

# Thermal Energy from Mine Workings

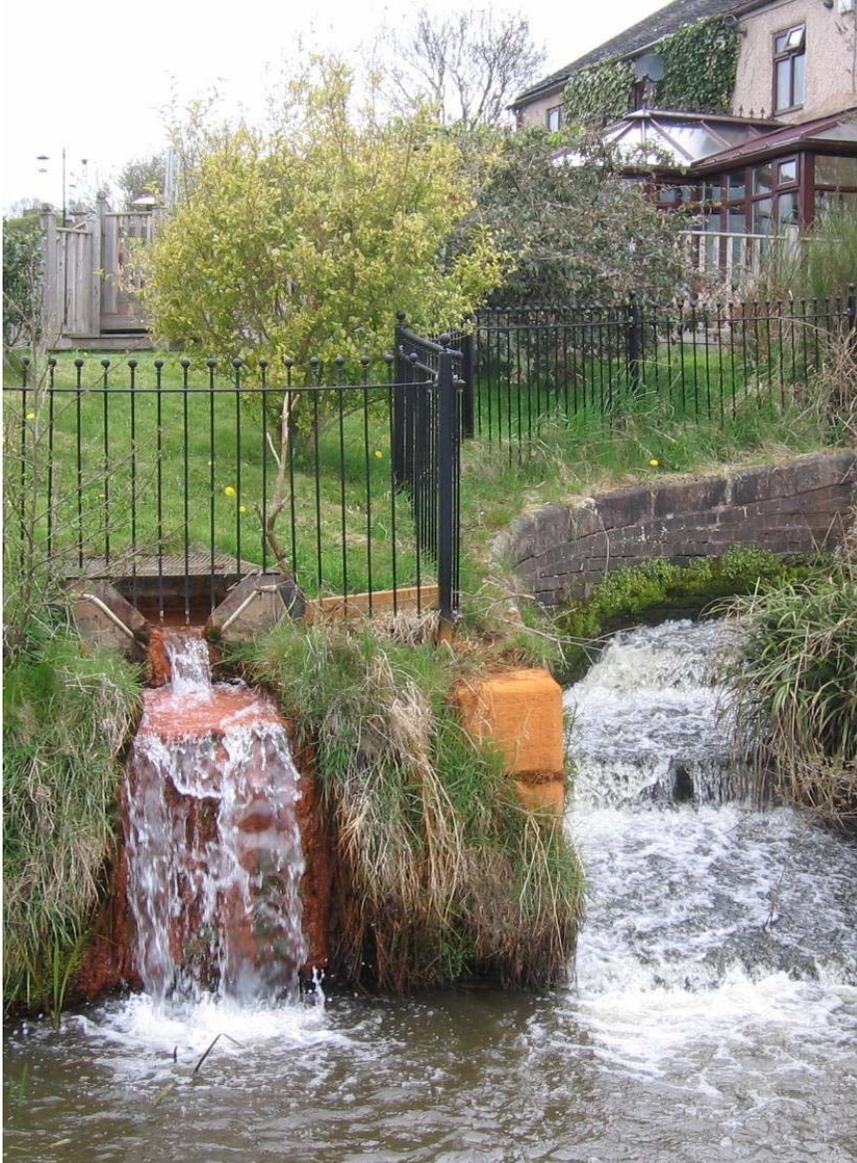
*"No; this my hand will rather  
The multitudinous seas incarnadine,  
Making the green one red."*

