THE EMERGING REQUIREMENT FOR EVIDENCE-BASED RESTORATION SCHEMES IN THE UNITED KINGDOM[1]

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Abstract: The concept of evidence-based decision making is now being applied by local government and regulators in the consenting and restoration of surface coal mines in the UK. The objective of this paper is to discuss some of the implications for the minerals industry by using, as an example, a recent application to extend a mine in South Wales.

Over the past 10 years there has been a fundamental change in the approach to strategic planning and control of development in the United Kingdom. Both have become evidence-based, meaning that a proposal should be based on and supported by researched facts, which are open to objective scrutiny. Government and local authorities have not only adopted this approach, but in several cases have reorganised and renamed functional departments to reinforce the stance.

The demand for evidence of the certainty of delivery of restoration schemes is a recent manifestation. Whereas, even as recent as 2-3 years ago, the detailing of restoration would be left as a reserve planning matter and finalised during the mining operation. This seems to be no longer some authorities' approach (as detailed evidence is required before approval of planning consent is granted). This may include a range of ecosystem service matters such as: land-use and habitat extent, types, character and ecosystem service function; establishment and management details during the statutory aftercare period; milestones and timescales for achievement, and its monitoring with target indicators. While this might be expected of modern mining operations, planning authorities in implementing their evidence-based agenda are taking it further to question the certainty of delivery (by demanding evidence it can be done), a measure of the certainty and detailing of fall-back measures and outcomes. A measure of success, *Areal Value Index*, is suggested whereby an objective assessment and judgement of certainty of delivery might be made.

Given that an evidence-based approach is now likely to be widely adopted, the industry should expect to be challenged and needs to prepare its evidence well in advance of the submission of future mining schemes.

Additional Key Words: habitat types, ecosystem services, mine planning

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[1] Paper was presented at the 2012 National Meeting of the American Society of Mining and Reclamation, Tupelo, MS ***Sustainable Reclamation*** June 8 – 15, 2012. R.I. Barnhisel (Ed.) Published by ASMR, 3134 Montavesta Rd., Lexington, KY 40502

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Proceedings America Society of Mining and Reclamation, 2012 pp 286-302

DOI: http://doi.org/10.21000/JASMR12010286 Either DOI may work, but the lower one is correct.

http://dx.doi.org/10.21000/JASMR12010286

Introduction

Strategic and development control of minerals in the UK is undertaken within extensive and long established legislative and planning policy frameworks (Cullingworth and Nadin, 2002). Whilst minerals can only be worked where they occur, planning and local mineral policies have a significant bearing on where and how mineral development takes place, and without planning consent the extraction, processing, and sales etc cannot legally take place (Department of Communities and Local Government, 2006; Scottish Executive, 2006; Welsh Assembly Government, 2009).

At the planning application stage, the compliance of proposals with national and local government policies has been and remains the key test for the competent authority, whether this is the Mineral Planning Authority or ultimately the relevant National Government body when appeal or call-in procedures apply. In some cases where the mineral resource is of national significance, such as silica sand, ball clays and magnesium limestone, applications may carry more weight in the decision making process. In all cases the proposals have to be acceptable in policy terms for the environmental impact and their socio-economic benefits.

The Change in the Policy-Making Landscape

Planning policies for mineral extraction in the UK have evolved from simply protecting resources in the post-war years to the current planned strategic release of mineral supply (industrial and aggregate) with a comprehensive range of socio-economic-environmental tests. All of this has been within an extensive framework of legislation and policy at national and local levels (initially the Town and County Planning Act 1947 and subsequently the Town and County Planning Act 1990).

Also, development control has evolved from simply determining the extent of the working boundary (often with no time limits) with no requirement for site restoration, to the current detailed and legally binding conditions and undertakings, and environmental licensing requirements embodying legislative requirements and best practices. Planning conditions have evolved from being purely a regulatory constraint (e.g. maximum level of dust emissions) to become a vehicle whereby new policy developments (such as protection and enhancement of biodiversity) can be implemented.

