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Tackling Contaminated Land in Wales

November 3rd 2005

Wales Millennium Centre, Cardiff, Wales

Programme

0900 – 0925	**Registration and Coffee**
Morning	**Chairman – Steve Smith, Head of Land Reclamation, Welsh Development Agency**
0930 – 0940	Introduction by Jane Forshaw, Chief Executive, CL:AIRE
0940 – 0955	Context for Land Remediation in Wales – Andrew Davies AM Minister for Economic Development and Transport
0955 – 1015	The Regulation of Contaminated Land – Ceri Jones, Contaminated Land Policy Advisor, Environment Agency Wales.
1015 – 1035	Impact of Part IIA Legislation – Professor Robert Lee, Cardiff University
1035 – 1055	The Development of Sustainable Remediation Technologies – Dr Rob Francis, Geoenvironmental Research Centre
1055 – 1100	DTI Remediation Technology Funding – Christopher Stewart, UK Department of Trade and Industry
1100 – 1130	**Tea/Coffee**
1130 – 1300	**Workshops**
	Session 1– Sustainability Appraisal - learn about the benefits and latest techniques, emerging from research at national and EU level, for incorporating sustainable development criteria into regeneration projects. Tom Bourne – Environment Director, WDA and Professor Hywel Thomas, Director Geoenvironmental Research Centre, Cardiff University
	Session 2 – Technology Development and Demonstration – the opportunity to learn more about innovative remediation technologies, the availability of research funding and your chance to shape future demonstrations. Jane Forshaw, CLAIRE, Christopher Stewart, DTI
	Session 3 – Cost-Effective Site Investigation for Contaminated Land – discover the risks and benefits of different approaches, including statistical analysis, risk assessments and an introduction to a new software modelling tool. Professor Mike Ramsey – Sussex University
	Session 4 – Groundwater Remediation –an examination of the different technologies and options for treating groundwater, including the design and build of plant, techniques for organic and inorganic pollutants and a discussion on the value and effectiveness of treatment Kelwyn Davies – Parsons Brinckerhoff
1300 – 1400	**Lunch & Poster Session**
Afternoon	**Chairman – Dave Clarke, Environment Agency**
1400 – 1420	CoSTaR Project – Paul Younger, University of Newcastle Upon Tyne
1420 – 1435	Contaminated Land Research Opportunities – Hugh Potter, Environment Agency
1435 – 1605	**Workshops** (see morning Workshops)
1605 – 1625	**Tea/Coffee**
1625 – 1645	Workshop feedback
1645 – 1700	Concluding Remarks – Hywel Thomas, Director Geoenvironmental Research Centre, Cardiff University

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Biographical Note

Jane Forshaw

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Jane Forshaw is the Chief Executive for CL:AIRE. She joins the team having been the Chief Executive at Urban Mines, another environmental charity for over 4 years.

In terms of her academic background she completed her Environmental Health Degree with a First Class Honours from Salford University, and then held a number of different positions employed by Birmingham City Council over a period of ten years. She first worked as an Environmental Health Officer and was then promoted to be Head of the Sustainability Team. She also became the personal advisor to the Chief Executive on sustainability issues. She was also on the Government's working group which published the National Sustainability Indicators Report.

She has led teams on a number of regeneration projects and is an accomplished networker. She sits on FIRSTFARADAYs Advisory Group and the English Partnerships Coalfields Project Board.

Jane holds three diplomas in Waste Management, Health and Safety and Management Development, and is a member of the Chartered Institute of Environmental Health and The Institute of Waste Management. She is currently a LEAD Fellow, an international programme which creates Leaders for Environment and Development.

Tackling Contaminated Land in Wales

Mynd i'r Afael â Thir Halogedig yng Nghymru

3rd November 2005

Jane Forshaw, CL:AIRE

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Contaminated Land: Applications In Real Environments

Why are we bothering?

- Sustainable solutions
- Availability of land - being a finite resource on a small island
- Legislative drivers EU and UK, for instance Landfill Directive, Groundwater regulations and Environmental Protection Act
- National Policy drivers – National Brownfield Strategy
- Upcoming legislation eg Water Framework Directive 2015, Soil Framework Directive

Contaminated Land: Applications In Real Environments

CL:AIRE

CL:AIRE - The Organisation

- Established in 1999
- Public/private partnership
- Environmental charity
- Encourage demonstration of remediation research and technologies
- Our Vision

To eliminate the problem of contaminated land

Contaminated Land: Applications In Real Environments

CL:AIRE

Our Role

- Our role is to improve the uptake of alternatives to dig and dump
- To raise the standard of the scientific understanding of remediation techniques by providing independent verification
- To raise the expectations of site owners and remediators
- To be a constructive partner to policy makers and opinion formers

Contaminated Land: Applications In Real Environments

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defra Department for Environment Food and Rural Affairs

English Partnerships The National Regeneration Agency

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SAGTA

SEPA Scottish Environment Protection Agency

WDA

Llywodraeth Cynulliad Cymru Welsh Assembly Government

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CL:AIRE

Some of our Achievements

- With £1.3 m of our core funding we have levered in £14.6m of other project funding
- We have completed or have ongoing 33 projects with over 70 partners
- Our database has over 4,500 registered organisations and individuals

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Technology Demonstration Projects

- Low temperature thermal desorption (2)
- Soil washing (3)
- Permeable reactive barrier (4)
- Bioreactor
- Wetlands
- Static biopile (2)
- Aerated biopile
- Solidification/stabilisation (2)
- Air sparging
- Ex situ Soil Vapour Extraction
- Accelerated Natural Attenuation using HRC

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The Alternative Becomes Viable

- Treatment costs per tonne below that of hazardous landfill
- Techniques being used for pre-treatment to reduce hazards
- Soil washing and on site biological treatments beating landfill prices, especially when transport costs are considered

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TDP2 Basford Gas Works

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TDP6 Biopile Avenue Coking Works

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- Signpost your queries
- Provide information and reports
- Assistance in finding the right partners
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CL:AIRE

Summary

Contact details for CL:AIRE:

Website: www.claire.co.uk
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Tel: 020 7340 0470

Contaminated Land: Applications In Real Environments

CL:AIRE

Today we want to :-

- Examine the Welsh policy and regulatory framework
- Showcase some best practice
- Identify new research & demonstration projects for Wales
- Produce recommendations & actions to turn your good ideas into reality

Contaminated Land: Applications In Real Environments

CL:AIRE

Biographical Note

Ceri Jones

Ceri Jones has 10 years waste and water quality regulatory experience in addition to working in the private sector. Having worked for a Welsh Local Authority as a Waste Regulation Officer Ceri transferred to the Environment Agency on formation in April 1996. Currently in the position of Contaminated Land Policy Advisor for Wales key areas of work include contaminated land policy in Wales linking with National colleagues. In particular the Welsh Region leads on Metal Mines and the Metal Mine Strategy for Wales is an ongoing project supported by the Welsh Assembly Government.

The regulation of contaminated land

CL:AIRE: 3 November 2005, Cardiff

Ceri Jones

Contaminated Land Policy Advisor

Content

- History of CL Regime
- Summary of Part IIA Regime
- Current Status of Part IIA in Wales
- Proposed RCL Regime
- Future

History of Contaminated Land in Wales

Summary of Part IIA Regime

- Main principle is to ensure land is suitable for its current use - it is a risk-based regime
- Remediation requirements limited to work necessary to prevent unacceptable risks to humans and the environment

Summary of Part IIA Regime *cont.*

s78A (2) EPA 1990:

"Any land which appears to the Local Authority in whose area it is situated, to be in such a condition, by reason of substances in, on or under the land that-

(a) Significant harm is being caused or there is significant possibility of such harm being caused; or

(b) Pollution of Controlled Waters is being or is likely to be caused"

Summary of Part IIA Regime *cont.*

- Regime for identification & remediation of contaminated land causing:
  - significant harm or significant possibility of significant harm to humans
  - significant harm or significant possibility of significant harm to non-human receptors (property and designated ecosystems);
  - pollution or significant possibility of pollution of controlled waters
- Excludes harm or pollution from radioactivity

When is land contaminated?

Need to identify one or more significant pollutant linkages (SPLs)

Summary of Part IIA Regime *cont.*

- LAs principal regulatory role:
  - Prepare inspection strategies
  - Inspect their areas to identify contaminated land
  - Consult EA on pollution of controlled waters
  - Ensure remediation of land identified as contaminated land
  - Transfer Special Sites to the Agency

Summary of Part IIA Regime *cont.*

- Environment Agency role:
  - Provide relevant information held by EA to LAs
  - Ensure remediation of Special Sites
  - National report on the state of contaminated land consulted during designation of Special Sites

Summary of Part IIA Regime *cont.*

- Special sites are:
  - Sites where EA has a regulatory involvement (e.g. IPC and nuclear sites)
  - Land owned by MoD
  - Sites used for particular activities eg petroleum refining, explosives manufacturing, acid tar lagoons
  - Certain types of serious pollution of controlled waters

Summary of Part IIA Regime *cont.*

- Remediation and Reasonableness:
  - Best Practical Technique (BPT)
    - best combination of practicability, effectiveness & durability and
    - reasonable
  - 'Reasonableness' = cost/benefit
    - Limited to financial costs (excludes 'social' considerations)
    - Benefits - reduction & mitigation of seriousness of harm or pollution (excludes things like reduction in anxiety)

Part IIA in Wales

- LAs inspection strategies
- EA Special Sites

Proposed RCL Regime

- Part IIA to be modified to include radioactivity
- Statutory Guidance to be amended to include RCL
- Public consultation October 2005 - December 2005
- Regulations and links to England

Future

- Indicators for Land Contamination
- State of Contaminated Land Report
- Environment Strategy for Wales
- Guidance - PPS 23 (TAN?), WLGA Guidance, EA Developers Guide
- Water Framework Directive

Biographical Note

Professor Robert Lee

Professor Lee is Professor of Law at Cardiff Law School and Co-Director of the ESRC Research Centre for Business Relationships, Accountability, Sustainability and Society. He has extensive experience in dealing with a wide range of matters connected to environmental regulation and is a professional development consultant to the Environment, Planning and Regulation Group of the European Law Firm of Freshfields Bruckhaus Deringer. He is a consultant to the Department of the Environment in Northern Ireland, has worked recently with the Irish Environmental Protection Agency on financial cover for pollution incidents and undertakes capacity building in environmental management on behalf of the UN Environment Programme.

INSPECTING FOR AND DEALING WITH CONTAMINATED LAND: REGULATION AND REMEDIATION UNDER PART IIA OF THE ENVIRONMENTAL PROTECTION ACT 1990

Professor Robert Lee

Co-Director ESRC Research Centre for Business Relationships, Accountability, Sustainability and Society (BRASS).

www.brass.cardiff.ac.uk

BACKGROUND

In any consideration of contaminated land it is important to stress the narrow parameters laid down by Part IIA of the Environmental Protection Act 1990. Under s78A(2) land may be contaminated by reason of substances in on or under the land which cause: (a) significant harm or the significant possibility of such harm; or (b) the pollution or threatened pollution of controlled waters. It is worth noting in passing that section 86 of the Water Act 2003 amends the latter part of this definition such that pollution of controlled waters will have to be "significant" to warrant intervention but the majority of this provision is yet to be brought into force. The guidance then amplifies the contaminated land definition by demanding a pollution linkage made up of a source of pollution affecting a receptor (or target) via a pathway. Only when this pollution linkage is made out, and the contaminant can be shown to be at least threatening the receptor can the land be considered as contaminated within the meaning of the legislation.

It is important therefore to distinguish between contaminated land in this narrow sense and other concepts of derelict or brownfield land. The Environment Agency Report on *Indicators for Contaminated Land, 2005,* suggested 292,000 hectares of potentially contaminated land in industrial land use in England and Wales (330,000 sites) of which 30,000 sites (57,000 hectares) might be identified as contaminated. This figure may be compared with earlier estimates of 100,000 sites which are affected by contamination to some degree in England and Wales (Environment Agency, *The State of Contaminated Land*, 2002). Of these it is further estimated that between 5 and 20% may require intervention to deal with the sort of harm that Part IIA addresses. This would suggest that there is anything between 5,000 and 20,000 sites in England Wales which are giving rise to unacceptable harm which requires regulatory intervention.

In 1998, the Government set a 'Public Service Agreement' target of 60% of all new housing to be built on brown land. This relates to previously developed land but not necessarily contaminated land. Under the target, 5% of brown field land would be reclaimed by 2004 and 17& by 2010. Progress towards this target is good, but we may see some slow down because it is likely that the easier (non-contaminated) sites are being tackled first. In distinguishing between these type of concepts of brown, derelict and contaminated land, it may be useful to refer to industry profiles published by DEFRA that provide information on different categories of industrial activity to help identify the likely contamination resulting.

The Revised Planning Policy Statement 23 (*PPS 23 Planning and Pollution*) contains guidance for the development of land that might give rise to Health or Environmental impacts because the land is likely to be subject to contamination. The Policy follows a similar approach highlighting likely environmental risk both in terms of the historic use of the site but also the potential use of the site post-development. It stresses both the key role of planning in addressing problems of brown land remediation and emphasises a precautionary approach. It follows that planning permission is likely to be refused where no risk assessment information is given in redeveloping a site with (say) former industrial use, or where there can be no confidence that the development work planned for the site will deliver a 'suitable for use' solution. Either through conditions attached to any planning permission or through planning agreement with the planning authority (subject to which planning permission may be granted) the effective remediation of sites can be secured. But such conditions are likely to be more wide-ranging than those achievable under Part IIA of the 1990 Act. This is for two reasons. The first is that powers under the 1990 Act depend upon (at least) the threat of significant harm or water pollution, whereas planning conditions can address a much wider range of issues. The other reason is that a remediation notice can only demand the effective breaking of the pollution linkage, whereas the planning system might dictate a wider clean-up of the site.

In any case the redevelopment of brown field land is pursued largely by the private sector, not least because the majority of it is privately owned. In many urban areas demand for land stock remains high so that, given the right location, there may be little difficulty in marketing land capable of redevelopment. This is particularly true given the promotion of national town and country planning policy through regional planning policy and into local structure and development plans which, driven by regional development agencies and the planning authorities, all seem to promote economic regeneration of brown field land. Grant aid may be available to assist this, and the Finance Act 2001 allows companies to offset 150 percent of the cost of contaminated land remediation against corporation tax. All of this suggests the context in which there is a strong emphasis on bringing back brown land to fruitful use even where a relatively small proportion of that brown land could be contaminated in the formal legal sense of the word. This will mean that much remediation activity will proceed through the planning system. As the occasion demands, remediation powers under Part IIA of the 1990 Act may be used to supplement the existing planning framework but this will rarely prove necessary. However, in the remainder of this paper we wish to explore the duty, under the Contaminated Land Regime, of local authorities to positively seek out land that is "contaminated" and the circumstances in which local authorities' strategies have chosen to isolate, independently of the planning system, sites which are problematic and which must be subject to remediation. Much of the information is based upon the work of English local authorities. This may seem strange for work conducted within Cardiff University but it came about because the regime was implemented in England some 15 months ahead of Wales, and the early work was intended to be useful in Wales at a policy level.

