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# Dawdon Mine Water Heat Pump Trial

14-Dec-12

This presentation was produced by The Coal Authority

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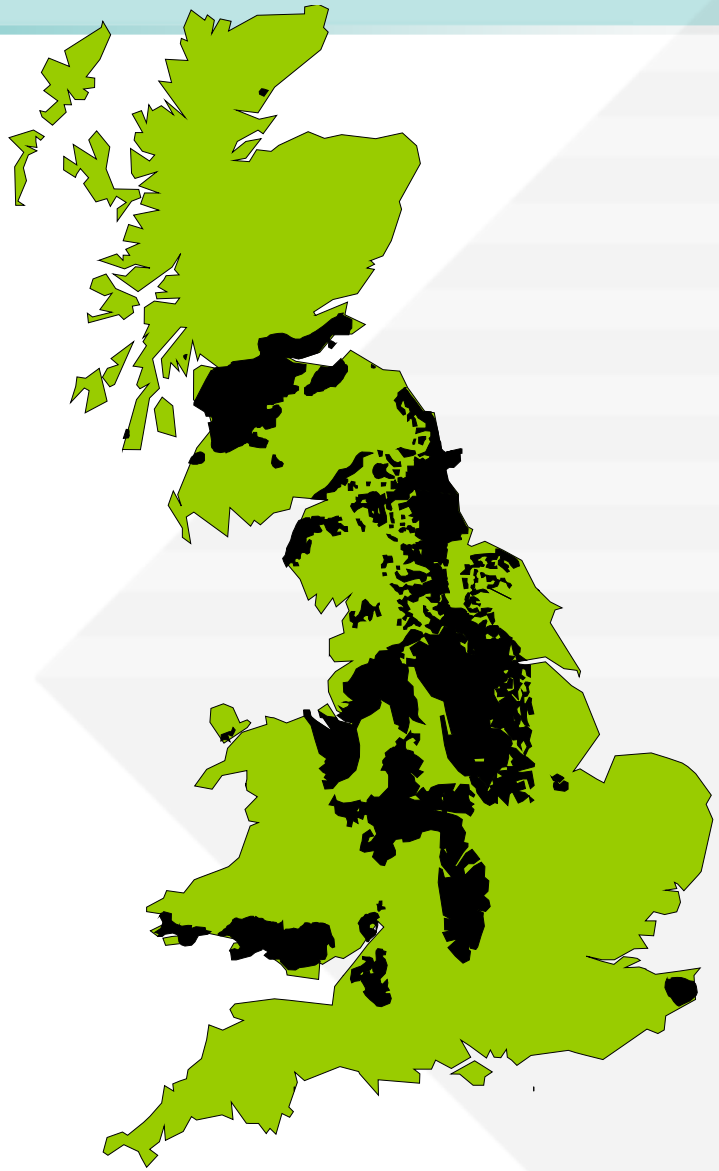
# Contents

- Potential for Mine Water sourced heating
- Dawdon heat pump trial
  - A demonstration project

# The UK Coalfield

- 7.7 million properties on UK Coalfield
- 2 million sit on the shallow coal workings
- Many areas have flooded mine workings in the near sub-surface
- Potentially a large resource



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# Treatment of coal mine waters
# 60 schemes in UK

# Mine water sourced heating?

- Only a handful of examples worldwide, including:
  - Nova Scotia, Canada (1986)
  - Scotland (2001)
  - Heerlen, the Netherlands (2008)
    - Plus a few others