**Dave Banks**  
**University of Glasgow**  
**Holymoore Consultancy, Chesterfield**

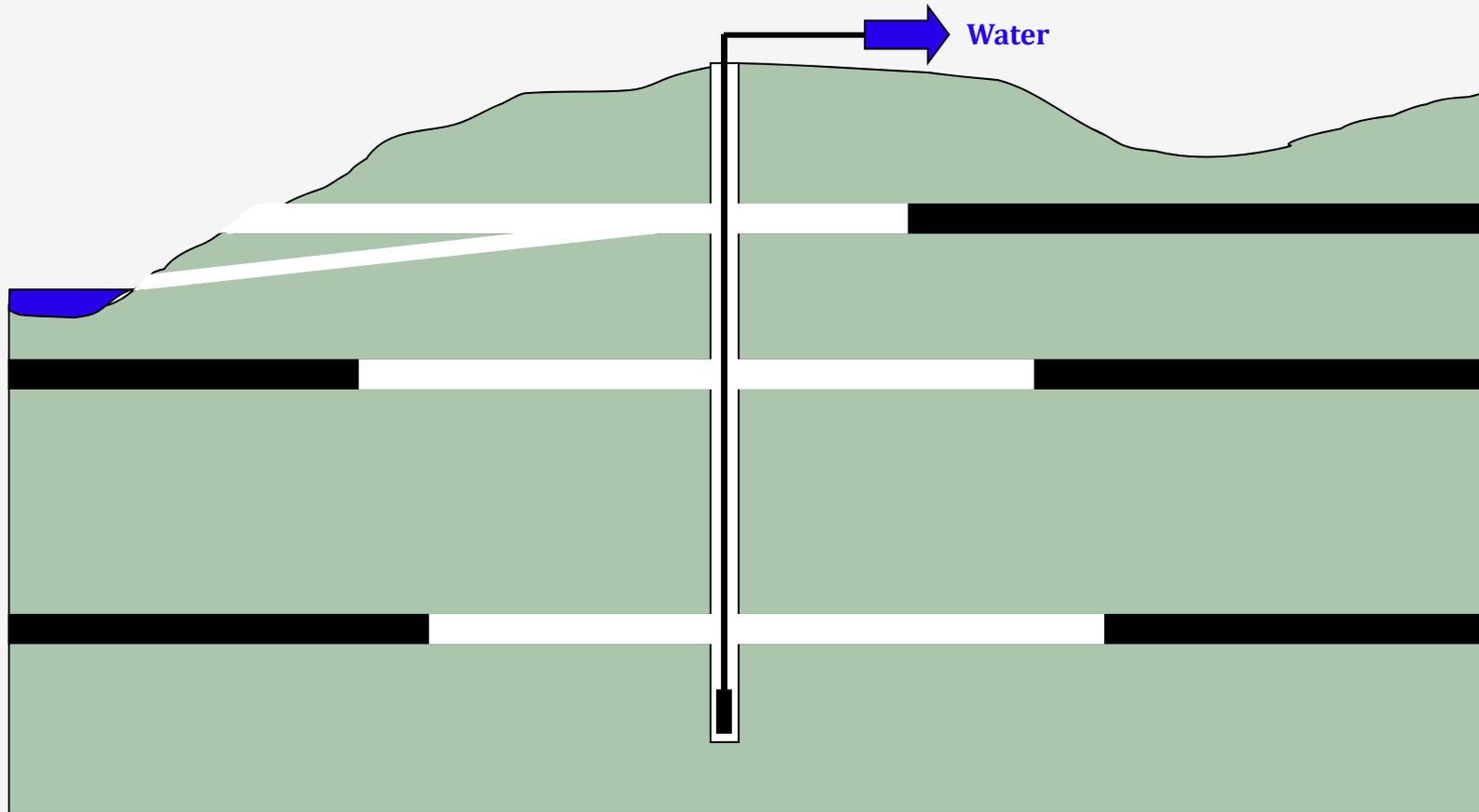


**Macbeth, Crucible, Sheffield.**

“...making the red one green”