GUIDELINES FOR INSPECTION STRATEGIES

The amendments to the Environmental Protection Act 1990 are contained in the Environment Act 1995. In fact, this statutory material (considered below) can go overlooked as the focus is on the other more detailed material to be found in the Contaminated Land (England) Regulations 2000 (SI2000/227) and the DETR Circular, *Contaminated Land: Implementation of Part IIA of the Environmental Protection Act 1990 (DETR Circular 02/2000)*. In addition there are two bodies of material upon which local authorities in particular rely in creating the inspection strategies. The first document is the technical advice made available by the DETR: *Contaminated Land Inspection Strategies – Technical Advice for Local Authorities* (May 2001 – hereafter 'Technical Advice'). This seeks to promote technical good practice and the formulation of inspection strategies, and contains useful material such as checklists. There is a second document entitled *Local Authority Guide to the Application of Part IIA of the Environmental Protection Act 1990* (July 2001 – hereafter 'Local Authority Guide'). This is a joint production from the Chartered Institute of Environmental Health, the Local Government Association, DEFRA and the Environment Agency. This is more procedural in tone, and indeed formed the basis of a training programme promoted by the Chartered Institute of Environmental Health.

Although both of these documents are long and detailed, neither document is prescriptive. For example, although the technical advice provides an outline structure for the strategy document, the guide accepts that other approaches are "equally acceptable provided that they comply with the statutory guidance". There are two reasons why the documents may have felt that it was less than appropriate to prescribe precise methods to be used by local authorities. The first reason is that the legislation and the statutory guidance are itself general in tone. Those then charged with preparing further, or practical guidance for local authorities probably felt that they had no mandate to suggest particular methodologies. The second reason is that it may have been felt that a standard approach by all local authorities was not appropriate. In the words of the local authority guide:

> "The local authority may…choose to prescribe a prioritisation process which would reflect the overall priorities and characteristics of its area."

Whilst these are weighty considerations, this paper attempts to demonstrate (below) that very different approaches have been pursued by local authorities. There have been undoubtedly economic inefficiencies in terms of local authorities struggling to develop strategies in isolation in situations where more work could have been done at a central level had the statutory framework allowed this. Moreover, this also means that those seeking access to information in inspection strategies (whether as a company, NGO, or professional adviser) will never know quite how full or useful the local authority inspection strategy might be in advance of reading it.

STATUTORY REQUIREMENTS

The duty upon a local authority is to cause land in its area to be inspected in order to identify contaminated land and, beyond that to determine which sites may be designated as special sites lies in s78B(1) of the EPA 1990. One interesting issue is that this might allow the delegation of inspections to consultants. Few local authorities disclose the use of consultants in the preparation of strategies, although some intend to use commercial packages from companies such as Landmark to assist with the initial desk studies. Guildford and Waverley Borough Councils appear to have agreed to tender for consultants to undertake any intrusive investigations needed, or to review intrusive investigations submitted, where further information on a site is necessary to pursue investigations in line with their strategies (Guildford Executives Minute, 17 July 2003). Similarly East Hampshire Borough Council announced in their strategy the likelihood of using outside consultants for risk assessment work. Nottingham has the criteria for selection of consultants written into an appendix of its strategy. Local authorities were given 15 months within which to complete these strategies. We know from the Environment Agency (see *Dealing with Contaminated Land in England,* September 2002) that by July 2002 (one year after the deadline) 94 per cent of authorities had completed their strategy. Of the remaining six per cent, which included some authorities with known problems of contamination, all had produced a draft strategy for consultation. By May 2005, all but one of the 353 Part IIA authorities in England, had formally adopted a strategy with the one recalcitrant having published a draft. Strategies for Welsh authorities are completed and available via the Land Regeneration Network at:

- http://www.grc.cf.ac.uk/lrn/resources/land/contamination/part_iia/strategies.php

The following subsection (s78B(2)) demands that local authorities act in accordance with the statutory guidance when carrying out inspection duties. The statutory guidance itself demands "a strategic approach" to the identification of land which then might require more detailed inspection (paragraph B9). Paragraph B15 demands that the local authority makes some prioritisation as to which sites might be the subject of detailed inspection, and at the same time lays down arrangements and procedures for both planning and reviewing that inspection programme. Because s78B demands that the inspection process take place "from time to time" it would seem that the local authority is not carrying on a "one-off" operation, but is developing an approach that is sufficiently adaptable to be followed in the future. Interestingly, one Home Counties' authority plans to link re-inspection with environmental accreditation through EMAS/ISO 14001. The first report of the Environment Agency on the working of Part IIA, published in September 2002 demonstrated that 10% of authorities had made no provisions to review their strategies, but, in contrast, 20% had committed the authority to an annual review.

In a section of the guidance repeated in many of the inspection strategies themselves, there are certain underpinning criteria for the approach of local authorities in devising inspection strategies. Paragraph 9B of the guidance demands that local authorities:

" a. be rational, ordered and efficient;
b. working in a manner proportionate to the seriousness of any actual or potential risk;
c. seek to ensure that the most pressing and serious problems are located first;

d. ensure that resources are concentrated on investigating in areas where the authority is most likely to identify contaminated land; and
e. ensure that the local authority sufficiently identifies requirements for the detailed inspection of such areas of land."

In terms of the content of any strategy, paragraph B15 demands a description of the characteristics of the local area and the consequences for the approach taken by the authority. In addition the authority must state its particular aims, objectives and priorities within its area, and lay down a timescale for inspection. The same paragraph of the guidance also demands that the local authority put in place arrangements and/or procedures covering a range of other duties. These include liaison responsibilities both with other statutory agencies and with people in the local area, including local businesses and members of the public. The local authority must state the procedure that it intends to follow for considering both potential sources of pollution and potential receptors. Finally, it must set out the process for detailed inspection, for updating the strategy, and for handling and maintaining information gained in the course of the fulfilment of statutory duties.

In paragraph B10, the statutory guidance accepts that local authorities may already have and be able to use evidence of local harm or pollution, or may know of vulnerable receptors and their potential exposure to contamination. Local authorities are asked to consider such information together with the industrial history of the locality, its past redevelopment (including earlier remedial actions) and information held by other regulatory authorities. Interestingly there are different approaches to problem sites that have been subject to redevelopment, with some authorities regarding such sites as effectively remediated while others state an intention to review the adequacy of remedial work at an early stage. Some strategy reports state known problems of contamination. In certain cases this builds on earlier work undertaken by the authority. Kirklees for example cites 4,000 potentially contaminated sites, and has an interest as owner or previous owner/occupier of 974 of these. Much of this information may have been gained from an excellent analysis in the Unitary Development Plan of 'Derelict and Neglected Land'. Some local authorities specify particular sites. For example Barking and Dagenham highlighted a former button factory now in its ownership in the strategy as contamination was known to have resulted from leaking underground solvent tanks. As the button factory had gone into liquidation years earlier, the Borough accepted that it had (at least) Part B liability and registered a remediation statement for the half-hectare site as early as March 2002. The remediation plan was for a reactive clay barrier allowing groundwater to flow through, but slowly removing solvent contamination.

There are many things that the statutory material does not cover. To take one significant example, there is no indication as to which department within a local authority ought to have responsibility for the development of the strategy. The local authority guide accepts that local authorities are:

> "likely to take into account where their necessary skills, experience and resources are located and how the interest of each department (for example, in the outcome of inspection) can be best served".

This is understandable. Although there may have been some responsibility within the statutory nuisance regime for local authorities to deal with problems of the land-based pollution prior to the implementation of Part IIA, in general terms, these responsibilities upon the local authority are new. Dealing with land contamination is a technically complex matter, requiring considerable expertise. In such circumstances it might be considered foolish to demand that one particular department in every local authority takes control of the statutory responsibilities. Having said that, this paper will attempt to show (below) that the location of the responsibilities within particular local authority departments may greatly influence the tone and nature of the strategy devised.

RISK CHARACTERISATION

If one examines the process as laid down in statute, it can be described in the following way. There is an initial process of risk characterisation. This lies in the devising of the inspection strategies. The demand within the statutory framework for prioritisation suggests that there must be some screening of risk at this stage, and that certain sites (or at least types of sites) should be singled out for further risk assessment. That risk assessment takes the form of a detailed inspection. That inspection may or may not involve intrusive investigation. It is open under the guidance for a regulatory body to demand that a full site assessment takes place as the first step within a remediation notice (see below). Nonetheless, that risk assessment, in terms of the more detailed investigation, should put the authority into the situation in which it can decide whether or not to serve a regulatory notice. The determination in relation to the service of the notice may be described as the risk evaluation part of the procedure. Finally, the demands in the remediation notice will set out steps for the effective risk management of the pollution linkage identified upon the site. It is important to note therefore that the inspection of strategies involves a broad process of risk characterisation which will allow a more targeted approach to risk assessment.

The second thing to note is that the risk methodology is sketched out in broad terms in the statutory framework, albeit that the terminology in the Guidance is confusing in referring throughout to ‘risk assessment’ without making the distinctions explained above. Having undertaken initial screening within the local area, the purpose of the detailed risk assessment must be the isolation of a “pollution linkage”. As outlined above, this will consist of a source of pollution, a receptor as defined within the regime, and a linking pathway between the two.

A17 of the guidance makes it quite clear that without the identification of all three elements of the pollution linkage (source, pathway and target) land cannot be identified as contaminated within the meaning of the Act. The notion of a pathway between a source and a target is useful in beginning to understand how precisely land might be identified for further inspection. Paragraph A15 of the guidance states that:

> “It is possible for a pathway to be identified…on the basis of a reasonable assessment of the general scientific knowledge about the nature of a particular contaminant and of the circumstances of the land in question. Direct observation of the pathway is not necessary.”

This seems reasonable enough. If we fear that asbestos dust might affect a human population, it is probably sufficient to hypothesise that the dust might be air-borne, without the need to actually observe this effect. However, implicitly, when the guidance talks about identifying all three elements of a pollution linkage, there must be an identified source of pollution (pollutant) and target (receptor) in additional to the plausible pathway. At this initial stage, however, in conducting the risk characterisation process and publishing a strategy, it is sufficient that a local authority can hypothesise as to the possibility of pollution linkages which might then be more specifically identified (or eliminated) by more detailed inspection and risk assessment. In passing, it is worth observing that virtually all strategy documents dwell at length on one pathway, the geological/hydrogeological features of the ground, in a level of detail well beyond most non-specialist readers of the strategies.

In looking at receptors, it is also interesting to note that the receptor may have been introduced to the site in such a way as to render a party other than the original polluter liable to clean-up costs. This happened in a recent High Court decision in *Circular Facilities (London) Limited v Sevenoaks District Council* [2005] EWHC 865. Circular Facilities, a house builder, appealed against a remediation notice and the matter was heard in the Magistrates’ Court, where a District Judge concluded that Circular Facilities was the appropriate person within the terms of Part IIA of the 1990 Act because the scheme of the 1990 Act was to make the developer of land in such circumstances responsible for harm resulting from contaminants on the site. On appeal to the High Court, it was held that the mere existence of the soil investigation report on the planning register was insufficient to impute knowledge of the contents of the report to Circular Facilities. In spite of the finding that the case should be remitted back to the Magistrates, the case does show that by introducing a potential target (or indeed pathway) to land, new liabilities may be created.

It is also interesting to note that many strategies work on the assumption that it is the regulator’s task to undertake intrusive investigation. Indeed, as is explained above, some local authorities are retaining consultants for such work. In fact the Guidance makes it clear (C.10-C.15) that remediation actions can be phased and that the first phase can consist of "further assessment actions". Of course a remediation notice requiring this can only be done in a situation in which (e.g.) the local authority has determined that significant harm is being caused where "it has carried out an appropriate scientific and technical assessment of all the relevant and available evidence" (B.44). But it may well be that there will be sufficient available evidence without further on site investigation.

One interesting example of this problem arises out of the fire on 30 October 2000 at the Cleansing Service Group site at Sandhurst, Glos. This incident is well documented not least because it resulted in a joint Health and Safety Executive (HSE)/EA report to the Deputy Prime Minister (30 April 2001). The problem caused by the fire was exacerbated by the flooding of the site within a week of the fire and prior to major contaminants being removed from the site. The fire on the site caused the evacuation of many Sandhurst residents and Gloucestershire Health Authority continue to monitor the health impact upon residents. The site was licensed for the chemical treatment of waste oils and oily wastes, but the fire helped expose waste treatments and waste transfers well beyond this type of activity. This led to three planning enforcement notices issued by the planning authority on grounds of unauthorised change of use. It also led to the suspension of all waste management activities on the site as from 14 August 2001. It is unusual for the Environment Agency to revoke a licence, as this tends to lead to less rather than more control over the site. A note to residents stated that a licence can only be revoked where the prevention of environmental pollution or harm to human health cannot be achieved by licence modification. This seems to be a doubtful interpretation of s38(1) of the EPA 1990, which states that, where continuation of *licensed* activity is causing pollution or harm, the licence should be modified if possible rather than revoked. It appears, however, that the company activity went beyond the scope of the licence. Nonetheless, the problems of keeping the company within the parameters of the licence and curbing the risk of events such as fire and flood ought to be achievable by the enforcement of well-devised licence conditions.

However, all of this left Tewkesbury Borough Council with a difficulty in the form of the presence of a well informed and organised action group made up of local people that had longstanding complaints (particularly concerning odour nuisance) in relation to the site. The Sandhurst and Area Action Group (SAAG) pressed the local authority in relation to public health concerns at the facility. In particular the local authority came under pressure to exercise powers under Part IIA. The problem for the authority was presumably twofold: did concentrations of contaminants threaten harm to any receptor so also constitute a pollution linkage, and did the nature of this pollution linkage then render the site a special site? The problem for the authority lay in (e.g.) separating out any health impacts from the fire from ongoing problems posed by the site and in isolating ongoing problems unlikely to be resolved by waste management licensing (such as historic pollution). In view of this the Executive Committee of the Council committed over £20,000 to cover the necessary site investigations. This demonstrates the difficulty, even in an extreme case such as this, in shifting risk assessment work into the remediation notice.

RISK ASSESSMENT

A grasp of the difference between broad risk characterisation and more detailed risk assessment is fundamental in understanding the content of the inspection strategies. They inevitably offer a broad review of possible sources of pollution and likely vulnerable receptors. In the words of the technical guidance:

> "In principle the method should begin by comparing the location of potential contamination with areas where there are sensitive receptors. The geographical coincidence of these two will confirm that two parts of a potential pollution linkage are in place, and will allow the authority to define inspection areas or sub-areas."