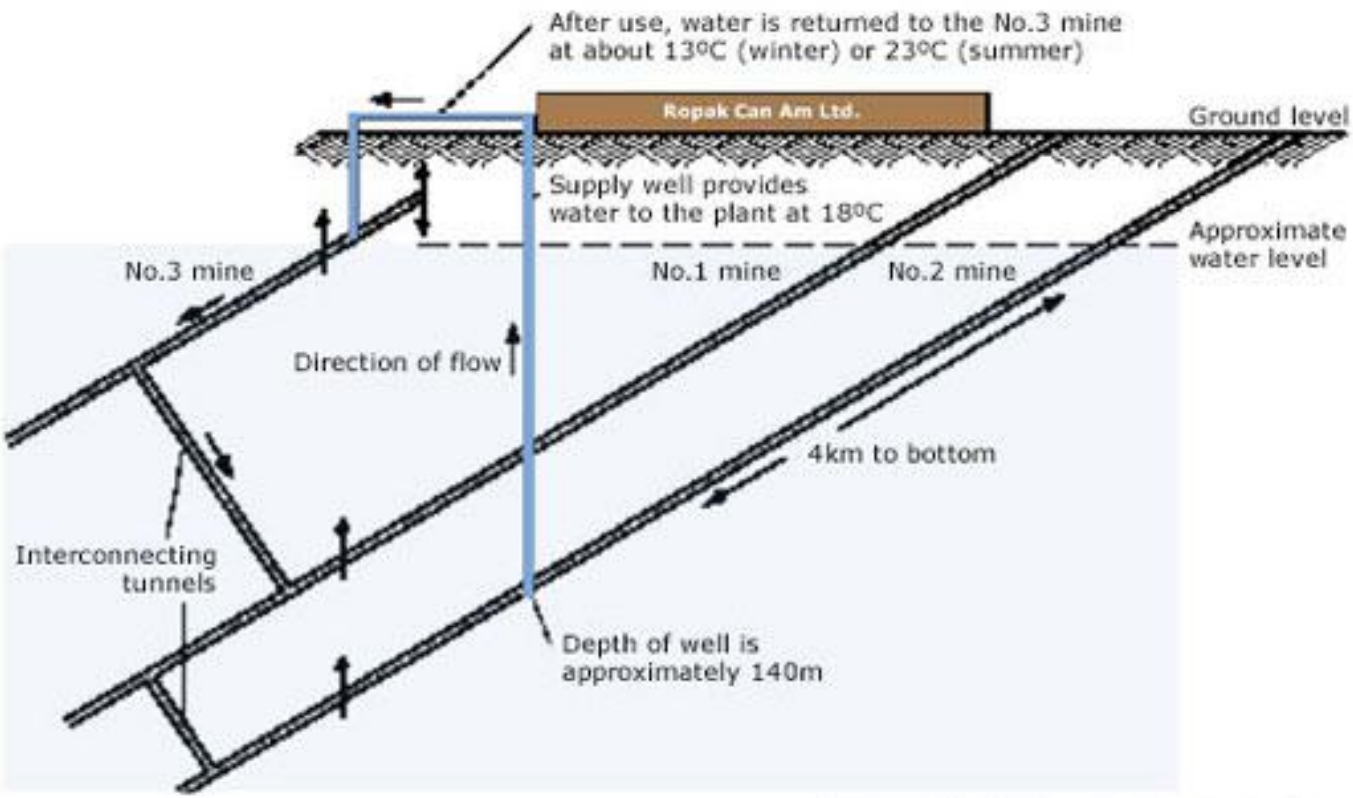
- Substantial UK potential
  - Gravity discharges 17 – 2877 $Kw_{thermal*}$ (*out of 11 coal mine water discharges*)
  - Pumped flows 69 – 1205 $Kw_{thermal*}$ (*out of 7 pumped flows – Moira to Horden*)
  - Many more potential sites >100MW



*ΔT 5K

# Mine water sourced heating/ cooling

- Vast amounts of water in mine void
- Relatively stable temperature year round
- Access via open shafts at some former mines




Schematic of system at Springhill, Nova Scotia

Source: Canada Centre for Energy: http://www.centreflow.ca/2011/03/31/coal-as-renewable-energy/

# Licensing and Information

- Permission required from CA to enter mine workings or coal seams
  - ~20 / year issued relating to GSH, mainly closed loop
- Specific Mine Water Heat Access Agreements available for exclusivity rights over geographical areas
  - 7 Access Agreements issued to date
    - Abstract water, extract heat, and return to mine workings
- Provision of Information
  - Mining information
  - Hydrogeological information

