Carmont Derailment – Investigation of the Geotechnical Elements

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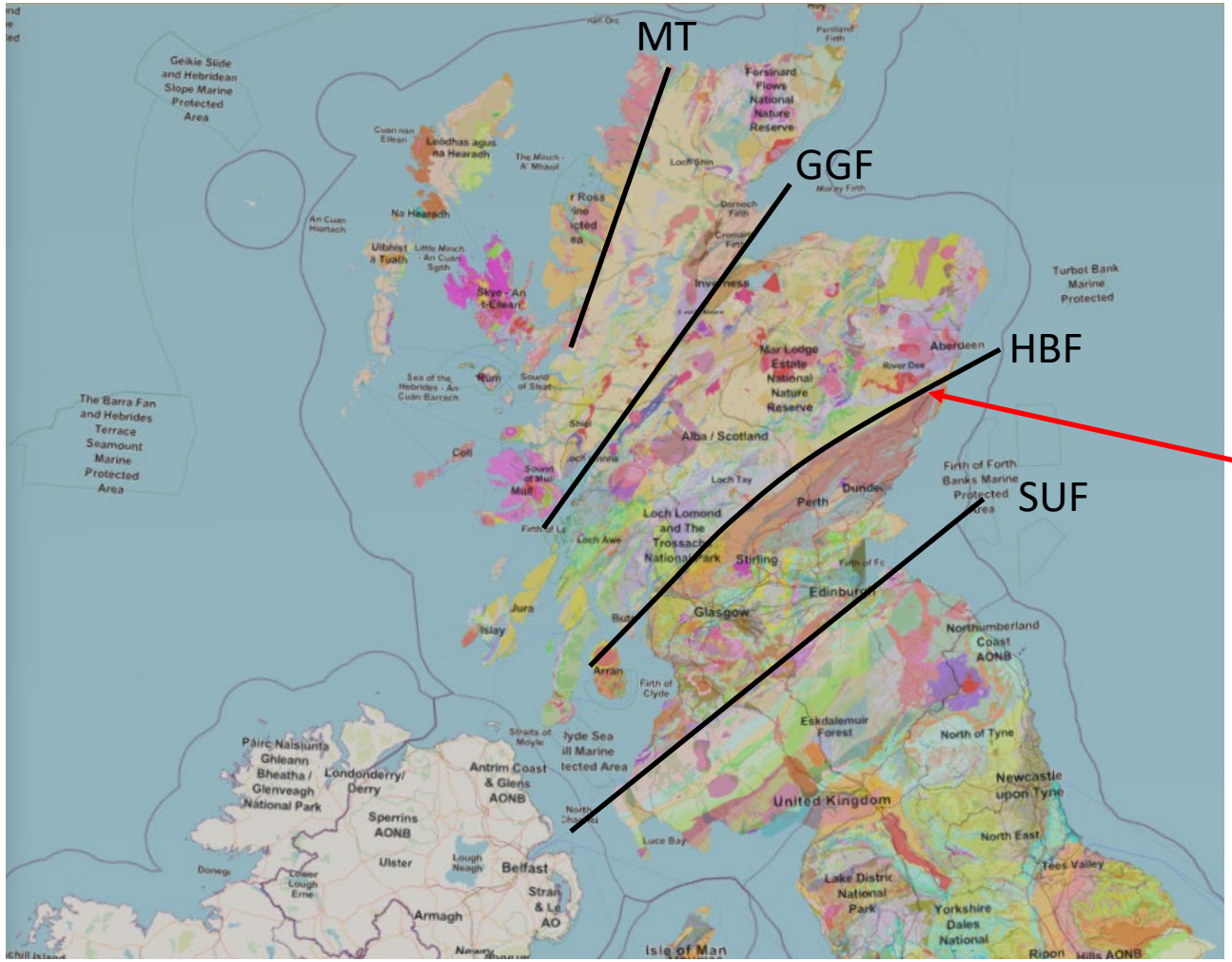
Stages of the Investigation

1. Desk Study
2. Conceptual Ground Model
3. Geophysical Survey
4. Intrusive Ground Investigation
5. Laboratory Testing

Desk Study

- Geology
- Site History
  - Historical Mapping
  - Historical Aerial Photographs
  - Historical LiDAR Surveys

