

CONTEMPORARY GEOTECHNICAL ISSUES ASSOCIATED WITH HISTORIC MINING



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FNEIMME



*Investigating the past
for your future*

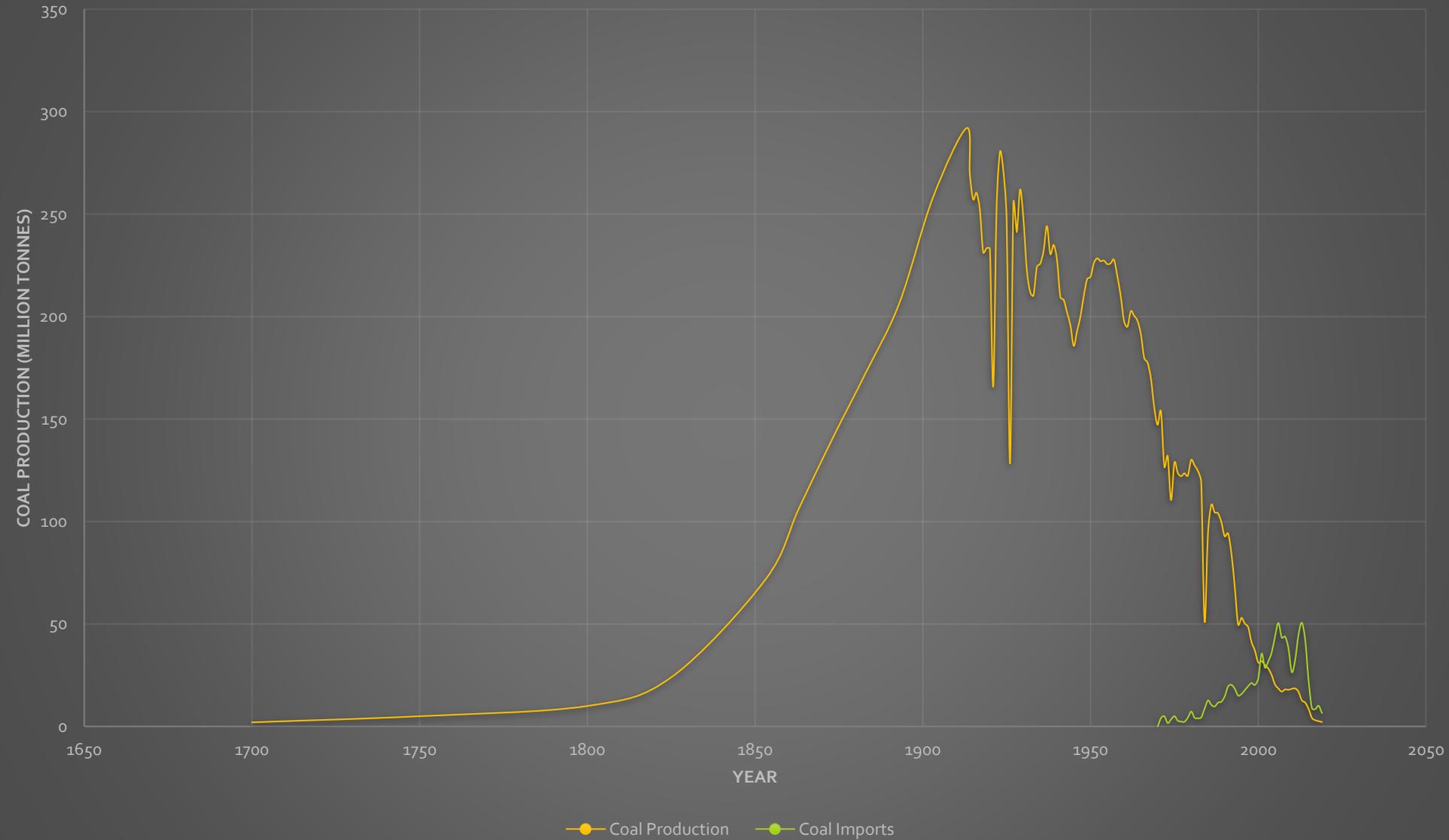
TALK OVERVIEW

- Brief review of historic mining
- Overview of contemporary geotechnical hazards
- Methods of investigating historic workings
 - **Broomshields Avenue** - subsidence
 - **Throckley** – development above opencast and mine shafts
- Remedial techniques
 - **Throckley** – gas membrane
 - **Anfield Plain Grouting** – grouting of worked seams

