



CRC CARE

*A safer, cleaner
environmental future*

Dealing with Derelict Mines 2016

International Summit on Derelict Mines

Novel risk-based approaches to managing problems, issues and policy challenges

6–8 December 2016

Singleton Diggers, York Street, Singleton NSW 2330

Summit abstracts



THE UNIVERSITY OF
NEWCASTLE
AUSTRALIA



**Department
of Industry**



Australian Government
Department of Industry,
Innovation and Science

Business

Cooperative Research
Centres Programme

Cooperative Research Centre for **Contamination
Assessment and Remediation of the Environment**

www.crccare.com

Contents

Chris McCombe: Perspectives on the minerals industry.....	2
Gilles Tremblay: Managing orphaned and abandoned mines – The Canadian perspective.....	3
Dr Yubiao Li: Derelict mine management in China – opportunities and challenges.....	4
Professor Harold Annegarn: Abandoned and derelict mines of the Witwatersrand: reclamation, restoration and reparations.....	5
Dr Hugh Potter: Cleaning up centuries of pollution: the UK approach to managing abandoned mines.....	6
Erinn Shirley: Abandoned mine land management in the United States: a 25-year perspective at the Bureau of Land Management.....	7
David Blackmore: Overview of NSW Derelict Mines Program.....	8
David Blackmore: Woodsreef asbestos mine remediation – a whole-of-government approach.....	9
Mike Fawcett: Managing mining legacies in the Northern Territory.....	11
Mike Fawcett: Redbank Copper Mine – a legacy mine case study.....	12
Oskar Kadletz: An overview of the Queensland Abandoned Mine Lands Program.....	13
Karen Caple: Mine closure in Western Australia.....	14
Dr Peter Nadebaum: Developing an appropriate response to the Australian derelict mines problem.....	15
Antonia Scrase and Raul Mollehuara: Former mines in South Australia and lessons of a long-term remediation strategy at Brukunga mine site.....	16
André Kemp: Reducing risk through improved contaminant source term understanding.....	17
Professor Tim Roberts: Derelict mines: ownership past, present and future.....	18
Stephen White: A portfolio of rehabilitation and remediation experience in Minerals Australia.....	19
Stuart Ritchie: Managing rehabilitation and closure to avoid derelict mines.....	20
Barbara Campany: Risk and reputation management matters associated with the risk communication management of derelict mines.....	21
Dr Jeff Taylor: Inert atmosphere installations – a new approach to controlling AMD discharges from underground mines.....	22
Dr Dane Lamb: Application of a risk-based approach to sites in NSW.....	23
Professor Garry Willgoose: Sustainable mine rehabilitation: resolving the technical issues ...	24

Chris McCombe: Perspectives on the minerals industry

Assistant Director-Environmental Policy, Minerals Council of Australia



Gilles Tremblay: Managing orphaned and abandoned mines – The Canadian perspective

Technical Manager, International Network for Acid Prevention (INAP)

Gilles.tremblay@inap.com.au



Abstract

Gilles Tremblay, Technical Manager, International Network for Acid Prevention (INAP)

Charlene Hogan, National Orphaned/Abandoned Mines Initiative (NOAMI) Secretariat

The legacy of orphaned and abandoned mines, including environmental liability, human health concerns, and the cost of clean-up and long-term monitoring and maintenance is a serious issue facing Canada and many other countries. Orphaned or abandoned mines are those for which the owner cannot be found, or is financially unable or unwilling to remediate the site. These mines can pose environmental, health, safety and economic problems for communities, the mining industry and governments.

The National Orphaned/Abandoned Mines Initiative (NOAMI) was formed in 2002 at the request of the Canadian Mines Ministers, and based on recommendations put forward at a multistakeholder workshop, Orphaned and Abandoned Mines in Canada, held in Winnipeg in 2001. The workshop determined the key issues associated with orphaned/abandoned mine sites, and laid down a series of guiding principles and objectives which apply to NOAMI as it exists today.

NOAMI is guided by a multi-stakeholder Advisory Committee that brings together representatives from the mining industry, federal, provincial and territorial governments, non-governmental organizations and Aboriginal Canadians. NOAMI's activities are jointly funded by the federal, provincial and territorial governments and industry and are administered by a secretariat at Natural Resources Canada.

NOAMI does not directly clean up orphaned and abandoned mine sites. Rather, they assess issues and make recommendations for collaborative implementation of remediation programs and policies for orphaned and abandoned mines across Canada. The program examines two aspects of orphaned and abandoned mines – issues surrounding remediation and long-term management of existing sites, and best practices to prevent the occurrence of future abandonments. A pan-Canadian effort, NOAMI has made tremendous progress in the past 12 years in fulfilling this mandate. The achievements of NOAMI and its jurisdictional partners are demonstrated by studies that reflect different approaches and partnerships.

