Mine Rehab 2019
Conference Handbook

19 - 21 June
NEX Newcastle Exhibition & Convention Centre
309 King St
Newcastle West NSW 2302

minedlandrehab.com.au
Thank you for your attendance

The 9th Annual Best Practice Ecological Rehabilitation of Mined Lands Conference (‘Mine Rehab 2019’) is brought to you by the Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE) and the School of Environmental and Life Sciences at the University of Newcastle. This annual conference brings together leading professionals, stakeholders and companies from the mine rehabilitation sector and beyond.

The Mine Rehab Conference is a significant event not only for the Hunter Region, but also nationally. It provides an important avenue for promoting best-practice rehabilitation of mined lands.

The organisers would like to acknowledge the Tom Farrell Institute for the Environment (TFI), the University of Newcastle’s Environmental outreach arm until it wound up in 2018. TFI managed the Mine Rehab Conference for eight years from its inauguration, growing it into the world-class event we see today. Indeed, Mine Rehab 2018 sold out, making it one of the largest mining rehabilitation conferences in Australia.

Your attendance at this event ensures this crucial conversation will continue into the future, enabling and improving best practice rehabilitation of mined lands. Thank you for your invaluable role in a truly important endeavour.

Nex Newcastle Emergency Procedures

Building evacuation

In the event of an emergency, you will be advised that an evacuation is required by the Services and Facilities Manager or via an announcement over the public address system. Follow the instructions of Club Management regarding the evacuation procedures.

Remain calm. Make your way out of the building in a calm and orderly manner, following the exit signs and head to the designated assembly areas. Do not re-enter the building until advised that it is safe to do so by the Services and Facilities Manager / Chief Warden.

In the event of an emergency evacuation, occupants will be advised by the Duty Manager or by an announcement over the public address system if an evacuation is necessary. Managers and supervisors are fully trained in evacuation procedures and have all the necessary equipment on hand to deal with an evacuation.

Occupants must make their way out of the building in a calm orderly manner following the exit signs. Staff are responsible for directing customers to the exits and assist them out of the building. DO NOT USE ELEVATORS.

Once outside, occupants are to assemble at the designated assembly areas, stay there, do not leave and wait for further instructions from emergency response personnel such as Chief Warden or Fire Brigade / Police.

Medical emergency

In the event of a life-threatening or serious injury, phone an ambulance immediately (dial 000). Following this, contact the Function Supervisor to activate the Medical Emergency Alarm System.

Earthquakes

DURING HEAVY SHAKING – Get under a desk, table, door arch or stairwell. If none are available, move against an interior wall and cover your head with your arms. Remain under cover until the movement subsides. Stay away from large windows, shelving systems or tall room partitions. After shaking has stopped, survey your immediate area for trapped or injured persons and ruptured utilities. Evacuate the building using the stairs—not the elevators. Move to your designated assembly area and await further instructions from emergency personnel.

Cover image

Glencore’s remarkably well rehabilitated Westside mine. The mine area has been reshaped to remove any high walls, covered with topsoil and seeded with native vegetation. The rehabilitated site has second-generation flora and seven threatened species of wildlife have been observed.
CONTENTS

NEX – NEWCASTLE EXHIBITION & CONVENTION CENTRE 4
THE 3-DAY PROGRAM 6
THE TEAM 7
A WELCOME MESSAGE FROM OUR CO-CHAIRS 10
CONFERENCE ORGANISER 11
MINE REHAB 2019 SPONSORS 12
OUR EXHIBITORS 14
MINE REHABILITATION SITE TOUR 19
THE PROGRAM 20
THE PRESENTERS 24
THE POSTER PRESENTERS 36
WORKSHOPS 46
NOTES 52
NEX – NEWCASTLE EXHIBITION & CONVENTION CENTRE

309 KING STREET NEWCASTLE WEST NSW 2302

Location
NEX is conveniently located in the heart of Newcastle just 35 minutes from Newcastle airport. Located in the harbour city precinct on the corner of King and Union Streets, Newcastle West, NEX is well serviced by public transport and central to a range of accommodation options, a wide selection of cafes and bars, pristine beaches, and the Port of Newcastle foreshore.

Parking
Parking is available on-site with 140 spaces, including parking for drivers with a disability.

There are two car parks located on site:
- The King Street underground car park is located underneath our Wests City Club, with entrance via King Street ($3.00 per hour)
- The Bull Street hangar parking is located to the side of Wests City, with entrance via Bull Street ($2.00 per hour). The Bull Street park also offers an Earlybird Parking Special of $8.00 for the day if your vehicle is in between 6:30am and 8:30am and out before 6pm
NEWCASTLE EXHIBITION & CONVENTION CENTRE FLOORPLAN
THE 3-DAY PROGRAM

WEDNESDAY 19 JUNE

Workshops at NewSpace City Campus, University of Newcastle.