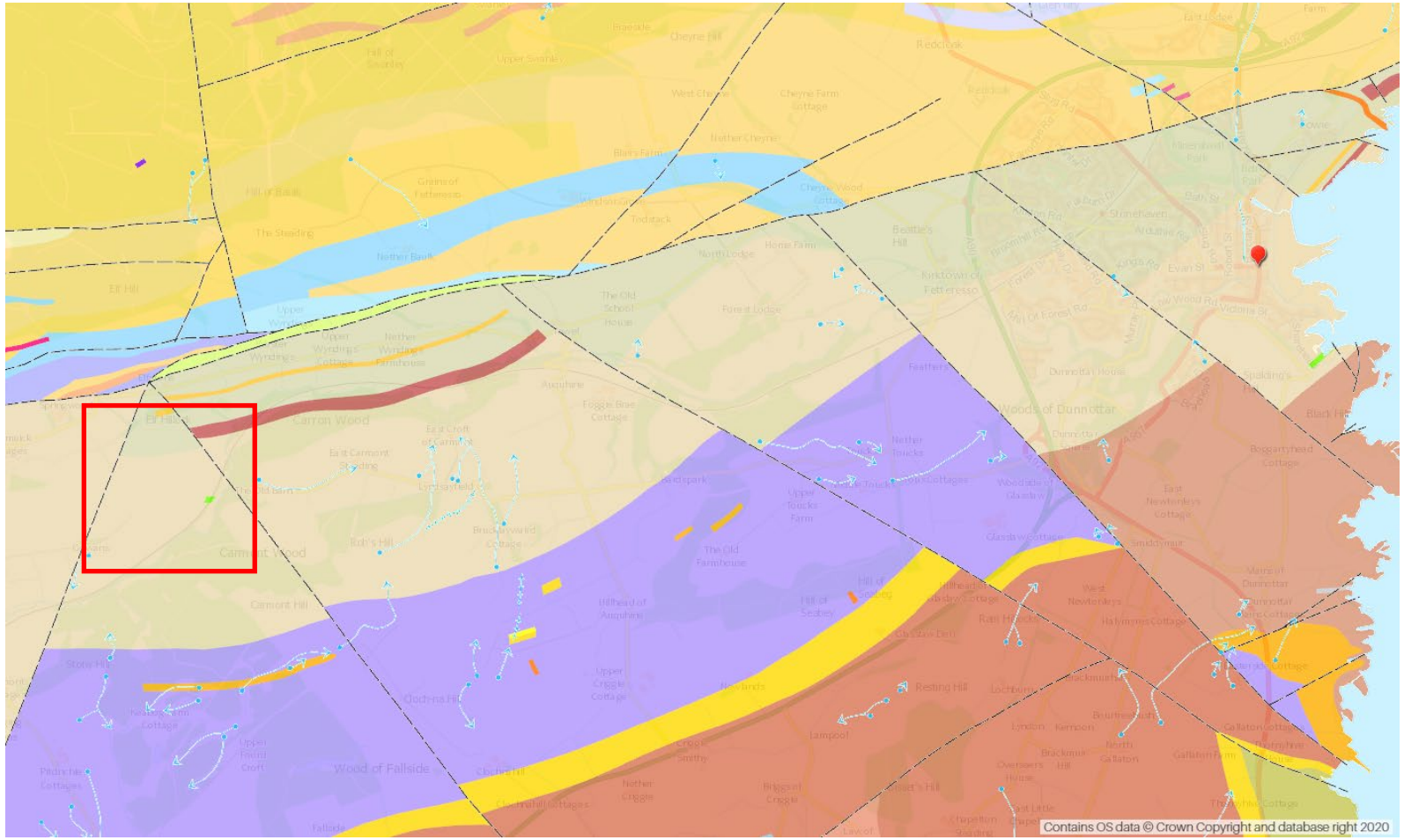
Geology of Scotland



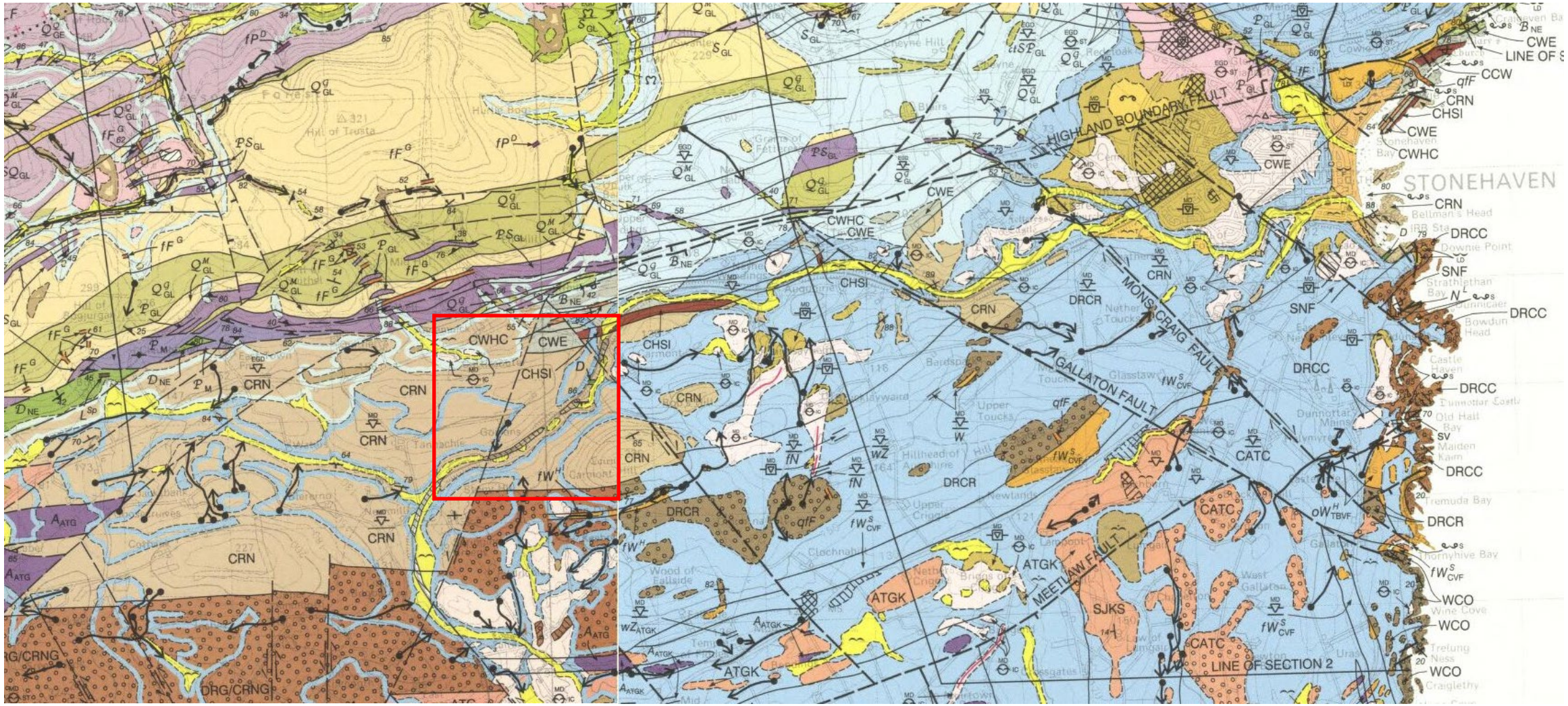
Major Faults

MT	- Moine Thrust
GGF	- Great Glen Fault
HBF	- Highland Boundary Fault
SUF	- Southern Upland Fault