Development control for mining in the 1990s was simple and typically the setting of conditions to regulate operational limits and environmental 'exceedence' limits, and the provision of a restoration scheme. For the restoration scheme this was largely the provision of plans and documentation. The latter was satisfied by reference to published guidance on matters such as soil-handling methodology, and tree stock and seed mixtures to be used for the particular land use proposed (Department of the Environment, 1996).

The past construct of public (government) policies has been characterised as being: speculation and opinion driven (often ideologically led), relying on past measures as precedents, reactive (dealing with problems as they emerged) and short term, and treating the symptoms rather than the cause of the matter being addressed (Gray, 1997).

A watershed for policy construct and implementation in the UK occurred in the late 1990s when the Blair government adopted an evidence-based (objective) approach to its policy making as a means of sidestepping ideological dogma (Cabinet Office, 1999a and 1999b). The evidence-based approach has its roots in medicine where it is used to support clinical decisions, and was extended to social and educational policies, and is now an integral part of all UK policy making and decisions.

The underpinning principle of this approach is that science based research is at the heart of policy development and implementation (Smith, 1996; Davies, 2004). Evidence-based approaches, in contrast to opinion-based, rely on rigorous multiple studies of high quality rather than selective studies, vested views or speculation. It is recognised that some evidence-based science may be insufficient in terms of scope and quality when novel approaches are proposed to achieve compliance or when insufficient scientific knowledge exists. Consequently, in some matters there had to be a gradual or sequential change over time from an opinion to an evidence led basis.

Evidence-based policy making has been challenged on the grounds that other factors are often material, and that reliance solely on research evidence is therefore misplaced. Experience, expertise and judgement are influential and possibly overriding facets. Resources and pragmatism (as cost-effectiveness, cost-benefit and cost-utility), values, and habit and tradition are cited as others (Davies, 2004; Banks, 2009). While such critical views may be justified, the reality is that the evidence-based approach of central and local government is now part of their

institutional thinking, projects and programmes, and is embedded across all departments and functions. For example government departments have even been renamed, the former Welsh Office Agriculture Department has now become the Sustainable and Environmental Evidence Division of the Welsh Government. This has also instigated a culture of challenge in both local government and regulatory officers (Banks, 2009).

Types of Evidence-bases

The types of evidence commonly used in supporting policy making, include;

- *Reviews* (as systematic searches and critical reviews): provide balanced view and high value, not commonly available or used
- *Single Studies*: commonly available and used, but may be subject to limitations (sample, time or context specific), of value where specific matters need to be addressed in particular circumstances or site conditions
- *Pilot and Case Studies*: are a dual source of evidence for policy making and implementation, recommended for where new policies or practices are proposed, value only if completed for full duration of study design
- *Research* (effectiveness (outcome), implementation and delivery, descriptive analytical, statistical modelling): each has its own methodology and form of data required, value where information about broad outcomes and practices required
- *Expert*: only of any value if expert is up to date with existing evidence and uncertainties of existing knowledge, and then less valued than the above

The choice of type of evidence-base is likely to be determined by the particular question being asked (Davies, 2004).

The objective of this paper is to discuss some of the implications of an evidence-based approach for the minerals industry. To illustrate this, reference is made to a recent application to extend a surface coal mine in South Wales.

An Evidence-Based Scheme in South Wales

Nant Helen is a 345ha surface coal mine operated by Celtic Energy Ltd in South Wales, UK, where the extraction of coal is within the core of the mountain Mynydd-y-Drum. It is an upland site at an altitude of about 240m with an average annual rainfall of about 2,000mm. The site sits in a very sensitive landscape on the fringe of the Brecon Beacons National Park and has typical

upland vegetation of priority habitat types identified as being of importance in the UK National Biodiversity Action Plan; although the habitats are of relatively poor quality (through over-grazing and burning).

The surface mine has been operational since 1986, the second phase (1999 - 2013) is currently in operation, and the site has just received planning consent for a third and final phase of mining (2012 - 2017). A small part of the initial phase was restored to upland agricultural pasture in the mid 1990s. There was no specific commitment in the first planning application in 1984 to re-establish native upland vegetation, whereas there was in the 1996 application. In both cases the restoration details given were minimal and comprised grassland seed mixtures with an outlining of the preparation methods. These were accepted at the time by the regulators and planning authorities without challenge.