# Minewater

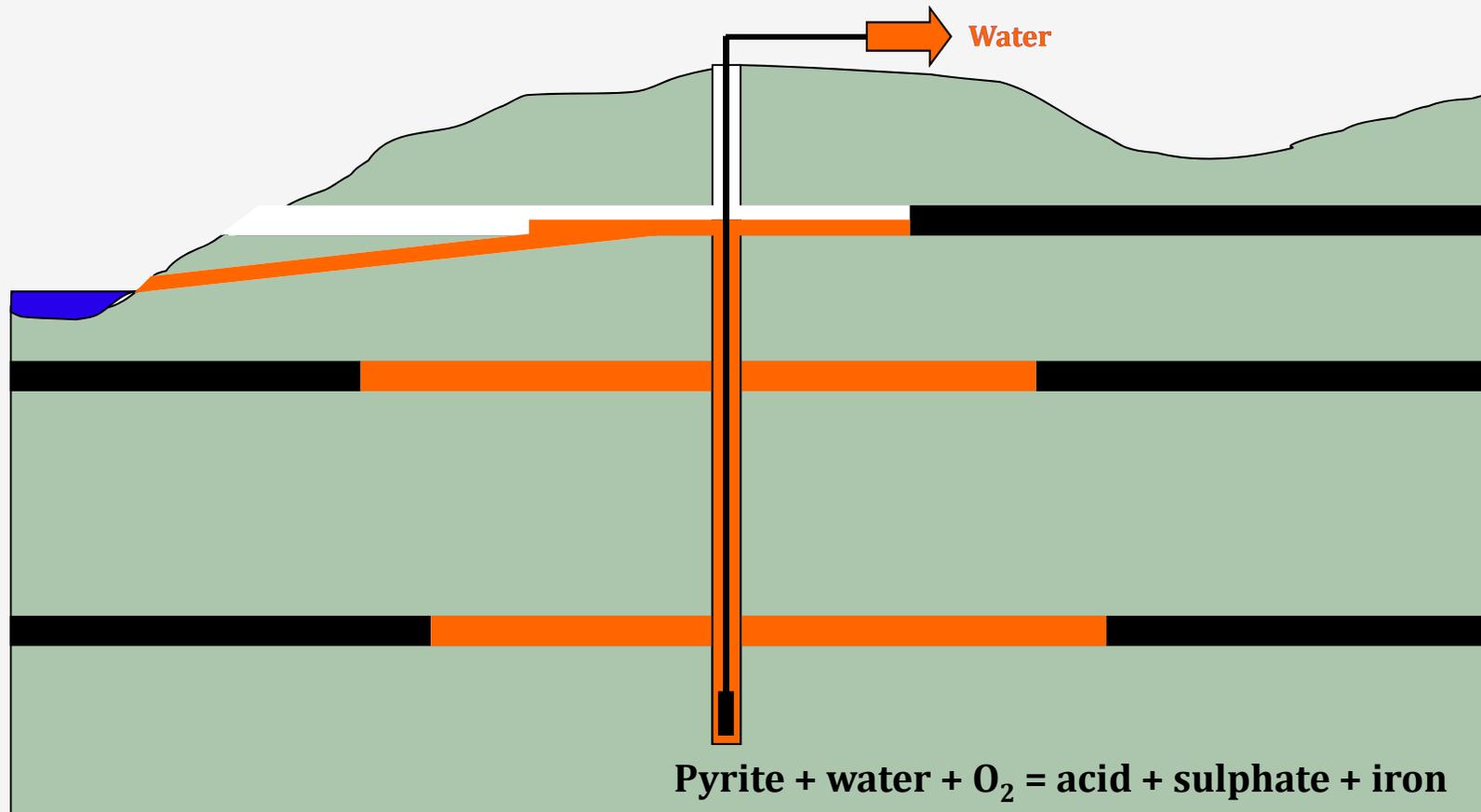


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# Minewater



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# Pump and treat



reatment scheme, near Wakefield