Bedrock Geology – Carmont & Stonehaven Area

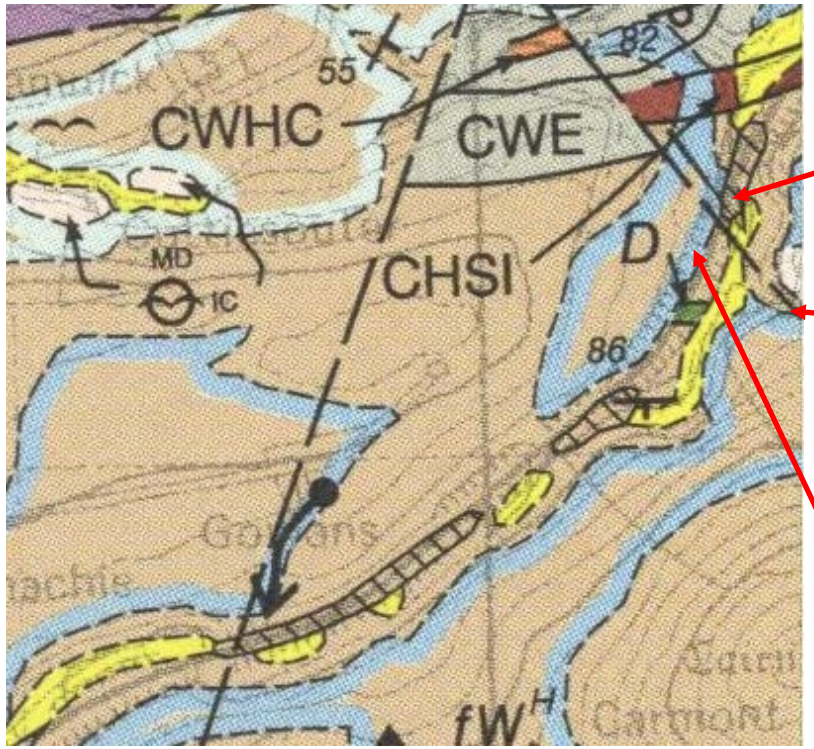


Geological Map – Carmont & Stonehaven Area



Extracts of BGS Maps 66E Banchory and 67 Stonehaven

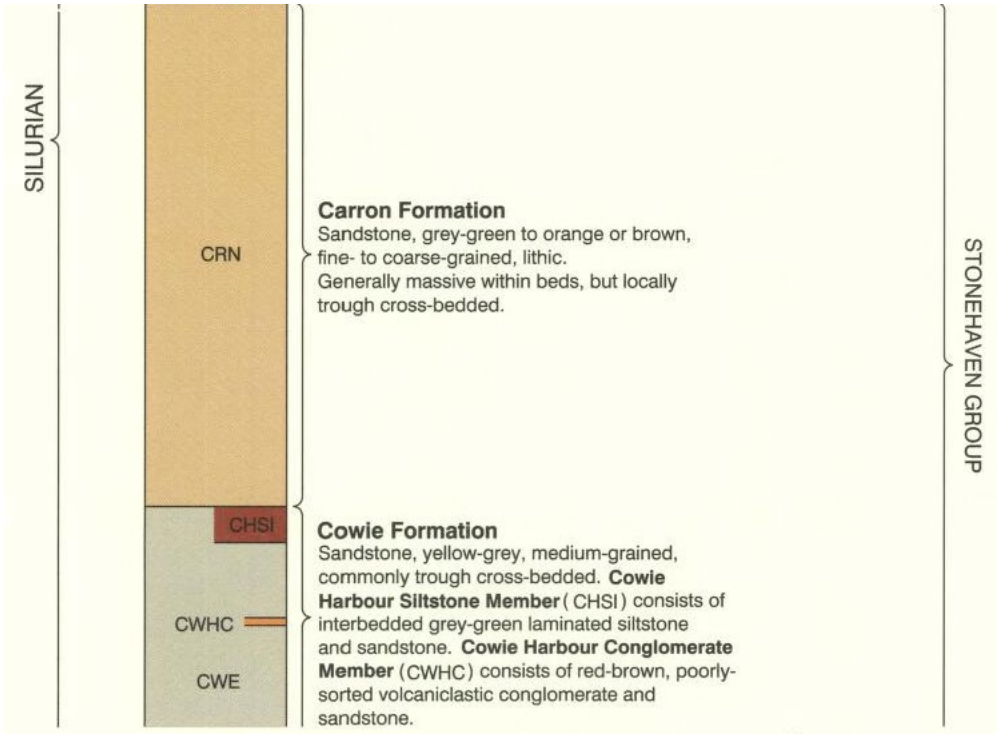
Geological Map – Close Up of Carmont



Bridge 325

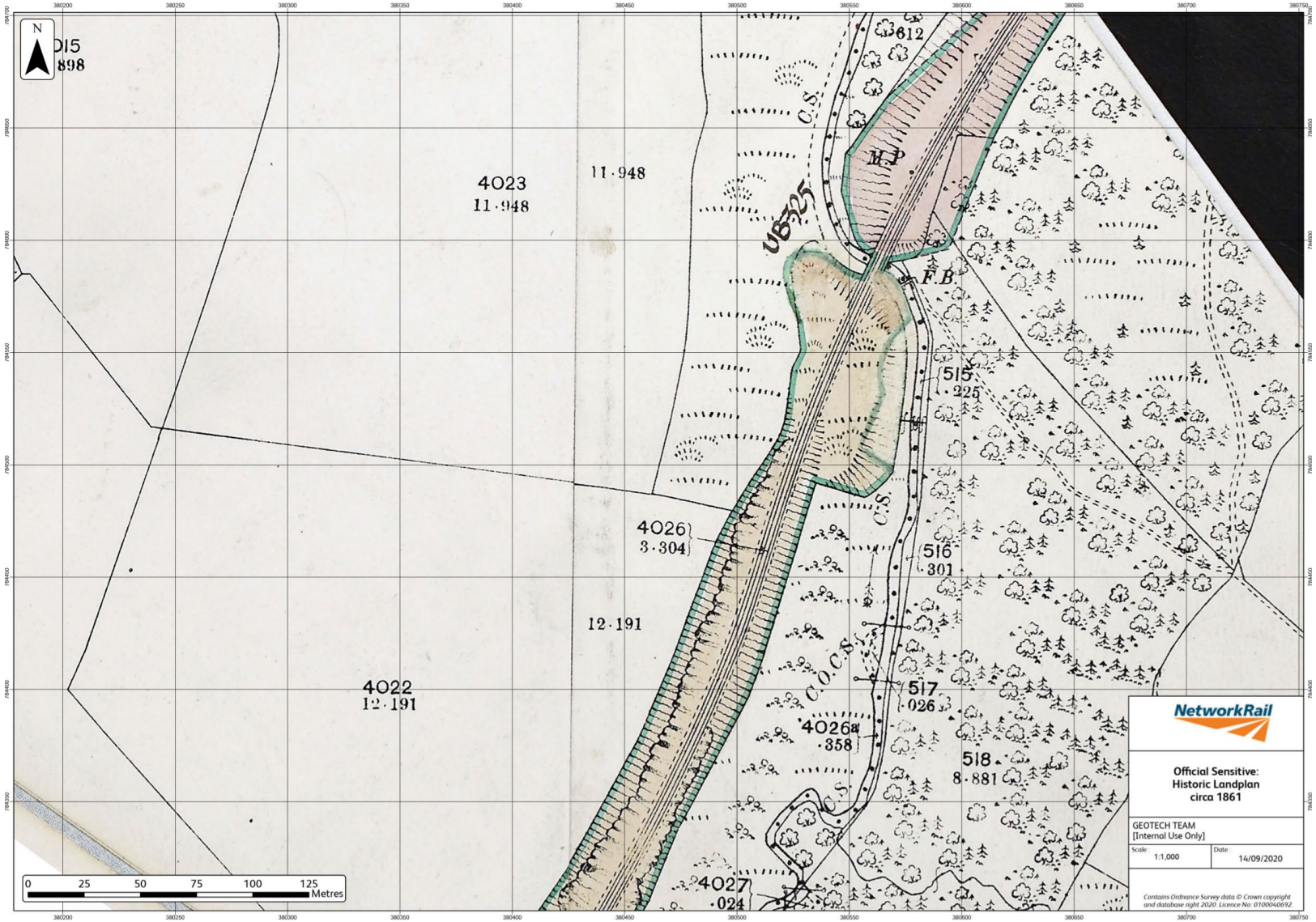
Fault

Carmont cutting



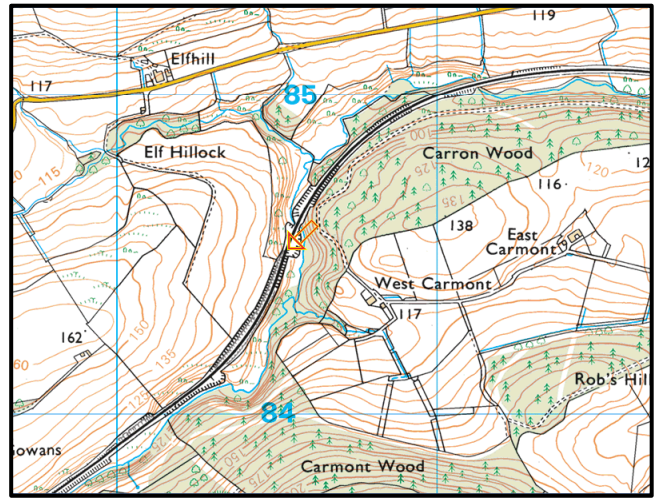
Age	Formation	Material