The application for the final phase in 2011, for operational reasons, encompassed the initial site and its intermediate phase extension. Again, a commitment was given to restore the upland vegetation. This time the regulator, Countryside Council for Wales, and National Park wanted specific priority BAP habitat types to be established, and for the first time demanded evidence that such vegetation could be re-established. In addition, they required a detailed fall back plan should the proposed scheme fail. All were required before the planning authority would consent planning permission to extend the surface mine.

This change in approach and attitude of the authorities was something of a surprise to the applicant. Its manifestation in the Nant Helen application and not in other of its recent surface mine applications is believed to be simply the lag time it takes for process change and education to work its way through institutions, and nothing particular about the Nant Helen site *per se*. However, it soon transpired that the approach was also new to the Countryside Council for Wales and the Brecon Beacons Park Authority, besides, it was unclear to them as to what was required and the form it should take. It was left to the mining company to propose an evidence-based delivery scheme for its restoration proposals and the authorities would decide if it was adequate.

In the absence of guidance a broad *ecosystem service* approach (Landberg et al, 2011; UK National Ecosystem Assessment, 2011) was adopted, and the following schedule of evidence was devised. It was based on defining the key (ecosystem) function of the wider area in the

contexts of land use, visual appearance, and the UK and local biodiversity action plans. Included was a risk assessment (i.e. degree of certainty based on completeness of knowledge) estimating the probability of achieving the target habitats.

In practice, reclamation failures in modern schemes occur locally (ie patchy) rather than on a wholesale scale. Hence, the risk of not achieving the target habitat was expressed as: Areal Value Index: *Area of Habitat Proposed* x *% Certainty = Notional Area (ha) of Habitat achieved*)

This gives a measure of the relative extent the proposal might be expected to successfully achieve on the basis of current scientific understanding, and against which an objective judgement of acceptability or acceptable risk might be applied (according to the relative extent achieved or probability of achievement, or availability of an acceptable fallback alternative). For example, an acceptable level of certainty might be > 80% of the proposed area might achieve the required vegetation or the probability of success was 8 in 10, whereas <50% or a 2 in 10 or less probability would not be acceptable. Well tried methods for regularly successfully established habitats might be rated as 80-100% (e.g. wetlands and dwarf shrub dry heath), less well tried, but successful habitats, might be rated as 50-70% (e.g. whorled caraway grassland and meadow foxtail - great burnet flood meadows), and for untried, insufficient knowledge, or difficult habitats might be < 20% (e.g. wax-cap acidic grasslands). Given the available scientific knowledge base and documented history of establishment of native vegetation on mine sites, it should be possible to derive a certainty/probability ranking/value for target habitats.

In tandem with this, a 'fall back' vegetation (i.e. that achieved if the target type had failed to establish) was to be identified to enable an assessment of the remedial or mitigation measures that might be adopted. In many cases a functional land use and landscape can be achieved in a fall back situation.

It was considered that the most appropriate evidence for restoration schemes was the achievements of past similar restoration schemes (i.e. Case Studies). Where novel restoration proposals were proposed, the knowledge base should be based on field-scale Pilot Studies. Research in many cases, unless for a specific aspect (e.g. engineering of soil wetness) and in the same context, could be regarded as too speculative. Both case and pilot schemes are seemingly the preferred evidence-bases for restoration schemes.

Delivery Schedule and Evidence

Three types of upland grassland were proposed. A schedule was prepared for each and comprised the following information:

- Habitat (Target) Feature
- Land Use
- Character / Form
- Function
- Establishment
- Milestones and Timescales
- Delivery Monitoring
- Final Target Indicators
- Evidence
- Certainty
- Fall Back
- Areal Value Index

Acid Upland Grassland

The *Habitat Feature* is grassland and the *Land Use* on restoration is 145ha of upland open moorland. The *Character and Form* is to be acid grassland of a local landscape character comprising common bent-fescue-mat grass with bedstraw (National Vegetation Classification (NVC) U1/U5, *in sensu* Rodwell, 1992). The *Function* is low intensity grazed grassland providing open mountain top habitat and linkage to surrounding moorland on a landscape scale with biodiversity and visual landscape integration on the restored site.