It is clear that some inspection strategies have begun their risk characterisation primarily by the identification of potential sources of pollution, whilst others focus much more clearly on potential damage to receptors. To give examples, in Halton, a heavily industrialised area with a long history of chemical manufacturing, we find a strategy that is very much source-led. It states its confidence that it has available information already to determine some sites as contaminated land and that "this will be recorded within the strategy". In fairness to the report in question, what this appears to mean is that there is land which, even at the initial stages of devising the strategy, can be singled out on a site-specific basis as requiring immediate further risk assessment. This report annexes Integrated Pollution Control (IPC) authorisations within its area and admits to a clear ranking of priorities in terms of potential impacts beginning with health and residential property as the threats to be most immediately addressed. This is notwithstanding the presence in the area of a special protection area under the Wild Birds Directive, and three Special Sites of Scientific Interest (SSSIs).

An alternative approach is taken by (e.g.) Chester and by East Herts, the latter using a shortened version of the 1991 list of potentially contaminative uses and listing the numbers of sites within its locality subject to each such use. The 1991 list is annexed in many reports (see Richmond London Borough Council) or lists taken from DoE industry profiles are annexed (see Leicester and Oxford). Some authorities risk weight (Leeds) or rank (Taunton Deane). Having considered sources there is then a detailed discussion in some reports of certain sites which have been subject to investigation and or remediation. In the section on receptors in the Chester report, a known incident impacting on drinking water is discussed. Interestingly, when setting out the prioritisation programme, the authority establishes this with reference to the environmental setting of the land (i.e. the approach is largely target-led).

An inspection strategy for Bournemouth begins with a much more target-led approach pleading "significant ecological, heritage and aesthetic assets" within the local area. In this particular report, there is a concern with water quality in controlled waters especially in the north of the local authority area, and the inspection strategy makes it clear that the local authority hopes to work with the Environment Agency to track sources of contamination. In this report there is little identification of specific industries or sites, although there is a general listing of types of contaminants. In contrast with the approach of Halton in indicating sites already believed to be contaminated, the Bournemouth report states that "particular reference to potentially contaminated sites, other than old landfills, cannot be made at the time of writing". Although the report adopts the categorisation procedure from CLR6, in practice the local authority seem in no position at the time of writing the strategy to identify the category one sites under that procedure requiring urgent remediation action.

It may well be that these different methodologies for risk characterisation are entirely appropriate within the areas in question. It should be emphasised, however, that not all heavily industrialised areas seem to adopt a source-based approach, whilst local authorities with lesser industrial activity adopt a target-based approach. By way of example, Manchester states that it is faced with considerable potential work under Part IIA and that it will "review first any land that would be a serious threat to human health if seriously contaminated". It then goes on to identify such land in what is essentially a target-based screening process. It produces a list of land in accordance with usage, or with proximity to water (including groundwater source protection zones).

Again, the issue here is not that some of these approaches are better than others in terms of the task of risk characterisation. Although it is surprising to find quite diverse approaches to risk characterisation, the important point is that the risk methodology determines the content of the strategies and that they are really quite different to one another. It follows that someone obtaining a local authority inspection strategy, with a view to attempting to determine whether a target site might be singled out for regulatory intervention in the future, may find much more precise information in some local authority strategies rather than others. In broad terms those strategies which adopt a source-based method of risk characterisation would generally be more specific in sites attracting regulatory interest and to that extent will be likely to prove more useful in due diligence exercises. Having said that, certain local strategies place very considerable emphasis on particular vulnerable receptors such that the likely impact of sites in proximity to such receptors would need to be taken extremely seriously indeed.

Finally it is worth emphasising that the inspection strategies are by no means the final word here. As we shall see below in relation to timetable, the pace of the next phase, and the methodologies pursued vary. Some authorities intend the next part of the programme to consist of more detailed desk (phase 1) studies for sites already identified as problematic. Bournemouth plans a desk top study for each industrial site in the locality. Obviously the more detailed studies may provide a valuable and inexpensive source of information once these are available. Having said that, some of the reports (such as Chester) contain already a level of detail on issues such as local receptors that one would wish to see in a well produced phase one report.

TIMETABLE

Given that authorities will move from general inspection strategies to much more specific site identification, the timetable within which authorities will operate is important for those looking to uncover specific information within a locality. Many reports do set out a timeframe within which site identification and assessment will be conducted. Strategies vary. Some local authorities will undertake a process of site identification within a stated timeframe. This then leads to a programme of desk studies. However some strategies, particularly those with more detailed risk weighting (see below) take longer time on site identification and move to site by site “inspection” which may or may not entail a desk study, depending on how much information is available in relation to the particular site through the risk weighting process. Finally, as we have seen, some authorities seem to be prepared to move straight to a desk study approach for all sites within their locality.

Assuming that all of this information will be accessible, the timescale of such inspection strategies may be an important factor for those dealing with suspect sites. The speed at which authorities intend to proceed seems to be governed to some considerable extent by the type of screening process used. In some instances, scores for the sites are determined through the assignment of numerical values according to stated criteria. Thus in the Greater Manchester area the Manchester Area Pollution Advisory Council (MAPAC) produced a procedure entitled “risk prioritisation methodology for sites of potentially contaminated land”. This seems to have been adopted by MAPAC members. Similarly, a type of risk classification is to be employed by Birmingham whose timescale shows it as dealing with detailed site inspection (including intrusive investigation) from the outset where the risk weighting score is sufficiently high. Most timetables show no detailed inspection activity taking place (commonly) in 2004, but as is clear in the section on determinations (below), authorities are prepared to employ their statutory powers immediately should a pollution linkage be proven.

The Environment Agency report gives a short overview of the timetable built into the strategies. This contains little detail, but it does reveal that the production of the strategy will be followed in most cases by a more detailed identification of priority areas for inspection. Thus the date when local authorities will have finished the inspection process, and be expected to move to greater remediation action varies between 2002 and 2006. This would seem to suggest that remediation activity in England would now be largely in full flow. This is not reflected in the figures, however, as the following information suggests:

Table 1. Part IIA Regulatory Activity England

	LA determinations	Special sites	Remediation statements	Remediation notices	Remediation declarations	Special site inspections
2000/01	13	2	0	0	0	7
2001/02	21	11	9	2	0	22
2002/03	39	2	13 (9 special)	1	0	28
2003/04	9	5	2	1	0	42
2004/05	220	1	17 (3 special)	0	1	25
2005/06[3]	2	1	0	0	0	0
Totals	**304**	**22**	**41** **(12 special)**	**4** **(0 special)**	**1** **(0 special)**	**124**

In fact even these low figures turn out to be misleading in that they include multiple determinations in relation to single sites. For example, in 2004, 109 remediation notices were served on a housing estate in Manchester which was built on a waste tip. In truth, local authorities have only averaged about 15 sites per annum. There is not much greater level of activity in relation to Special Sites for which the Environment Agency has responsibility. The figures suggest that 22 sites have been designated as Special Sites of which 12 sites have actually been cleaned up.

PROCESSES AND PLANNING

Another striking difference in local authority inspection strategies is the extent to which they interrelate to other work within the authority. Again the emphasis here may vary according to which local authority department takes a lead. However what is also important here are the established management priorities within the authority as a whole. References made in the reports to a wide range of other material which is seen to influence the inspection process. This includes:

- Agenda 21 strategies;
- draft local plans;
- unitary development plans;
- the Concordat on Good Enforcement;
- internal consultation strategies; and
- environmental action plans.

The content of these sorts of instruments help shape the inspection strategy for contaminated land. For example, does a draft local plan already identify areas of concern in relation to pollution? To take another example, Halton, with a highly developed local consultation plan, expresses concern in relation to land which, although identified as problematic, does not fall within the definition of "contaminated land" within the meaning assigned to it by s78A(2) of the EPA 1990. The authority discusses how the expectations raised on the part of stakeholders will then be met. Brighton and Hove's report discusses the involvement of stakeholders, and it becomes clearer that the "stakeholders" referred to are actually the appropriate persons that will be the subject of regulatory activity.

Consultation procedures adopted by authorities seem to be important. Often these will link to other ongoing processes within the authority including Agenda 21 programmes. Some reports give a real flavour for an ongoing and open dialogue with local communities into which problems of contaminated land will fit. For other authorities, this is less true, and consultation seems to be limited almost exclusively to statutory consultees. There are differences too in the manner in which an authority might deal with complaints. For example Oldham states very strongly that it will never consider anonymous complaints. In considering this question, Manchester states that anonymous complaints will be dealt with 'on their merits' and that the important factor is the likelihood of the accuracy of the information and the environmental risks attaching to it. Again these seem to be extremely important issues for legal advisers. Where there is a history of local complaints in relation to industrial activity, the responsiveness of the authority is not an unimportant factor.

One important consideration is the extent to which the activity under Part IIA links with the planning system. In some authorities, there are strong links into the planning system. The Leeds strategy makes it clear that a large part of the regulatory impetus will come from the careful scrutiny of former industrial sites coming up for redevelopment. Indeed in other respects the pace of regulatory activity in this authority would seem to be slow. This is very different from a strategy taken for a second south coast borough in which there is little emphasis on, or indeed mention of planning processes within the inspection strategy as a whole. Again, this may be important information for developers, and those advising developers. An examination of the inspection strategy gives a real indication of the extent to which land contamination issues will be dealt with at planning stage.

DETERMINATIONS

The Environment Agency Report *Dealing with Contaminated Land in England* reveals that, by 31 March 2002, 33 sites had been designated as contaminated land. At that stage no remediation notices had been served, but 7 remediation statements had been agreed. Of the initial 33 sites, 11 were designated as "Special Sites" falling to be handled primarily by the Environment Agency. In addition by 31 March 2002 there were a further 31 potential Special Sites still in the course of review by the Environment Agency together with the relevant local authorities. The Agency report tells us that most of the sites were relatively small, affected primarily by organic or metal-based pollution which posed a risk primarily to either people or controlled waters. Approximately one-quarter of the sites were from the waste management sector, presumably largely former landfills. The updated figures are given in the Table 1. above, but we can learn quite instructive lessons by looking at this initial batch of designations.

When one looks at the actual sites designated for remediation, it becomes clear that the vast majority of the designations are not as a result of site redevelopment, nor are they ordinarily proceeding out of inspections in line with the contaminated land strategies. For the most part they seem obvious incidents either of severe water pollution, or of locally based problems to which the relevant local authority feels that it ought to react by the use of its statutory powers. To take an example of the former, the Mirfield chemical site has been designated a Special Site by the Environment Agency. Here the discharge of tarry process residues into a shallow alluvial aquifer allowed migration into the River Colder, Mirfield, Kirklees. The remediation works, largely involving a sheet pile cut-off wall and the collection of oily product is a phased remediation, the initial parts of which were secured by supplementary credit approval funding in the absence of an appropriate person. One difficulty with such funding in relation to a phased remediation is that separate applications were needed to fund the initial investigation and remedial design and for the subsequent Phase 3 works.

Another high profile special site remediation involves the dump sites at Nancekuke facility, RAF Portreath, North Cornwall. This site has been used in the past for the production of both nerve agents and other riot control agents such as CS gas. Although there is no evidence to show that chemical weapon agents were dumped at the site, other chemicals and asbestos were clearly placed into the dumps, the content of which is less than certain. Historic activity on the site is no secret, not least because it was declared under the Chemical Weapons Convention in May 1997 and was subsequently visited by international inspectors. A programme of remediation started in 1999, and by 2001 the RAF passed to Kerrier District Council information that allowed designation as contaminated land. Involving Ministry of Defence land, the site is a Special Site, and the first landfill to be remediated, with Phase 3 work (scheduled for Spring 2005), which involves a dump in close proximity to the coastal path, and a Site of Special Scientific Interest. Clearly the reason for this remediation declaration was the fact that the Ministry of Defence had already commenced work on remediation, and now wish, as part of a policy of openness, to see the work conducted under remediation statements. These were submitted to the Environment Agency in March 2003. The time lag between February 2001 and the provision of information to the local authority, and the submission of remediation statements more than two years later indicates that whilst Part IIA contains a "stand-off" period of three months between the possible designation of the site and regulatory intervention, in practice this period may be much greater.

There certainly seem to be indications that local authorities are more likely to act in situations in which the site may be declared a Special Site and responsibility handed to the Environment Agency. An alternative explanation may be that impact upon water arising out of land contamination is much more common than impact on human health, and as a result more of the early sites have constituted Special Sites. Wales worked on a different timetable to the rest of the United Kingdom since the Contaminated Land (Wales) Regulations were introduced only in September 2001, such that inspection strategies were scheduled for completion only by the end of 2002. However, by March 2003, Rhondda Cynon Taf County Borough Council announced its intention to designate the Brofiscin quarry site near Groes Faen as a contaminated site within the meaning of Part IIA and sought specific provision, in the form of the Contaminated Land Capital Fund, to contribute to the investigation and remediation. The quarry is in fact a landfill used for the disposal of industrial waste and chemicals in the 1960s. Risk assessment work has been undertaken on this site since 2000 funded by the Welsh Assembly Government. The second phase of that investigation was completed in March 2003 indicating chemical contamination of the surface waters on the site and the groundwater beneath the waste. In addition there was clear potential risk to human health. Whilst further risk assessment is under way, this report allowed the local authority to designate the site at this stage, leaving the Environment Agency Wales to determine whether the site meets the statutory definition of a Special Site within Part IIA.

Similarly, Copeland BC designated the former Albright & Wilson site in Whitehaven as contaminated land in October 2002. Since the occupation by Albright & Wilson, the site had passed to Rhodia Ltd. However, Rhodia announced the closure of the site in the Summer of 2001 with the intention of ceasing operations at the end of that year. This was said to follow the declining market in the types of phosphates produced at Whitehaven. Because of the resulting job losses and the impact upon the local community, a high level task force, headed by the leader of Cumbria County Council, met with Rhodia management to consider the impacts upon employment and the local economy. At that stage, according to the minutes, the task force quotes "reminded the company of its environmental responsibilities to ensure that the site is returned to industrial quality standards enabling its future use". Doubtless this, together with the fact that water impacts might render the site a Special Site led to its later designation.

In June 2004 St Albans DC designated a housing estate as contaminated land. The housing estate of 66 properties is located on the site of a former chemical works involved in the bromine-based chemical business until 1980. It became clear to Three Valleys Water Plc that there was contamination to a chalk aquifer in May 2000. There was evidence of considerable bromate contamination and when this was traced back to the estate, a site investigation was commissioned by St Albans DC in August 2000. This was followed by a second investigation in November 2001 allowing the Environment Agency to identify significant pollution linkages. It was then declared contaminated by St Albans DC. The site constitutes a Special Site, and an important issue will be the liabilities of householders on the site if no Class A appropriate parties can be found.

One final example of a designation following risk assessment work undertaken by the local authority involves a Bayer CropScience site in Hauxton, South Cambridgeshire. Consultants hired by South Cambridgeshire District Council had found no pollution linkages such to support a determination of contaminated land on two of three sites scheduled for investigation, but did so on the third site, because of groundwater impacts. Concerns were expressed by local counsellors that contamination at the site may be affecting crop growth in the area, and the site was designated as contaminated land in the expectation that it would constitute a Special Site at a council meeting in May 2003. Bayer informed the Council that they intended to remediate the site on a voluntary basis, indicating that at some future point in time the land may be subject of a remediation statement.