Quaternary	Mill of Forest Till Formation	Diamicton
Silurian	Carron Formation	Sandstone

Historical Ordnance Survey Mapping - 1861



Historical Ordnance Survey Mapping - 1974

Historical Ordnance Survey Mapping - 1992



Historical mapping indicates that land use not changed significantly

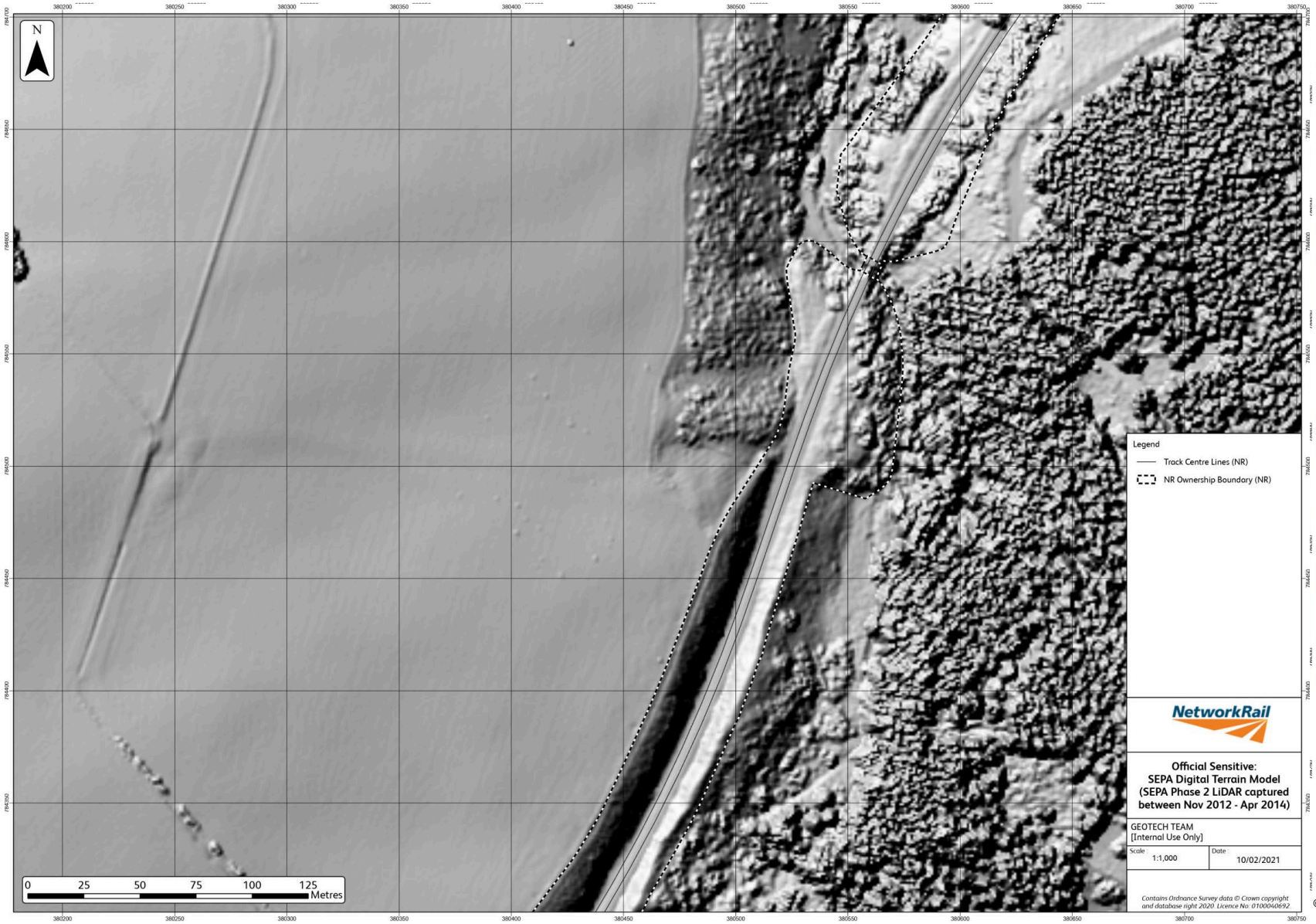
Historical Aerial Photographs - 2007

Historical Aerial Photographs - 2011

Aerial photographs indicate:

- Field boundary removed mid 2000's
- Construction work on cutting visible April 2011

Historical LiDAR Survey



LiDAR shows:

- The bund was present from the time of the first survey (2012-2014)
- Comparison of SEPA LiDAR with subsequent NR surveys shows no significant *detectable* change in profile

Aerial Photographs

NR Routeview – 01/05/2018

Aerial Photographs – Post Derailment

Aerial Photographs – Post Derailment

Desk Study – Questions to be answered

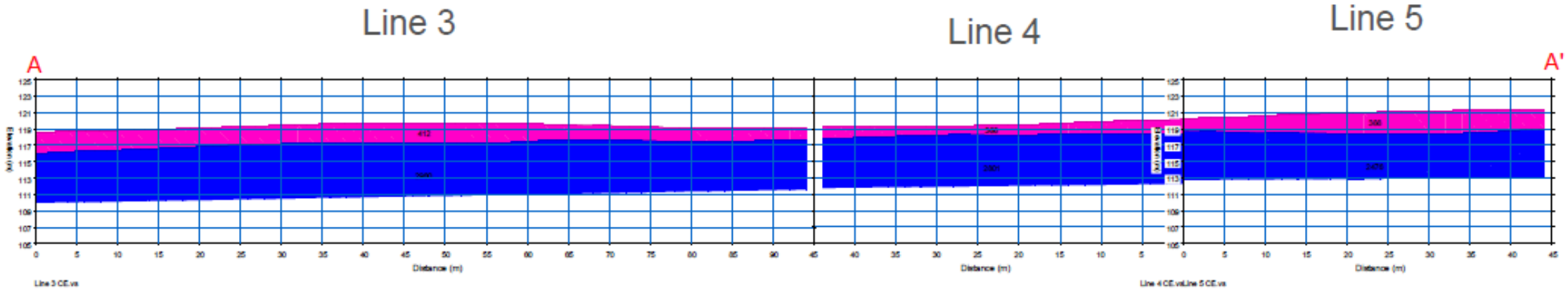
- Confirm ground model:
  - Till over sandstone
  - Significance of fault
- Confirm significance of lines in the field

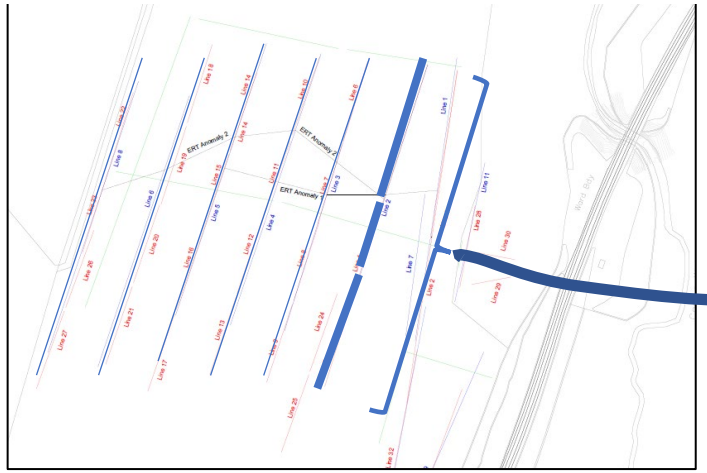
Geophysical Survey

- Objectives of the survey (specified by NR):
  - Determine the depth to bedrock.
  - Identify position of a geological fault.
  - Identify potential field drains and near surface obstructions

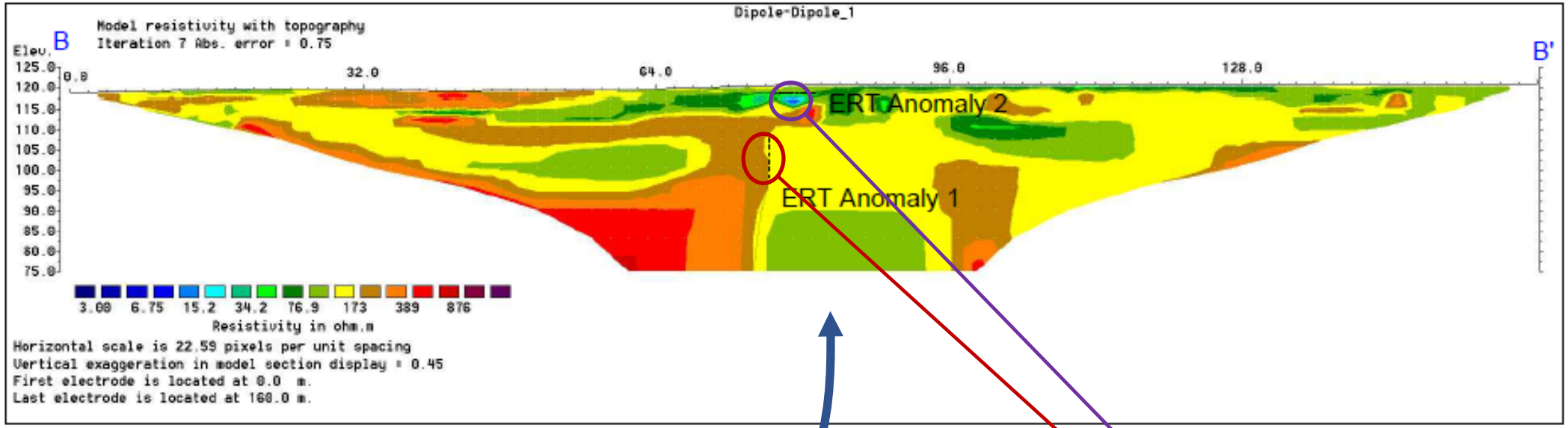
- Three techniques used (selected by the Geophysical Specialist):
  - Seismic Refraction
  - Electrical Resistivity Tomography (ERT)
  - Ground Penetrating Radar (GPR)