Mine Rehab 2019 workshops provide excellent professional development opportunities, allowing participants to learn from world-renowned experts in their field. This year’s conference includes four workshops – see page 46-51 for further details.

• Pathways to relinquishment and opportunities to transition to productive alternate land uses
• Understanding acid mine drainage / acid rock drainage and the implications for rehabilitation and closure
• Harnessing hyperaccumulator plants to phytoremediate contaminated mining sites
• Issues in tropical forest rehabilitation post mining.

THURSDAY 20 JUNE

Full-day conference with presentations, posters, exhibitors and panel session at NEX Newcastle, followed by the conference Gala Dinner. Learn from and network with some of the leading thinkers on best-practice mined land rehabilitation, then wind down at the conference Gala Dinner.


FRIDAY 21 JUNE

Mine Rehabilitation Site Tour run by the Hunter Environmental Institute in partnership with CRC CARE.

A rare opportunity to visit and learn about mine sites that have been rehabilitated or are in the process of rehabilitation. This year’s tour includes:

• Glencore’s remarkably well rehabilitated Westside mine
• Attempted rehabilitation of the sulphuric acid-polluted creek downhill from an old spoils pile at the Neath Colliery site.
• Kooragang/Ash Island near Newcastle to see the outstanding reafforestation work of the Kooragang Wetland Rehabilitation Project and view offset lands reconstructed for shorebird habitat and amphibian habitat.

For more information or to book, see page 19 or visit www.hei.org.au/event/mine-rehabilitation-site-tours-2019.

The Department of Planning and Environment’s Division of Resources and Geoscience is responsible for growing geoscientific knowledge and facilitating the ecologically sustainable development of geological resources to benefit the people of NSW.

We enable evidence-based policy development and decision-making in the use of geological resources. We acquire, synthesise and deliver best-available geoscientific information and advice, and provide exploration and mining titles assessment services.

The Department of Planning and Environment is proud to sponsor the Mined Land Rehabilitation Conference.

Find out more at www.resourcesandgeoscience.nsw.gov.au
THE TEAM

THE MINE REHAB 2019 ORGANISERS

9th Annual Best Practice Rehabilitation of Mined Lands Conference

Our small team is dedicated to ensuring you have the best experience possible Mine Rehab 2019.

Conference Co-Chair
Professor Ravi Naidu
Ravi has been a research leader in environmental contaminants, bioavailability and remediation for over 30 years. He is co-author of more than 700 technical publications and co-editor of 11 books in the field of environmental science including field remediation of contaminated sites. He was the initiator and inaugural director of the Centre for Environmental Risk Assessment and Remediation where he conceived, developed and led the successful bid for CRC CARE in 2004. He was also the initiator and founding Managing Director/CEO of CRC CARE, having engaged significant local and international collaboration, and led the successful bid for CRC CARE’s nine-year extension in 2010. Prior to joining UniSA in December 2002, Ravi was Chief Research Scientist and Leader of the Remediation of Contaminated Environments Program at CSIRO Land and Water Division, and Component Coordinator of CSIRO’s Land and Water Sector. He is a University of Newcastle Global Innovation Chair and the initiator and inaugural director of the University of Newcastle’s Global Centre for Environmental Remediation.

Conference Co-Chair
Emeritus Professor Tim Roberts
Tim took up the position of Tom Farrell Institute Director, following the completion of his tenure as Dean of Research at JCU Singapore. His previous tenure was as inaugural Dean of the Singapore campus of the University of Newcastle. In line with his appointment as Conjoint Professor in Biology he continues to be active in research in the laboratory of his long-time collaborator, Associate Professor Hugh Dunstan, at the University of Newcastle. He has published more than 100 papers. Professor In 2018 Tim was appointed Emeritus Professor in Biology at the University of Newcastle.