Dr Yubiao Li: Derelict mine management in China – opportunities and challenges

Associate Professor, Wuhan University of Technology in China



Abstract

In China, over 95% of fuel, 80% and 70% of the industrial and agricultural raw materials, respectively, are from mineral resources. After taking useful minerals from the natural deposits, most of the mining sites become a legacy problem, e.g. producing acid mine drainage, resulting in water and soil erosion as well as geological disaster. Currently, there are more than 100,000 derelict mines in China, with most of them being not yet remediated. Both the central and local governments, together with the private companies, invest more than 10 billion RMB each year in mine site remediating activities including revegetation, rebuilding them into national- or provincial- scale mine parks, however, more improvements are required to successfully achieve the overall aims. Hence, both opportunities and challenges derived from the derelict mines are waiting for both domestic and international cooperation from academic and industrial people.

Professor Harold Annegarn: Abandoned and derelict mines of the Witwatersrand: reclamation, restoration and reparations

Adjunct Professor, Energy Institute @ SARETEC, Cape Peninsula University of Technology; and

Extraordinary Professor, Geography and Environmental Management North West University Potchefstroom

Symphony Way, Bellville, Cape Town, South Africa.
hannegarn@gmail.com



Abstract

The term 'Derelict Mines' evokes an image of ghost towns, with ruins of buildings and mine infrastructure half covered with wind-blown sand. Within a broader concept, one may use this term to categorise any mining operation post the phase of ore recovery of the primary mineral resource. South Africa, once the world's leading gold production region, reached peak gold production in 1976. Subsequently, many of the original mines on the Witwatersrand gold field reached end-of-life of recoverable ore, and either have been passed to new owners, abandoned without traceable owner, or repurposed. This paper will present a broad overview of the positive and negative aspects of the legacy gold mines of the Witwatersrand region, touching on infrastructure, environmental, social, economic and developmental aspects. The topic will be dealt with under three themes:

Reclamation - recovering mineral value from legacy mine tailings, and the environmental consequences associated with reclamation activities.

Restoration - repairing damaged landscapes into usable land; deriving economic value from repurposed land and infrastructure. Purposeful urban planning incorporating former gold mining land has successfully transformed the urban landscape of Johannesburg.

Reparations – for the human dereliction of legacy mining. Legal processes have been instituted to claim compensation and restorative justice for retired miners suffering from silicosis.

The review reveals many innovative and positive approaches that have been implemented on the Witwatersrand to deal with derelict mines, and draws attention to some of the remaining challenges.

Dr Hugh Potter: Cleaning up centuries of pollution: the UK approach to managing abandoned mines

Technical Advisor in the National Geosciences Team of the Environment Agency's Environment & Business Directorate

Visiting Fellow in the Newcastle University Institute for Sustainability



Abstract

The UK has a long history of mining with evidence of Bronze Age, Roman and medieval activity. The most productive period was during the 18th and 19th centuries however very few of these 10,000 mines remain active today. Abandoned mines contribute up to half of the metals such as cadmium, lead, zinc, copper and iron found in surface waters - as much as all permitted discharges from industry combined.

Until 2000, operators could abandon mines without any liability for pollution. The UK Government has given the Environment Agency and Coal Authority the task of dealing with this industrial legacy. Abandoned coal mines were government-run until 1994 and so the UK Government accepts a duty to deal with pollution from deep mines. More than 250km of rivers have been cleaned up and several groundwater drinking water supplies have been protected.

Almost all the metal mines closed in the early 20th century but they continue to damage aquatic life in more than 2,000km of rivers. These mines were all privately owned. In 2010, the UK Government provided funding to begin to clean up this pollution. Three treatment schemes, including the first passive system in Europe to remove zinc and cadmium in a compost-based pond, protect 15km of rivers.

The main challenges to cleaning up rivers are better quantification of metal sources at catchment scale, minimising long term operating costs, persuading the public to accept treatment systems in their communities, securing long term funding and predicting the ecological recovery of aquatic ecosystems.

Erinn Shirley: Abandoned mine land management in the United States: a 25-year perspective at the Bureau of Land Management

Abandoned Mine Lands Specialist – US Department of the Interior, Bureau of Land Management

20 M St. SE Washington, DC 20003, eshirley@blm.gov



Abstract

The Bureau of Land Management (BLM) is an agency within the U.S. Department of the Interior and is the United States' largest public land manager. BLM has been addressing abandoned mine lands (AML) for over 25 years under its AML program. The program has grown from a pilot inventory to a budget of over \$16 million annually. The BLM, along with its federal, state, and local partners, inventories and addresses hundreds of AMLs each year. Even after a quarter century of addressing AMLs, the entire scope of the problem still remains unknown and the costs continue to accrue. With a multiple-use mission and other regulatory parameters, the BLM uses a risk-based approach to prioritizing physical safety and environmental features. Fiscal, regulatory, and social challenges are ubiquitous to the program which endeavors to restore environmental and safety impediments across the Western US.

David Blackmore: Overview of NSW Derelict Mines Program

Director Environmental Sustainability Unit. Division of Resources and Energy, NSW

Abstract

Dr D. P. T. Blackmore¹, N. G. Staheyeff¹, K Maddison¹

¹Division of Resources and Energy, NSW Department of Industry

PO Box 344 Hunter Region Mail Centre NSW 2310, Maitland, 2320, Australia

INTRODUCTION

The NSW Government recognises that it requires a proactive approach to managing derelict mines in accordance with best practice industry standards. These standards are imposed to ensure human safety and that the integrity of the environment is maintained.