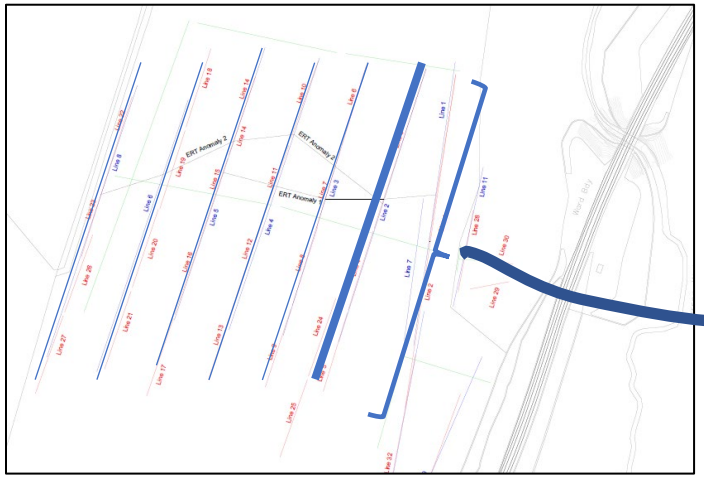
Geophysics Survey – Seismic Refraction Results

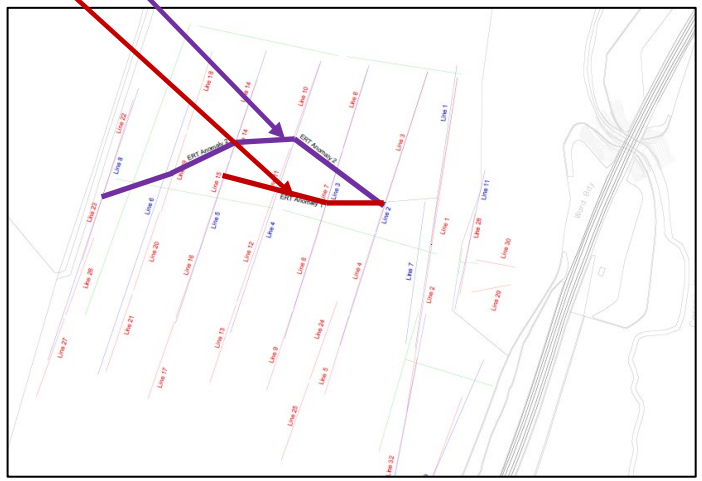




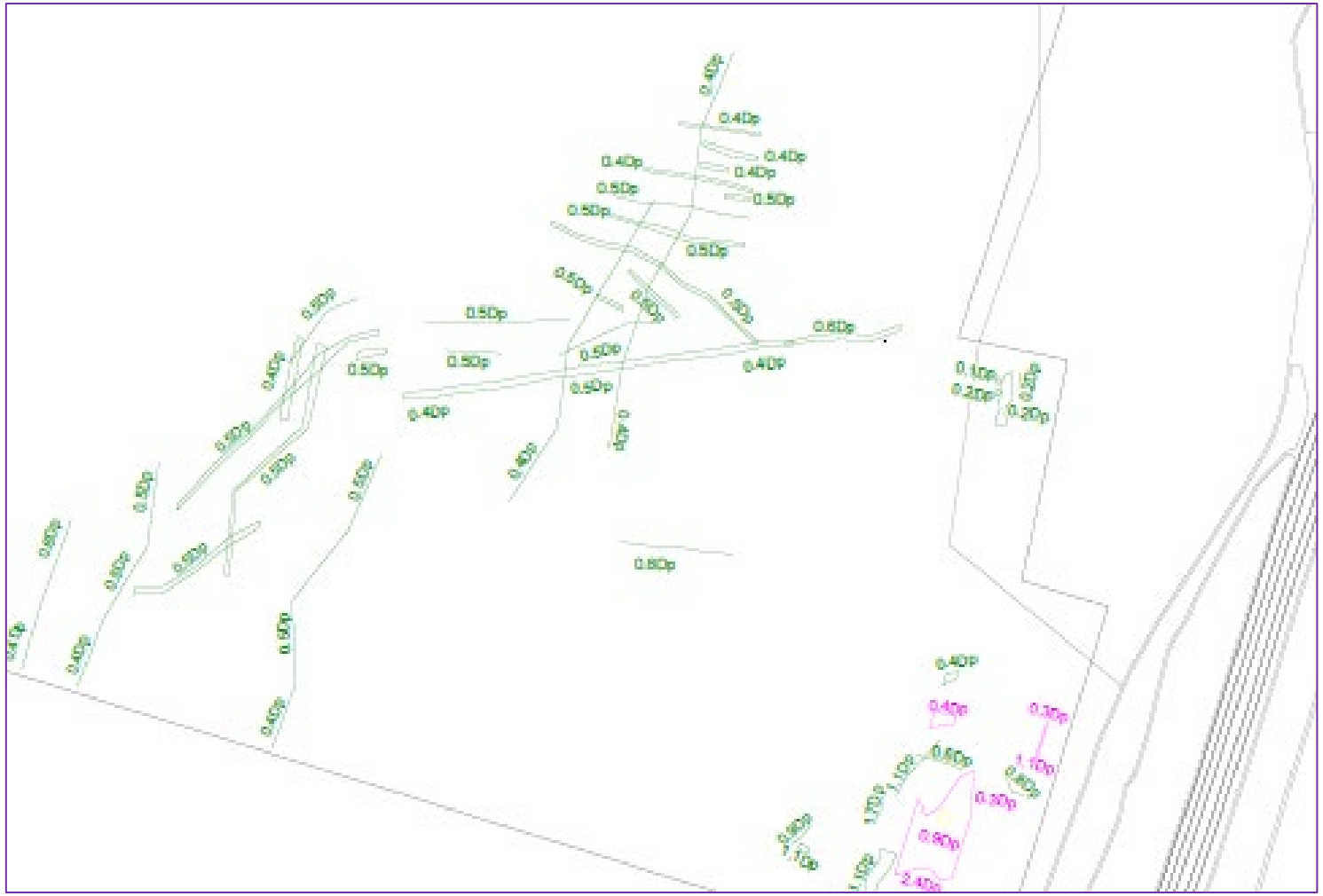
Geophysics Survey – ERT Results







Geophysics Survey – GPR Results



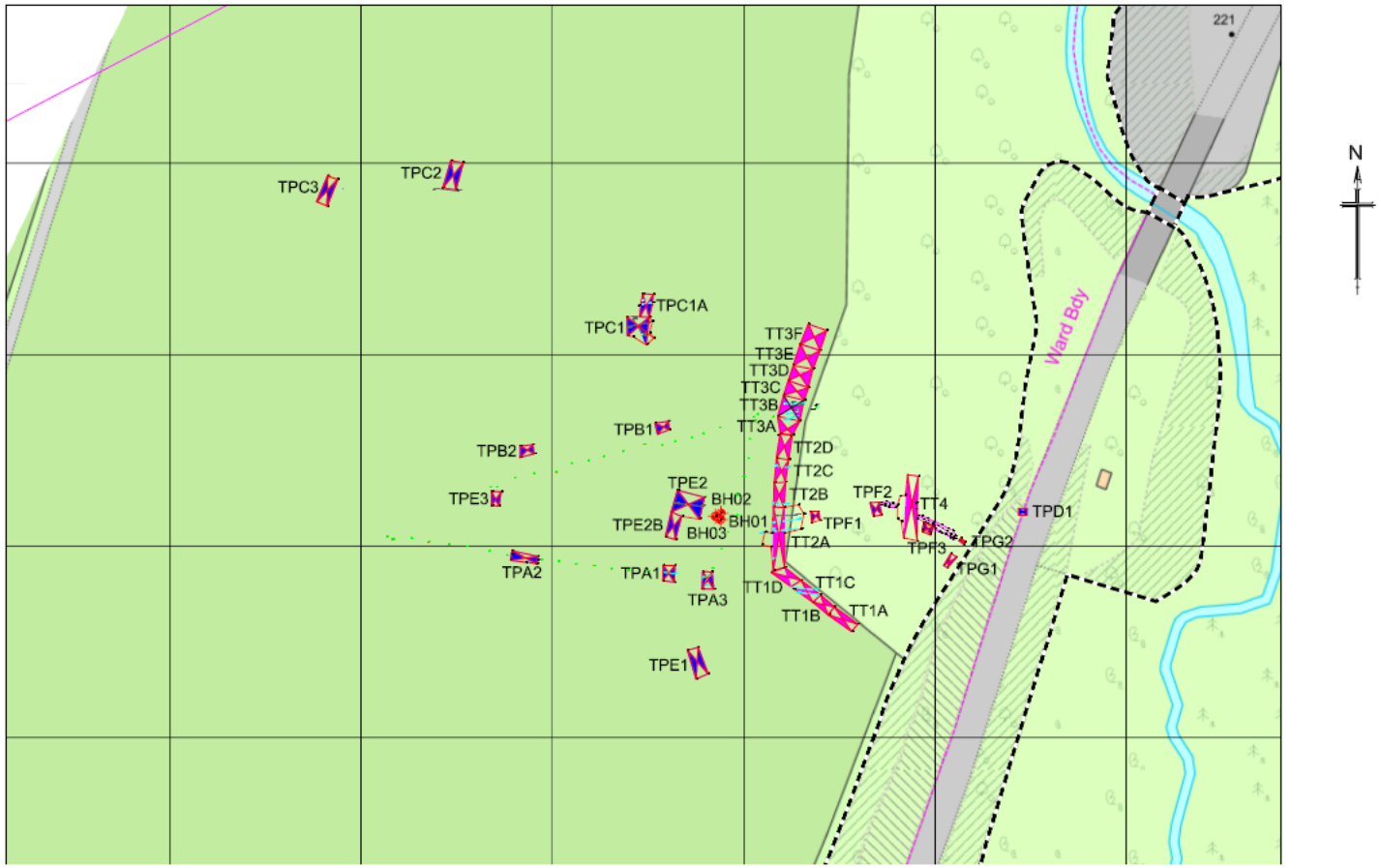
Purpose of the Ground Investigation

- To confirm the geology of the site
  - To confirm the thickness and nature of the glacial till present
  - To identify the extent of any weathering on the surface of the bedrock
  - To identify evidence for a mapped geological fault crossing the site
  - To identify the presence of permeable horizons that may convey groundwater towards the railway
- To identify the presence, construction and condition of any land drainage systems intersected by the trial pits
- To investigate mapped anomalies identified from the geophysical investigation