Alec Roberts
Alec is an experienced project manager, community renewable energy advocate and the current chair of CLEANaS (Clean Energy Association of Newcastle and Surrounds). CLEANaS is a not-for-profit community energy association that aims to drive the uptake of renewable energy generation technologies in Newcastle and surrounds through developing projects for community funded renewable energy installations and by running events and initiatives to educate members and the public about the opportunities that exist in participating in clean energy. Alec was project officer with the Tom Farrell Institute for the Environment from 2015 to 2018.
Nigel Stace
Nigel is a proactive and dynamic member of the team who worked as events coordinator for the Tom Farrell Institute from 2014 to 2018. Nigel has maintained an ongoing interest in energy ever since twin events in the early 1970s. The first event was the 1973 oil crisis and the second was an impromptu speech by one of Nigel’s high school teachers. This teacher warned the students that they would have to deal with the greenhouse effect caused by civilization’s burning of fossil carbon. When he studied for his BE(Chem) at UNSW, he chose the Fuels elective which lead to a career at the BHP Newcastle Steelworks, starting as a Combustion Engineer.

Dr Prashant Srivastava
Prashant is CRC CARE’s business manager and also oversees outreach activities, is chief organiser of the biennial CleanUp conference, and the primary contact for technical services. He heads the demonstration programs for the Australian Institute of Petroleum, working closely with the mining and oil sectors, environmental practitioners, regulatory authorities, and scientific researchers from around Australia. He also coordinates the Petroleum LNAPL Forum, which advises CRC CARE on its Petroleum Program. Prashant received his PhD and Masters in soil chemistry, fertility and plant nutrition from GBP University of Agriculture and Technology in Pantnagar, India, and subsequently obtained another PhD degree in environmental soil chemistry from the University of Sydney. He conducted his postdoctoral research at the Savannah River Ecology Laboratory of the University of Georgia (USA). His research interests include fate and transport of petroleum hydrocarbons, heavy metals and nutrients in soil and plants. He also holds tertiary qualifications in project/program management. Before joining CRC CARE, Prashant was a Sydney-based environmental scientist/consultant, working on contamination assessment and remediation of soil and groundwater.

Ratin Mathur
Ratin leads CRC CARE’s efforts to upskill Australia’s remediation workforce through training and capacity building. He organises the CRC’s short courses and workshops and engages with industry to ensure that training needs and knowledge gaps are well understood. He holds a Bachelor of Chemical Engineering and has tertiary qualifications in project management, marketing and sales. Prior to joining CRC CARE, he held the title of Project Engineer at Mount Gordon Mine in Northern Queensland. Earlier in his career, Ratin held positions with various chemical and petrochemical industry groups in India. He specialises in project planning and development, project management, and project implementation.
Adam Barclay

Adam has more than 15 years’ experience in science communication, working in agricultural science, international development, the public sector, private business, and as a freelance writer/editor. His work has spanned several countries and diverse clients including government agencies, research institutes and nongovernment organisations. He holds a Graduate Diploma in Science Communication and a Bachelor of Science (Hons), majoring in genetics. Prior to joining CRC CARE, Adam spent more than five years in the Philippines working for the International Rice Research Institute (IRRI), where he managed, wrote for and edited the institute’s magazine, Rice Today, and handled IRRI’s media relations during the international rice crisis of 2008.
A WELCOME MESSAGE FROM OUR CO-CHAIRS

CHAIRS’ WELCOME

On behalf of the Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE), the University of Newcastle, and the New South Wales Government, it is our pleasure to welcome you to the 9th Mined Land Rehabilitation Conference (Mine Rehab 2019) from Wednesday 19 June to Friday 21 June 2019.

This conference, which was run annually from 2011 to 2018 by the Tom Farrell Institute, University of Newcastle, is a significant event on the Hunter Region calendar. It provides an important avenue to promote best-practice approaches to rehabilitating mined lands. The conference is well recognised by the mining and allied sectors in Australia and overseas. The success of the conference depends upon the support and participation of people and organisations from industry, government and academia.

This year, Mine Rehab 2019 is primarily organised by CRC CARE – a long-time supporter of past conferences – with support from the School of Environmental and Life Sciences at the University of Newcastle and generous sponsorship from the NSW Chief Scientist & Engineer and the NSW Department of Planning and Environment.

Mine Rehab 2019 delegates can participate in workshops, mine tour and networking events, as well as the main conference. The Organising Committee has prepared an outstanding scientific and educational program, which combines cutting-edge research with industry best practice and experience.

The Organising Committee is pleased to have secured the NEX – Newcastle Exhibition & Convention Centre, conveniently located in the heart of Newcastle. Just 35 minutes from Newcastle Airport, NEX is well serviced by public transport and central to a range of accommodation options, a wide selection of cafes and bars, pristine beaches, and the Port of Newcastle foreshore.

The conference promises to be a highly rewarding educational and networking experience for all. We encourage you to take advantage of this opportunity and to contribute to the success of this special event.

We are very happy to welcome you to Mine Rehab 2019.