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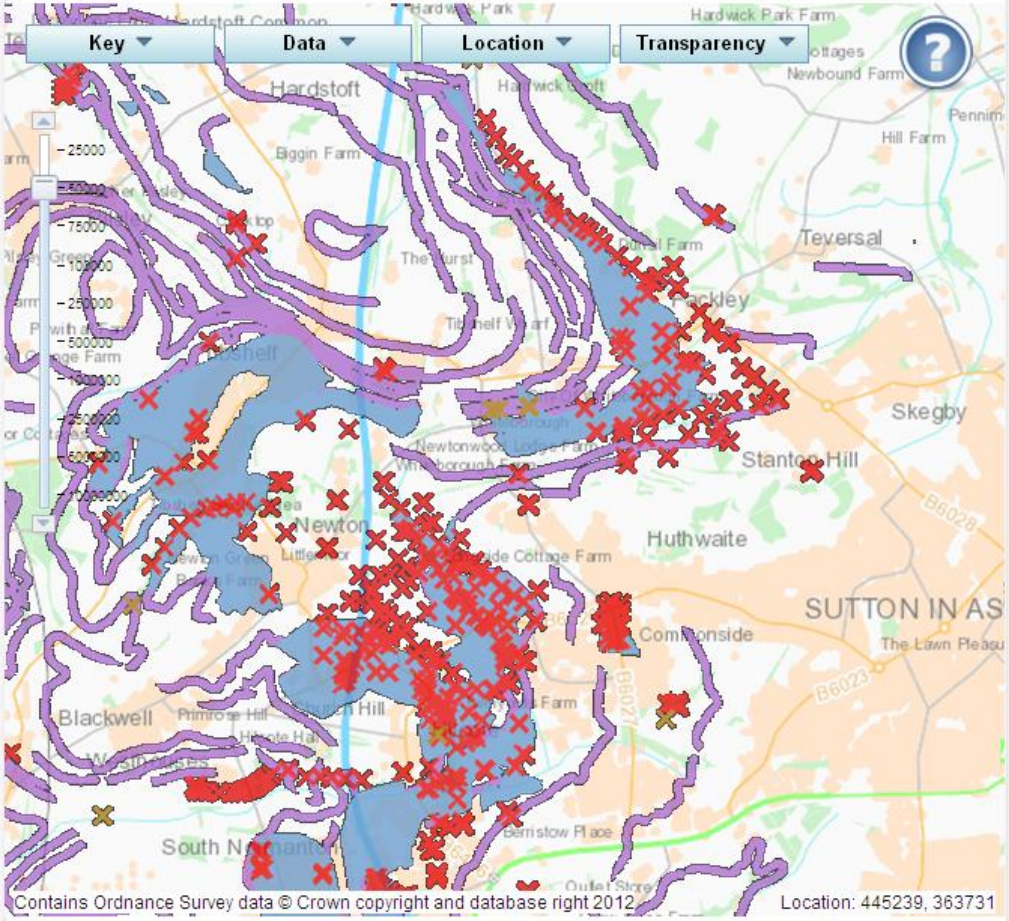
# Interactive Viewer
# http://coal.decc.gov.uk

Publications and Information > Mining Information and Datasets > Interactive Map Viewer

## INTERACTIVE MAP VIEWER

This map viewer has been produced to enable selected coal mining information to be viewed around your area of interest. This information has been extracted from the national coal mining database, held and maintained by the Coal Authority.

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### THE INFRASTRUCTURE FOR SPATIAL INFORMATION IN EUROPE (INSPIRE)

We are currently working towards INSPIRE compliance for our metadata and web mapping services and our statement of compliance will be documented here once this has been completed.

INSPIRE is a Directive passed by the European Commission, the executive body of the EU, to establish a European-wide spatial data infrastructure (SDI).

### ABOUT THE COAL MINING INFORMATION WE PUBLISH:

Find out more about the information held within the national coal mining database and how it has been derived.