Establishment details included the seed mixture, standard agricultural soil-seed bed preparation methods, supplementary fertiliser applications (no lime; spring 60kg N/ha, 40kg P_20_5/ha) and controlled grazing (from year 2, 3-10 ewes/ha April-August only) during the aftercare (establishment period), and rush control. Diversification of the grassland was to be achieved by natural colonisation and differentiation in response to the creation of a varied topography and drainage; locally supplemented with the over-sowing of harvested seed on a two year cycle (years 3, 5, 7, 9).

The *Milestones and Timescale to Achieve* the grasslands was <5 years for the core acid grassland and < 10 years for colonisation and initiation of a typical community character. The *Delivery Monitoring* (and final *Target Indicators*) comprised an annual species list and DAFOR scores (acid grassland species; predominantly bents, wavy hair grass, fescues, sorrel and bedstraw; with absent/rare agricultural ryegrass and clovers) for each phase, NVC survey after 10 years (U1 / U5), winter and summer photographs (spatial and temporal texture/colour variation in harmony with undisturbed land), soil tests (pH < 6.0; PK Indices < 2), a biennial

upland breeding bird survey (nesting and chick rearing of northern wheatear, skylark, meadow pipit).

The *Evidence* specifically required by the regulators and the National Park to gauge the *Certainty* of delivery of the acid grassland of a recognisable NVC type and the creation of micro-topography was provided as three Case Studies:

- Case Study - Model type of acid grassland created at Nant Helen site in the mid-1990s (described in Humphries, et. al., 1999)
- Case Study - Semi-natural grassland type of recognisable NVC type (described in Humphries and Benyon, 1999)
- Case Study - Micro-topography and diverse communities (described in Richards, 2009)

The case histories were accepted as evidence of 100% *Certainty* of delivery for this component of the upland restoration and giving an Areal Value Index (area x certainty) of 145ha of acid grassland.

The *Fall Back* position would be a less species rich acid fescue-bent grassland, but which would have the potential to diversify to achieve the same target vegetation, but over a longer period of time in the absence of further intervention.

Enclosed Agricultural Meadows

The *Habitat Feature* is grassland and the *Land Use* on restoration is 82ha of enclosed meadows on the mountainside. The *Character and Form* is to be productive neutral agricultural grassland comprising ryegrass and clover (National Vegetation Classification (NVC) MG7, *in sensu* Rodwell, 1992). The *Function* is to provide livestock grazing and winter forage for stock taken off the mountain top.

Establishment details included the seed mixture, standard agricultural soil-seed bed preparation methods, supplementary fertiliser applications (lime as-required; spring 80kg N/ha, 45kg P_20_5/ha, 45kg K_2O/ha), controlled grazing (from year 2, 10-20 ewes/ha March-November only) during the aftercare (establishment period), and rush control.

The *Milestones and Timescale to Achieve* the grasslands is 5 years. The *Delivery Monitoring* (and final *Target Indicators*) comprised an annual species list, DAFOR scores (neutral

agricultural grassland species; predominantly ryegrass, timothy, clovers) for each phase, and soil tests (pH > 6.0; PK Indices > 2).

The *Evidence* specifically required by the regulators and the National Park for gauging the *Certainty* of delivery of the productive agricultural grassland was provided in the form of a Case Study:

- Case Study - Model type of productive grassland created at adjacent Onllwyn site in the 1980s (described in Humphries and Leverton, 2010)

This past success was accepted by the authorities as evidence with a low risk of failure (i.e. 100% *Certainty* of delivery) for this element of the site restoration and giving an Areal Value Index (*area* x *% certainty*) of 82ha of neutral meadow grassland (i.e. the entire area proposed). For this type of grassland the *Fall Back* position would be similar neutral grassland.