REVIEW OF HISTORIC MINING

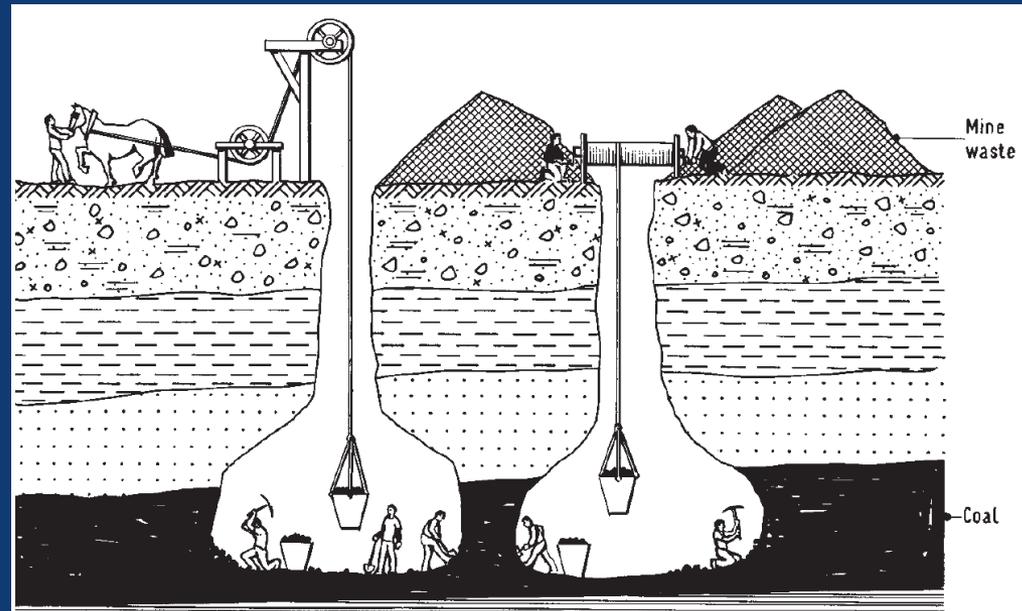
- Flint axes found embedded in coal indicate that coal has been mined near the surface prior to the Roman invasion.
- Coal mines are recorded in Durham as early as the 12th century.
- During the industrial revolution the demand for coal increased exponentially as coal became the primary power source for Britain.
- Coal mining peaked in 1913 at 287 million tonnes and has since been in continued decline.
- On 21st April 2017 Britain went a full day without using coal generated power for the first time since the industrial revolution.

COAL PRODUCTION



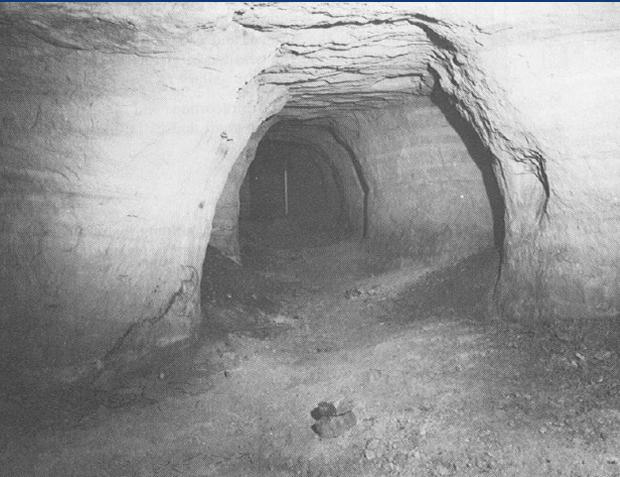
BELL PITS

- Bell pits employed primitive mining techniques, in which a shaft was sunk to the depth at which the coal was found and miners excavated outwards.
- Bell pits often flooded due to the lack of drainage and this, together with the lack of supports and the inevitability of collapse, meant they had a limited lifespan.