CONCLUSION

Local authority inspection strategies are now complete. They are readily available on the internet for the most part, although some care ought to be taken, since, on occasions, shortened versions are placed on the site, with the full version not so immediately accessible. The length and detail of the reports do vary. Some are very general indeed, repeating large elements of the statutory guidance. Such reports make it difficult to gain any practical information about which sites might be subject to further regulatory scrutiny. Some sites even in heavily industrial areas seem quite complacent about prospects of contamination in their area, whilst others single out large numbers of sites for further investigation.

Most strategy reports, but by no means all, indicated provisions for public registers where sites are designated. However, research to date has found no examples of on-line registers even though there are some claims that these are scheduled for development. Nonetheless, anyone wishing to undertake due diligence for a corporate or conveyancing transaction would be foolish to ignore the easy availability of contaminated land inspection strategies. Although one will be faced with uneven information, many reports would give some sort of indication, through their initial risk characterisation, of the difficulties that might attach to an acquisition.

In terms of formal designations we have seen that this is a very early stage indeed in most scheduled programmes, and the vast majority of work involved in the duty of inspection is yet to begin. We do however see a pattern that where there is known problems of significant local interest, and in particular where it is likely that a site would be scheduled as a Special Site, then ad hoc designations may take place, and the indications are that local councils will react, and will make available funding for further risk assessment work, where this is requested by the relevant officers of the local authority.

In the main however, as indicated at the beginning of this paper, it may well be that more will be achieved in the clean-up of potentially contaminated sites through the planning process rather than through Part IIA. Even when inspections begin, the Part IIA regime may well be reserved for sites that cause significant concern because of their impacts on the environment. The second potential reason for the lack of regulatory action (and one which is inherently linked to a reluctance of the authorities to litigate) is that formally designated sites are just the very small tip of a potentially huge iceberg. Such land is often subject to consideration at the time of land transfer. Whereas most statutory liability schemes identify clearly the polluter who is liable to pay, this regime allows risk transfer by agreement. Although contractual indemnities agreed between private parties (such as the buyer and seller of companies or land) allocate sums of money to pay for any environmental liabilities imposed by statute as between the parties, that agreement does not affect the primary liability. The statutory enforcing authority will seek to recover costs from the polluter identified within the statute.

In the case of Part IIA, however, the enforcing authority is obliged to give effect to private agreements and/or take into account mechanisms to exclude parties under various tests in the Guidance that are not necessarily clear or straightforward. In effect, a private agreement made between a buyer and a seller of contaminated land changes the liability pattern and alters the person to be considered a 'polluter' for the purposes of the statutory definition. The rationale giving effect to private agreements and applying exclusion tests is to allow the market to negotiate the transfer of liability at a cost, normally reflected in the reduced value of contaminated land. Essentially private contractual certainty can give the comfort denied by the public liability regime. It follows that the regime may be highly influential in ensuring land clean-up without the service of remediation notices. To put it another way, you shouldn't judge the quality of a watch dog by the number of people that it bites!

Robert G Lee
Cardiff Law School
ESRC Centre for Business Relationships, Accountability, Sustainability and Society

CONTAMINATED LAND: LOCAL AUTHORITY INSPECTION STRATEGIES AND SITE DESIGNATIONS

Professor Robert Lee
ESRC Research Centre for Business Accountability, Sustainability and Society, Cardiff University

A Quinquennial Review

- 5 years experience in England
- Inspection strategies
  - 66% within 15 months
  - 92% by end 2002
  - Only one now outstanding (and in draft form)

Nature of Inspection Strategies

- "The local authority may choose to prescribe a prioritisation process which would reflect the overall priorities and characteristics of its area."
- Source based
- Target based
- 352 Strategies with lack of controversy

Regulatory Activity

- 304 determinations – but double counting
- 22 Special sites of which 12 cleaned up
- Only 4 notices
- 124 site inspections in total
- But importance of private agreements

A Bit of Law

- "A person who caused or knowingly permitted the contaminating substances to be in on or under the land will be the appropriate person…"
- Polluter pays?
- Class A and Class B liability
- Exclusions

Knowingly permitting

- Extent of knowledge
- Standard of knowledge
- Inaction and permitting
- Timeframe?

Circular Facilities

- Facts
- Application of test 6 – introducing receptors
- No need to know of harm
- But need to prove actual knowledge
- Inadequate clean-up is ‘permitting’

Problems of Overlapping Controls

- Water pollution and works notices
- Waste regulation and *Van de Walle*
- Environmental Liability Directive

Conclusion

- Complex regime
- Not helped by lack of uniformity
- Under-resourced
- Of greater private than public significance
- Influential in shaping thinking on land remediation

BRASS
The Centre for Business Relationships Accountability, Sustainability & Society

Biographical Note

Dr Rob W. Francis

Robert Francis is a Chartered Civil Engineer, with a BSc and PhD degree in Civil and Structural Engineering from Cardiff University. He is currently working at Cardiff University's Geoenvironmental Research Centre (GRC) as a project manager, responsible for coordinating the Centre's industrial activities.

He has worked for local and international firms of Civil Engineering Consultants. During this time, he has project managed multidisciplinary contracts from land regeneration projects on former industrial sites to highway structures and production facilities.

His experience with the GRC has included managing academic and industrial teams on a wide variety of research and development contracts in the field of land regeneration and waste management. His expertise in recent years has been to manage a process by which new and innovative technologies are developed from research ideas and taken forward into commercially viable products. Many of these projects have resulted in new businesses being created from the technologies being developed.

THE DEVELOPMENT OF SUSTAINABLE REMEDIATION TECHNOLOGIES

Dr Robert W. Francis

Project Manager Geoenvironmental Research Centre, Cardiff

The Geoenvironmental Research Centre (GRC) at Cardiff University, established a Geoenvironmental Research Park (GRP) on a former industrial site in South Wales. The GRP project was part financed by European Regional Development Fund (ERDF)(West Wales and the valleys Objective 1 programme 2000 – 2006). Funding was available for three years from January 2002 to December 2004.

The purpose of the GRP project was to develop new and innovative sustainable technologies for the clean up of contaminated land, and for the creation of economically viable products from industrial waste materials. These technologies would then be developed by companies in Wales with a view to commercially exploiting the research findings.

The project acted as an R&D support facility for companies, with the emphasis on how to facilitate the creation of start up companies through the demonstration of new technologies, and how to support company growth and job creation through the commercial exploitation of research and development.

The project team, led by the GRC included nine organisations, namely GRC, The Welsh Development Agency; BP Chemicals Ltd; TRL Limited; Minton Treharne & Davies; Trinity College, Carmarthen; Hafren Group; Excel Industries; and Aggregate Industries.

Completed projects include:

- development of gasification for treatment of soils contaminated with organic compounds;
- evaluation of enhanced bioremediation as a technique for the reduction of persistent organic pollutants;
- reclamation/reuse of industrial wastes for the cement and construction industries
- determine the likely extent to which poultry manure can be used to enhance the ex-situ bioremediation of hydrocarbon contaminated soils;
- development or conversion of molecular, microbial and analytical technologies for use in the environmental and industrial sectors;
- stabilisation of sabkha soils in Kuwait;
- techniques for the closure of an industrial waste lagoon;
- technique investigated and demonstrated for the treatment of contaminated sediments;
- grass seed mulching trials from waste paper;
- bund constructed from construction waste; and
- slate produced from slate waste.

Each of the above projects progressed with a blend of academic research input coupled with the commercial know-how of the industrial partners. Projects were trialed in the laboratory, demonstrated at pilot scale and in some cases taken forward to commercial exploitation.

The GRP project exceeded its targets which include:

- over 100 firms provided with advice on Innovation, R&TD;
- over 25 collaborative projects between firms and research institutions;
- over 25 projects transferring environmental technology to the business sector;
- over 40 jobs created;
- over 100 jobs safeguarded;
- 3 companies created to date (expected outcome 10 companies created); and
- over £5m increase in turnover of supported firms.


GRC
THE DEVELOPMENT OF SUSTAINABLE REMEDIATION TECHNOLOGIES
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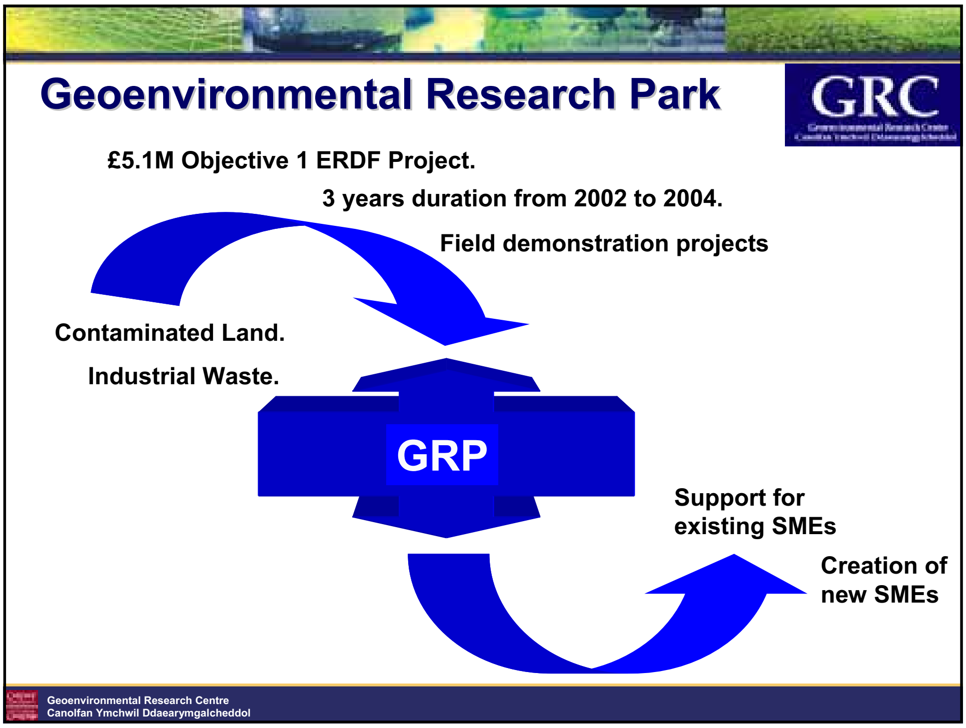

Geoenvironmental Research Park
GRC
£5.1M Objective 1 ERDF Project.
3 years duration from 2002 to 2004.
Field demonstration projects
Contaminated Land.
Industrial Waste.
GRP
Support for existing SMEs
Creation of new SMEs
Geoenvironmental Research Centre
Canolfan Ymchwil Ddaearymgalcheddol


Project Partners are:
GRC
Geoenvironmental Research Centre (GRC)
WDA
Welsh Development Agency
TRL
TRL Limited
bp
BP Chemicals Ltd
MTD
Minton Treharne & Davies
EXCEL
Fibre Technology
Excel Industries Ltd.
Trinity College, Carmarthen
Hafren Group
Hafren Group
AGGREGATE
INDUSTRIES
Aggregate Industries
Geoenvironmental Research Centre
Canolfan Ymchwil Ddaearymgalcheddol


Geoenvironmental Research Park
GRC
Produce technical solutions to problems in land contamination and industrial waste
Export the technology / expertise to solve similar problems elsewhere.
Geoenvironmental Research Centre
Canolfan Ymchwil Ddaearymgalcheddol

GRP: Contaminated sediments

Major mine-water discharge incident from former mine

High level of Iron and Heavy Metal pollution.

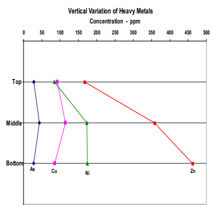
Blanketing of the canal bed affects invertebrate habitats.

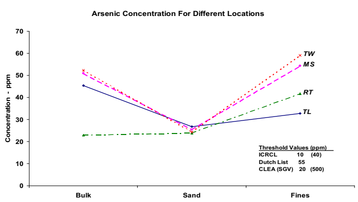
Adverse visual impact affecting regeneration of the area

Geoenvironmental Research Centre
Canolfan Ymchwil Ddaearymgalcheddol

GRP: Contaminated sediments

- Characterise the site
- Assess sediment leachability
- Evaluate soil washing/separation process
- Assess the viability of dewatering processes
- Propose potential benef icial uses of the sediment





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GRP: Grass Seed Mulching Trials

Enhanced Bioremediation of Soils

To evaluate enhanced bioremediation as a technique for the reduction of persistent organic pollutants.

MAIN PROJECT TASKS

1. Field work for soil and groundwater collection

2. Molecular microbial analysis of indigenous species

3 Microcosm studies using varied enrichment conditions

Sustainable Management of Poultry Manure

Project Aim:

- To determine the likely extent to which poultry manure can be used to enhance the ex-situ bioremediation of hydrocarbon contaminated soils.

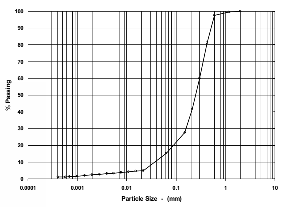
Project Outline:

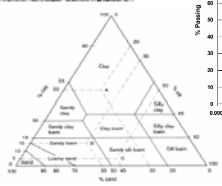
- Laboratory-scale treatability studies.
- Chemical analyses of contaminant degradation over time.
- Microbial population dynamics via 16S rRNA PCR-DGGE analyses.

Geoenvironmental Research Centre
Canolfan Ymchwil Ddaearymgalcheddol

GRP: Mineral Waste Utilisation

- Characterisation of the waste
  - Chemical
  - Geotechnical
  - Mineralogical
- Lab-scale trials
- Field scale trial
- Compliant with the relevant standards and guideline





Geoenvironmental Research Centre
Canolfan Ymchwil Ddaearymgalcheddol

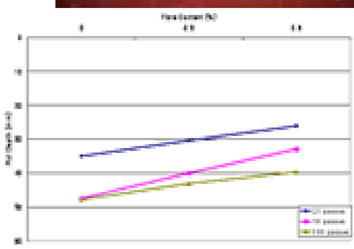
Soil Reinforcement Grass Covered Area

- Grassed areas used as access roads, overflow car parks, emergency access etc.
- Improvement of load bearing capacity of the soil to sustain vehicular traffic.
- Investigate the use of waste materials to enhance the soil.