Professor Ravi Naidu
Managing Director and CEO, CRC CARE
Global Innovation Chair and Director, Global Centre for Environmental Remediation, University of Newcastle
Mine Rehab 2019 Co-chair

Emeritus Professor Tim Roberts
School of Environmental & Life Sciences
University of Newcastle
Mine Rehab 2019 Co-chair
CONFERENCE ORGANISER

THE COOPERATIVE RESEARCH CENTRE FOR CONTAMINATION ASSESSMENT AND REMEDIATION OF THE ENVIRONMENT (CRC CARE)

www.crccare.com

CRC CARE was launched in 2005 as part of the Australian Government’s Cooperative Research Centres (CRC) Program and in 2011 successfully bid for a further nine years of funding. The CRC Programme supports industry-led collaborations between industry, researchers and the community. It is a proven model for linking researchers with industry to focus on research and development towards use and commercialisation.

CRC CARE’s innovative research is divided into four complementary programs:

1. Best Practice Policy: More effective, efficient and certain national policy for assessing and remediating contamination
2. Better Measurement: More accurate, rapid, reliable and cost-effective measurement and assessment
3. Minimising Uncertainty in Risk Assessment: New technology, methods and knowledge for assessing risks to human health and the environment
4. Cleaning Up: Innovative clean-up technologies and a wider range of effective management options.
The role of the NSW Chief Scientist & Engineer has two main responsibilities:

1. to foster and encourage a lively state innovation system, particularly by promoting productive links between business, the professions, universities and government
2. to provide independent advice on how to address difficult policy problems that involve engineering or science. Examples include coal seam gas, sea level rise, road tunnel air quality and coal dust emissions.

World-renowned robotics expert Professor Hugh Durrant-Whyte took up his appointment as the NSW Chief Scientist & Engineer in September 2018.
Anglo American is a leading global mining company and our products are the essential ingredients in almost every aspect of modern life. Our portfolio of world-class competitive mining operations and undeveloped resources provides the metals and minerals that enable a cleaner, more electrified world and that meet the fast growing consumer-driven demands of the world’s developed and maturing economies. With our people at the heart of our business, we use innovative practices and the latest technologies to discover new resources and mine, process, move and market our products to our customers around the world – safely, responsibly and sustainably.

Global Soil Solutions
Global Soil Systems is a leading environmental consultancy and contractor, with more than 25 years’ experience specialising in mining and industrial rehabilitation and revegetation. With access to a variety of mine specification plant and equipment, our qualified and experienced team offer end to end management of both small and large-scale projects.

HCEG is a networking group of environmental professionals that: facilitates the exchange of technical knowledge and practices between operatives in environmental management in the coal mining industry of the Hunter Region promotes excellence in environmental management in the mining industry promotes the benefits and achievements of successful environmental management in the coal mining industry of the Hunter Region.
**OUR EXHIBITORS**

**BOOTH 1**

**Landforma**

The GeoFluv method applies fluvial geomorphic principles to rehabilitating disturbed land. Field data from nearby reference areas are used to design landforms that would naturally develop over thousands of years. The landforms are stable and functional – conveying the water from the site efficiently, without the need for engineering controls such as contour banks, drop structures, rock drains etc. Landforma is the Australian reseller of the Natural Regrade Software from Carlson Software – which incorporates the GeoFluv method. We offer software, training and support to guide users through the entire process from design stages, through implementation and monitoring.

**BOOTH 2**

**Vital Chemical & Vital Environment**

As an industry leader Vital Chemical formulates, manufactures and supplies quality specialty chemical solutions with a focus on environmentally sustainable outcomes. Australian owned and operated since 1977, Vital Chemical has more than 40 years of experience delivering erosion control, revegetation and land rehabilitation solutions across Australasia. In partnership with Vital Environment, Vital Chemical supplies products and services to construction, civil, concrete, agriculture and resources industries. Through dedication to innovative products and an industry first ESC testing and training facility, Vital are renowned for delivering tailor-made environmental and industrial solutions with a focus on a sustainable future.

**BOOTH 3**

**Toolijooa Environmental Restoration**

Toolijooa Environmental Restoration is a leading provider of environmental management and restoration services throughout Sydney and Hunter regions. Our areas of service include consultancy, native nursery, large scale revegetation, bushland restoration and management.

With 15 years’ experience in mine rehabilitation, we offer practical solutions to the restoration and establishment of native vegetation on highly disturbed soils. We specialise in Endangered Ecological Communities and projects with high conservation value.