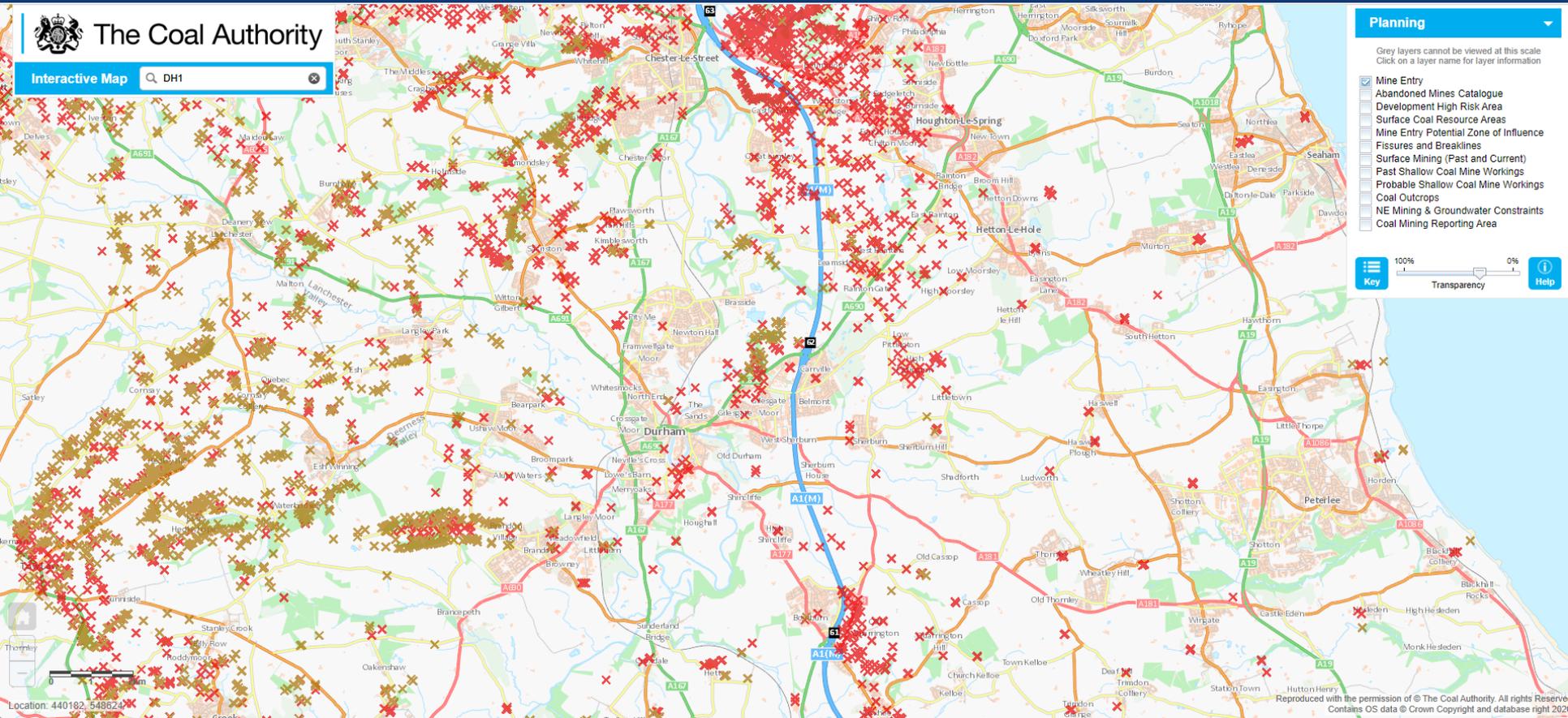


ROOM AND PILLAR

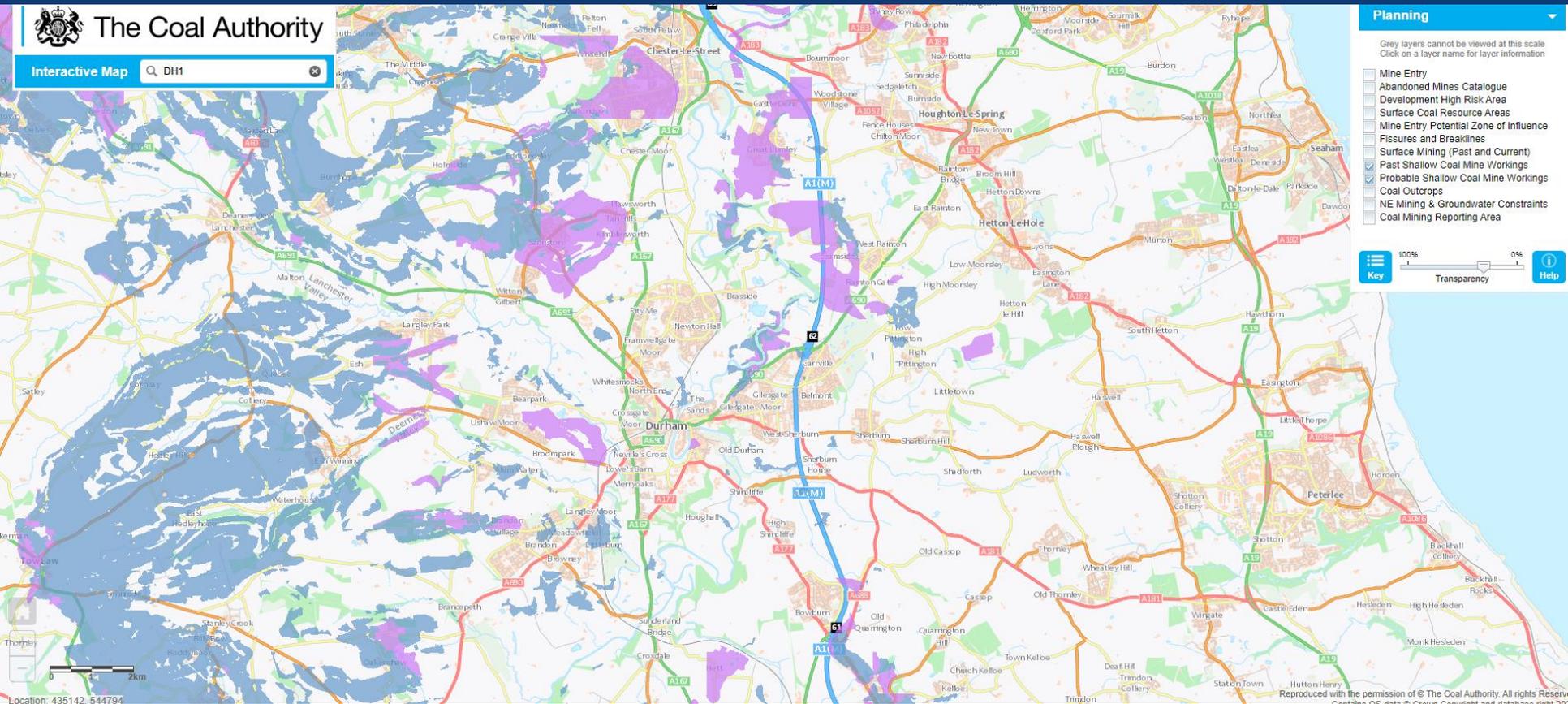
- A mining system in which the material is extracted across a generally horizontal plane, creating horizontal arrays of rooms and pillars.
- To do this, "rooms" of ore are dug out while "pillars" of untouched material are left to support the roof overburden.



