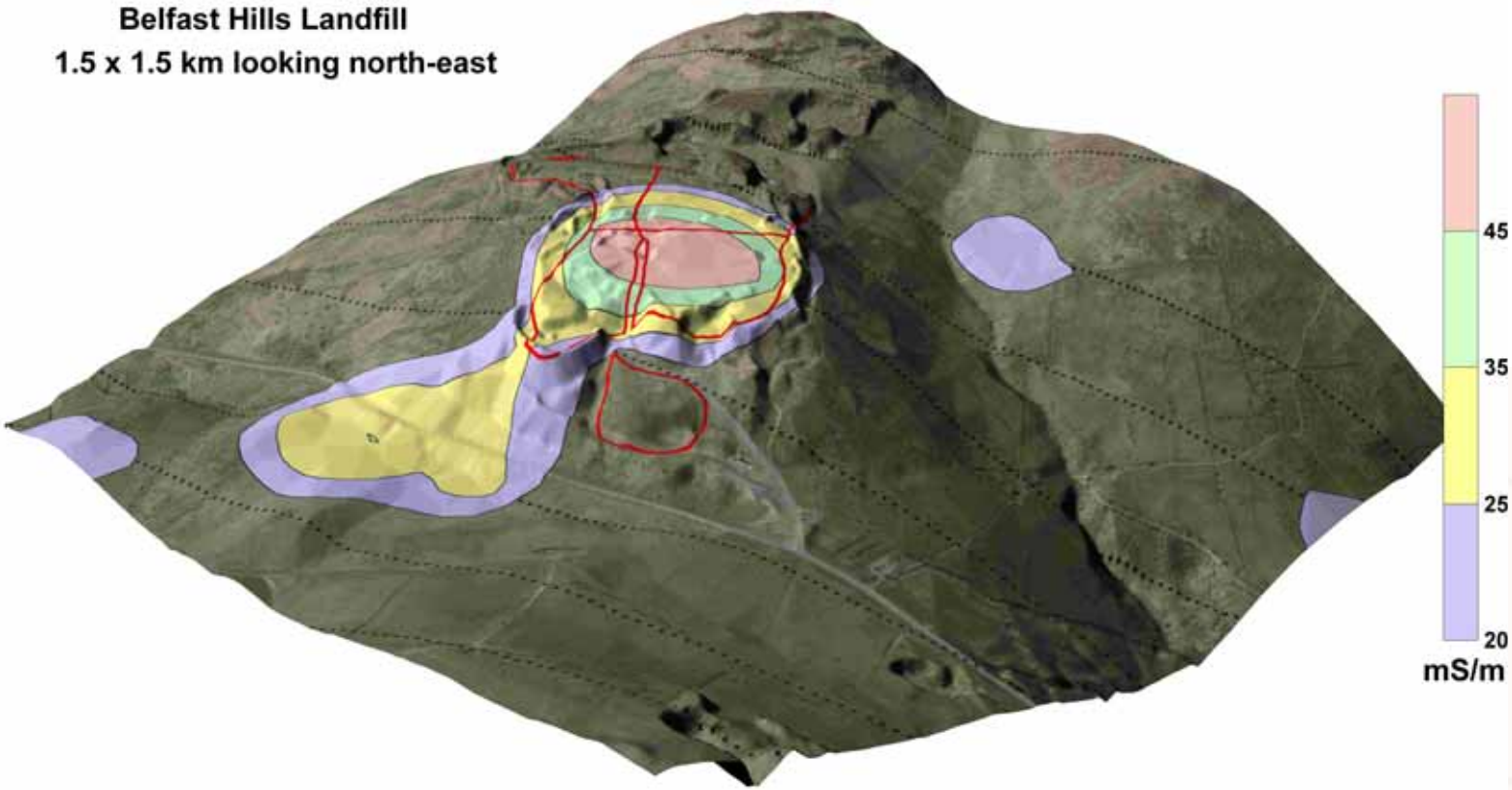
Demonstrating conductivity mapping at shallowest frequency



AEM shallow apparent conductivity (25kHz)
200m flight line sampling (dots)