Outstanding legacy issues surrounding over 550 derelict mines (Figure 1) have the potential to cause immediate safety and environmental impacts as well as, that if not managed, potentially contributing to community misunderstanding of the sustainable life cycle of mining, and hence, be potentially damaging to the industry overall.

As such, the Government understands that for current mining operations to attain a social licence and for the government to effectively regulate a sustainable mining industry, legacy issues must be adequately dealt with.

The Derelict Mines Program (DMP) within the Division of Resources and Energy (DRE) has recently finalised a risk assessment of all derelict mines across NSW. This risk assessment in turn informs an investigation and works program to be executed over the next several years.

The risk assessment has placed the DRE in a position, where a prioritised work program, targeting safety and the environment simultaneously in the management of derelict mines will result in:

- the improved and successful management of derelict mine sites throughout the state.
- maintenance of derelict mines management on the NSW Government agenda;
- formalised systems and processes based upon international standards to manage legacy mining issues.

The risk assessment program has been implemented with upgrades to the Derelict Mines Program Database, a data cleansing program of Derelict Mines information kept by Government and a program of site inspections and ground-truthing for highest priority sites.

DRE has successfully developed a semi-quantitative assessment of the risks to public safety and to the environment on derelict mines within NSW. The assessment groups derelict mine sites into categories ranging from negligible to extreme risk to assist in management.

Coupled with development of a spatially enabled Derelict Mines Program Database, this has enabled a rapid, systematic and formalised compilation of data concerning the key safety and environmental hazards of over 550 sites. DMP's approach to the assessments has been to use document and spatial databases as well as site visits and verification.

Prioritisation using the methodology has allowed DMP to channel resources into the highest risk sites, has allowed it to continue to implement its works program to meet Government objectives for management and remediation of derelict mines sites.

David Blackmore: Woodsreef asbestos mine remediation – a whole-of-government approach

Director Environmental Sustainability Unit. Division of Resources and Energy, NSW

Abstract

Dr D. P. T. Blackmore¹, N. G. Staheyeff¹, K Maddison¹

¹Division of Resources and Energy, NSW Department of Industry

PO Box 344 Hunter Region Mail Centre NSW 2310, Maitland, 2320, Australia

INTRODUCTION

The Woodsreef asbestos mine near Barraba ceased production in 1983 is undergoing remediation work by the NSW government to address public health risks associated with exposure to asbestos. The site itself comprised of a significant waste rock and tailings dumps which are uncapped, a number of open pits (some containing considerable quantities of water) and a number of derelict buildings. Open-cut mining for asbestos occurred at Woodsreef Mine between 1918 and 1923. Large scale mining continued between 1970 and 1983.

Whilst problems such as the legacy of the Woodsreef Asbestos Mine are minimised today because today's mines are strictly regulated and lodgement of a security deposit is required to cover rehabilitation costs, this site represented some unique constraints and issues that required a whole of government approach.

Following the NSW Ombudsman's report into the Woodsreef Asbestos Mine, \$6.3 million was allocated to address some of the most significant issues on the site.

The program of works has included:

- a health risk assessment
- comprehensive air monitoring program
- demolition of the dilapidated mill house and silos,
- burying the contaminated materials on site, and
- the closure of Mine Road, Woodsreef.

The NSW Government recognising the need to act proactively at this site allocated the funding of \$6.3 million for the special Woodsreef Mine Major Rehabilitation Project and this involved the formation of the first inter-agency team dealing with an issue such as this. The project is reported under a cross government agency - the Woodsreef Taskforce (being established in 2008).

The large-scale works program, which included demolition of structures also needed to factor in the need for careful relocation of the Large-eared Pied Bat, a threatened species that was roosting in the mill, and, hence, Federal Government Approvals.

The multi-agency Taskforce comprises representatives from the NSW Department of Industry, Ministry of Health, Environment Protection Authority, WorkCover NSW, Hunter New England Health and Crown Lands with the Derelict Mines Program as the Secretariat.

Works have included:

- Demolition scoping, planning and implementation
- State environmental approvals

Dealing with Derelict Mines 2016

- Commonwealth environmental approvals.
- Installation of a comprehensive air monitoring program and a health risk assessment.
- Drainage and erosion control works
- Closure of Mine Road to reduce access to the site.

A key component of the works programme has been the Commonwealth Department of the Environment granting approval to the Department of Industry to demolish infrastructure and carry out rehabilitation works at the derelict Woodsreef asbestos mine

In conjunction with the works programme Department of Industry has engaged suitably qualified experts to conduct an Air Monitoring and Health Risk Assessment Project. The final report, Long Term Health Risk Assessment, is scheduled to be finalised in late 2016 for release in 2017.

This report which will contain the data collected from air monitoring that was conducted prior, during and on conclusion of the demolition works plus activity based air monitoring will be utilised by the Government in the long term management of the mine.