PREVALENCE OF HISTORIC MINING



HISTORIC SHALLOW COAL MINING



Source:
<https://mapapps2.bgs.ac.uk/coalauthority/home.html>

CONTEMPORARY GEOTECHNICAL HAZARDS

Hazards

- Collapse of workings
- Collapse of mineshafts
- Infiltration of mine gas into sensitive receptors
- Rising mine water

Figure 14
Long-term conical void migration in weathered Coal Measure rocks from old mine workings (courtesy West Yorkshire Metropolitan County Council)



INVESTIGATIVE APPROACH

- Desk Based Study
- Site Recognisance
- Non-intrusive study, i.e. geophysics
- Intrusive investigation, i.e. boreholes or trial holes

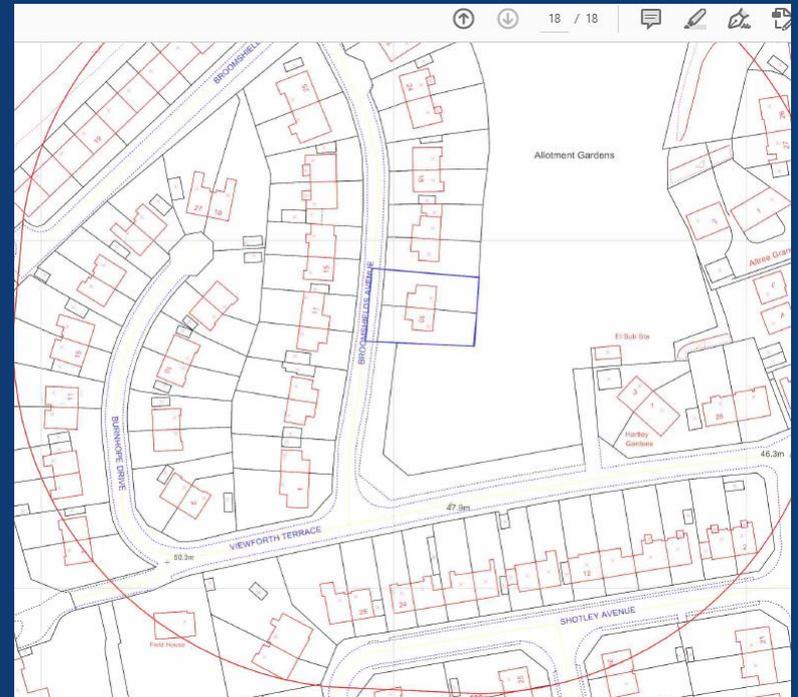
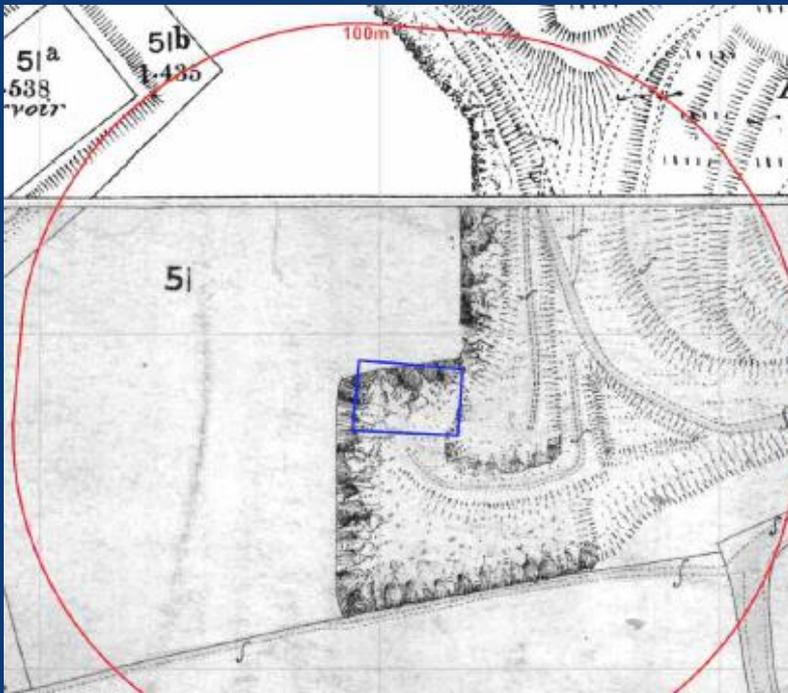
BROOMSHIELDS AVENUE, SUBSIDENCE