Enclosed Wet/Marsh Grassland

The *Habitat Feature* is grassland and the *Land Use* on restoration is 20ha of enclosed wet/marshy grassland. The *Character and Form* is to be wet grassland of a local landscape character with purple moor grass and tormentil (National Vegetation Classification (NVC) M25, *in sensu* Rodwell, 1991). The *Function* is low intensity grazed grassland providing a diverse grassland community supporting a range of invertebrate assemblages of nature conservation value and visual landscape interface between open upland and enclosed grasslands of the restored site.

Establishment details included the specific landform required (gently sloping with base soil flow in subsoil, oversown with marshy grassland seed mixture, standard agricultural soil-seed bed preparation methods, supplementary fertiliser applications (no lime; spring 40kg N/ha, 20kg P_20_5/ha), controlled grazing (from year 3, 3-5 cattle/ha June-August only/with rest years) during the aftercare (establishment period), and rush control. Introduction of devil's-bit scabious as plant plugs in years 3-5. Diversification of the grassland was to be achieved by natural colonisation and differentiation in response to the creation of a varied topography and drainage; locally supplemented with the over-sowing of harvested seed on a two year cycle (years 3, 5, 7, 9).

The *Milestones and Timescale to Achieve* the grasslands was < 10 years for the core acid grassland and < 10 years for colonisation and initiation of a typical community character. The *Delivery Monitoring* (and final *Target Indicators*) comprised an annual species list, DAFOR scores (> 25% cover purple moor grass, > 'rare' abundance of devil's-bit scabious), NVC survey after 10 years (M25), winter and summer photographs (spatial and temporal texture/colour variation in harmony with undisturbed land), soil wetness (SW Class V), soil tests (pH < 6.0; PK Indices < 1), and triennial invertebrate transects / sweeps for butterflies and moths (meadow brown, small heath, small square-spot, Devon carpet, marsh fritillary).

The *Evidence* specifically required by the regulators and the National Park to gauge to the *Certainty* of delivery of purple moor grass wet grassland of a recognisable NVC type, the ability to engineer wet soils of the required wetness, and the successful use of plant plugs to introduce key plant species was provided as two Case Studies and two Pilot Studies:

- Case Study - Model type of wet purple moor grass grassland previously created in the mid-1990s restoration at Nant Helen site
- Pilot Study - Over-sown wet grasslands of recognisable NVC type (described in Carstairs, 2007)
- Pilot Study - Engineered soil profiles to create Soil Wetness Class V (described in Humphries et al, 1995)
- Case Study - Successful introduction of plants as 'plugs' (described in Richards, 2009)

The studies were accepted as evidence with a 90% *Certainty* of delivery for this component of the upland restoration and giving an Areal Value Index (*area x certainty*) of 18ha out of 20ha of the proposed wet grassland.

The *Fall Back* position would be an 'improved' type of hay meadow (NVC MG 5 / MG6) - which would not support the proposed diverse invertebrate assemblages and integrate into the upland setting.

Only after detailed examination of the supporting restoration evidence by the nature conservation regulator and the National Park was the Nant Helen extension scheme accepted by the planning authority. The application was given consent, subject to conditions and legal agreements, by the Mineral Planning Authority in early 2012. Had the restoration scheme been

based on traditional agriculture or forestry after uses, it is certain that evidence for its success would not have been demanded (given the track record over the past 20 years and published guidance). In this case, the traditional restoration practice would not have been acceptable because of the location of the site and the aspirations of the regulators for biodiversity action plan habitats to be established. Such a scheme would have been refused and resulted in lengthy costly delays if the decision went to appeal and with no certainty of the decision being over-ruled. Clearly, the message to the industry is where there is no track record for a particular land use or habitat type, it will need to provide up-front evidence of its certainty of achievement, and particularly in the case of 'natural' vegetation.

Implications For Future Restoration Schemes

The authorities and regulators requiring evidence to support various aspects of mining schemes should not be a total surprise to the minerals industry as the approach is implied, even if not stated, in the guidance such as the Department of Communities and Local Government's (2006) Planning and Minerals Practice Guide, the Scottish Executive's Planning for Minerals or the Welsh Assembly Government's (2009) Minerals Technical Advice Notes.