Mike Fawcett: Managing mining legacies in the Northern Territory

Director Mining Remediation, Northern Territory
Department of Primary Industry and Resources

mike.fawcett@nt.gov.au



Abstract

The Northern Territory has a long history of mining reaching back to the gold rushes of the late 19th century. Moving into the 20th century there were significant surges in activity commencing in the 1930's in the Tennant Creek region. However, the most significant from the point of view of mining legacies occurred from the 1980's onwards, when the combination of rising gold prices and new technologies led to a large number of relatively short life mines being developed. The combination of the higher gold prices combined with the use of CIP/CIL treatment process allowed for previously uneconomic low-grade and often sulphidic ore bodies to be exploited.

The legacies left behind by these three phases of mining fall into two main categories; the late 1800's are mainly human safety, mid-20th century are a combination of safety and environmental and the late 20th century are predominantly environmental. In combination, informal assessments by the Department put the cost of remediating these unsecured legacies to be in the order of \$1 billion.

The Northern Territory Government is dealing with this issue on two fronts, firstly; since the mid-2000's instituting a policy of 100% security to cover the cost of remediation of approved activities undertaken by the operator. The security can only be in the form of cash or an unconditional bank guarantee. In addition the Department is very close to issuing comprehensive new Mine Closure Guidelines. In combination, these actions should ensure that no further unsecured liabilities accrue to the Government.

The second initiative was the amendment to the Mining Management Act in 2013 to require an annual cash levy to be paid by the authorised mine operator. The levy is set at 1% of the security held on an operation. The purpose of the levy is for the administration of the Act in relation to minimising or rectifying environmental harm caused by mining activities. At least 33% of the money collected by the levy must be paid into the Mining Remediation Fund, where the money may be used in connection with minimising or rectifying environmental harm caused by unsecured mining activities. The levy is expected to collect approximately \$13 million this year.

Income from the levy facilitated the establishment of a specialist Legacy Mines Unit (LMU) within the Department's Remediation Division. The LMU was fully staffed by early 2014 and commenced undertaking a range of activities and projects across the Northern Territory. The focus for the LMU has been to prepare an inventory of legacy sites across the NT, this is scheduled to be completed in the very near future, with the results being subjected to a formal risk assessment process that will identify priority projects. In parallel with this the LMU has completed approximately 20 projects at a cost of around \$2 million, most of which relate to priority human safety issues, with the remainder collecting information to allow for planning for actions on selected sites.

In the past year alone two legacy mine sites been surrendered to the Department and their cancelled. This along with one earlier surrender now leaves the Department with three significant legacy sites requiring management and remediation planning. They are; Goodall and Woolwonga in the Pine Creek Geosyncline and Redbank Copper mine in the Gulf region.

Mike Fawcett: Redbank Copper Mine – a legacy mine case study

Director Mining Remediation, Northern Territory Department of Primary Industry and Resources

mike.fawcett@nt.gov.au



Abstract

The Redbank Mine Site is located in the Gulf region approximately 1250 km by road east of Darwin and 40 km west of the Queensland border. Copper was discovered there in 1916 and then was mined on a small scale for the following 45 years. Between 1971 and 1992 there were a number of exploration programs undertaken and the site went through a multitude of owners, none of which were able to bring a mine into production.

In 1994, Redbank Copper Ltd developed the current open pit mine and constructed a processing plant on site. However, mining was only undertaken from March to December of that year before the processing plant was shut-down due to recovery issues. A modified processing plant was recommissioned in June 1995 and shut down again in July 1996, when the mine was placed on care and maintenance. No mining has been undertaken on site since June 1996. Since the mid-2000s the sites various owners have undertaken a number of exploration programs to prove-up sufficient resources to enable mining to recommence, none of these were successful. In June 2016 the Mining Leases covering the site were surrendered to the Department and cancelled

In 2012 the Department's Environmental Monitoring Unit (EMU) undertook a an extensive surface-water sampling program over 42 km of stream length and a total of 41 surface water samples were collected along the 42 km from the mine site to the QLD border. Results of this sampling indicated that copper contaminated water discharging from the site, via both surface and groundwater flows had measurable adverse impacts on water quality in the creek systems for over 35 km downstream from the site.

There are a number of registered Sacred Sites both adjacent to and downstream of the mine site that have been adversely impacted by the mine. Hanrahan's Pool and the waterways downstream are important to the traditional Aboriginal owners (TO's).

In 2013 the then Minister for Mines and Energy met with TO's on site and committed to use the mining remediation fund to address the ongoing issues at the mine site.

To date the former Department of Mines and Energy and Department of Primary Industry and Resources (DPIR) through the actions of its Legacy Mine Unit (LMU) has spent approximately \$1.01 million primarily sourced from the Mining Remediation Fund. In addition, indirect costs incurred by DPIR since 2012 are likely to be in excess of \$150,000.