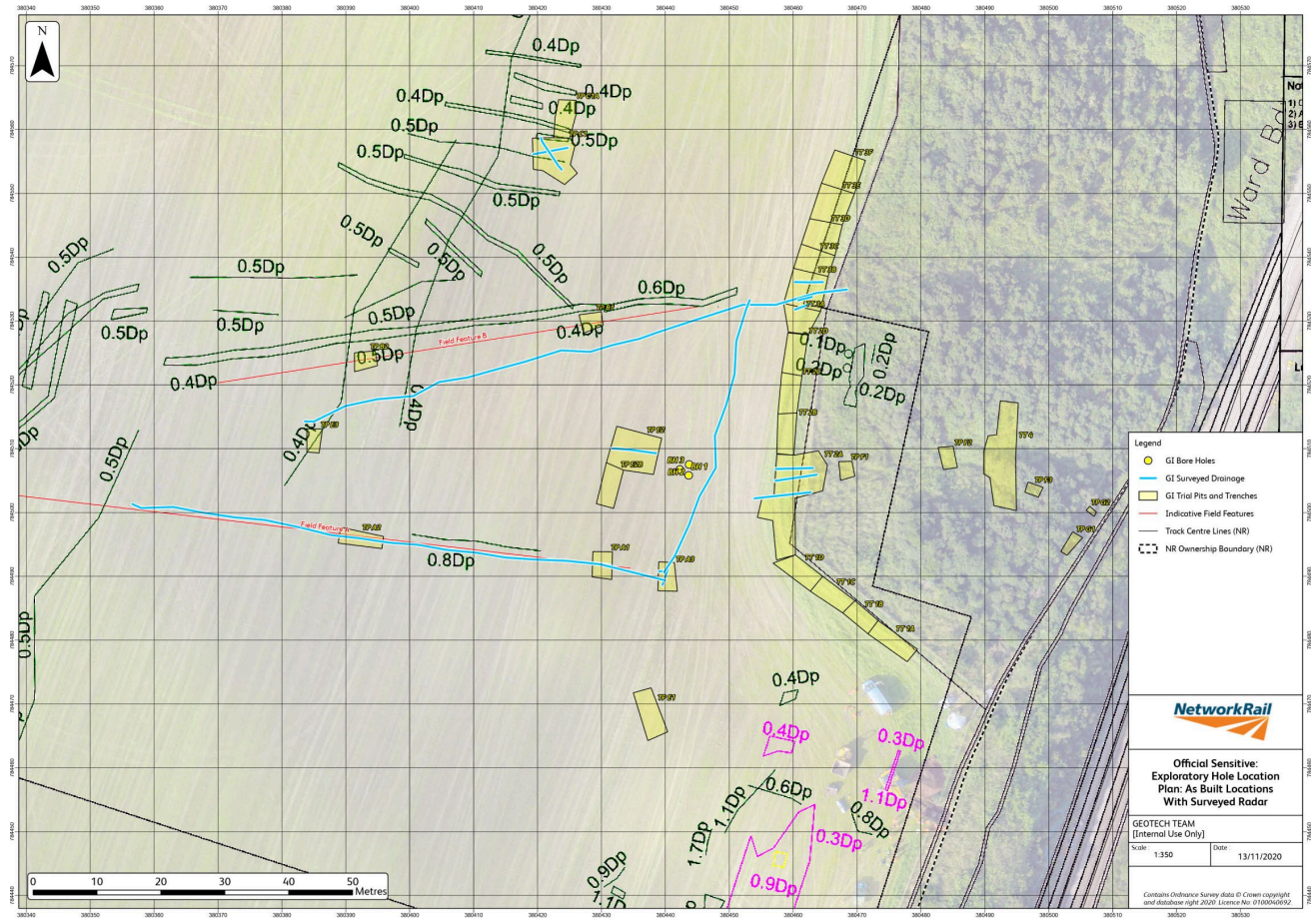
Scope of Ground Investigation

Number	Type	Depth	Purpose
3	Rotary Boreholes	First to 15m Second and third shallower	Logging, Permeability testing, Instrumentation
12	Machine excavated trial pits	Up to 6m	Investigate geophysical anomalies Prove the depth of the glacial till
4	Machine excavated trial trenches	Up to 6m	Investigate presence of natural and artificial drainage features
2	Machine excavated trial pits	Up to 6m	Investigate the nature and thickness of the superficial materials within a natural gully
2	Machine excavated trial pits		Investigate the construction of the Network Rail drainage system
1	Trial Pit		recover samples of the failed material from the derailment site

Scope of Ground Investigation



Scope of Ground Investigation



Ground Investigation

Ground Investigation

Ground Investigation

Findings of the Ground Investigation

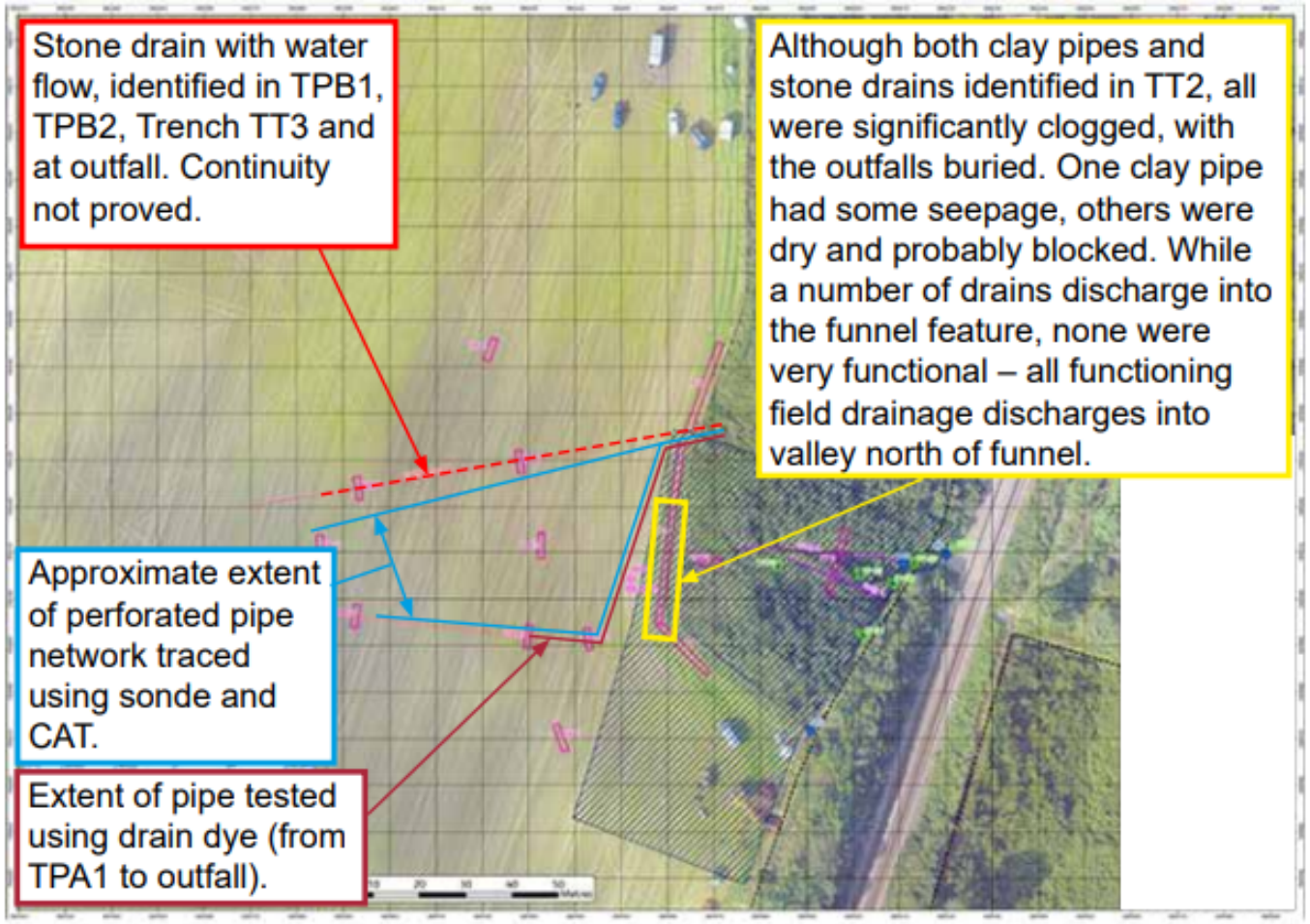


Figure G.5: Field drain survey findings (edited version of Network Rail drawing)

Findings of the Ground Investigation

Laboratory Testing

Review against the purpose of the Ground Investigation

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