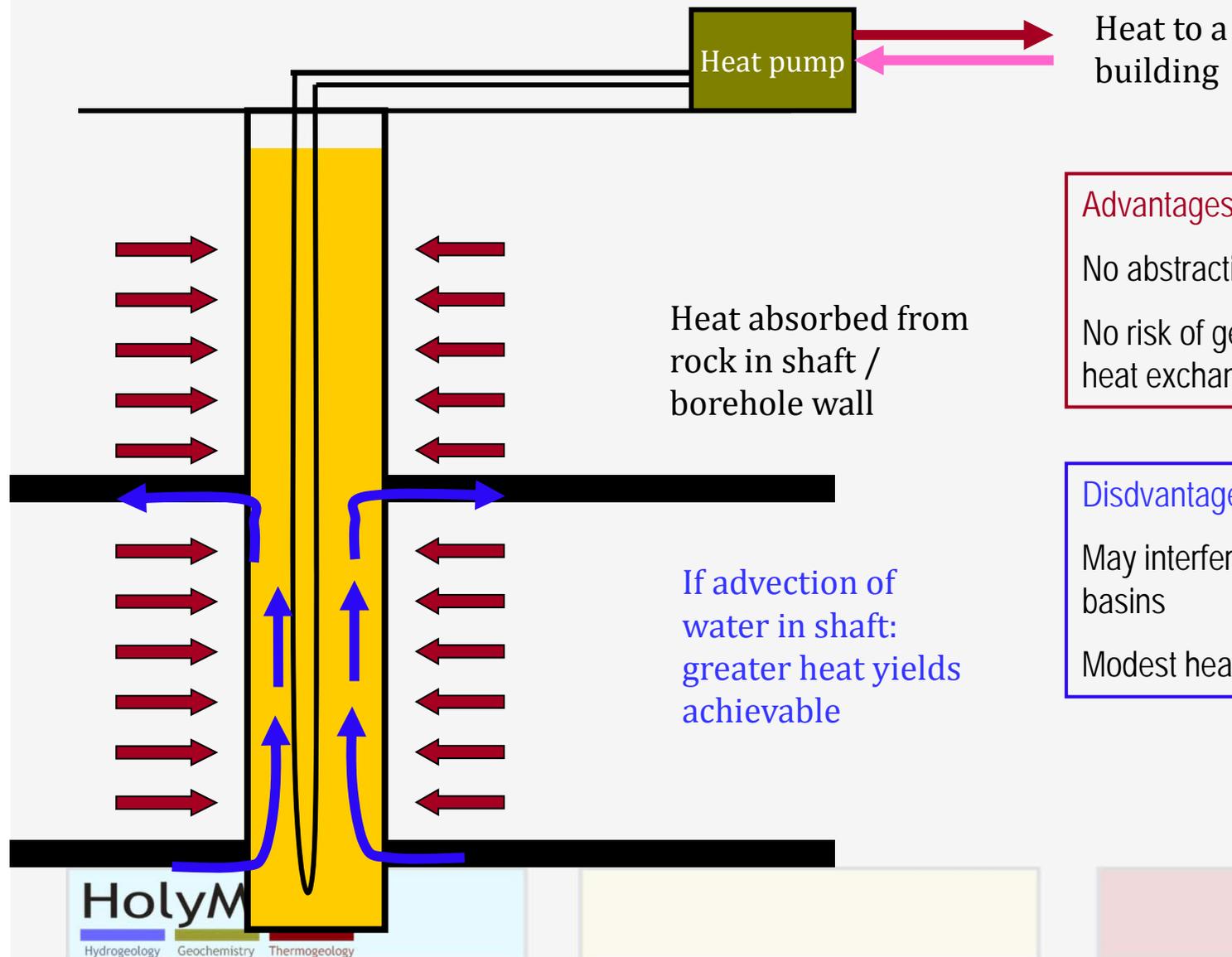


Katowice mine, Poland

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# Closed loop – the low risk way



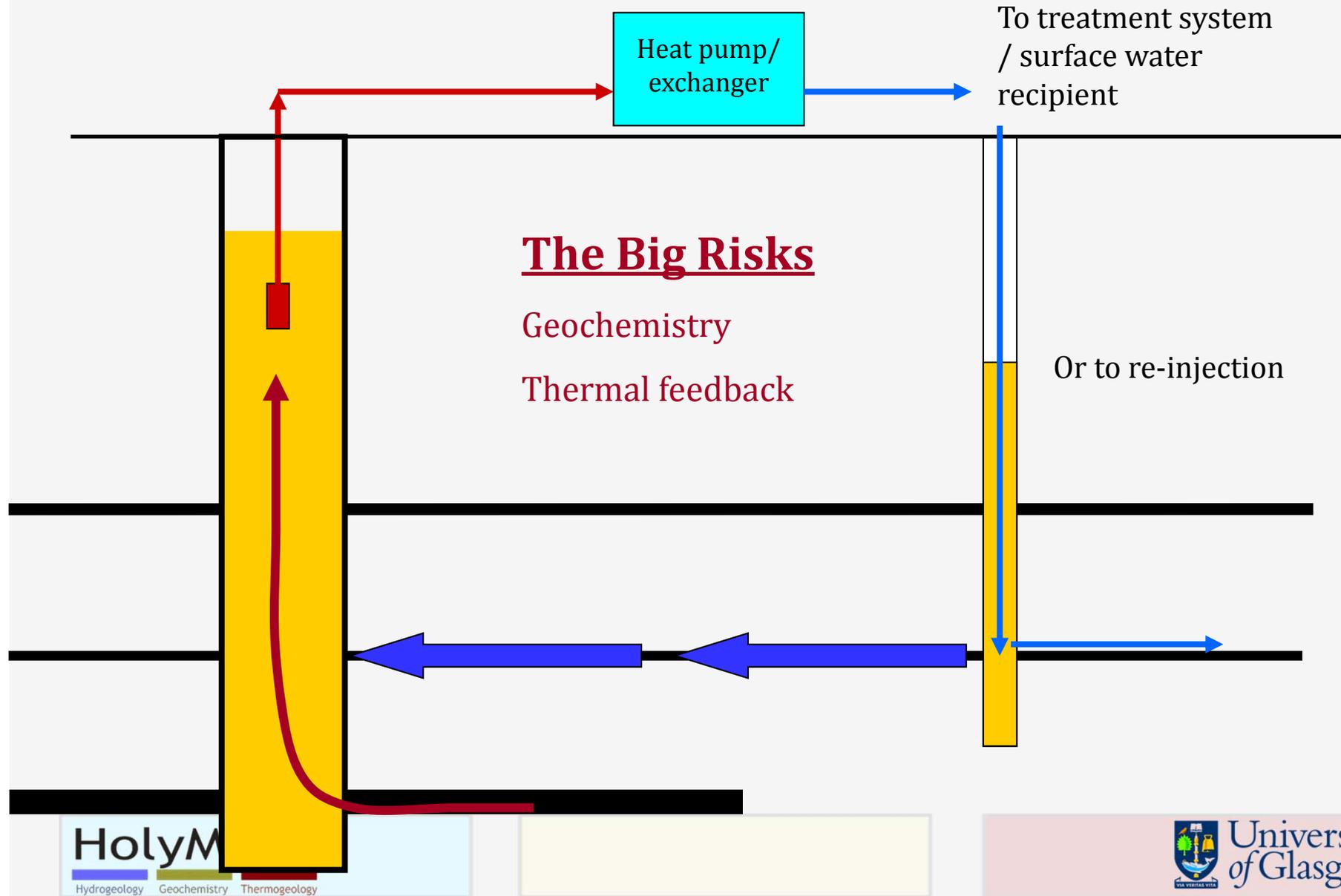
## Advantages:

- No abstraction of mine water
- No risk of geochemical fouling of heat exchanger

## Disdvantages:

- May interfere with desludging of basins
- Modest heat yield

# Typical open loop system





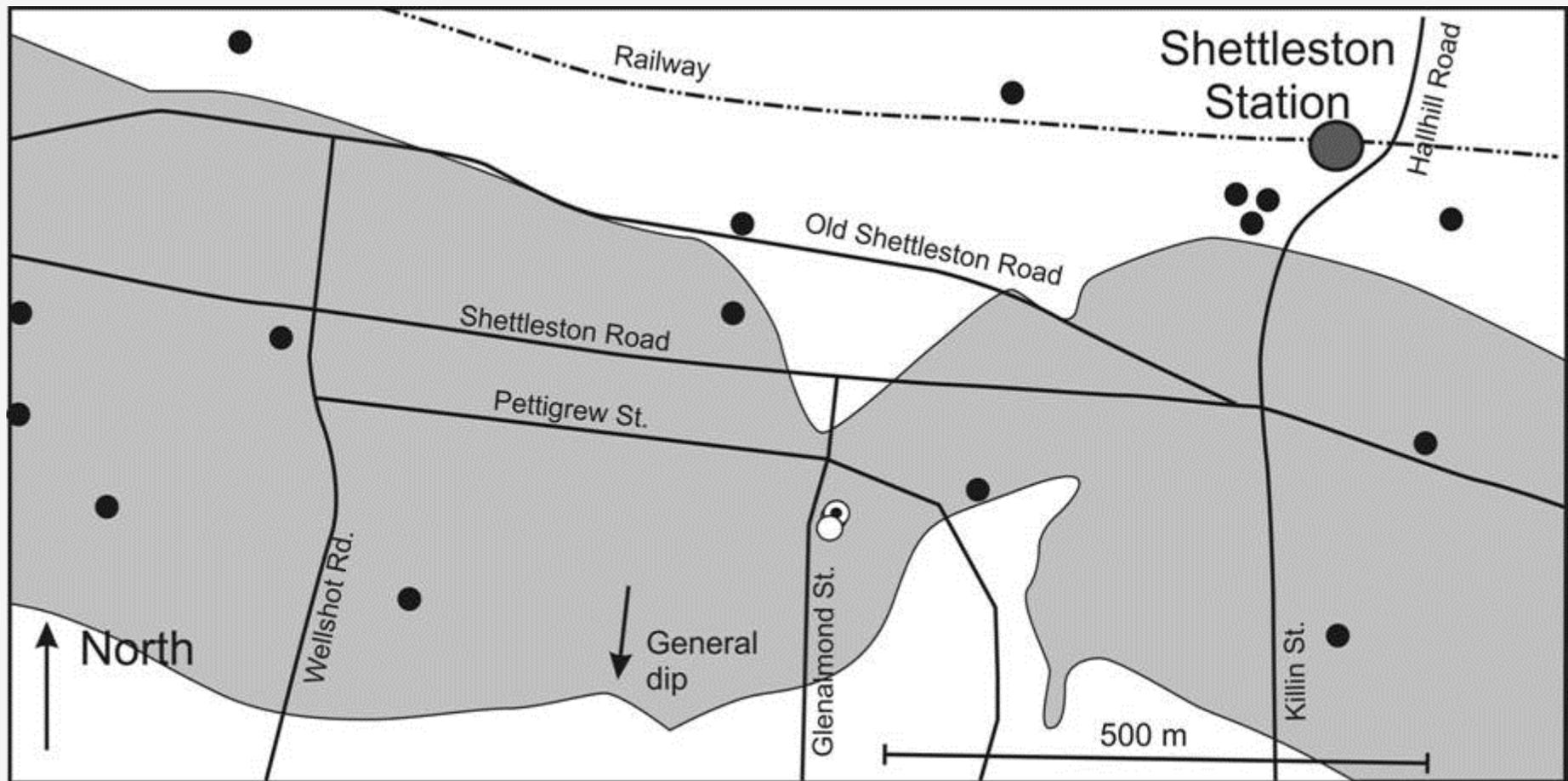
# Why mine water ?