# Mine water sourced heating

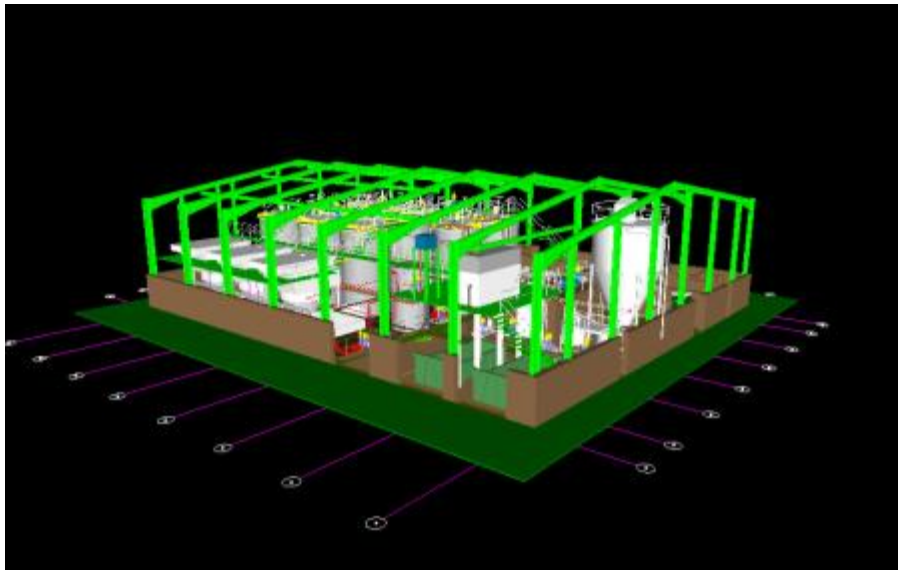
- Why has mine water not been used for heating schemes more widely?

- Perhaps due to fears over potential clogging of pipes and mechanisms…

# Demonstration site

- CA considered benefits of a trial
- Decided to proceed to:
  - Demonstrate technology to interested parties
  - Explore performance optimisation

# Dawdon mine water treatment scheme



Dawdon, Seaham, Co. Durham

pumps 100 l/s mine water

to protect aquifer from pollution

High salinity

High Iron (removed by lime treatment)

Offices , 8 rooms

# Dawdon heat pump

- Warm mine water that is treated reliably and fully within consent limits
- Potential to trial a heat pump unit within facility, usefully heating offices
  - Utilising 1.5 l/s mine water @ 20C
- Assess reliability and performance (COP) of system – up to 5 anticipated (typical ground source heat systems achieve 3.5).

# Treated mine water

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# System set-up

- Mine water loop: ~1.5l/s, 20degC, <1mg/l Fe
- Heat exchanger units, interchangeable:
  - Bowman Heat Exchanger (Tube in Shell);
  - SWEP Gasket Plate Heat Exchanger
- Heat pump unit:
  - Danfos DHP - L Opti Pro 3 Ph.12KW
- Radiators:
  - 21 standard domestic type units,
  - low temperature to simulate underfloor heating,
  - total surface area approx 60m$^2$
- DHW also provided to offices

Danger
Danfoss
Danfoss
Tel: 0114 270 3900
Danfoss
This unit is only to be connected to a heat pump
Do not connect to a gas boiler or any other
heat source that exceeds 65°C
Danfoss
L
2010

# Dawdon – initial results

- System commissioned April 2011
- Successful heating of offices and provision of hot water
- COP 3.5 – 4 (including immersion heater used to boost hot water supply)
- Various issues with temperature probes, leaks and electrical problems
- Rapid clogging of tube in shell heat exchanger, resulting in failure of system (June 2011)

# System re-built

- Replacement heat exchanger
- Y-strainer filter installed
- Flow meter installed in mine water circuit to identify any clogging early
- System re-started in October 2011
  - Heating season resumed

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- Heating resumed - COP typically 3.5 - 4
  - Ideal COP of 5 – 6 not observed

- Y – strainer filter had to be cleared every couple of days (see photo)

- System finally failed again in April 2012 due to clogging of tube in shell heat exchanger