Biodiversity Driven Restoration Schemes

The mineral industry is seen as a major facilitator of the UK's biodiversity recovery programme (Humphries, et. al., 2000), and has in many cases made positive contributions to national and local programmes (e.g. Meade and Humphries, 2007). There has been enthusiasm in all quarters, the planning authority, regulator, non-governmental organisations and mineral companies to proffer biodiversity schemes.

Government, local authorities and regulators are now legally responsible for the protection and enhancement of national and local biodiversity, and their performance is audited annually (Her Majesty's Government, 2006). Any loss of biodiversity through granting a planning consent or the failure of replacement or enhancement restoration schemes to deliver will be of concern to them. There is an imperative for them that such schemes comply with the statute and policies, and are successful. Hence, there is seemingly an overt push for an evidence-base approach where a biodiversity led scheme is proposed.

As a cautionary note, Banks (2009) reminds us, the hurdle for achievement in evidence based schemes will be ever raised and more stringent sanctions applied. He refers to government and

regulators being “frank and fearless” in exercising the evidence approach, and warns of ever higher introduction of analytical hurdles requiring greater qualification of benefits and stronger sanctions for inadequate compliance. The outcome could result in excessive delays; a topic of considerable cause for concern in the industry.

There is a risk that a point will be reached when the evidence demanded may materially become out of proportion to the benefit gained or protection sought, and development is essentially blocked or the delay commercially compromises the project. Such may have already occurred in the UK in respect of the protection of important habitats and species by the EU Habitats and Wild Birds Directives and affecting the progress of major projects (Her Majesty's Government, 2012). This has instigated the Coalition Government to carry out a joint review by developers, industry, regulators and its policy making departments to streamline the *evidence-based* process to a more *risk-based* approach in concert with data sharing.

Sources of Evidence

There is also a move, initiated by the UK Coalition Government, to encourage the pooling and sharing of environmental data between industry, developers, regulators and planning authorities to assist in arriving at acceptable impact assessments (including mitigation and compensation) on important habitats and species (Her Majesty's Government, 2012). This has resulted in the setting up of 'expert' government bodies and easier access to sources of information, clearly demonstrating awareness in government, local authorities and regulators of the resource demands of the scientific evidence-based approach. The initiative is directed at major nationally important infrastructure and power projects, particular those involving marine development, but not minerals *per se.*

There is currently no central data-holding body for assessing evidence-based restoration success for the minerals industry in the UK. Each minerals company is be expected to have and maintain its own evidence-bank. Although mining and quarrying trade associations have over the years pooled case histories and examples of best practice, these are usually non-technical and may have limitations in their use.

In the 1970s-1990s the UK government funded several programmes of research into restoration practices through its research institutes like the National Agricultural Advisory Service (later the Agriculture Development and Advisory Service) and the Forestry Commission,

and also universities. Whilst government focus was on the restoration of the extensive mineral wastes arising from the legacies of the slate, china clay and coal industries, it also funded other research such as techniques to restore prime agricultural land and reduce the visual impact of aggregate quarries. The research was very beneficial and the findings provide much of the technical guidance contained in the current planning policy guidance (Department of the Environment, 1996; Office of the Deputy Prime Minister, 2005; Scottish Executive, 2006; Welsh Government, 2009). However, the justification for public funding stopped with reclamation of much of the legacies. Subsequently, the aggregate industry was taxed in the form of a levy (Aggregates Sustainability Levy Fund), part of which was used to fund more than 200 environmental projects between 2002 and 2011, including restoration studies and the collation of best practices. This source of funding has now ceased to be available. Consequently, restoration knowledge base is highly fragmented and can be difficult to source, and is likely to be insufficient to meet both some of the current and future demands for scientific evidence.

It is believed there is justification for a UK centre for the restoration of mineral workings (Humphries, 2000). Such a centre could not only be an open source of information, but also carry out a risk-based assessment for likely achievement of proposals. It has been suggested that government or similar institution are better placed to carry out or organise the type of research required than individual mining companies. In the current austere times this sort of initiative is unlikely, however, it is believed this could be self-financing through a levy applied nationally to (mineral) planning application fees (R. Thompson, pers. com.).