Conductivities > 20 mS/m
5 cell construction in red

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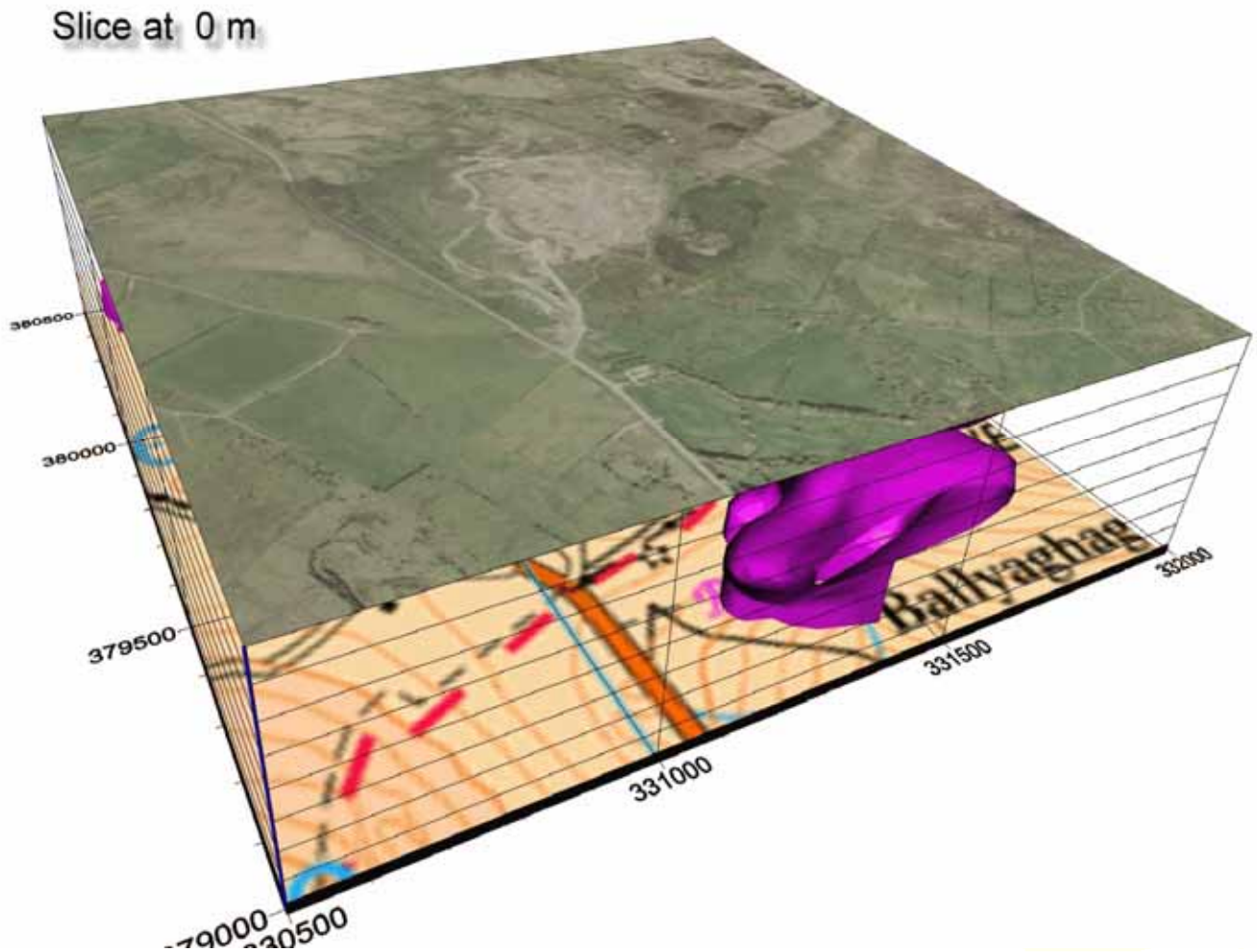
Demonstrating conductivity iso-surface > 55 mS/m, slices to 80 m depth



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Summary

To a degree I've have been showing you the data with a view to addressing the environmental question:

- What's in my back-yard ? Or more correctly….
- What's under my back-yard ?
- …..that can be a sensitive question
- From a safe perspective, it may be best to treat the airborne data (at the site-scale) as 'pathfinder' information
- It is 'new' information and takes time/effort to digest
- The data, inevitably, tend to pose questions that require further understanding and follow-up studies

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