- Dunelm attended site which had undergone significant, >250mm, instantaneous subsidence.



DESK STUDY FINDINGS

- Broomshields Avenue was built running along the highwall of a infilled limestone quarry.
- Anecdotal evidence suggests that plots to the west of Broomshields avenue have no historic issues, and plots to the east have significant issues associated with settlement.



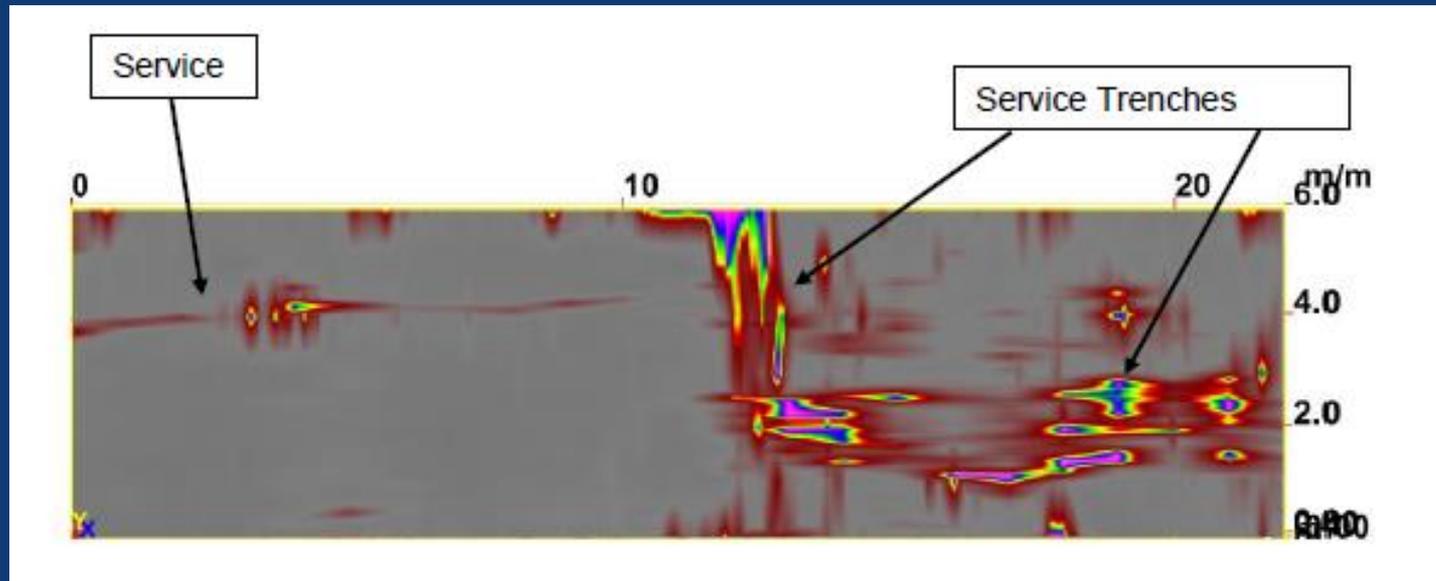
STRUCTURAL DAMAGE

- Significant structural damage and subsidence, $>200\text{mm}$, to residential properties and public roadways.