Our experience and professionalism has led to our reputation for superior quality natural area management and restoration, providing value to our clients while delivering positive and enduring outcomes for Australia’s natural heritage.
EcoScape Solutions

EcoScape Solutions is a locally based contractor specialising in large scale rehabilitation, revegetation and erosion control throughout NSW. Our skills and expertise have been utilised over many years on construction, mining, pipeline, and roadside projects since 2010. EcoScape Solutions can offer a broad range of services from consulting and site preparation services right through to design and implementation. EcoScape Solutions use an integrated approach to tailor make solutions for every client and individual site requirements. Utilising the latest technologies in hydromulching, organic amendments and industry best practice techniques gives us the edge in ensuring success of every project.

PGG / DURA Veg

DuraVeg™ sustainable revegetation is at the forefront of innovation delivering complete environment rehabilitation and erosion control solutions to meet the demanding characteristics of Australian environments. DuraVeg from PGG Wrightson Turf offer a complete range of revegetation and erosion control solutions across the full range of environmental conditions that Australia can deliver. From mine reclamation through to urban revegetation, you can trust in DuraVeg’s research and development driven approach to deliver cost effective, environmentally friendly revegetation strategies for the results you need.

Loop Organics

Loop Organics supplies a range of soil amendment materials for mine rehabilitation and agriculture in the Hunter Valley. These products are derived from beneficial organic wastes including biosolids and paper. Biosolids, sourced from the Hunter and Central Coast regions, are suitable to be delivered directly to site for land application. Biosolids are also incorporated into our specialised soil additives, blended with other organics at our compost facility at Ravensworth. For mine sites, Loop Organics’ team of environmental scientists can work with you to create a soil additive or soil replacement that will ensure the best, long term outcomes for your rehabilitation site.
emapper provides compliance-driven mine site Rehabilitation Performance Metrics (RPM), through our web-enabled analytics platform www.minerpm.com. We use the latest technology in drones and aerial imagery – combined with our expertise in mine closure, precision survey and remote sensing analysis – to improve environmental outcomes. RPM analyses landform geometry, stability and vegetation across entire mine landscapes. The results are compared to the mine closure criteria and analogue (reference) sites for monitoring and reporting. The analysis is quantifiable and comparable to existing historical field data, meaning that legacy data can be integrated into the analysis. Through RPM we aim to improve the efficiency of rehabilitation through site-wide monitoring and help our clients achieve decreases in time required to site relinquishment. It reduces the need for ‘boots on the ground’, providing cost efficiency and increased safety for rehabilitation monitoring. emapper and RPM give our clients the power to monitor and manage their environmental activities, impacts and outcomes. Join a growing list of organisations across mining, government, utilities, natural resource management and conservation that use emapper to monitor and manage their environment.

CRC CARE

The Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE) is an independent organisation that performs research, develops technologies and provides policy guidance for assessing, cleaning up and preventing contamination of soil, water and air. CRC CARE’s innovative research is divided into four complementary programs: Best Practice Policy; Better Measurement; Minimising Uncertainty in Risk Assessment; and Cleaning Up. CRC CARE has driven a shift to a risk-based, in situ approach to managing contaminated sites – cleaning up contamination where it lies, rather than the traditional ‘dig and dump’. By demonstrating that contaminants only pose a risk if they can be absorbed by humans, animals and plants, CRC CARE has fostered a more rational, effective and affordable clean-up. CRC CARE works with end-users to develop solutions to real-world contamination problems. Examples include: matCARE™ technology, which irreversibly immobilises PFAS from firefighting foams; health screening levels for petroleum hydrocarbons; and acid sulfate soil remediation in degraded wetlands.

University of Newcastle

Built on the principles of equity, excellence and engagement, the University of Newcastle has a reputation as a world-class institution making an impact within its own region, throughout Australia and across the globe. Our research is world-class and diverse. Our degree programs are internationally recognised and our partnerships and collaborations drive innovation. Our alumni are leaders and our students are preparing to make a difference in the world. We have long been known as a champion of innovative approaches to education. We strive for a dynamic teaching culture that delivers world-class educational outcomes. We are a research intensive university and proud of the great things we have achieved in collaboration with our partners in industry, business, government and the community – here and around the world. The University of Newcastle is ranked in the top three per cent of universities worldwide.
EnviroStraw

EnviroStraw is an Australian erosion control company that manufactures unique products for the industry. Their products are proven to revive soil and establish native vegetation with increased carbon levels. They contain built-in nutrients for sustainable growth and work fast (with minimal water) and are cost efficient. EnviroStraw strives to be able to revegetate any site – no matter how depleted or erosion prone. EnviroStraw is proud of their Australian manufactured range of revegetation solutions and their erosion-control product, GeoSpray, which were developed by Australia’s leading soil scientists over 12 years. They have been carefully developed to accommodate all land sloping variants, and are environmentally friendly. EnviroStraw is backed by professionals and scientists, and we look forward to discussing our products and suite of services.