Most GSHP schemes deliver savings on CO<sub>2</sub> emissions and on OPEX. BUT they require considerable CAPEX on borehole drilling and subsurface heat exchangers.

The use of mines and mine water can reduce capital expenditure because:

1. Flooded, interconnected mine workings allow access to a huge reservoir of warm mine-water via only one or two boreholes, or via existing shafts.
2. The interconnected network of tunnels within the mine itself represents an enormous heat exchange surface.
3. Some abandoned mines are already committed to expenditure on pumping and/or treatment merely for the purposes of environmental protection, while regarding the pumped water merely as a troublesome “waste” product.
4. The UK Coal Authority pumps and/or treats around 3000 L/s water from abandoned mines, with temperatures of 9-18°C,  $3000 \text{ L/s} \times 4200 \text{ J/K/L} \times 5^\circ\text{C} = 63 \text{ MW}$

# Glenalmond Street, Shettleston, Glasgow Workings in Ell Coal Seam



○ Abstraction and reinjection boreholes      ● Abandoned shaft

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University  
of Glasgow

# Glenalmond Street, Shettleston, Glasgow

Completed 1999

Serves 16 newly-built dwellings (1600 m<sup>2</sup>)

Source = 100 m borehole in flooded coal mine workings of the *Ell Seam*

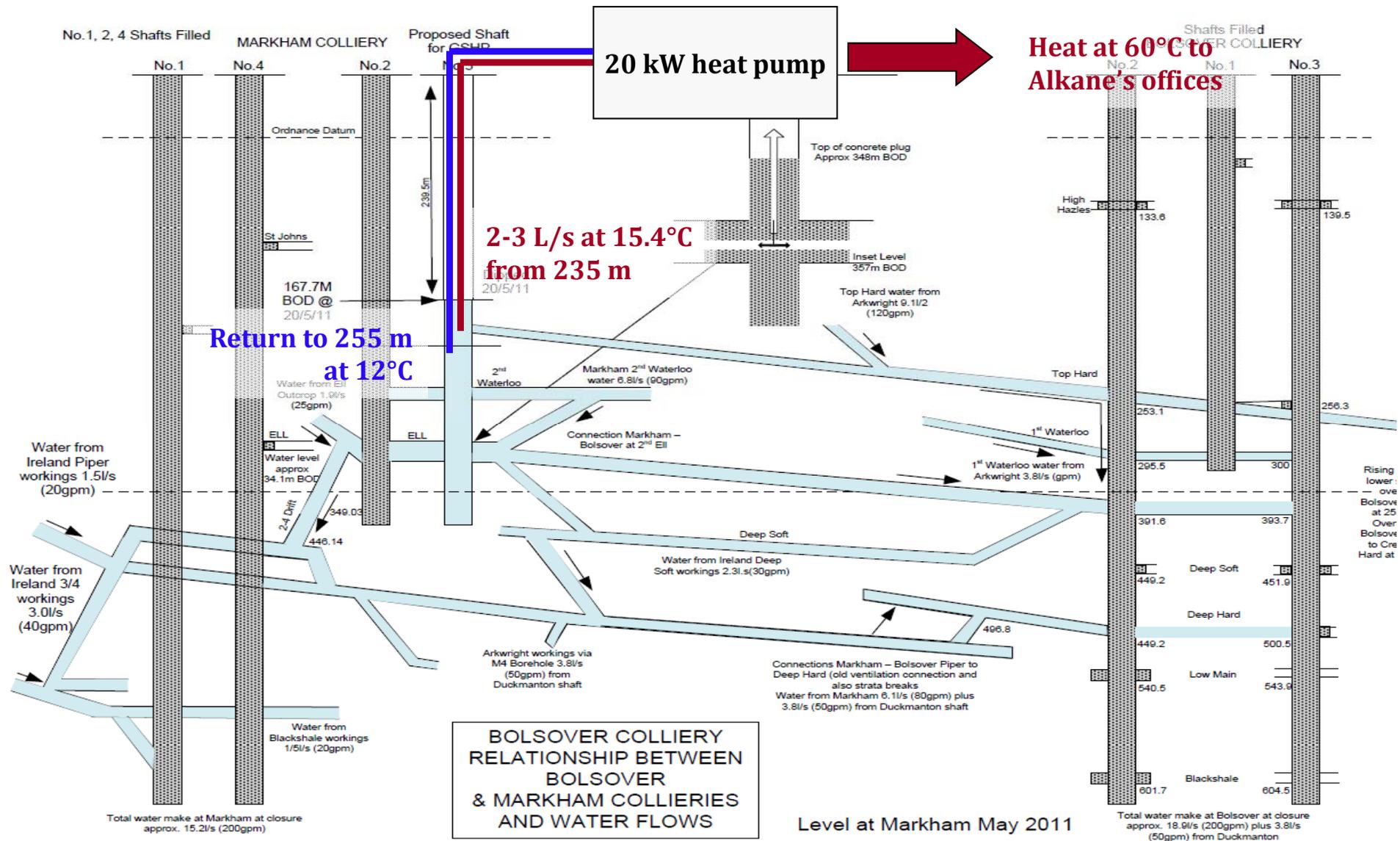
Water pumped at 12°C circulated via water-to-water heat pump (65 kW peak output), and returned via shallower reinjection borehole