Oskar Kadletz: An overview of the Queensland Abandoned Mine Lands Program

Abandoned Mines Coordinator, Department of Natural Resources and Mines (Queens

oskar.kadletz@dnrm.qld.gov.au



Abstract

Queensland is a major mining province and has a legacy of about 15,000 abandoned mine sites from 150 years of mining. The majority of these (about 95%) are very small sites consisting of just a few mining features such as mine shafts, shallow workings, small stockpiles, and remnant structures.

The program is directly responsible for the 3,500 abandoned mines on public land such as national parks, state forests, timber reserves and other State owned land.

Where there is a public interest, or mine induced subsidence has created a public hazard and unsafe living environment, the State may undertake work on an abandoned mine.

Activities of the program include ongoing management of approximately 20 large sites across the State, responding to reported hazards such as historic shaft collapses and subsidence of underground workings, maintaining the historic shaft repair programs in Gympie and Charters Towers, and administration of the Collingwood Park State Guarantee relating to major underground coal mine subsidence events at Ipswich in 2008 and 1988. A recent addition is managing the government owned land at Rainbow Beach which has legacies from historic mineral sands mining.

Progressive risk reduction at smaller abandoned mines is undertaken through assessment of mines sites close to communities and areas of human activity, followed by on-ground risk mitigation works.

The aim of the AMLP is not to fully remediate abandoned mine sites but rather to minimise and mitigate public risks in a cost effective manner using the State funds provided. Risk mitigation strategies are developed in consultation with local landholders, other stakeholders and the relevant government agencies to ensure that issues and expectations are understood and incorporated where possible.

The current level of funding for the Queensland Abandoned Mine Lands Program is \$8.3 million per year. Whilst the funding provides resources for management and maintenance of site safety and water control systems at the major sites, much more is required to enable progressive reduction of risks to a point where they are effectively closed out and the site can be passed back to private enterprise.

Most sites contain significant residual mineral resources within historic stockpiles such as tailings dams. New more cost efficient mineral processing techniques are required to make reprocessing activities economic and support site operations which could also assist in large-scale remediation of legacies. The Abandoned Mine Lands Program aims to facilitate such opportunities.

Mines newly disclaimed under Australian Federal Corporations law are a new challenge. The program works closely with other agencies responsible for mining regulation, including the Department of Environment and Heritage Protection to share information and knowledge on the best response for managing disclaimed mines and mines at risk of ceasing operation.

Karen Caple: Mine closure in Western Australia

General Manager, Administration and Reform

Department of Mines and Petroleum

karen.caple@dmp.wa.gov.au



Abstract

Abandoned mines have been an on-going legacy issue for the Western Australian Government since the mid-1900s with some 192,000 abandoned mine features currently recorded. To address this issue, after extensive consultation with the mining industry, the Government of Western Australia passed a new model of mining security, the Mining Rehabilitation Fund, which commenced in July 2013. While this model ensures that the rehabilitation liability for the State is adequately covered, it also provides a dedicated source of funding to address derelict and abandoned mine sites in Western Australia.

The Mining Rehabilitation Fund Act 2012 decrees that money in the fund can be used to rehabilitate abandoned mine sites as part of the Abandoned Mines Program after all efforts to recover the funds from the tenement holder/operation have been exhausted. Furthermore, it legislates that interest earned on the fund can be used to rehabilitate historical abandoned mine sites. The framework for the prioritisation, management and/or rehabilitation of abandoned mine sites is outlined in the Government of Western Australia's Abandoned Mines Policy released in January 2016.

The Abandoned Mines Program currently consists of four pilot projects which will test the approach and inform continuous improvement activities across all processes. In addition, an unplanned project was initiated in late 2015 following abandonment by the operating company. Rehabilitation work has been undertaken at three sites to date, including the site added in 2015, to address environmental and safety risks. Additional sites will be selected for inclusion in the Abandoned Mines Program using a risk-based assessment and prioritisation process.

Dr Peter Nadebaum: Developing an appropriate response to the Australian derelict mines problem

Senior Principal - Environment at GHD



Antonia Scrase and Raul Mollehuara: Former mines in South Australia and lessons of a long-term remediation strategy at Brukunga mine site

Antonia Scrase: Principal Officer Mine Closure, antonia.scrase@sa.gov.au

Raul Mollehuara: Project Director Brukunga Remediation Strategy,
Raul.mollehuara@sa.gov.au

Mineral Resources Division, Department of State Development, South Australia

Abstract

Mining has occurred in South Australia since the early 1840s with the first Australian metal mines at Glen Osmond and copper mines at Kapunda and Burra. Mining is part of the rich cultural heritage of South Australia and was responsible for the State's economic development from early colonisation. This has resulted in up to 3000 mines, pits and quarries that were abandoned after the resource was exhausted. Most of these sites were never rehabilitated and, as a result, the responsibility and liability has reverted to the Crown or to private owners. Today, mining legislation provides a regulatory framework for ensuring mining operations achieve appropriate closure outcomes.

Liability for public safety and environmental effects resulting from mining of a former mine wherever it has occurred, is a complex issue and hinges on the specifics of each case. In general, but depending on the circumstances, a landowner (including where applicable the Government) is likely to have the primary responsibility for public safety and environmental matters in respect of former mines.