Hunter Land Management

Hunter Land Management is a land management consulting and contracting company delivering pest and weed management projects across Australia. Our services include revegetation, weed control, pest animal control, bushfire management and all GIS mapping and reporting requirements. Our speciality is the management of Biodiversity Offset Management for a variety of clients across the state and country. 2019 sees Hunter Land Management achieve 20 years of operation delivering over 3500 land management projects. Hunter Land Management’s Daniel Lewer is happy to provide obligation free inspections and advice so come along and see us at Booth 11!

Sky Land Management

Sky Land Management is an innovative company providing high quality, tailored land management solutions. Using our high payload Unmanned Helicopters, we deliver safe, targeted, efficient and cost effective solutions to your site. These include:

- Weeds spraying
- Seeding
- Fertiliser spreading.

Mine site applications include:

- Dams / tailings dams
- Topsoil stock piles
- Low and high walls
- Rehabilitation areas
- Pre strip areas
- Steep and previously inaccessible or unsafe areas.

The targeted application is ideal for staged rehabilitation programs and establishing varying vegetation communities specific to site micro environments.
BOOTH 14

Bettergrow

Bettergrow has been supplying innovation and solutions to the NSW and Queensland organics recycling industry since its creation over 40 years ago. Service and responsiveness form a fundamental basis for our business. We specialise in the production of quality soil amelioration products, including composts, and producing growing media specifically tailored to a range of applications. Bettergrow also offers site soil analysis services and regulatory reporting to ensure environmental compliance. Talk to our team of environmental and soil scientists and let Bettergrow provide you with a soil amelioration product suitable for your application. Our team is ready to help.

BOOTH 15

NSW Government Department of Planning and Environment

The NSW Department of Planning and Environment helps create great places and experiences for all. We plan for a changing and thriving NSW, inspire strong and resilient communities and regions, and ensure the responsible and sustainable use of our state’s resources. Our Department supports NSW with long-term, strategic planning for the State’s regions, driving well-located housing and employment land, assessing State significant development proposals, and ensuring the planning system is efficient and effective.

BOOTH 0

Stem Industry School Partnerships

SISP is a contemporary and proven education model that, in partnership with industry, is inspiring students to study STEM and prepare for their futures. It is a dynamic program that is actively growing students’ job readiness skills and contributing to the international competitiveness of regional NSW. The SISP program is an initiative of the NSW Department of Education in partnership with Regional Development Australia and Industry.
MINE REHABILITATION SITE TOUR

Organised by the Hunter Environmental Institute in partnership with CRC CARE.

Friday 21 June 21, 8:00 am – 5:00 pm
Registration: $80.00 (lunch included)

An exciting and informative day of networking and education – take a bus through the Lower Hunter Valley to visit mine rehabilitation, reafforestation and coastal rehabilitation work and acid mine drainage sites.

When and where
Depart from NEX in King Street at 8:15 AM and returning to NEX by 4 PM – participants should ensure that they are at NEX by 8 AM at the latest.
First up we visit Glencore’s remarkably well rehabilitated Westside mine. The mine area has been reshaped to remove any high walls, covered with topsoil and seeded with native vegetation. The rehabilitated mine site has second-generation flora and seven threatened species of wildlife have been observed.
Next stop is a tour of Kooragang/Ash Island near Newcastle to see the outstanding reafforestation work of the Kooragang Wetland Rehabilitation Project and to view offset lands reconstructed for shorebird habitat and amphibian habitat. This is one of the largest active coastal rehabilitation projects in Australia, undertaken to compensate for the loss of fish, shorebird and other wildlife habitat in the Hunter estuary caused by 200 years of draining, filling and clearing. The wetlands feature expanses of mangrove and saltmarsh and in non-tidal areas, riparian woodlands, remnants of lowland floodplain rainforest and ephemeral, freshwater wetlands.

Requirements
For your safety, you are required to wear enclosed shoes, long pants and a long-sleeved shirt. It is recommended you wear sunscreen and a hat. Cameras, phones and photography are allowed. We are hopeful of dry weather but please plan your attire for the contingency for wet weather as the walk at Neath is some 500 metres return. Please bring a water bottle.