Geoenvironmental Research Centre
Canolfan Ymchwil Ddaearymgalcheddol

GRP: Soil Reinforcement

- Characterisation of the materials
- Wheel Loading Tests
- Model Footing Tests
- CBR Tests
- Experimental Parameters include:
  - *1 Manufactured soil mix*
  - *1 Type of fibre*
  - *2 Fibre content (0.3%, 0.6%)*
  - *2 Moisture conditions (Ambient, Wet)*
  - *2 Compaction effort*



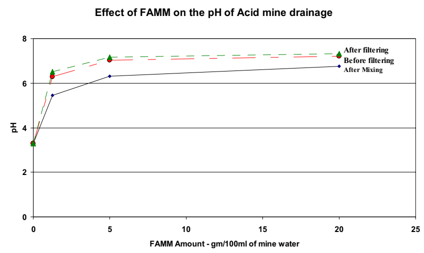
Geoenvironmental Research Centre
Canolfan Ymchwil Ddaearymgalcheddol

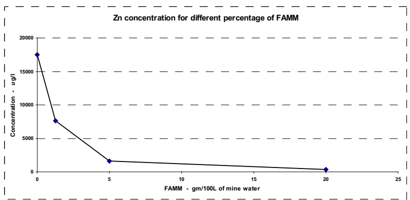
GRP: Acid Mine Drainage Project

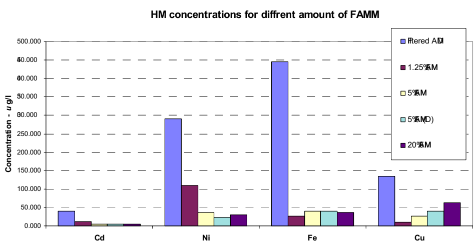
- Characterisation of the mine water
- Characterisation of the FAMM
- Lab-scale experiments of mixing the mine water with different amount of FAMM and check the changes in:
  - pH,
  - Electrical Conductivity and
  - Heavy Metals concentrations

Geoenvironmental Research Centre
Canolfan Ymchwil Ddaearymgalcheddol

GRP: Acid Mine Drainage Project







FAMM is successful in neutralising the acidity of the mine water even at low dosage

FAMM is very effective in reducing the contaminants HM loading

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Stabilisation of Kuwaiti sabkha soils

GRC

Sabkha is a saline, evaporative flat soil that forms under arid climates.

Problem with sabkha;

Strength reduction, due to salt dissolution
Heave, during salt crystallization
Corrosive action, due to high salinity

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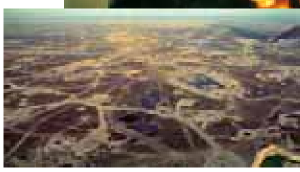
Utilisation of oil residues in construction

GRC

49 Km^2 were covered by partially combusted oil residues in Kuwait

- Heavily contaminated areas which pose a serious environment hazard to air, land and groundwater
- Huge areas of oil residues lakes are covered by a thin layer of sand that pose a potential hazard of drowning
- Affecting the regeneration of the area
- The aim is to investigate the possibility of using the residues in construction.



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Objectives

- To investigate possibility of using local waste materials to stabilise sabkha soil through studying;
- Physical properties
- Geotechnical properties
  - Strength aspects
  - Consolidation aspects
- Environmental Effects
  - Leachability
- Field testing

Field Testing

5 test beds of 1.6m x 0.7m and 0.20m depth were constructed and filled with stabilised soil

One test bed was left exposed and was subjected to wetting at certain times. The rest were loaded with blocks to simulate the load of road layers.

Tests will be carried out on the strength and leachability of the stabilised soil under these conditions.

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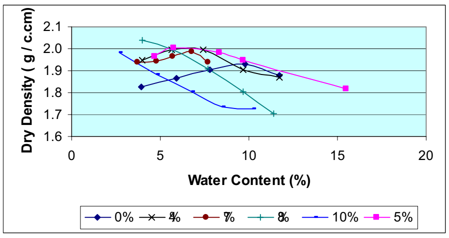
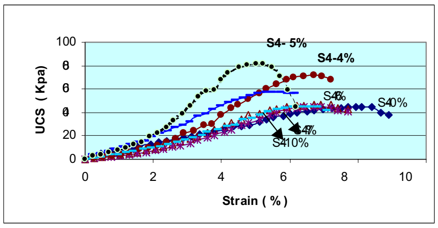
Conclusions

GRC

- The UCS of the sabkha soil is enhanced with addition of the waste up to certain amount.
- Consolidation characteristics are enhanced at this waste percentages
- Compressibility characteristics are reduced.
- Swelling characteristics are slightly affected .
- Collapse potential of the soil is reduced.





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GRP Projects - Hudol

GRC

A number of pyrolosis/gasifier units currently under development - disadvantages:-

Poor control over process parameters.

Regular maintenance reqirement and freqent process down time.

Frmation of high levels of Hydrogen and Carbon

Hudol has developed a system, which is designed to address the problems associated with conventional pyrolosis/gasifier units

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GRP Projects - E&IE

Reclamation/reuse of industrial waste for the cement and construction industries

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GRP: Contract targets

Output Targets	Target	Achieved
Firms provided with advice on Innovation, R&TD	100	224
Collaborative projects between firms and research institutions	25	31
Projects transferring environmental technology to the business sector	25	25
New technology, R&D, innovation and incubator centres created	4	4

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GRP: Contract targets

GRC

Results Targets.....	Target	Achieved
New patents/trademarks registered	1	2
Gross safeguarded jobs	100	100
Gross new jobs	20	21
Gross new jobs in high tech sectors	20	20
Increase in turnover of supported firms	£5m	TBA

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GRP: Contract targets

GRC

Additional Targets.....	Target	Achieved
No of companies assisted	150	151
Gross new firms created in high tech sectors	10	9

The above additional targets were also achieved.

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GRP – COMPANIES DEVELOPED

GRC

- Hudol Limited
- High Eye Limited
- Phytophoenix Limited
- Alurec Limited
- Biosol Technologies Limited
- Envirogene Limited
- Caerphilly Brick & Tile Manufacturing Limited
- Celtic Mineral Recovery (Senghennydd) Limited
- Environmental Rubber Technology Ltd

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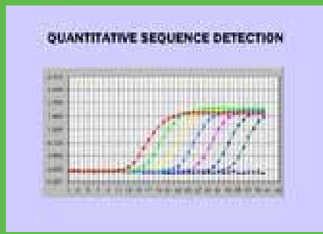
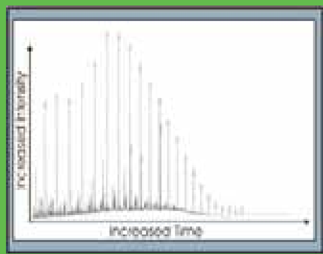
BIOTECHNOLOGICAL SERVICES TO THE ENVIRONMENTAL AND INDUSTRIAL SECTORS

EnviroGene

COMPANY FOCUS

THE DEVELOPMENT OR CONVERSION OF MOLECULAR, MICROBIAL AND ANALYTICAL TECHNOLOGIES FOR USE IN THE ENVIRONMENTAL AND INDUSTRIAL SECTORS





EnviroGene

ENVIROGENE HISTORY

- Incorporated in May 2004
- Trading started September 2004 following receipt of a SMART Cymru award
- Located at Tredomen Innovation & Technology Centre

EnviroGene

ENVIROGENE HISTORY

- Support received from:
  - GRP for crucial pre-trading technology development
  - Caerphilly Borough Council for provision of premises
  - Wales Trade International for support with branding and export activities
  - WDA for technology and market evaluation through phase 1 SMART Cymru award

EnviroGene

ACTIVITY AREAS (1)

QUALITY OF BATHING AND GROUNDWATERS WATERS

↓

HOST SOURCE IDENTIFICATION OF CONTAMINATING BACTERIA

↓

EXPORTING TO USA THROUGH COLLABORATION WITH FLORIDA BASED COMPANY

LAND/GROUNDWATER RECLAMATION

↓

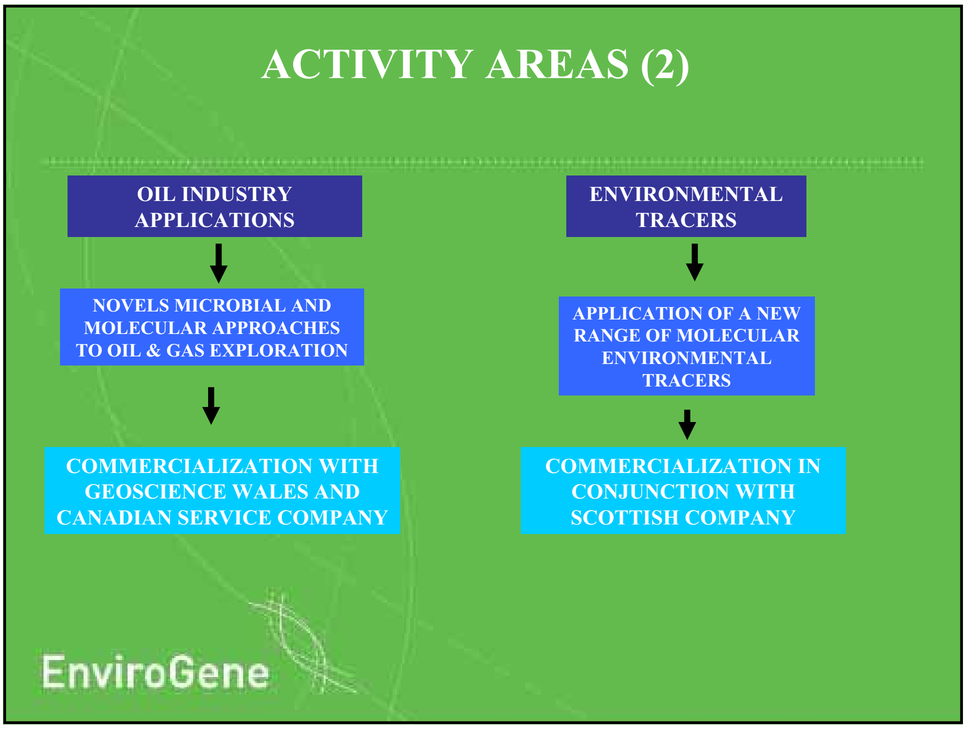
DETERMINATION OF NATURAL ATTENTUATION POTENTIAL AND RATES

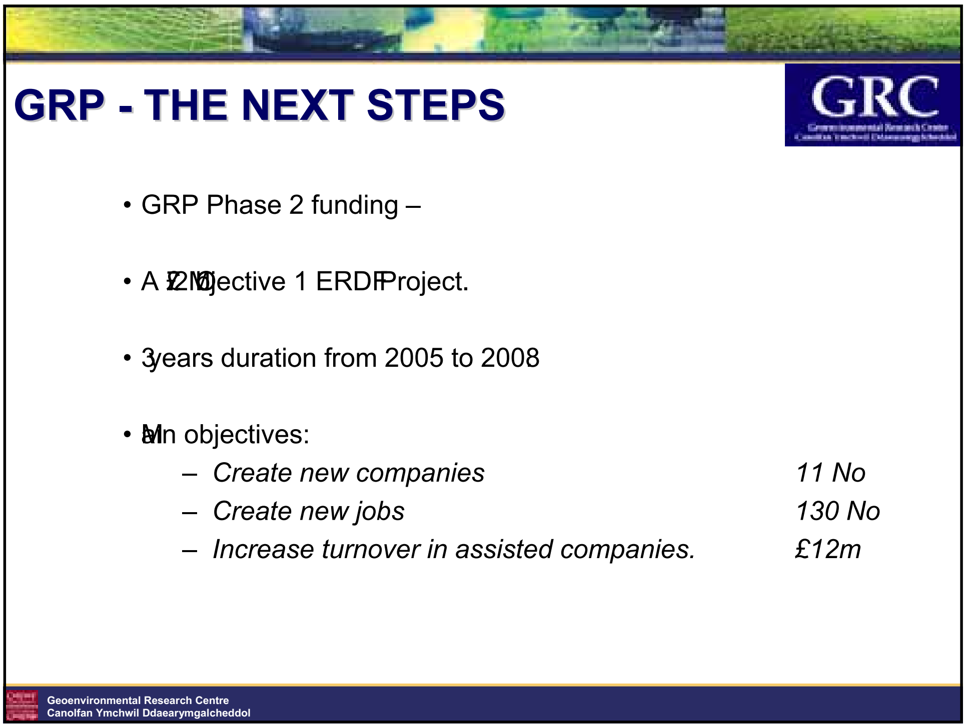
ASSESS BIOREMEDIATION EFFICACY

↓

COLLABORATION ESTABLISHED WITH TENNESSEE COMPANY FOR 2-WAY TECHNOLOGY TRANSFER

EnviroGene


ACTIVITY AREAS (2)
OIL INDUSTRY APPLICATIONS
NOVELS MICROBIAL AND MOLECULAR APPROACHES TO OIL & GAS EXPLORATION
COMMERCIALIZATION WITH GEOSCIENCE WALES AND CANADIAN SERVICE COMPANY
ENVIRONMENTAL TRACERS
APPLICATION OF A NEW RANGE OF MOLECULAR ENVIRONMENTAL TRACERS
COMMERCIALIZATION IN CONJUNCTION WITH SCOTTISH COMPANY
EnviroGene


GRP - THE NEXT STEPS
GRC
• GRP Phase 2 funding –
• A £2M Objective 1 ERDF Project.
• 3 years duration from 2005 to 2008
• Main objectives:
– Create new companies 11 No
– Create new jobs 130 No
– Increase turnover in assisted companies. £12m
Geoenvironmental Research Centre
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DIOLCH YN FAWR AM WRANDO
THANK YOU FOR LISTENING

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Biographical Note

Professor Paul Younger

Paul Younger is a hydrogeologist and mining environmental engineer with more than 20 years' experience in groundwater engineering, particularly in the remediation of polluted mine waters. He has personally designed some seven full-scale mine water remediation systems, two of them in Wales. Paul has also played a leading role in other mine water management projects in the coalfields and metallic orefields of Wales. Currently HSBC Professor of Environmental Technologies at the University of Newcastle, Paul has published more than 150 papers in the international literature and has acted as principal author / lead editor of 5 books. In addition to his academic duties, he sits on the Boards of Directors of three companies engaged in the environmental consulting, construction dewatering and ground-source heat technology markets. He has coordinated three of the European Commission's most prominent mine water R&D programmes. He currently serves as the principal European representative on the Global Alliance of acid rock drainage abatement organizations, convened by the International Network for Acid Prevention (INAP), a collaborative organization formed by the world's largest mining houses.

Post-mining pollution in Wales: eliminating the water pathway

Paul L Younger

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INTRODUCTION

Pollution from former mining sites is a worldwide problem. A number of pathways exist for the transfer of pollutants from mine site sources to sensitive receptors, such as human populations and ecosystems, amongst which airborne dust emissions and outflows of polluted water are pre-eminent (Younger 2004). In humid, temperate countries such as Wales, the water pathway is by far the most important, especially in the long-term after vegetation has largely stabilised the surfaces of mine waste deposits. This paper focuses on the water pathway for mine waters in Wales and how it can best be eliminated, thus protecting sensitive receptors from harm. Mine water discharges commonly destroy freshwater ecosystems. They also affect human livelihoods: although their impacts on water resource availability are not major in a wet country such as Wales, the bright orange staining of watercourses associated with mine water discharges detracts from the quality of life of communities in many former mining areas.