In the interim, given that the knowledge base regarding the establishment of habitats (other than agriculture and forestry) is incomplete, it is only to be expected that more evidence will need to be provided at each and subsequent mining scheme. As the lead-in times involved are likely to be long as the primary evidence will most likely be in the form of trials and case histories, the mining companies need to initiate research/pilot programmes well in advance so that the evidence is available in a timely manner.

Forward Looking

The evidence-based approach has only been required of mining businesses recently. This means that the industry has to catch-up the authorities and regulators in its understanding and thinking, and responses.

Clearly, the minerals industry needs to be forward looking and should not take the stance that it is to be solely concerned with the implementation of and compliance with government policies. Monitoring data it collects from successful projects provides the opportunity to challenge government and the regulators, and become a driver for policy-making. To avoid surprises, the industry should have the foresight to examine its operations and identify the evidence likely to be required in the future, including policy changes.

The indications are that the mining industry will be expected to collect the evidence needed to defend and challenge, and to provide evidence for delivery of its implementation schemes. The collection of appropriate evidence will take time and resources, in some cases there will be an '*evidence-void*' for a period of time. Where such evidence is critical, either, contingency plans will be required or a case for trialling and monitoring will be developed or otherwise *expertise* in the traditional sense will have to be relied upon.

Implicitly, it would be expected that any operational matter could be subject to challenge, particularly those which are design based (e.g. stability of excavations and tips, restoration), but also some that are subject to regulation (noise, dust, water). It would be expected that such operational activities would have monitoring data as evidence (typified as case histories). To address such requirements, the industry should identify those areas where monitoring data will be necessary and ensure it has a sufficient and robust 'evidence bank' it can draw upon. If this is not currently available, it will take time and effort to construct one, and in many cases it will take a specific initiative. For novel operations or proposals it is to be expected that an evidence base is created in advance of a proposal being made; this will require foresight on behalf of the mining industry as such data takes time to collect. The type of evidence required (i.e. review, research, case study, pilot study) will depend on the topic and circumstances, and the degree of uncertainty of knowledge; the use of expert knowledge in these circumstances is of less weight than 'hard' facts.

In driving for sustainable development the UK Government is now expecting ecosystem principles to be applied to all developments (Her Majesty's Government, 2011). The application of the approach to mining schemes has become established on the international mining scene. With sufficient foresight, the mineral industry's future approach to restoration will have to embrace ecosystem services in its evidence collection; whether it is replacement services or the

provision of new or additional ones. Consequently, the scope of restoration evidence to be provided may well go beyond the traditional measures of vegetation and soil productivity to embrace the likes of contribution to hydrological function and soil carbon sequestration on a wider landscape and catchment basis.

Acknowledgements

I am grateful to Celtic Energy Ltd for allowing me to use their Nant Helen surface coal mine site as an example of an evidence-based approach. The views expressed in this paper are solely those of the author and not necessarily those of Celtic Energy Ltd.

In preparing this paper I am pleased to acknowledge helpful thoughts and opinions shared by my colleagues and friends within the minerals industry; in particular Rob Thompson and Dr Mike Gandy (Celtic Energy), and David Park (Lafarge Aggregates UK).

Literature Cited

Banks, G. 2009. Challenges of Evidence-Based Policy-Making. Commonwealth Government of Australia, Brisbane.

Cabinet Office. 1999a. White Paper: Modernising Government. Her Majesty's Government, London.

Cabinet Office. 1999b. Profesional Policy-Making for the Twenty First Century. Her Majesty's Government, London.

Carstairs, I. 2007. Chapter Thirteen, Sowing Seeds. pp125-129. The Yorkshire River Derwent: Moments in time. Halsgrove Press.

Cullingworth, B. and V. Nadin, 2002. Town and Country Planning in the UK, 13th Edition. Routeledge, London.

Davies, P. 2004. Is Evidence-Based Government Possible? The Jerry Lee Lecture, 4th Annual Campbell Collaboration Colloquium. Washington D.C.

Department of the Environment. 1996. Mineral Planning Guidance Note 7: Reclamation of Mineral Workings. London.

Department of Communities and Local Government. 2006. Planning and Minerals: Practice Guide. TSO, London.