Rehabilitation for former mines is on site by site basis, usually driven by stakeholder interest or known impacts to the environment. South Australia is looking to develop a state wide or collaborate on a national approach risk tool/ process for determining risk rankings of former mines to enable a risk based approach to rehabilitation to be adopted.

The Brukunga mine site case study

The South Australian Government is responsible for the former Brukunga Mine since 1977. The mine has not been rehabilitated and has approximately 11.5 million tonnes of mine waste rock and tailings. The waste at Brukunga generates acid and metalliferous drainage (AMD) that led to water pollution of the local creek (Dawesley Creek) during and post-operation. The implications for the site and the local creek were significant, it raised public concerns and community reaction in particular from local and downstream land holders as water in the creek could not be used.

In 2001, the Government committed to address the issue of water quality in Dawesley Creek and to carry out mine rehabilitation at the site.

Water quality in Dawesley Creek has been managed through a creek diversion and the operation of an acid neutralisation plant and associated infrastructure. It is an operational approach that poses risk and a financial liability.

The long term strategy designed and developed by a Technical Advisory Group through a series of extensive research and investigations validated a sound and robust concept for a long term remediation of the site. The concept of a saturated co-disposal of mine wastes involves the encapsulation of tailings, waste rock and limestone within an engineered impoundment.

The extent of investigation, modelling and engineering carried out at Brukunga has highlighted the complexities and challenges involved in rehabilitating a former mine in accordance with current standards and a mine completion criteria.

André Kemp: Reducing risk through improved contaminant source term understanding

Principal Engineer, O’Kane Consultants



Abstract

Andre Kemp¹, Josh Pearce² and Paul Weber³

¹ O’Kane Consultants (OKC), Perth, Australia, Principal Civil Environmental Engineer, akemp@okc-sk.com

² O’Kane Consultants (OKC), Perth, Australia, Senior Environmental Geochemist, jpearce@okc-sk.com

³ O’Kane Consultants (OKC), New Zealand, Principal Geochemist, pweber@okc-sk.com

Abstract

Reducing risk to the receiving environment and environmental liabilities for derelict mines is a key objective for environmental and closure professionals worldwide. It requires understanding relationships between key physical and geochemical processes for any given site and the development of a site specific conceptual model. If these key processes and their relationships can be determined as part of understanding site specific contaminant loads, hydrological and hydrogeological regimes, and source term characterisation, it is possible to focus rehabilitation efforts on the process that will have the greatest influence on minimising risk and environmental liabilities.

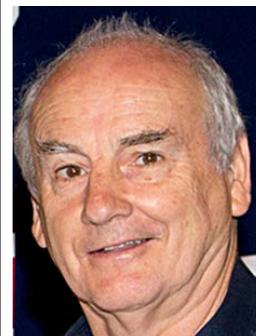
For legacy sites (and operational ones) with mine impacted drainage issues, there are often numerous impacted seeps and streams, which can be used to determine typical water quality, solubility constraints, flow rates, and contaminant loads from their parent structures. This requires the development of a conceptual model for the catchment to determine source terms (water quality) from the various site structures (waste rock dump, tailings storage facility, pit walls), which are based on flow rates and water quality. The conceptual model validated and developed from flow, quality, and load data will indicate the key processes contributing to poor water quality in the catchment and thus the targets for focused cost-orientated rehabilitation efforts.

For many sites, development of the conceptual model often identifies waste rock dumps as the key controlling structure for site water quality. Therefore, understanding the composition of the waste rock (e.g., geochemical/physical attributes), how it was constructed (e.g., high tip head versus paddock dump construction methods including spatial distribution), and the hydrological regime enables a more informed assessment of remediation options and their associated costs. For instance, remediation alternatives can include passive and active water treatment technologies, reducing net percolation through infiltration management to reduce contaminant load, and even reconstruction activities. All options need to be considered, often with a number of techniques being employed to determine from a cost:benefit perspective the best outcome for stakeholders.

The following paper discusses how various methods have been employed to improve our understanding of key contaminant sources, which have subsequently driven remediation options to reduce risk and liability for both derelict and operational sites.

Professor Tim Roberts: Derelict mines: ownership past, present and future

Director, The Tom Farrell Institute for the Environment
IDC219, Industry Development Centre, University of Newcastle



Abstract

Tim Roberts, Elspeth Pottie & Steven Lucas

Tom Farrell Institute for the Environment, The University of Newcastle, Callaghan, NSW2308, AUSTRALIA. Tim.roberts@newcastle.edu.au

Abstract

Since time immemorial, the mining of the earth's riches has been a universal and necessary function of societies across the world. The situation has been no different in Australia, from the workings that yielded the stone agate implements of the indigenous peoples, through to the sandstone quarries of the First Fleeters, the shafts of the gold rushes, and most recently the huge excavations of coal mining. For individual wealth creation, and national wealth creation through taxing with licences and royalties, the riches have been there for the taking. From the dawn of mining, the abandonment of the mine once the resource has been exhausted has been common practice, with clean up, restoration and reinstatement of the landscape left to the communities who inhabited the space pre-mining. With some 50,000 abandoned mines across Australia, the impact on these communities is manifold. From innocuous holes in the ground used for recreation and often viewed as historic relics, to disturbed land prone to sinkholes and subsidence, through to highly dangerous toxic and acidic leachate emitters, mining leaves its mark on the land and communities. Although governments have been quick to set in place the taxing implements related to active mining, it is only in recent decades that rehabilitation requirements have been enshrined in legislation.

