A UK perspective on managing mine waters sustainably.

Dr Ian Watson CGeol, Steve Hill, Carl Banton, Tracey Davies

MEND conference, Vancouver December 2015
A UK Government Agency

- Established 1994 - Privatisation of the Coal Industry
- The Coal Authority owns, on behalf of the country, the vast majority of the coal in Great Britain, as well as former coal mines.
- Managing the legacies of our mining industry.
- Cover England, Scotland, and Wales
- An increasing amount of NON-COAL related work
- Funded by government, primarily
Mine Water programmes

• Environment programmes
  – Coal mine waters:
    • Remediation Schemes
    • Preventative Schemes
    • ~70 operational Schemes
  – Non-Coal Mine Waters:
    • Remediation of metal mines
    • 3 operational schemes
Preventative schemes

- Many areas of rising mine water
  - Follows near complete closure of coalfields
  - Monitored at ~800 locations
- High priority to protect
  - Groundwater
  - Surface waters
Frances Pump + Treat Scheme

• Frances, Fife
  – Typical preventative
  – Pumping
  – Chemical dosing
  – Iron Removal
  – Desludging
  – High Cost + Carbon

18 February 2016
Remediation schemes

• Existing discharges treated
• Prioritised with environmental agencies
• Implemented subject to:
  – Funding availability
  – Technical feasibility
  – Evaluation of benefits > costs (for whole life)
Glyncastle Mine Water Treatment Scheme

Settlement Ponds

Reed Beds

Glyncastle Mine Water Treatment Scheme

September 2005
Remediation results in Wales

Glyncastle Minewater Treatment Scheme

Before

~3 months After

© The Coal Authority
Mine Water Programme National Progress

- Completed >70 treatment schemes
- Improved over 140km of watercourses
- Over 230km of watercourses protected
- Prevents 2900 tonnes of Iron ochre from entering watercourses each year
- Major drinking water aquifers protected in Durham and Cannock
- Very successful sewage/mine water co-treatment to remove phosphates at Lamesley
- Many schemes provide local amenity

18 February 2016
Major costs

• Biggest costs of managing mine water
  – Pumping
  – Treatment
  – Waste sludges
• Many schemes >10 years old, some >20
  – Refurbishments needed
• Coal Authority continues to work on cost reduction for increased sustainability
Pumping cost reduction strategies

• Find a new pumping location
  – At a lower elevation
    • Currently planning new site near Frances
  – Ideally low enough for gravity driven flow
    • Implemented in North East England coalfield
    • Page Bank, Vinovium, Chatershaugh
    • Pumping was >100 l/s each
    • now none (gravity)
    • Kimblesworth progressing now
Water Quality in UK

- Most mine waters
  - Net-alkaline; circum-neutral pH
  - AMD is very rare in UK coal and metal mines

- Main problems are:
  - Iron (coal mines)
  - Zinc (metal mines)
  - Salinity as Chlorides (deep coal mines)
Example of AMD treatment, Blenkinsopp, England

Blue water caused by NaOH dosing into mine water with 1000 mg/l iron in 2005

After 10 years iron < 200 mg/l so dosing costs have decreased
Treatment cost reduction strategies

• Can active schemes be converted to passive?
  – Need large area available
  – Blenkinsopp now nearly fully passive (below)
  – Horden (NE England) successfully converted
AMD treatment using RAPS in the UK

• A few sites are treated by RAPS
  – Reducing, Alkalinity Producing Systems
  – Typically 50:50 mix limestone: compost

• Expected Lifetime?
  – So far oldest schemes, ~20 yr, struggling
  – Newest ~10 yr continues to do well
    • Tan y Garn, Wales
RAPS operational

After 2 weeks operation Compost barely visible through ochre
Current RAPS condition

Ochre and vegetation growth on surface, but vertical flow downwards continues

Maintenance to date – clearance of ochre + plants every few years

Limestone dissolution, and sulphate reduction processes continue to occur
Maintaining treatment in passive schemes

- Vast majority of UK schemes use:
  - Settling ponds + / Reedbeds
  - Reedbeds need occasional maintenance
Channelised Reedbeds

Channels like these typically occur after 5 to 10 years. Cutting of the reeds normally restores uniform flow across beds.
Sludge waste cost reduction strategies

- Desludging lagoons
- Use gravity sludge drain
  - Instead of pumping or digging out
  - Need suitable topography with lagoon above drying bed
  - Implemented at 3 sites so far.
Sludge waste cost reduction strategies

- Dewatering methods
- Drying beds good, but takes time.
- Trialled methods to dry ochre sludge quicker. Included:
  - Centrifuge
  - Belt press
  - Electrokinetics
- EK performed well
Ochre Sludge re-use

• Ultimately aiming for full re-use
  – Avoid increasing landfill costs
• So far only limited use for bricks
  – At Dawdon HDS plant, NE England
• CA R+D team looking at several options
  – Including waste water treatment for P
Can the heat in mine water be used, creating value, and decreasing costs of treating water?
A heat pump trial at Dawdon

- UK has growing ground source heat market
  - Minimal use of mine water so far
- We’ve implemented a demonstration project to encourage wider uptake in UK.
- A small pilot trial heats offices at Dawdon plant
- DHW also provided to offices
- Mine water used: ~1.5l/s, 20degC, ~80mg/l Fe
- Heat pump unit: 12KW
- Coefficient of Performance = 5
Metal Mine Water treatment challenge

• Most UK experience so far is for coal
• Cost effective treatment of zinc rich metal mine waters is more challenging.
• We are exploring several options to identify solutions with lowest whole life cost
Force Crag Pilot Trial

Research with Newcastle University, Environment Agency and the National Trust

Passive vertical flow reactor (VFR)
Pilot treatment scheme built in 2014
>95% Zn removal currently being achieved
Feasibility of using VFR technology now being assessed for other metal mine sites in UK
Metal Mine R+D

• Working with a variety of partners
• Testing various materials including
  – Ion exchange media
  – Sorption media

Treatment trial using biochar,
Aberystwyth University
Summary

• Operation of ~70 schemes including closed coal and metal mines
• Continually improving sustainability by looking at a wide range of factors:
  – Pumping
  – Treatment
  – Waste Management
  – Etc
• New ideas are always welcome