Gray, J.A.M. 1997. Evidence-Based Healthcare: how to make health policy and management decisions. Churchill Livingstone, New York.

Her Majesty's Government. 2006. The Natural Environment and Rural Communities Act. London.

Her Majesty's Government. 2011. The Natural Choice: Securing the value of nature (CM 8082). London.

Her Majesty's Government. 2012. Report of the Habitats and Wild Birds Directives Implementation Review. London

Humphries, C.E.L., R.N. Humphries, and H. Wesemann. 1999. The role of a fertiliser trial in reconciling agricultural expectations and landscape ecology requirements of an opencast site in South Wales, United Kingdom. Pp 262-272. In S. A. Bengson and D. M. Bland (eds). Proceedings of 16th Annual National Conference of the American Society of Surface Mining and Reclamation, Scottsdale, AZ.
https://doi.org/10.21000/JASMR99010262

Humphries, R.N., P.R. Benyon, and R.E. Leverton. 1995. Hydrological performance of a reconstructed (wet) heath soil profile. Land Contamination and Reclamation, 3: 101-103.

Humphries, R.N. and P.R. Benyon. 1999. Standard criteria and methods to assess the reclamation of native vegetation on mined land. pp 72-80. *In* Bengson, S.A. and D.M. Bland (eds). Proceedings of 16th Annual National Conference of the American Society of Surface Mining and Reclamation, Scottsdale, AZ.
https://doi.org/10.21000/JASMR99010070

Humphries, R.N. 2000. An evaluative methodology for reclamation achievement and techniques. pp 345-352. *In* Daniels, W.L. and S.G. Richardson, (eds). Proceedings of the 17th Annual National Conference of the American Society for Surface Mining and Reclamation, Tampa, FL.
https://doi.org/10.21000/JASMR00010345

Humphries, R.N., P.J. Horton, and R. Foster. 2000. Biodiversity and mineral extraction in the United Kingdom: A biological action plan. pp 376-385. *In* Daniels, W. L. and S.G. Richardson, (eds). Proceedings of the 17th Annual National Conference of the American Society for Surface Mining and Reclamation, Tampa, FL.
https://doi.org/10.21000/JASMR00010376

Humphries, R.N. and R.L. Leverton, 2010. Onllwyn – Agricultural Land Classification Survey of Land Restored with Soil Forming Material in mid-1980s. Celtic Energy, Caerphilly.

Humphries, R.N. 2012. Understanding the implications of soil carbon land use policies for open pit mining in the United Kingdom. Proceedings America Society of Mining and Reclamation, 2012 pp 269-285. http://dx.doi.org/10.21000/JASMR12010269

Landberg, F., S. Ozment, M. Stickler, N. Henninger, J. Treweek, O. Venn, and G. Mock. 2011. Working Paper: Ecosystem Services Review for Impact Assessment - Introduction and Guide to Scoping. World Resources Institute. Washington D.C.

Meade, R. and R.N. Humphries, (eds). 2007. Mineral Extraction and Wetland Creation. Natural England, Peterborough.

Office of the Deputy Prime Minister. 2005. Mineral Policy Statement 2: Controlling and Mitigating the Environmental Effects of Mineral Extraction in England. London.

Richards, J. 2009. *Alchemilla micans* at Keepershield Quarry, South Northumberland (v.c.67). Botanical Society of British Isles, News, November 2009, pp10-11.

Rodwell, J.S., (ed). 1991. British Plant Communities, Volume 2, Mires and Heaths. CUP, Cambridge.

Rodwell, J.S., (ed). 1992. British Plant Communities, Volume 3, Grasslands and Montane Communities. CUP, Cambridge.

Scottish Executive. 2006. Scottish Planning Policy, SSP4, Planning for Minerals. Edinburgh.

Smith, A.F.M. 1996. Mad cows and ecstasy: chance and choice in an evidence-base society. Journal of the Royal Statistical Society, A, 159, (3), 367-383.

UK National Ecosystem Assessment. 2011. The UK National Ecosystem Assessment: Synthesis of the Key Findings. UNEP-WCMC. Cambridge.

Welsh Assembly Government. 2009. Minerals Advice Note 2: Coal. Cardiff.