A derelict mine is one that no longer has an owner, but through the legacy it leaves, it is indeed "owned" by the community of that area. These communities associated with the landscape before it was disturbed live with the impacts now and into the future. Similarly, the government has moral ownership of the derelict mine, having been party to approval and implementation of the mine through licensing, taxing and royalty collection.

The socio-cultural legacies of abandoned mines are intimately intertwined with the environmental legacies which are all too often a visible scar on the landscape. Communities endure however, and the derelict mines, whilst inducing solastalgia in the individual generations that lived through the period of active mine life, in some cases offer opportunities for new uses of the landscape, and in others an enduring environmental hazard.

Stephen White: A portfolio of rehabilitation and remediation experience in Minerals Australia

Manager Rehabilitation and Biodiversity at BHP Billiton

Principal Rehabilitation and Biodiversity, Health Safety and Environment Analysis and Improvement

BHP Billiton Minerals Australia, 125 St Georges Terrace, Perth WA

stephen.m.white@bhpbilliton.com



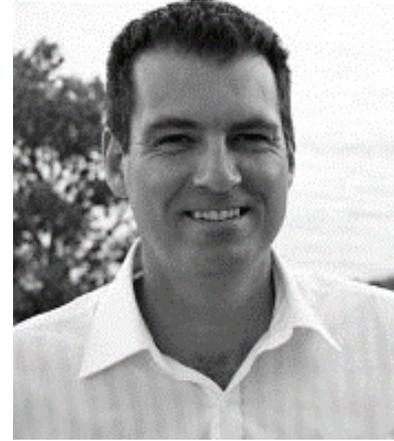
Abstract

BHP Billiton has recently undergone a business wide organisational restructure. This has resulted in assets previously managed by commodity, now being managed by region. Three operational units now exist, Minerals America, Petroleum and Minerals Australia. This presentation will consider knowledge sharing on closure, rehabilitation and remediation with three different operational situations within Minerals Australia.

Stuart Ritchie: Managing rehabilitation and closure to avoid derelict mines

Manager Environment, Rio Tinto Coal Australia

Stuart.Ritchie@riotinto.com



Abstract

This paper addresses the closure governance processes developed and utilised by Rio Tinto and then explores the various drivers leading to rehabilitation and closure by way of two current closure case studies.

Barbara Campany: Risk and reputation management matters associated with the risk communication management of derelict mines

Executive Advisor, Strategic communications, GHD,
Barbara.Campany@ghd.com



Abstract

The great balancing act: How can we work together to create better environmental outcomes and preserve social values in an operating context of high profile, high risk contentious issues associated with the communications on assessment and remediation of contaminated sites?

The presentation explores issues associated with the management of Derelict Mine sites through the lens of risk communications and reputational impacts. Exploring how the formation of key relationships has a direct impact on how well people and groups receive and accept information and facts.

The presentation explores how all parties from policy makers, environmental regulators, industry operators, community and social planners need to aggressively collaborate to safeguard people and communities social, economic and physical health through developing innovative and sustainable communication and engagement strategies and solutions. Practical communication approaches that raise awareness, inform, educate and engage honestly and early to lessen the potential for adverse responses. Minimising risk.

Providing advice on how to better communicate often dense and confronting technical detail in a manner that is accessible to the non-technical individual or group is an essential piece of being effective and being perceived as transparent and operating with integrity and consideration.

The presentation also explores how poor communication or incorrectly targeted communications escalate risk levels, can destroy trust and even cause projects to stall or be played out in the public media arena. All going toward the high risk scenario of damaging reputations and making future communications and relationships problematic.

Dr Jeff Taylor: Inert atmosphere installations – a new approach to controlling AMD discharges from underground mines

Director, Senior Principal Environmental Geochemist,
Earth Systems, enviro@earthsystems.com.au

Abstract

Nic Bourgeot¹, John A. Muchan¹, Andrew Sampaklis², Nick Staheyeff², and Jeff R. Taylor¹

¹Earth Systems Pty. Ltd., 14 Church Street, Hawthorn, Melbourne, Victoria, 3122, Australia. enviro@earthsystems.com.au

²NSW Department of Industry, Division of Resources and Energy, Derelict Mines Program, 516 High St., Maitland, NSW, 2320, Australia. andrew.sampaklis@industry.nsw.gov.au

One of the most significant challenges to the successful remediation of derelict mines is the management of acid and metalliferous drainage (AMD). A large proportion of derelict mines worldwide were underground operations. Although rehabilitation techniques are available for waste rock and tailings storages, few are applicable to managing drainage from underground mines. Most of the AMD from historic adits is generated by the oxidation of sulfidic waste rock that was backfilled into stopes and drives. Mine void wall rock is rarely a significant contributor to acidity loads. While hydraulic seals near adit entrances are used to flood mine workings and thereby retard sulfide oxidation, the high pressures and corrosive nature of the void water has resulted in the catastrophic failure of many pressure bulkheads.