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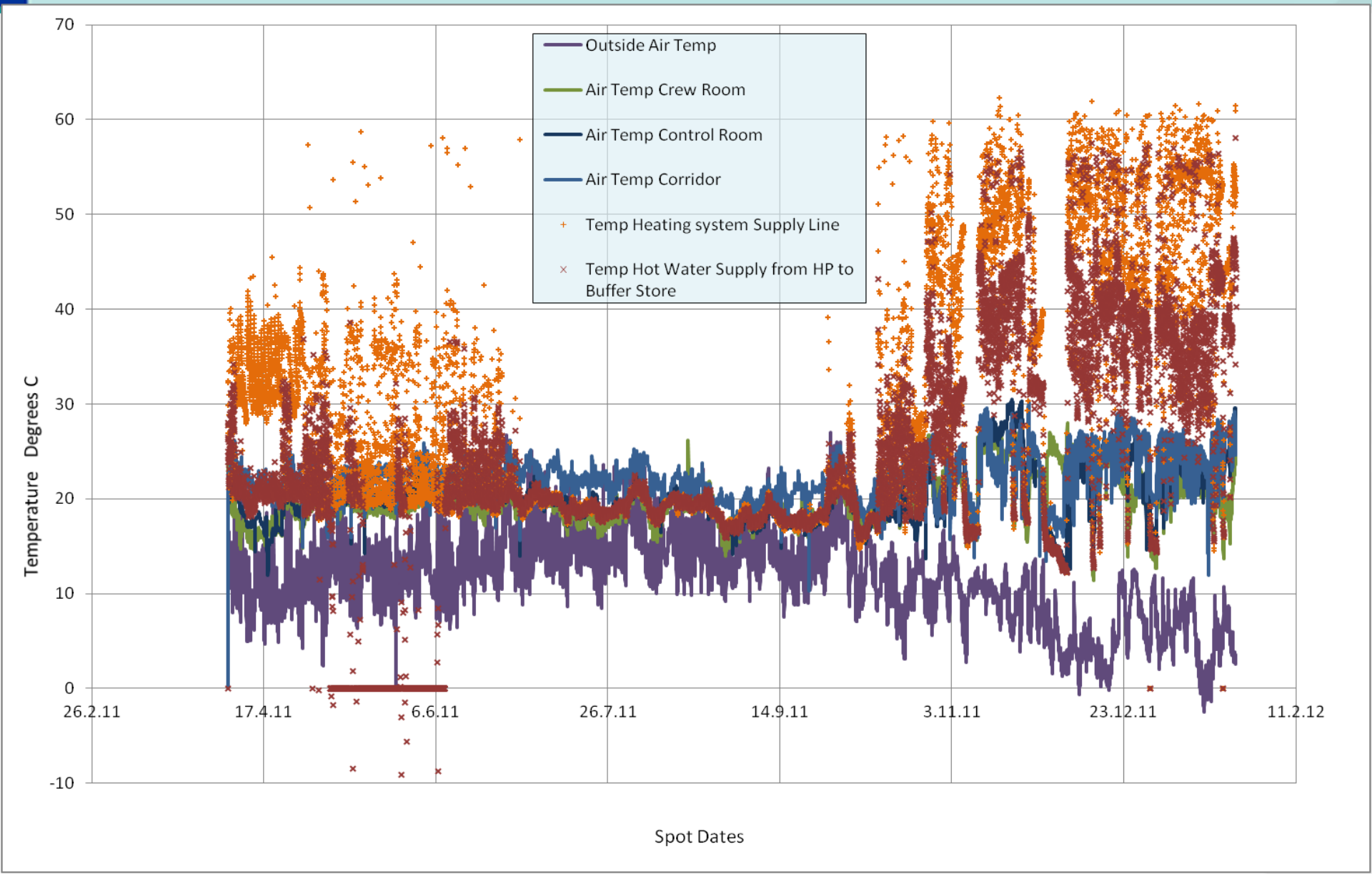
# Heating circuit temp. plots