GEOTECHNICAL INVESTIGATION

- Shallow GRP survey to identify possible undetected near surface voids. The radar results were limited with a maximum signal depth penetration of approximately 1.0 meter with the 300/800Mhz antenna. No unanticipated voids identified.
- Exploratory boreholes to identify nature of underlying deposits



EXPLORATORY BOREHOLES

- 2 No. rotary boreholes were advanced using dynamic sampling with rotary follow on.
- Boreholes encountered made ground to a depth up to a depth of 17.3m bgl.
- The made ground generally consisted of granular material including brick, wire, wood and concrete between 0.15m and 3.7m bgl underlain by suspected quarry backfill.



COMMON REMEDIAL TECHNIQUES

- Grouting of worked seams
- Sealing / capping of mineshafts
- Installation of gas membranes

THROCKLEY – HOUSING DEVELOPMENT

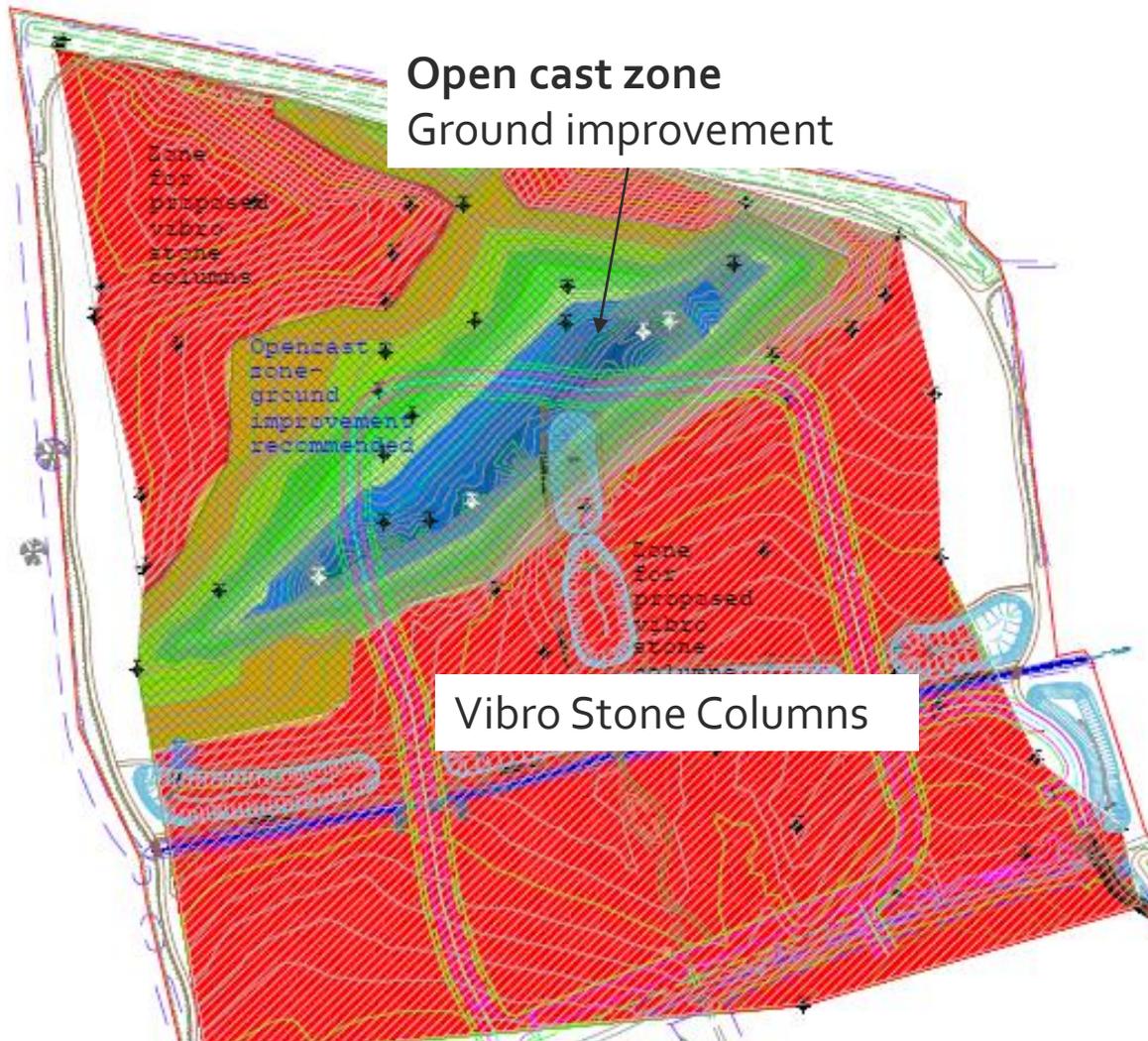
- Proposed development was located above the Three quarters, Tilley and Top busy seams.
- Nine recorded mineshafts are recorded within the development boundary.
- An opencast was located running east to west across the centre of the site.
- Multiple phases of ground investigation.