Earth Systems has developed a new technique for controlling AMD from underground mine voids by establishing an internal inert (low oxygen) atmosphere. The technology is commonly deployed in two stages. Stage 1 requires the installation of low permeability seals across all possible air entry points (eg. adits, shafts, stopes, portals, opencuts, glory holes, drillholes...etc). Seals need to be sufficiently robust to lower gas migration mechanisms from advection to diffusion controlled. Mine seals must be tested to confirm that key air entry pathways have been identified and isolated. Under the influence of restricted air entry pathways, sulfide oxidation processes within the workings should naturally lower internal oxygen concentrations within months, thereby significantly improving drainage quality. If the local geology is relatively porous and does not facilitate the necessary oxygen control, then rehabilitation will require progression to next stage. Stage 2 involves the installation of an inert gas generator to produce a constant, very slight inert gas overpressure within the mine workings, sufficient to overcome air entry related to barometric pumping. Inert gas generation systems can vary from passive to fully active and automated. System requirements will be site specific.

Earth Systems is working in collaboration with the NSW Division of Resources and Energy, Derelict Mines Program to apply the Inert Atmosphere technique to the high profile Sunny Corner derelict mine site near Bathurst. This was a silver-lead-zinc mine that operated from the 1850's until the 1920's. The site is currently discharging ~55 tonnes of H₂SO₄ acidity per year, with drainage from the Level 4 Adit is contributing close to 35 tonnes of this annual load. The acidity load is comprised of H⁺, Fe, Al, As, Cu, Pb, Zn, Cd and Mn. Stage 1 inert atmosphere works are currently underway, and when finished will be monitored for 12-18 months for internal gas compositions, and adit discharge water quality. Results from the monitoring program will determine whether a small-scale inert gas generator is necessary to further improve water quality.

The inert gas technology offers a low risk and low cost strategy for lowering or preventing water pollution from small to large derelict underground mines. At some sites, simple mine seals may be sufficient to control AMD discharges. This method has the potential to prevent or minimise the need for water treatment in perpetuity at derelict mines across the globe. Unlike other management methods, inert gas installations can be reversed at negligible cost in a few days, if mining is to recommence at a site.

Dr Dane Lamb: Application of a risk-based approach to sites in NSW

Global Centre for Environmental Remediation, University of Newcastle, dane.lamb@newcastle.edu.au



Abstract

The legacy of industrialisation and mining activities pre-environmental movement has resulted in the unmanaged introduction of contaminants to soil and water globally. Historical sites are highly complicated due to the lack of information on activities undertaken and the environmental processes controlling contaminant dispersal. Risk based land management of derelict mine sites is a suitable approach that utilises several stages of assessment within a single site, allowing prioritisation of funds. This presentation will present firstly an overview of the development of a risk based tool, illustrated by incorporation of human health and terrestrial biotic ligand models.

Professor Garry Willgoose: Sustainable mine rehabilitation: resolving the technical issues

University of Newcastle, School of Engineering



Abstract

Garry Willgoose^{1,2}, Greg Hancock³

¹School of Engineering, The University of Newcastle, Callaghan, NSW

²Member, NSW Government Mining and Petroleum Gateway Science Panel

³School of Environmental and Earth Sciences, The University of Newcastle, NSW

This presentation reviews the progress in achieving the aim of being able to provide technical predictions and reliability assurances for mine rehabilitation beyond closure. Depending on the application this may mean making design predictions (and providing some assurances regarding their reliability) 100-500 years in the future for typical post-mining landforms and landscapes, up to 1000 years for groundwater impacts, and for specialist applications such as containment of uranium mill tailings and low-level nuclear waste up to 10,000 years. Considerable progress in mining specific applications has been made across these design lifetimes in the last two decades, but in some areas considerable technical challenges remain. This presentation will review progress across three main application areas:

1. Landforms and landscapes: Containment of waste and minimising off-site impacts involves erosion predictions for the containment layers/caps and design of geomorphically stable landforms. Our group have pioneered technologies in this area (e.g. EAMS-SIBERIA) and predictions (with confidence limits) are now mostly routine, subject to site specific data. Examples of applications will be shown.
2. Soils: Satisfactory water holding capacity of soil, soil grading and soil geochemistry are crucial for establishing and maintaining sustainable post-mining ecosystems or agriculture. We now have the scientific tools for providing predictions for soil evolution long-term but mine specific applications and reliability assessment are still a work in progress. Examples of our existing prediction capability will be shown.
3. Infilled final void geochemistry and groundwater: We do not yet have the technical ability to be able to predict groundwater geochemistry (nor to some extent groundwater flow) 500-1000 years into the future. Thus we cannot yet provide guarantees regarding off-site impacts on natural groundwater resulting from off-site movement of groundwater from infilled final voids. Some preliminary experimental work towards this aim will be shown.