To book
# The Program

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<tr>
<th>Start</th>
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<th>Minutes</th>
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<tbody>
<tr>
<td>8:30am</td>
<td>8:31am</td>
<td>1</td>
<td>Emeritus Professor Tim Roberts, The University of Newcastle</td>
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<td>Introduction</td>
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<td>Emeritus Professor Tim Roberts, The University of Newcastle</td>
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<td>Introduction part 2</td>
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<td>Professor Ravi Naidu, Managing Director and CEO of CRC CARE</td>
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<td>Welcome</td>
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<td>Michael Wright, Acting Deputy Secretary, NSW Department of Planning and Environment,</td>
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<td>Division of Resources and Geoscience</td>
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<td>Conference launch and opening speech</td>
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<td>8:50am</td>
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<td>Speaker 1: Rob Loch, Landloch Pty Ltd</td>
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<td>Towards a broader perspective on design of waste landforms</td>
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<td>Questions</td>
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<td>9:10am</td>
<td>9:25am</td>
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<td>Speaker 2: Stephen White, BHP</td>
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<td>Progressive Certification of Rehabilitated Land</td>
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<td>Questions</td>
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<td>Speaker 3: Matthew Newton, NSW Resources Regulator</td>
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<td>The Resources Regulator’s approach to ensure the mining industry meets its rehabilitation obligation.</td>
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<td>Poster Session</td>
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<td>Short presentations (less than 1 minute) from each poster presenter</td>
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<td>10:10am</td>
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<td>Morning Tea</td>
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<td>10:40am</td>
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<td>Brief presentation by session chair</td>
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<td>Speaker 4: Ishan Noor, University of Lambung Mangkurat</td>
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<td>Zero Quicklime by Swampy Forest</td>
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<td>Speaker 5: Chris Gimber, KBR</td>
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<td>Rehabilitation practices at Clermont Coal Mine in Queensland, Australia</td>
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<td>Speaker 6: Travis Peake, Umwelt Environmental and Social Consultants</td>
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<td>Ecological Mine Rehabilitation – Preliminary Outcomes of an ACARP-funded Project</td>
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<td>Speaker 7: Ingrid Meek, Energy Resources of Australia Ltd.</td>
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<td>The revegetation strategy at ERA Ranger uranium mine</td>
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<td>The reinstatement of Biophysical Strategic Agricultural Land (BSAL) on post mining landforms – An industry update and future directions.</td>
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<td>Brief presentation by session chair</td>
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| 1:30pm     | 1:45pm   | 15      | Speaker 9: Karin Fogarty, University of Western Australia  
Post-mine land use trends in the New South Wales and Queensland coal industry |
| 1:45pm     | 1:50pm   | 5       | Questions |
| 1:50pm     | 2:05pm   | 15      | Speaker 10: Scott Sleap, NSW Department of Education  
Importance of STEM Workforce Development in Mine Rehabilitation |
| 2:05pm     | 2:10pm   | 5       | Questions |
| 2:10pm     | 2:25pm   | 15      | Speaker 11: Paul Storer, EnviroStraw Pty Ltd  
Rebuilding disturbed soils from construction sites to enhance soil biology providing a self-sustaining long-term outcome. |
| 2:25pm     | 2:30pm   | 5       | Questions |
| 2:30pm     | 2:45pm   | 15      | Speaker 12: Christopher Waygood, Golder  
A review of the successes and challenges associated with geomorphic landform design in the Hunter Valley, NSW, Australia |
| 2:45pm     | 2:50pm   | 15      | Questions |
| 2:50pm     | 3:05pm   | 15      | Speaker 13: Maria Cola, Anglo American  
Closure modelling and Value creation through planning integration |
| 3:05pm     | 3:10pm   | 5       | Questions |
| 3:10pm     | 3:40pm   | 30      | Afternoon tea |
| 3:40pm     | 3:45pm   | 5       | Brief presentation by session chair |
| 3:45pm     | 4:00pm   | 15      | Speaker 14: Colin Schiller, Walshs Seeds Pty Ltd  
Vegetative Stabilisation of Batters and Spoil Dumps on Asian Pacific Mine Sites |
| 4:00pm     | 4:05pm   | 5       | Questions |
| 4:05pm     | 4:20pm   | 15      | Speaker 15: Robert Scanlon, University of Newcastle  
Differences in soil ameliorant types change growth and number of trees |
| 4:20pm     | 4:25pm   | 5       | Questions |
| 4:25pm     | 4:40pm   | 15      | Speaker 16: Alex Watson, SRK Consulting  
Pit lake water quality modelling at Century Mine |
| 4:40pm     | 4:45pm   | 5       | Questions |
| 4:45pm     | 5:15pm   | 30      | Open mic  
General discussion and comments from the floor (60-second limit per speaker). |
| 5:15pm     | 5:20pm   | 5       | Closing comments from Conference Chair Professor Ravi Naidu |
| 7:00pm     | 10:00pm  | 180     | Mine Rehab 2019 Gala Dinner |
Rehabilitation obligations and security debt transfer to the new owner when a mine is sold or ownership transferred.