Heat pump output = 55°C to thermal store. Designed with supplementary solar thermal heating.

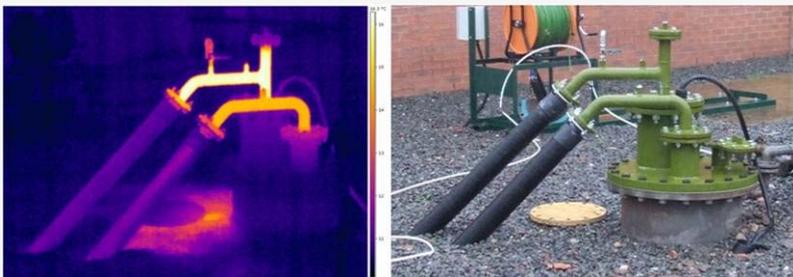
Feeds DHW (with supplementary immersion heater) and central heating

Photos by D Banks

# Alkane, Markham Colliery, near Bolsover



# Alkane, Markham Colliery, near Bolsover

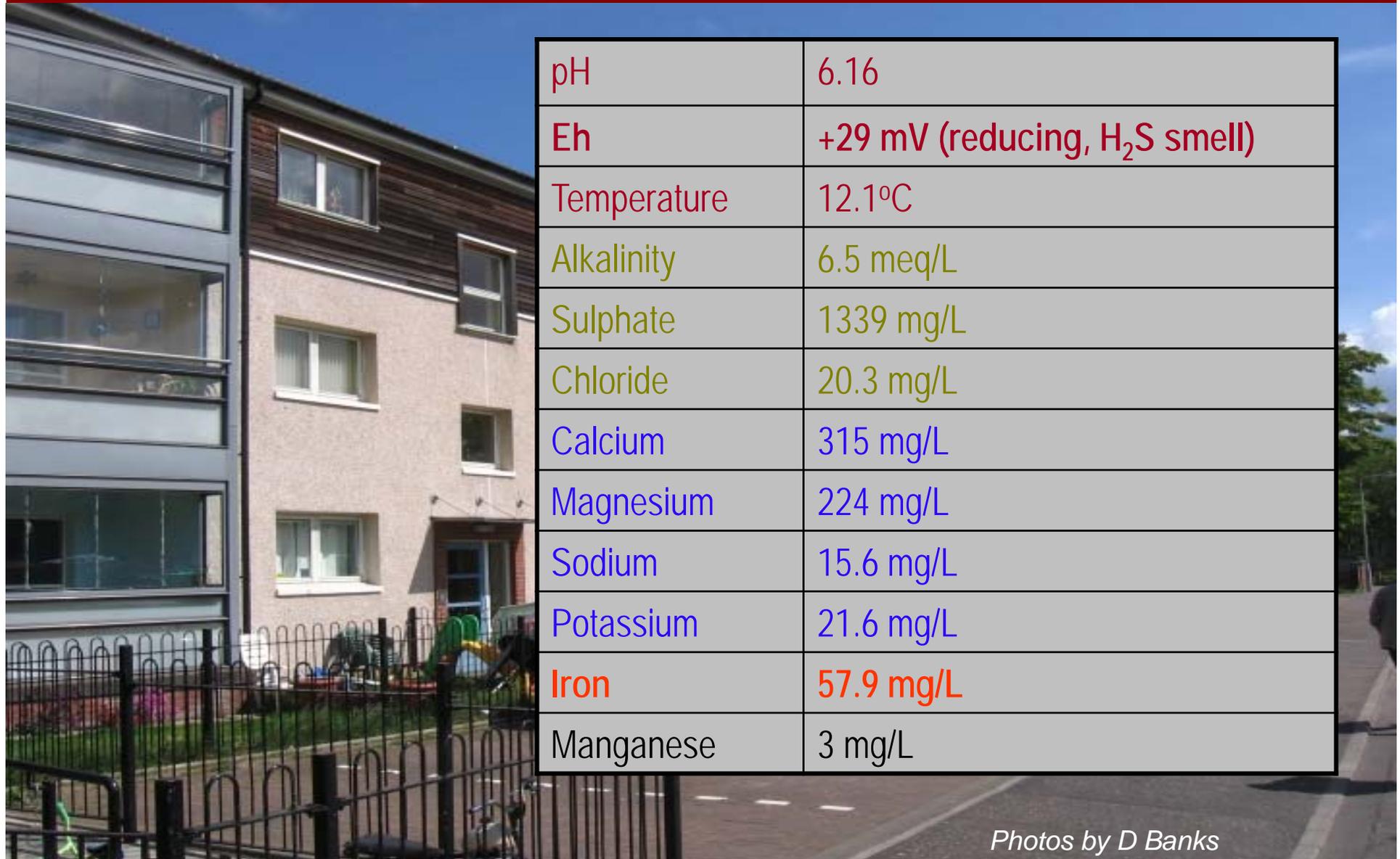


Fe at 4 mg/L

No clogging or feedback problems observed



# Ochil View, Lumphinnans, nr. Cowdenbeath, Fife



pH	6.16
Eh	+29 mV (reducing, H <sub>2</sub> S smell)
Temperature	12.1°C
Alkalinity	6.5 meq/L
Sulphate	1339 mg/L
Chloride	20.3 mg/L
Calcium	315 mg/L
Magnesium	224 mg/L
Sodium	15.6 mg/L
Potassium	21.6 mg/L
Iron	57.9 mg/L
Manganese	3 mg/L

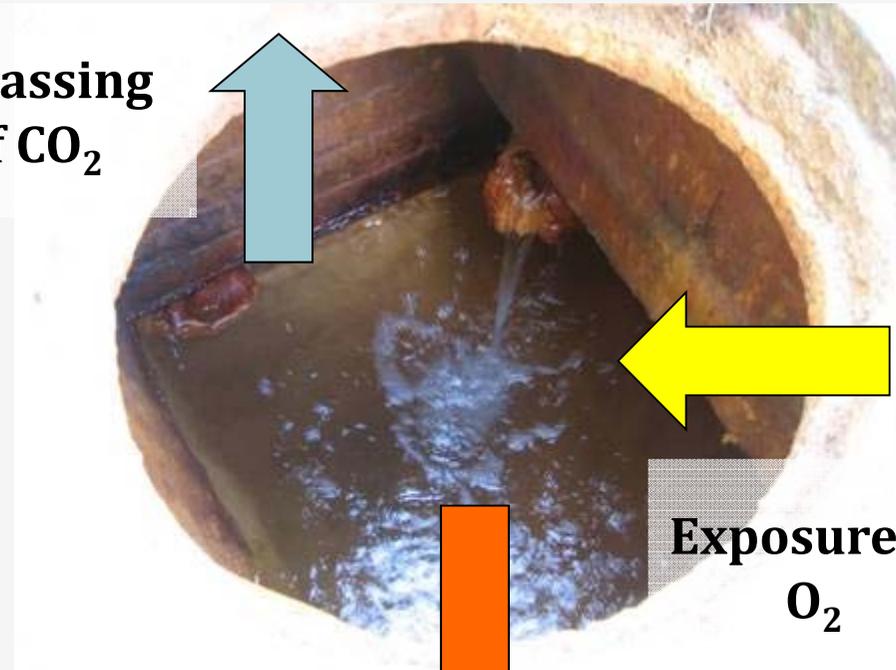
*Photos by D Banks*

# Hitherto...

The Shettleston scheme has had no problems of clogging at all...

But the recharge well of the Lumphinnans scheme was vandalised (2005)...

**Degassing of CO<sub>2</sub>**



**Exposure to O<sub>2</sub>**

**Precipitation of ochre, other metal hydroxides, calcite**



# Coal Authority Trial at Dawdon, Co. Durham

75 to 150 L/s minewater  
treatment capacity

Danfoss 12 kW heat pump heats  
office and DHW

1.5 L/s of treated minewater at c.  
20°C supports heat pump

Minewater saline, with c. 0.8 mg/L  
iron (peaks of 2-4 mg/L)



from Coal Authority website



# Coal Authority trial at Dawdon



When treated (aerated) water used, heat exchanger and filter rapidly became clogged



The Coal  
Authority

but, after raw (unoxygenated) water used, few problems

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# The secrets of success

A good understanding of subsurface geometry and hydraulics of mine workings  
A good understanding of hydrochemistry  
Gas management!

