

TDP 5 - A Reducing and Alkalinity Producing System (RAPS) for Passive Treatment of Acidic, Aluminium Rich Mine Waters

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Executive Summary

Leachates generated by old colliery spoil heaps can pose significant risks to ecosystems, drinking water supplies and agricultural uses of surface waters. As regulatory controls have tightened over the years, it has also become apparent that the risks posed by such sites are likely to persist for hundreds of years in most cases. Thus, remedial interventions which can be readily sustained over long time periods are increasingly required. Given that such treatment may have to be sustained for centuries, conventional 'active' treatment-technologies such as lime dosing and sedimentation (which have high operating costs) are unappealing. Passive treatment options (in which most expenditure is concentrated in construction costs and operating costs are minimal) are far more attractive.

Site Background

At Bowden Close, in County Durham, investigations have been underway since 1999 into low-cost environmentally-integrated methods for treating acidic, aluminium-rich spoil leachate and similar drift mine drainage waters. Successful pilot-scale field tests (undertaken by the University of Newcastle upon Tyne and Durham County Council in 1999-2001) showed that it is feasible to passively treat these leachates using subsurface flow biogeochemical reactors containing a mixture of compost and limestone. These so-called 'Reducing and Alkalinity-Producing Systems' (RAPS) improve water quality by the combined action of bacterial sulphate reduction and limestone dissolution, safeguarding the porosity of the limestone layer. A full-scale passive treatment system based on this approach was constructed in the Autumn of 2003 and fully commissioned in the summer of 2004. The full-scale system incorporates two RAPS units and a polishing aerobic wetland.



Earthworks for the treatment system at Bowden Close.

The RAPS units were specifically designed to optimise aluminium removal, as well as other contaminants, and consist of a mixed one-layer substrate, in contrast to the conventional dual-layer approach.

The performance data from the new system are very encouraging: pH rises to neutral values and key pollutants are almost completely removed. Based on the performance data, the pilot study and experiences with other passive treatment sites, lifetime and life-cycle costs were calculated. These estimations demonstrate the economic advantages of passive treatment, in particular over extended periods of operation.

With significant logistical and financial support from CL:AIRE and the BOC Foundation, the University of Newcastle's SRIF2 Earth Systems Laboratories initiative, the LINK sponsored ASURE project and the European Commission FP6 CoStaR project, the Bowden Close remediation site features unparalleled monitoring facilities and has become a focus of national and international research. As such it is hoped that experience of the Bowden Close investigations will yield insights of use to many other owners of former colliery sites in the UK and worldwide.

General Conclusions

The RAPS at Bowden Close is a novel passive mine water treatment technology which is successfully remediating a series of acidic and metal-rich discharges arising from abandoned coal mining facilities near the small village of Helmington Row, County Durham. The full report illustrates not only the success of the system as a treatment unit *per se*, but also the beneficial outcomes of (ongoing) research at the site, which has been focused on establishing the precise mechanisms and rates of contaminant attenuation processes within the system.

An important side-effect of the full-scale treatment system is the creation of a valuable habitat, both for wildlife and local residents. Pheasants, herons, ducks and various other waterfowl have been spotted and some of them even breeding within or next to the treatment lagoons. Local residents frequently stroll along the public footpath adjacent to the site and enjoy the pleasant countryside setting. Although it is difficult to express the economic value of creating such a habitat, it is apparent that a passive system is certainly preferred by local residents and wildlife than an active treatment plant.

Limitations of the Technology

Despite the successful performance of the full-scale system at Bowden Close, there are some important limitations for the application of RAPS in mine water treatment:

- An important cost factor is space. If no cheap land is available for the construction of treatment lagoons, or if very high flow rates require excessively large lagoons, the construction cost could soon become prohibitive, if indeed such a large area is available at all
- To benefit fully from the low operating costs, the topography of the site should offer sufficient hydraulic head to avoid the need of pumping

- The economic advantage only comes into effect after longer periods of operation. Usually mine waters are a long-lasting source of pollution, but in situations where treatment may only be needed in the short- to medium-term, active treatment may be economically favourable. It is for precisely this reason (together with issues of land availability) that active treatment is often employed at operational mines

- In areas without a local source of limestone, the cost of delivering limestone to the site might be considerable (such as parts of Scotland).

An example of a mine water discharge of such high metal and acidity loads that passive treatment would simply not have been feasible is Wheal Jane (see Younger *et al.*, 2005 and CL:AIRE Case Study Bulletin CSB4, 2004). It should be noted that the RAPS at Bowden Close is in the order of 5 times smaller than an equivalent compost wetland for remediation of such a discharge. Thus, by designing more efficient systems, the limitations of space are gradually being reduced.



Established RAPS system

Applicability and Potential Future Developments

There are probably far more than 100 former mining sites in the UK where acidic mine drainage could be treated by a passive system. Most of them are in local authority ownership and are yet awaiting any remediation concept. Notwithstanding the constraints outlined in the previous section, passive treatment and RAPS systems in particular may offer a low cost and sustainable solution for many of these sites.

A major uncertainty is still the longevity of passive treatment systems. By combining microbiology and geochemistry, the ongoing research at Bowden Close and at other remediation sites is expected to deliver a sound scientific answer to these questions. With several treatment systems coming into age in the course of the next few years (such as Quaking Houses), the scientific background will be complemented with practical experience, thus demonstrating the manageability of longevity issues.

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