The total flow rate of polluted waters from all abandoned mine sites in Wales is not accurately known, but it certainly exceeds 100 Ml/d. Most of this flow emanates from highly-interconnected networks of flooded underground workings, both in the coalfields and in the metalliferous orefields. A small proportion of the total flow (unlikely to exceed 5%, by analogy with the situation in Scotland; Younger 2001) relates to the release of leachates from surface deposits of mine waste. [The term 'mine waste' encompasses both spoil (i.e. waste rock / overburden removed to facilitate mining) and tailings (a.k.a. finings, washery wastes etc, which are fine-grained materials arising from mineral washing / processing activities)]. Although mine waste leachates are volumetrically modest, they 'punch above their weight' in terms of environmental impact, as they are often far more acidic and metalliferous than deep mine drainage waters. In Scotland for instance, they account for around 30% of the total mine water pollutant loading, despite amounting to only 2% of the total flow rate (Younger 2001). There is no *a priori* reason to suspect that the situation in Wales would prove to be greatly different from this were a thorough evaluation completed.

Although mining is almost wholly a bygone industry in Wales today, the extent of former mining activities ensures that mine waters remain a live issue. Wales can rightly claim to be the European pioneer of the full-scale implementation of passive mine water treatment, following the installation of the small Pelenna I compost wetland in 1995, and the much larger Pelenna III system in 1997 (Younger 1998). The fruits of a decade of abandoned mine water treatment projects in Wales have been recently reviewed by Younger *et al.* (2004), and are summarised in the following section. This is followed by a brief 'gaps analysis', reflecting on what remains to be done in relation to mine water remediation in Wales. Drawing upon examples from two CL:AIRE-sponsored Technology Demonstration Projects (TDPs), which together form part of the larger CL:AIRE National R&D Facility 'CoSTaR' (Coal Mine Sites for Targeted Remediation Research), the existence of appropriate technology for at least one of the outstanding issues is demonstrated. Residual challenges remain with regard to diffuse sources of mine water pollution, which will likely require active management if Wales is to comply with the requirements of the EU Water Framework Directive.

WALES: EUROPEAN PIONEER OF PASSIVE MINE WATER REMEDIATION

The Ground-breaking Work of Neath Port Talbot County Borough Council

The installation of full-scale wetland systems to treat polluted mine waters emanating from five different points in the Pelenna catchment, near Port Talbot, South Wales, was the principal pioneering effort whereby passive treatment technology was introduced to Europe. Over the five years from 1994, the River Pelenna Restoration Project (RPRP) addressed a legacy of mine water pollution which had been severely polluting an otherwise beautiful mountain stream for nearly four decades, since the last collieries in the vicinity were abandoned. The challenge for the RPRP was to achieve a sufficient improvement in water quality that the river would regain its pre-mining status as a salmonid fishery. The RPRP was led by Neath - Port Talbot County Borough Council (NPTCBC), with active support from the Environment Agency and funding from the EU LIFE fund. (The Coal Authority was not involved in this project, as the RPRP was initiated before the formation of the Authority in 1995). Three distinct wetland systems were constructed by the RPRP (Table 1). The creation of the Pelenna Phase III wetlands represented the resolution of the greatest design challenge of the three systems, in that they were required to treat three discrete net-acidic, iron rich waters (Whitworth A, Whitworth B and Gwenffrwdd) all of which emanated from old adits on a steep hillside. The conceptual design for the system envisaged using an existing on-site pond to treat the smallest of the three discharges (Whitworth B), with two parallel trains of RAPS units (Figure 1) and aerobic wetlands being used to treat the much more substantial Whitworth A and Gwenffrwd discharges (Younger 1998). The resulting layout is shown in Figure 2.

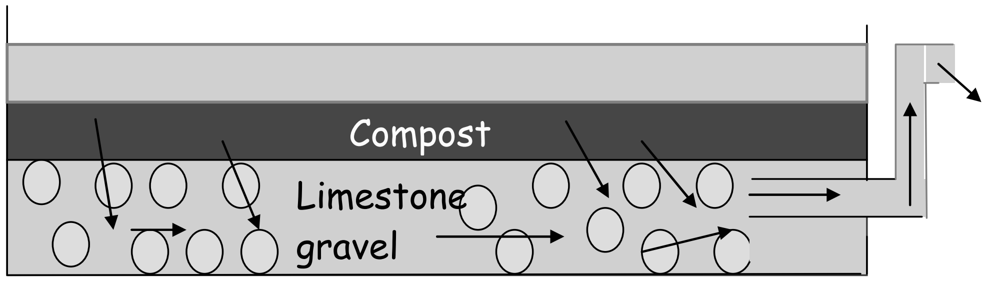

Fig.1. Cross-section through a traditional RAPS (Reducing and Alkalinity Producing System) passive mine water treatment unit, as used at Pelenna III. Water flows down through the compost layer in which bacterial sulphate reduction generates alkalinity and precipitates metal contaminants as sulphides, then receives further alkalinity in the limestone gravel layer. Compare with Figure 3.

Overall, the RPRP scheme proved highly successful, reducing the iron loading entering the river by between 82 and 95% (Wiseman *et al*. 2003). Trout rapidly returned to parts of the river which had previously been devoid of fish; the invertebrate population recovered to display a diversity comparable to that in unpolluted rivers in the area, and marked increases in the breeding success of riverine birds were recorded over the five-year period of the project.

While the RPRP was ongoing, a new mine water discharge arose from the Ynysarwed Adit in the Neath Valley. Although the Lower Ynysarwed Mine was abandoned in the 1930s, there was negligible flow from this old adit until the nearby Blaenant Colliery (located in the next valley to the west, the Dulais Valley) closed in 1991. Following closure of Blaenant, water levels in the mine rebounded until mine water commenced discharging into the Neath Canal in Spring 1993. Initially some 12km of canal were contaminated with ochre, severely damaging the invertebrate and fish populations as well as causing unsightly staining which persisted through Neath town centre. The Ynysarwed discharge exhibits average and peak flows of 28 and 36 l/s respectively. In 1993-94 the discharge had contained up to 400mg/l of dissolved iron, representing a particularly severe level of contamination when compared to all other discharges in South Wales (Brown et al. 2002). By 1996, it was already clear that a distinct (if gradual) decline in Fe concentrations was underway (Younger 1997), and by 2002

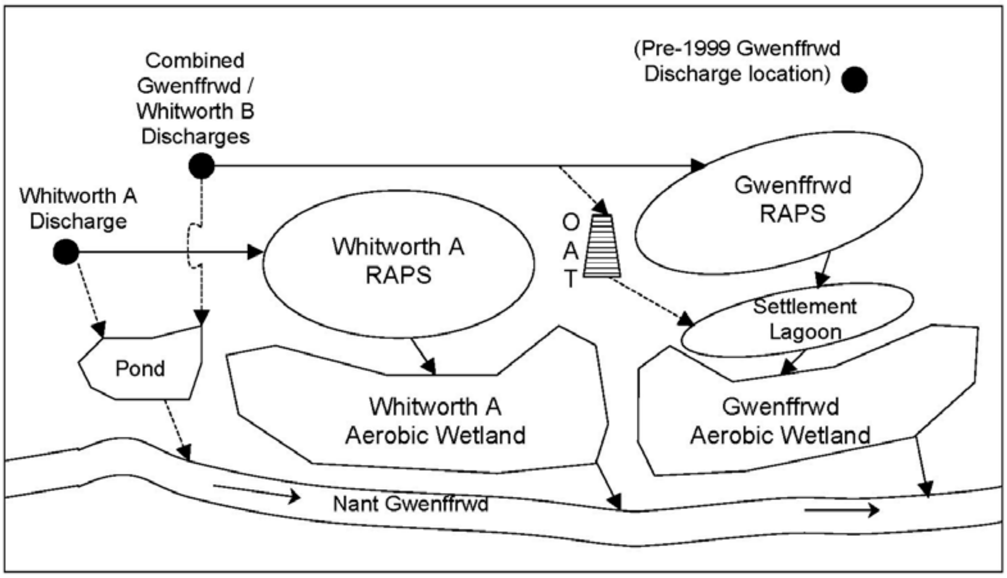

Fig. 2. Sketch plan showing the layout of RAPS and aerobic wetlands in the Pelenna IIII passive system. (OAT stands for 'ochre accretion terraces').

the Fe concentration had declined to about 100mg/l. Notwithstanding this improving trend, when the Environment Agency Wales in 1998 ranked all mine water discharges in terms of severity of impact if left untreated, Ynysarwed emerged as the single worst mine water discharge in South Wales. NPTCBC developed a two-phase strategy as the preferred treatment solution, involving active treatment as long as iron concentrations remain > 50 mg/l, followed by the long term use of passive treatment (by means of aerobic wetlands) once the iron concentrations had stabilised at a lower level. Active treatment is undertaken in a large stirred tank where lime is added to raise the pH and precipitate the iron as a hydroxide. A flocculant is added to the overflow from the reaction vessel to aid solids formation prior to introducing the flow into two lamella clarifiers where the solids are separated from the treated mine water, before it is passed to the wetland for polishing prior to discharge into the River Neath.

Table 1. Summary of existing mine water remediation systems in Wales.

Site	System owner	District	Date commissioned	Nature of treatment
Pelenna I	Neath Port Talbot CBC	Neath Port Talbot	1995	Compost wetland
Pelenna III	Neath Port Talbot CBC	Neath Port Talbot	1997	RAPS, aerobic wetlands
Gwynfi	Coal Authority	Neath Port Talbot	1998	Aerobic wetlands
Pelenna II	Neath Port Talbot CBC	Neath Port Talbot	1999	Compost wetland / RAPS
Ynysarwed	Neath Port Talbot CBC / Coal Authority	Neath Port Talbot	1999	Pumped, lime dosing, aerobic wetland
Taff Merthyr	Coal Authority	Merthyr Tydfil	2001	Pumped, aerobic wetlands
Six Bells	Coal Authority	Blaenau Gwent	2002	Pumped, peroxide / caustic soda dosing
Blaenavon	Coal Authority	Torfaen	2002	Aerobic wetlands
Lindsay	Coal Authority	Carmarthenshire	2003	Pumped, aerobic wetlands
Morlais	Coal Authority	Carmarthenshire	2003	Aerobic wetlands
Corrwg	Coal Authority	Neath Port Talbot	2004	Aerobic wetlands

The Coal Authority's National Mine Water Remediation Programme
With the advent of the Coal Authority (CA) in 1995, national policy for mine water remediation began to change rapidly. Within two years, the CA was beginning what is now a major UK-wide rolling programme of remediation of Britain's most polluted coal mine discharges, prioritised by the Environment Agency on the basis of the magnitude of environmental impacts. The leader of this programme has described its rationale and operation in detail (Parker 2000) and no further details will be given here. The CA has identified aerobic wetlands ('reedbeds') as its preferred technology, wherever feasible, for long-term mine water treatment. Active treatment is used only where mine water quality is too poor for direct passive treatment, usually with a polishing wetland following the active treatment in any case. Table 1 lists all existing mine water remediation systems in Wales, 8 of which were constructed by the CA. The CA's national programme has accelerated in recent years, and rapid strides are now being made to address the remaining catalogue of polluted coal mine waters in Wales, comprising the sites listed in Table 2.

Table 2. Planned Coal Authority mine water remediation systems in Wales.

Mine water discharge	Location / District
Abersychan	Pontypool / Torfaen
Blackwood	Blackwood / Caerphilly
Hawarden	Connahs Quay / Fflint
Corrwg Fechan	Glyn Corrwg / Neath Port Talbot
Craig y Aber	Pyle / Vale of Glamorgan
Cwmgors	Cwmgors / Neath Port Talbot
Dunvant	Dunvant / Swansea
Garwed Brook	Resolfen / Neath Port Talbot
Glyncastle	Resolfen / Neath Port Talbot
Goytre	Port Talbot / Neath Port Talbot
Llynfi	Bettws / Bridgend
Mountain Gate	Capel Hendre / Carmarthenshire
North Celynen	Newbridge / Caerphilly
Pontllanfraith	Pontllanfraith / Caerphilly
Rhymney Hengoed	Pontllanfraith / Caerphilly
Tanygarn	Ammanford / Carmarthenshire
Llechart	Pontardawe / Neath Port Talbot
Trosnant Brook	Pontypool / Torfaen
Ynyswen	Treorchy / Rhondda Cynon Taff

GAPS ANALYSIS: WHAT REMAINS TO BE DONE IN WALES?

The CA has responsibility for flooded underground mines in Wales. However, as its predecessor organisations (the National Coal Board and the Coal Authority) had largely disposed of surface assets to local authorities many years ago, it has very few spoil heaps in its ownership. As previously noted, however, spoil leachates are often far more heavily polluted than deep mine waters, and aerobic wetlands of the type preferred by the Coal Authority are <u>not</u> appropriate for the more acidic leachates. To date, in fact, not a single spoil leachate in Wales has been the subject of a mine water remediation project. Indeed, data on the extent and severity of spoil leachate pollution in Wales has yet to be drawn together. It seems more than likely, however, that these leachates will prove to be as polluted in Wales as elsewhere in the UK, and that appropriate technologies for their remediation will eventually be needed.

A second outstanding issue in Wales relates to polluted drainage from former metal ore mines. Unlike in the case of coal mines, metal mines have no single former owner; the CA has no formal role in relation to them. They are in general significantly more acidic / metalliferous than coal mine drainage (except in the limestone-hosted Clwydian Pb-Zn orefield), and pollutant loadings are often too high for existing passive technologies. Consequently, active treatment is likely to be needed at many sites. The Environment Agency is currently promoting a National Metal Mines Strategy for Wales, which envisages the encouragement of 'voluntary' partnerships of interested stakeholders in the pursuit of remedial actions. The two sites most likely to see early action under this scheme are Cwm Rheidol (near Aberystwyth), for which a passive treatment approach has been tentatively identified, and Mynydd Parys (Anglesey), for which a pilot active treatment system is currently being commissioned by Unipure Europe Ltd (based in Monmouth), whose team of treatment engineers were previously responsible for the development of the highly successful active treatment plant at Wheal Jane, Cornwall (Younger *et al.* 2005).

A third outstanding issue is not unique to Wales: the need to quantify and tackle diffuse sources of mine water pollution. To date, the focus of mine water research and practice has been almost exclusively on point sources. However, there is growing evidence to show that a significant proportion of mine water pollution is actually diffuse in nature. For instance, analysis of EA Wales data suggests that around 35% of coalfield mine water pollution is diffuse. Detailed studies in NE England are now revealing seasonal shifts in the point / diffuse balance, with as much as 95% diffuse being found at times (Mayes *et al.* 2005). Technologies to intercept and treat diffuse sources are not yet available; this is an area of active research activity being actively promoted by the Environment Agency, through their national Mine Water R&D Fellow based at Newcastle University.