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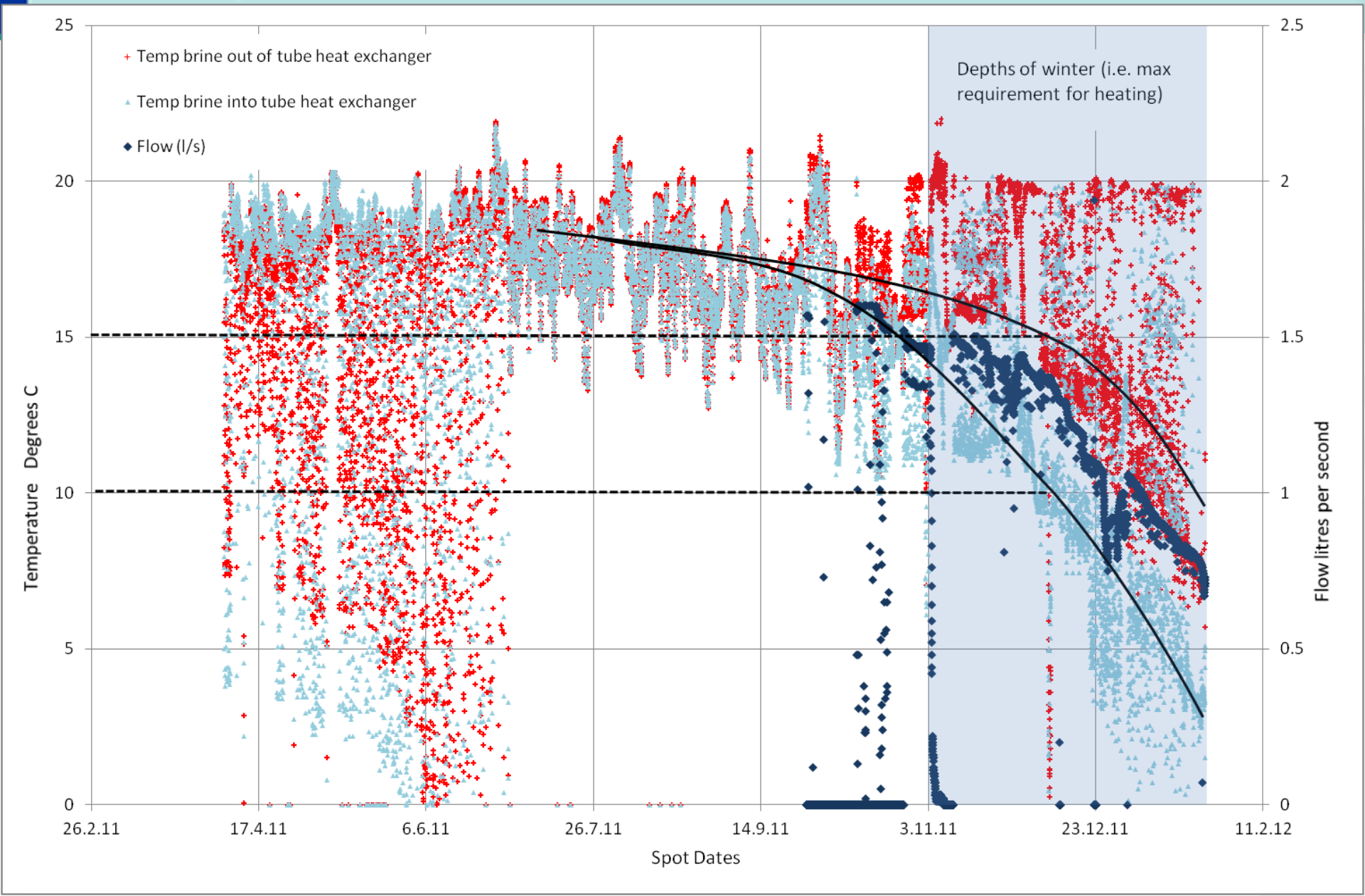
# Brine T, tube heat exchanger



# Why treated water caused clogging

- Clogging clearly an issue for sustained operation: ochre?
  - Mineralogical analysis undertaken of material blocking heat exchanger
    - Largely amorphous hydrous ferric oxide = ochre
- Treated water still contains ~1 mg/l total Iron – mainly as particles of iron
  - Hence high tendency for clogging.

# Untreated mine water

- Raw mine water feed?
  - Scheme in Lumphinnans, Scotland has been operating for 10+ years, with no reports of clogging issues, despite [Fe] ~80mg/l
  - Sealed systems prevent dissolved species precipitating from solution
  - Keep the oxygen out !