INVESTIGATION STRATEGY

- Investigate the nature of backfill within opencast
- Delineate the high wall of the opencast
- Identify if the depths of coal seams beneath the site and if they have been worked
- Identify nature of underlying natural deposits
- Locate abandoned mine shafts

FOUNDATION SOLUTION



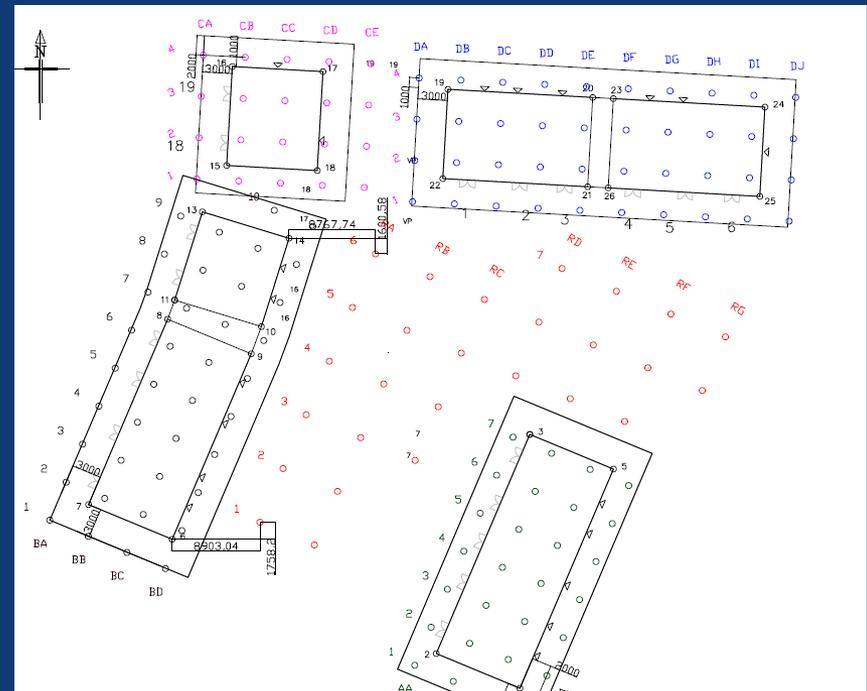
- Made ground up to 23.5m recorded in opencast.
- Ground improvement techniques where the made ground is greater than 7m.
- Where made ground is <7m deep in the north and south of the site, full depth vibro stone columns .
- Trench fill in the east of the site where made ground is <2m.
- Grouting of 3 worked seams beneath the site.
- Foundation is to incorporate a gas resistant membrane and a ventilated sub floor void.

THROCKLEY – GAS MEMBRANE



ANNFIELD PLAIN -GROUTING

- Mineworking identified within the high main seam below the site.
- Grouting was undertaken on a 4.25m square grid pattern beneath the buildings and a 6m grid beneath the roads.
- 157 boreholes drilled using a total of 811.5 tonnes of grout.







ANY QUESTIONS?



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