Of these three outstanding issues, only the first is amenable to ready solution by the adoption in Wales of technologies already proven in use elsewhere in the UK. This is the subject of the last section of this paper.

TECHNOLOGIES FOR ACIDIC SPOIL LEACHATE REMEDIATION: CL:AIRE FINDINGS

CoSTaR and CL:AIRE TDPs

It is a fundamental part of the research strategy of CL:AIRE to focus research on a small number of well-characterised sites. In accordance with this aim, in 2002 CL:AIRE joined forces with the University of Newcastle and the Coal Authority to establish CoSTaR (<u>Co</u>al Mine <u>S</u>ites for <u>Ta</u>rgeted <u>R</u>emediation Research), a cluster of six full-scale passive remediation systems located in NE England. CoSTaR has served as the focus for a number of UK-based R&D projects (most notably the BBSRC/EPSRC LINK project 'ASURE', involving the University of Wales, Bangor, as well as Newcastle University) and several PhD projects. On a grander scale, since 2004, CoSTaR has been designated and generously funded as an 'international access research infrastructure' of the European Commission. This funding is facilitating research by dozens of scientists based throughout the EU, who come to spend periods of between three days and 3 months at the CoSTaR facilities. Two of the six CoSTaR facilities are also CL:AIRE TDP sites in their own right; these two also happen to exemplify two distinct varieties of passive remediation technology for acidic spoil leachates (Younger 2003), as described below.

Bowden Close, County Durham (CL:AIRE TDP5)

The Bowden Close system in County Durham was finally commissioned in January 2005 with the completion of planting of an aerobic wetland, which receives the combined effluents of two separate RAPS units. The system was built by Durham County Council, who developed the detailed system specifications from a conceptual design prepared by the author (Younger *et al.* 2003). The layout and early highly successful performance of the Bowden Close system is detailed by Fabian *et al.* (2005).

Two key innovations distinguish the Bowden Close system. Firstly, instead of having two separate layers within the RAPS unit, a fully-mixed substrate is used (Figure 3). This avoids problems of (i) throttling of the flow by having the lowest permeability at the top of the sediment pile (as in Figure 1), and (ii) having an extremely soft upper layer, which is particularly hazardous for anyone accidentally inadvertently entering the pond. The second innovative feature is the inclusion of unique monitoring facilities, including multi-level piezometers sited in the centre of the ponds, but accessed via tubes in the bank sides, and secure, locked chambers in which hydraulic control and autosampling equipment are co-housed. These features were financed by CL:AIRE and the BOC Foundation and have already made the Bowden Close system the most extensively and intensively monitored example of its type anywhere in the world.

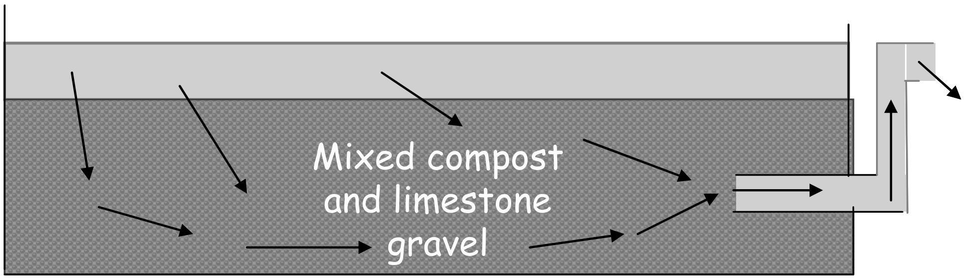

Fig. 3. A fully-mixed substrate implementation of the RAPS concept (cf Fig. 1) as used at Bowden Close, Co Durham.

Design and construction experiences to date at Bowden Close were incorporated into the European Union's 'PIRAMID' guidelines for passive remediation of acidic drainage (PIRAMID Consortium 2003; www.piramid.org). At the time of writing, tracer test data (provided through the EU FP6 funding for CoSTaR) is being used together with hydrochemical monitoring data to develop a system dynamics model of RAPS unit performance, which will inform future updating of the PIRAMID guidelines. The final report for TDP5 is due for completion at the end of October 2005, for publication by CL:AIRE early in 2006.

Shilbottle, Northumberland (CL:AIRE TDP 13)

Bowden Close is a rather hilly site, in which there is no shortage of topographic relief. At Shilbottle in Northumberland, by contrast, insufficient relief existed to allow deployment of a RAPS unit as in Figure 3. However, it proved possible still to deploy a sulphate-reduction based bioreactor by installing the mixed limestone / compost substrate in the form of a permeable reactive barrier (PRB). Downstream of the PRB, groundwater flows into the open air and into a series of three open ponds, where further polishing of oxidisable metals occurs, prior to final polishing of the effluent in the existing reed-bed (Figure 4).

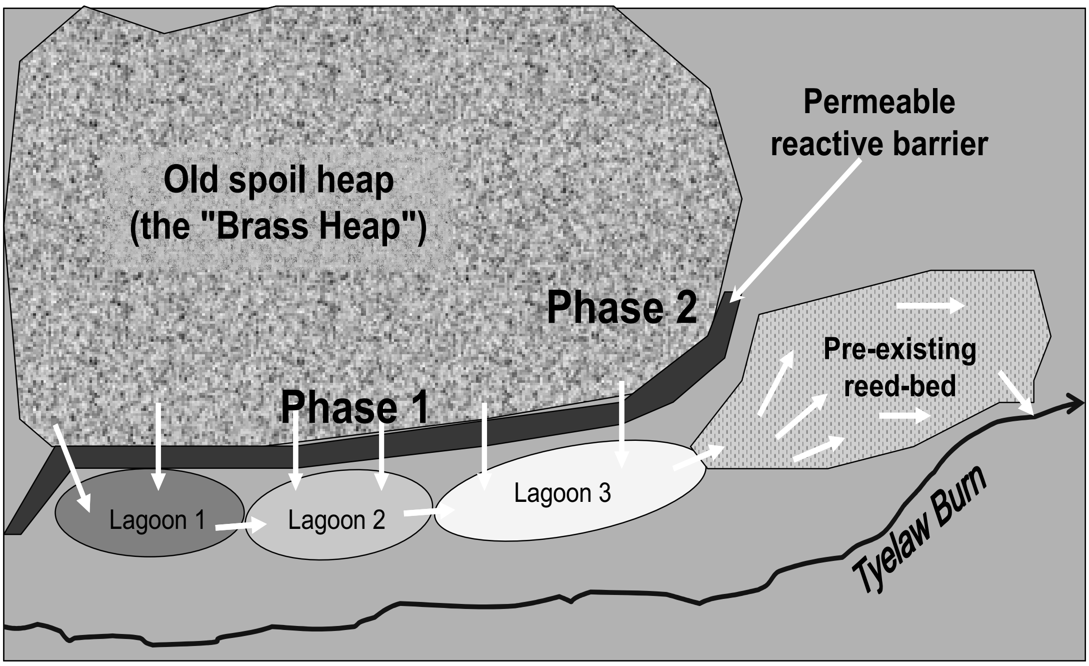

Fig. 4. Sketch layout map of the Shilbottle passive treatment system, comprising PRB, ponds and aerobic reedbed. (Small arrows show direction of water movement).

The Shilbottle PRB is by far the largest of its type in the world, being 180m-long (N-S), 3m deep by 2m wide. It was constructed using a simple cut-and-fill method by contractors working for Northumberland County Council, who developed the system design in collaboration with the Newcastle University team. In line with the recommendations from extensive lab-testing of possible reactive media (Amos and Younger, 2003), the Shilbottle PRB substrate consists of 25% composted horse manure and straw, 25% green waste compost, and 50% limestone gravel (mostly 25mm nominal single-sized, though there is one section of the barrier with 10mm diameter limestone gravel). In one section of the PRB, the limestone clasts were substituted by blast furnace slag. These organic and inorganic components of the substrate were thoroughly mixed using a large, mobile agricultural mixer. The mix was then loose-tipped into the trench to the full depth of excavation (i.e. there is a substantial unsaturated zone of reactive media above the water table in the spoil, which both provides further reactive capacity for some future period when heads in the PRB rise in response to clogging of pores, and also provides an O_2 consumption blanket in the meantime). Multi-level piezometers were installed in the media in two positions during emplacement, complementing previously existing boreholes up-gradient of the PRB, which continue to provide information on the native groundwater in the spoil. The downstream face of the PRB was lined with brick rubble, to provide a permeable exit filter to the oxidation ponds. In some places, an artificial liner was draped along the downstream face to divert some of the more voluminous feeders of water through larger volumes of the permeable reactive media than they would have been likely to enter had they been permitted to take the shortest flowpath across the barrier. The first two full years of performance data show that the PRB and ponds are very effectively treating the contaminated leachate (Younger and Moustafa 2005). The final report for TDP13 is due for completion at the end of January 2006, for publication by CL:AIRE in the Spring of that year.

CONCLUSION

The water pathway is the predominant post-mining pollution pathway in most mined environments, and this is certainly the case in Wales. There are currently eleven full-scale mine water remediation systems in Wales, all but three of which were installed by the Coal Authority. In contrast to the situation in England, where several spoil heap leachates are now being successfully treated using novel variants of anoxic passive technologies (Younger 2003; Younger *et al.* 2003), there are as yet no spoil leachate treatment systems in Wales (Younger *et al.* 2004). Information arising from two CL:AIRE TDPs (for the Bowden Close and Shilbottle sites, which comprise two of the six systems which together make up the CL:AIRE CoSTaR R&D facility) shows the feasibility of passive treatment for such spoil leachates under conditions which likely occur in Wales. Nevertheless, many metal mine waters in Wales are probably too heavily polluted for passive treatment to be an option; hence the current Unipure pilot active treatment plant activities at Mynydd Parys (Anglesey). Finally, it is increasingly becoming apparent that diffuse sources are responsible for a greater proportion of the total mine water pollution loading than had hitherto been appreciated. Further investment in the characterisation of diffuse mine water pollution and the development of new technologies will be needed before this challenge can be addressed.

ACKNOWLEDGEMENTS

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Post-mining pollution in Wales: eliminating the water pathway

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CL:AIRE

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Overview

- Post-mining pollution: importance of the water pathway
- Mine water remediation in Wales: the state of the art
- Gaps analysis: what remains to be done?

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Post-mining pollution in Wales

- Sources:
  - – Abandoned underground mine voids
  - – Abandoned surface mine void (Mynydd Parys Great Opencast)
  - – Surface deposits of mine waste
    - includes spoil (i.e. tipped overburden) and
    - tailings (fine-grained residues from coal washing / mineral processing)

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Post-mining pollution in Wales

- Pathways:
  - Airborne dust emissions (e.g. Mynydd Parys)
  - Gaseous emissions from underground workings
  - Water emissions, including:
    - Outflows from flooded underground workings
    - Mine waste leachates

The major pathways

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Post-mining pollution in Wales

- Sensitive receptors:
  - Human health and quality of life
    - Especially for settlements close to old mine waste deposits
    - Quality of life issues: e.g. ochre staining of streams → loss of amenity; occasional problems with H_2S / SO_2 odours (nuisance, if not health-threatening)
  - Ecosystems
    - especially freshwater environments

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Eliminating the mine water pollution pathway

- Prevention of pollutant release
  - Feasible for spoil heaps / tailings deposits
  - Infeasible for vast networks of flooded underground workings
- Treatment
  - Active (lime dosing, flocculation etc)
  - Passive (wetlands, RAPS, PRBs etc)

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Wales: European pioneer of passive mine water remediation

- Wales was the first country in Europe to implement passive mine water treatment at full-scale (Pelenna I compost wetland, 1995)
- Has now reclaimed to healthy status more than 40 km of previously-polluted rivers
- Currently 11 Passive systems in Wales, all but 3 owned by Coal Authority
- All existing systems in Wales treat outflows from flooded underground coal mines (contrast with England, where mine waste leachates also passively treated)

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Existing mine water treatment systems in Wales

Site	System owner	District	Date commissioned	Nature of treatment
Pelenna I	Neath Port Talbot CBC	Neath Port Talbot	1995	Compost wetland
Pelenna III	Neath Port Talbot CBC	Neath Port Talbot	1997	RAPS, aerobic wetlands
Gwynfi	Coal Authority	Neath Port Talbot	1998	Aerobic wetlands
Pelenna II	Neath Port Talbot CBC	Neath Port Talbot	1999	Compost wetland / RAPS
Ynysarwed	Neath Port Talbot CBC / Coal Authority	Neath Port Talbot	1999	Pumped, lime dosing, aerobic wetland
Taff Merthyr	Coal Authority	Merthyr Tydfil	2001	Pumped, aerobic wetlands
Six Bells	Coal Authority	Blaenau Gwent	2002	Pumped, peroxide / caustic soda dosing
Blaenavon	Coal Authority	Torfaen	2002	Aerobic wetlands
Lindsay	Coal Authority	Carmarthenshire	2003	Pumped, aerobic wetlands
Morlais	Coal Authority	Carmarthenshire	2003	Aerobic wetlands
Corrwg	Coal Authority	Neath Port Talbot	2004	Aerobic wetlands

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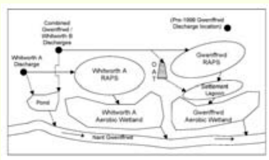
Mine water treatment systems in Wales



Pelenna III process diagram

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Planned Coal Authority remediation schemes in Wales

Mine water discharge	Location / District
Abersychan	Pontypool / Torfaen
Blackwood	Blackwood / Caerphilly
Hawarden	Connahs Quay / Fflint
Corrwg Fechan	Glyn Corrwg / Neath Port Talbot
Craig y Aber	Pyle / Vale of Glamorgan
Cwmgors	Cwmgors / Neath Port Talbot
Dunvant	Dunvant / Swansea
Garwed Brook	Resolfen / Neath Port Talbot
Glyncastle	Resolfen / Neath Port Talbot
Goytre	Port Talbot / Neath Port Talbot
Llynfi	Bettws / Bridgend
Mountain Gate	Capel Hendre / Carmarthenshire
North Celynen	Newbridge / Caerphilly
Pontllanfraith	Pontllanfraith / Caerphilly
Rhymney Hengoed	Pontllanfraith / Caerphilly
Tanygarn	Ammanford / Carmarthenshire
Llechart	Pontardawe / Neath Port Talbot
Trosnant Brook	Pontypool / Torfaen
Ynyswen	Treorchy / Rhondda Cynon Taff

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Gaps analysis

- What remains to be done in post-mining water pollution remediation in Wales?
  - Technologies for mine waste **leachate** remediation
  - Appropriate treatment technologies for metal mine waters
  - Tackling diffuse sources of mine water pollution