  - Dawdon System reconfigured to take feed off raw untreated mine water
  - Trial started at Dawdon in 2012-13 heating season

# Untreated mine water feed

14 December 2012

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# Current status

- In operation since September 2012
- Heating effectively provided to offices
- Flow has remained steady at 0.8 – 1.3 litres per second (depending upon plant flow)
- No clogging observed yet
- Data collection underway

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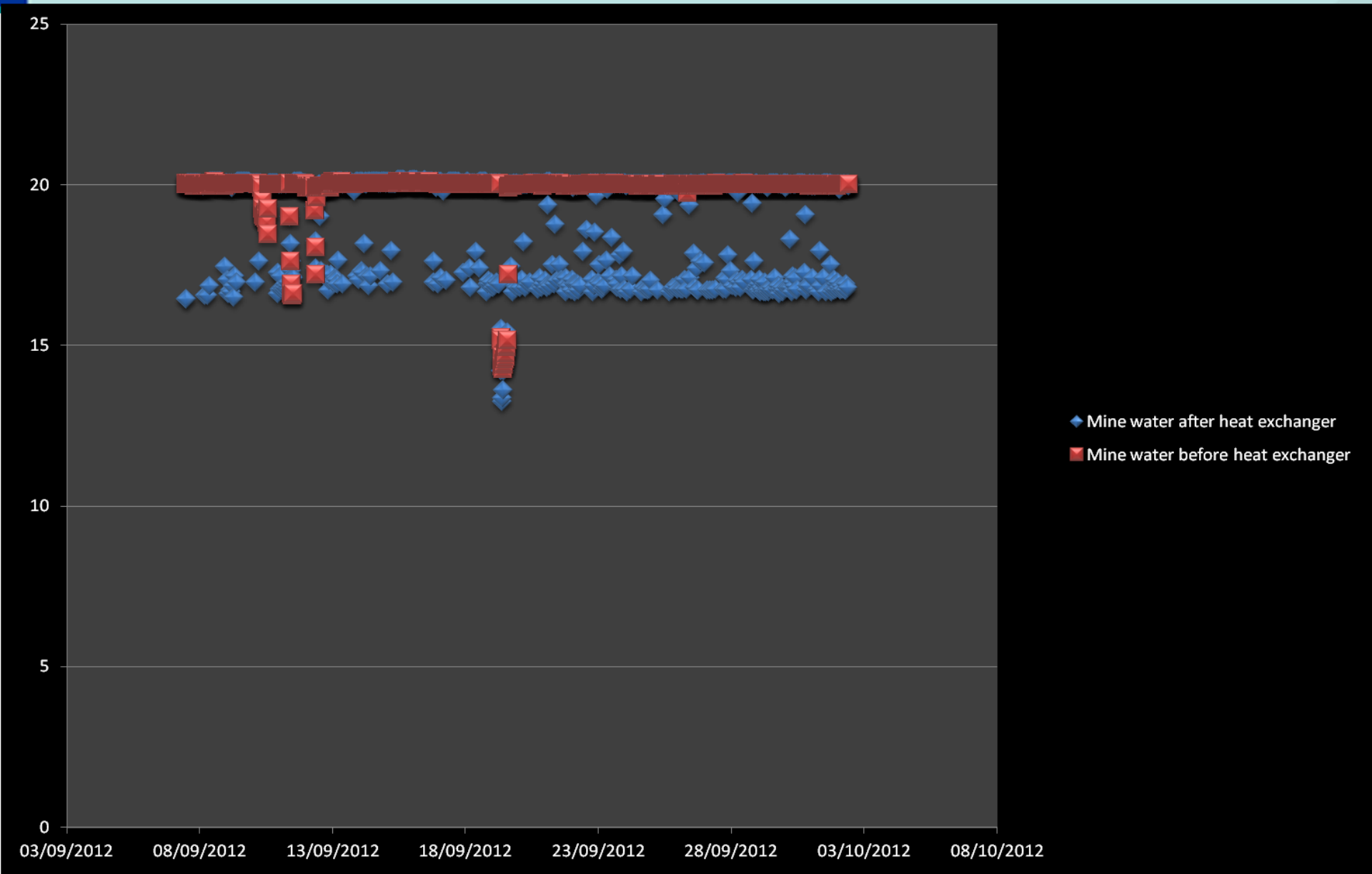
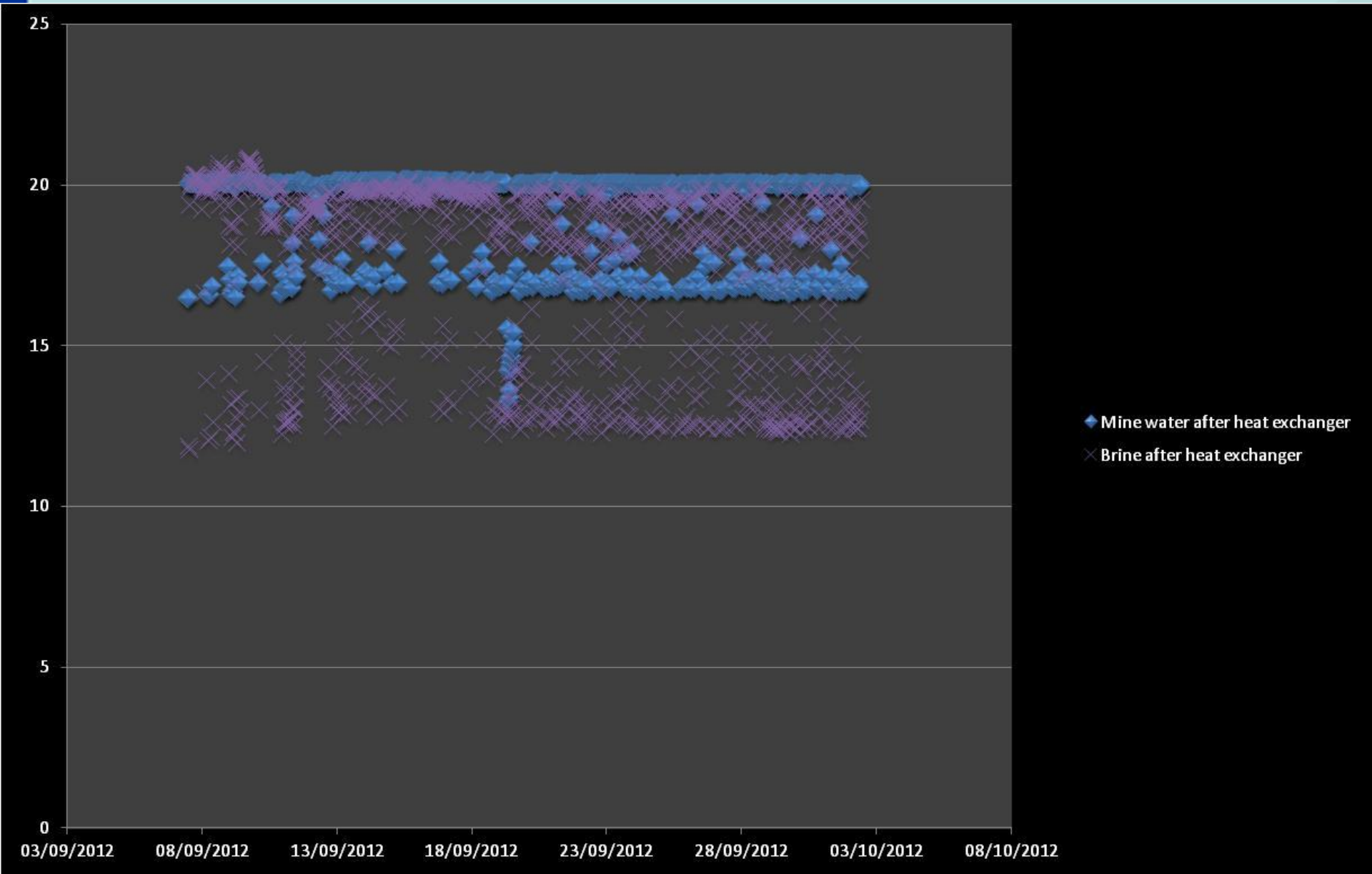
# ΔT mine water (3ºC)



# Heat exchanger efficiency (ºC)



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# Next Steps

- Demonstrate successful application of raw mine water use in heat pump system at Dawdon
- Continue:
  - Providing information across coalfields
    - Industry, developers, planners, etc
  - Issue Permits and Heat Access Agreements
    - Statutory requirement
- Facilitate the use of the resource by others