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Mine waste leachates

- Vast majority of sites in local authority ownership (hence lack of Coal Authority involvement)
- Often more acidic and metalliferous than deep (coal) mine outflows treated to date
- Generally, smaller flow rates than deep mine outflows
- Amenable to passive treatment using bacterial sulphate reduction / limestone dissolution under anoxic conditions
- Two CL:AIRE TDPs illustrate appropriate passive technologies

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Remediating acidic spoil leachates: CL:AIRE TDPs

- TDP 5: Bowden Close, County Durham:
  - 2 RAPS units plus joint aerobic wetland (final report due end Oct 2005)
- TDP 13: Shilbottle, Northumberland:
  - Permeable reactive barrier, ponds and aerobic wetland

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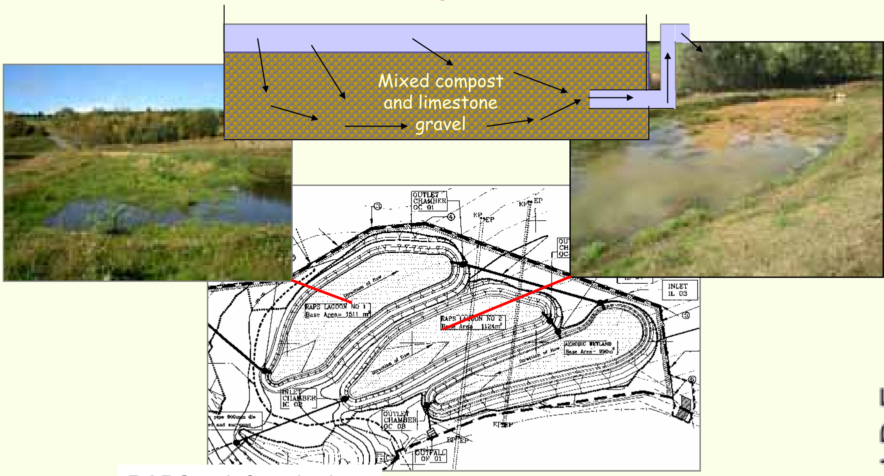
CL:AIRE TDP5 – Bowden Close, County Durham



RAPS unit functioning:

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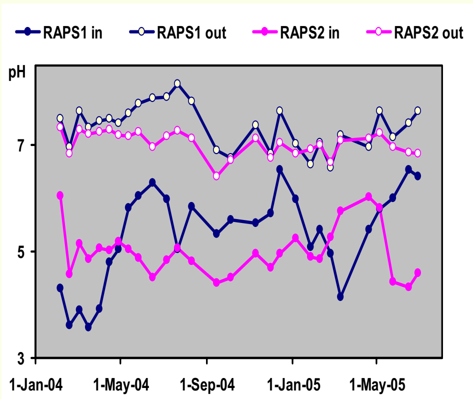
CL:AIRE TDP5 – Bowden Close, County Durham



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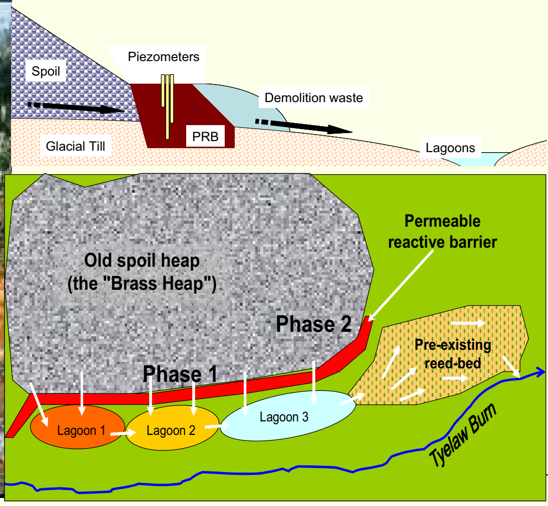
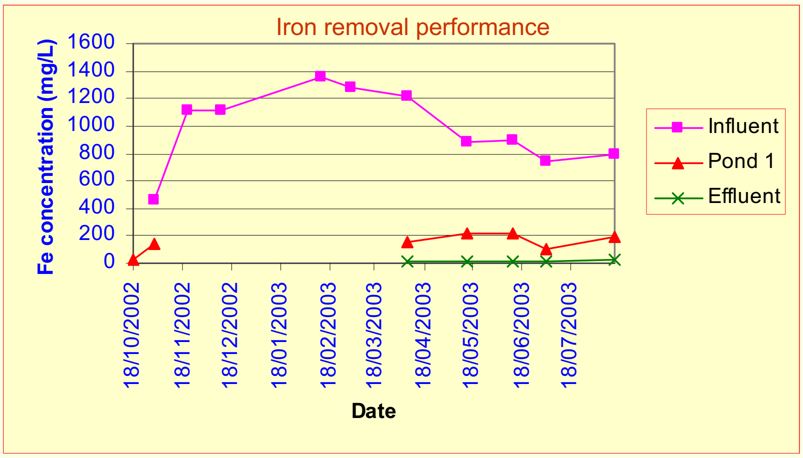
CL:AIRE TDP13 – Shilbottle, Northumberland



CL:AIRE TDP13 – Shilbottle, Northumberland



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Coal Mine Sites for Targeted Remediation Research (CoSTaR)

Contact: costar@ncl.ac.uk

Metal mine drainage

- No single former owner of sites (unlike coal); thus no CA involvement
- Significantly more acidic / metalliferous than coal mine drainage (except in Clwydian Pb-Zn orefield)
- Pollutant loadings often too high for existing passive technologies: thus active treatment likely needed many sites
- Two current priority sites under EA Wales National Metal Mines Strategy: Cwm Rheidol (nr Aberystwyth) and Mynydd Parys (Anglesey)

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Metal mines

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The Diffuse Pollution Challenge

- To date, focus has been solely on point sources
- Evidence is mounting that a significant proportion of mine water pollution is actually diffuse
  - e.g. analysis of EA Wales data suggests ~35% coalfield mine water pollution is diffuse
  - Detailed studies in NE England revealing seasonal shifts, with as much as 95% diffuse at times
- Technologies to intercept and treat diffuse sources not yet available

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Summary

- Water pathway is the predominant post-mining pollution pathway, and of major importance in Wales
- 11 full-scale mine water remediation systems now in Wales; most CA-owned, all for flooded underground mine outflows
- No spoil leachate treatment systems in Wales yet; appropriate technology has been pioneered in NE England in two CL:AIRE TDPs (both form part of CL:AIRE CoSTaR R&D facility)
- Metal mine waters in Wales: many likely to need active treatment
- Diffuse pollution: growing realisation of a problem without obvious existing remedies

Contaminated Land: Applications In Real Environments

Biographical Note

Dr Hugh Potter

Hugh Potter manages the Environment Agency's research programme on mining pollution and is providing technical support to the implementation of the *Metal Mines Strategy* in Wales. He has worked for the Environment Agency for 8 years as a hydrogeologist primarily dealing with the remediation of contaminated land and the regulation of landfills. After completing a BSc degree in geology at the University of Durham, Hugh spent several years as a post-graduate student at McGill University in Montreal. He was awarded a PhD in environmental geochemistry for his work on the retention of heavy metals by amorphous iron and aluminium oxides.

Contaminated Land Research Opportunities

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At the Environment Agency, we have always based our policies and regulatory decisions firmly on scientific evidence. In December 2004, we launched our *Science Strategy* which sets out a new approach to delivering R&D for all of our functions. This new science programme will help deliver our existing priorities and prepare us to implement the EU Water Framework Directive and other new regulatory challenges.

Our main drivers for contaminated land research are the Water Framework Directive, the Landfill Directive as well as the ongoing support to the Part IIA Contaminated Land regime. We are developing programmes of research for the next 5 years and the presentation will discuss two areas – remediation and mining pollution – which are particularly relevant for this CL:AIRE workshop. The current state of the CLEA (Contaminated Land Exposure Assessment) science programme will also be presented.

The first stage for implementing the Water Framework Directive has been to characterise the pollution pressures in all catchments across England and Wales. Diffuse pollution from historic coal and metal mining, and in urban areas, is a significant barrier that may prevent groundwater and surface water bodies achieving good chemical and ecological status by 2015.

MINING POLLUTION

Abandoned mines pose a particular challenge in Wales with coal mines in the south, and metal mines in central and north Wales. We are working with the Coal Authority to remediate existing and new discharges from coal mines. Technical support is being provided to Environment Agency Wales to help implement their *Metal Mines Strategy for Wales*. Demonstration projects are planned at Parys Mountain (Anglesey) and elsewhere on ways of ameliorating the impacts of acid mine drainage without destroying the important archaeological and industrial heritage, or the specialised ecosystems that thrive on metal-rich soils and sediments. We are working with various Universities in Wales (e.g. Cardiff, Aberystwyth, Bangor) on identifying new mine water remediation methods which require less land than current techniques (e.g. aerobic wetlands) or use waste materials to remove metals (e.g. de-alginated seaweed, ochre pellets).

We have created a *Research Fellowship for Mine Waters and Mine Wastes* in collaboration with the University of Newcastle. Dr Adam Jarvis is investigating the impacts of mining at the catchment scale so that remedial efforts can be applied in the most effective way. He is also working on new passive remediation systems to deal with difficult pollutants such as zinc and manganese.

REMEDIATION OF LAND CONTAMINATION

The Environment Agency promotes a risk-based approach to land contamination using knowledge-based solutions which require a good understanding of contaminant fate and transport. The *Model Procedures of the Management of Land Contamination (CLR 11)*, published jointly with Defra, provides the technical framework for structured decision making about land contamination. When remediation is needed, we advocate sustainable remedial techniques rather than simply transferring the contaminants to another location (e.g. landfill). The requirement in the EU Landfill Directive for wastes to be treated before going to landfill should encourage the development of economic on-site treatment technologies. Very few hazardous waste landfills remain open for the disposal of contaminated soils (and none in Wales).

Our Land Remediation Research programme is focussed on improving:

- data quality for the management of land contamination (including risk assessment and verification of remediation);
- the quality of land contamination site investigations and techniques for determining soil quality;
- confidence in remedial treatment of contaminated soil and groundwater for effective recovery of waste and regeneration of land.

The recently published report on *Indicators for Land Contamination (SC030039/SR)* identified that 300,000 hectares of land were potentially affected by contamination, and that 44,000 hectares had already been remediated. Ongoing research is investigating *permeable reactive barriers (PRBs)* through our jointly funded Research Fellow at Queens University Belfast. We are working with other organisations on research projects including enhanced natural attenuation of chlorinated solvents and heavy hydrocarbons, and PRBs to treat diffuse nitrate pollution from agricultural land.

The Science Group is keen to collaborate with UK and international partners, and work closely with networks such as FIRSTFARADAY and CL:AIRE. Ongoing projects include:

- EUGRIS (www.eugris.org) – the web-portal for soil and water management in Europe.
- SNOWMAN (Sustainable management of soil and groundwater under the pressure of soil pollution and soil contamination) – an ERA-NET project to increase co-operation for collaborative research in Europe.
- NATO/CCMS – network to discuss pollution prevention and remediation in selected industrial sectors. The 2004 meeting on rehabilitation of old landfills was held in Cardiff.
- QUESTOR (questor.qub.ac.uk) – a National Science Foundation industry-academic partnership setting an industry-relevant research agenda at Queens University Belfast.

We are enthusiastic to develop new collaborative proposals for research projects and would welcome suggestions that fit within our *Science Strategy*.

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Contaminated land research opportunities

Hugh Potter
Senior Pollutant Fate & Transport Scientist
Environment Agency Science Group

Outline

- Environment Agency *Science Strategy*
- Drivers
  - Water Framework Directive
  - Landfill Directive
  - Part IIA Contaminated Land
- Ongoing R&D
  - Mining
  - Innovative remediation technologies (PRBs)
  - CLEA

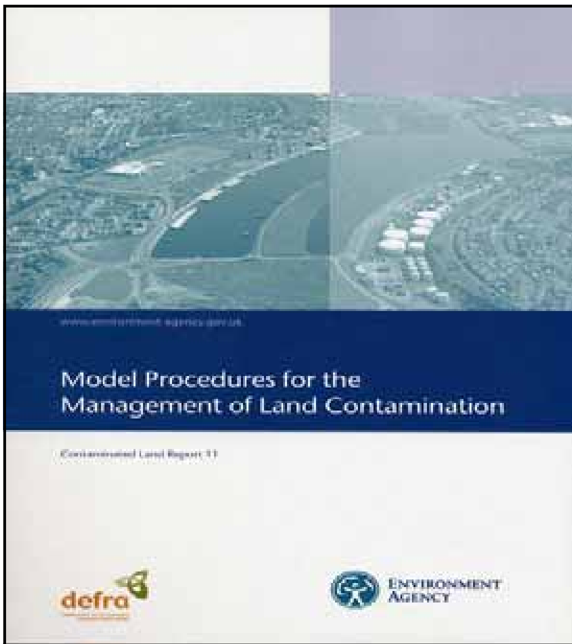
Legislative Drivers

- Water Framework Directive
  - catchment impacts as well as point sources
  - pressure maps - urban, mining, nutrients
- Landfill Directive
  - Waste Acceptance Criteria
  - pre-treatment of hazardous wastes
  - lack of hazardous waste landfills (Wales)
  - opportunities for innovative treatment

Mining programme

- Quantifying mining impacts at catchment scale
- Sustainable remediation technologies
- Research Fellowship at University of Newcastle
- Collaboration with other organisations

Environment Agency



Environment Agency

Recent and current projects (1)

- Indicators of land contamination
- PRB Fellow
- SABRE - enhanced natural attenuation of chlorinated solvents
- PROMISE - biopiling of weathered hydrocarbons
- NITRABAR - EU technology demonstration

Scale of the problem ("Indicators")

- Extent of industrial land use
  - 300,000 ha 325,000 sites
- Identification of land contamination
  - 67,000 ha 33,500 sites
- Remediation of land contamination
  - 44,000 ha 21,000 sites
- Newly created land contamination
  - 30 ha 750 sites

Recent and current projects (2)

Networking - a way to add value

- EUGRIS
- SNOWMAN
- NATO/CCMS
- QUESTOR
- CL:AIRE, FIRSTFARADAY, SAGTA

Remediation Programme 2006-2011

- Data quality for the management of land contamination
  - sampling strategies, field measurements
- Confidence in remedial treatment to support recovery of waste and land regeneration
  - in-situ remediation techniques, operating windows, verification tools

CLEA Science Programme

- R&D Publications CLR7 - 10
- Chemical specific reports - TOX and SGV
- CLEA UK software
  - Free to the end-user
  - Usable as part of GQRA and DQRA
  - Most parameters can be adjusted
  - Can add new chemicals, land-uses, soil types
- Will be launched *4th* November 2005 (*beta*)
  - www.environment-agency.gov.uk
  - e-mail: clea@environment-agency.gov.uk

Conclusions

- Drivers
  - Water Framework Directive
  - Landfill Directive
- Passive innovative remediation techniques
- Treatment due to Landfill Directive
- Ongoing R&D and networks
- New collaboration encouraged