We use regulatory tools to ensure that rehabilitation is undertaken in a timely manner.

The Mount Arthur mine in the Hunter Valley has the highest security deposit in NSW, totalling 250,000.

All exploration and mining approvals contain conditions regarding rehabilitation. If rehabilitation obligations are not met, part or all of the security deposit will be retained.

As part of open cut mining, title holders are required to undertake progressive rehabilitation.

NSW Mine Rehabilitation
For more information visit: resourcesregulator.nsw.gov.au

*as at January 2019

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Niche delivers innovative, practical, risk-based and cost-effective solutions to mine rehabilitation projects.

Our highly skilled team has proven experience in the implementation and management of robust ecological, environmental and cultural heritage programs for mine site rehabilitation.

**Services:**
- **Ecology and biodiversity**
  - Terrestrial
  - Freshwater, marine and coastal
  - Research and monitoring
  - Habitat recreation and augmentation
  - Soil analysis, including microbial testing
  - Landscape Function Analysis
  - Wildlife Schools and training

- **Heritage management**
  - Aboriginal heritage
  - Historical heritage
  - Conservation management
  - Community consultation
  - Archaeological, built and landscape values

- **Environmental management and approvals**
  - Impact assessments
  - Development approvals
  - Rehabilitation
  - Stakeholder consultation
  - Project management

- **Environmental offsetting**
  - Biodiversity Stewardship Agreements
  - Assessments (NSW, QLD, Federal)
  - Offset site strategy and management
  - Brokering
  - Conservation agreements

**Project experience includes:**
- **South 32 Illawarra Coal** - West Cliff Emplacement Area Annual Monitoring
- **Yancoal** – Mt Thorley-Warkworth Operations and Hunter Valley Operations: Rehabilitation monitoring
- **Wambo Coal** – Annual Environmental Monitoring: Flora, fauna, riparian and subsidence
- **Peabody** – Wilpinjong Coal Mine: Biodiversity Management Plan. Ecological management strategies, procedures, controls and monitoring for biodiversity offsets, regeneration and rehabilitation areas
- **LakeCoal** – Catherine Hill Bay Mining Operations Plan incorporating mine closure
- **Centennial Airly** – Landscape Rehabilitation Management Plan

**Locations**
- Sydney
- Illawarra
- Central Coast
- Newcastle
- Mudgee
- Port Macquarie
- Brisbane
- Cairns

**Contact**
Rhidian Harrington
Director
0488 224 999
02 9630 5658
rharrington@niche-eh.com

**CELEBRATING 10 YEARS IN 2019**
Rehabilitation obligations and security debt transfer to the new owner when a mine is sold or ownership transferred.

As part of open cut mining, title holders are required to undertake progressive rehabilitation.

All exploration and mining approvals contain conditions regarding rehabilitation.

The Mount Arthur mine in the Hunter Valley has the highest security deposit in NSW, totalling $250M.

$2.68Bn is held in security bonds for rehabilitation of exploration and mining impacts.

If rehabilitation obligations are not met, part or all of the security deposit will be retained.

For more information visit: resourcesregulator.nsw.gov.au

*as at January 2019
Towards a broader perspective on design of waste landforms

Viewed through a national perspective, there is enormous variation not only in the factors likely to cause erosive failure of a mine waste landform, but also in the factors to be considered to denote 'success'.

For arid zones (e.g. 200-250 mm annual rain), the low levels of vegetation cover that can be achieved mean that the properties of the materials placed and the landform design adopted can be critical for long-term stability. Managing material properties can be crucial, as can be the use of rock and tree debris to alter erodibility.

For wetter zones, the impact of vegetation can be much greater, and – for areas of moderate rainfall (~600-800 mm/y) but low rainfall erosivity – designing a stable waste landform can be relatively easy and the range of design options quite large. It is not surprising that interest in designing “natural” landforms is greatest in this zone, though features of natural landforms have long been used in the arid zone.

For areas where either (or both) rainfall erosivity and waste material erodibility are much higher, the challenges of achieving stability increase, the need for understanding material properties is much greater, and the range of design options is narrowed.

As well, there are always ‘special cases’ that present design challenges. This may be due to the need to produce an unusual landform that meets site imperatives for reduced footprint or other specific design requirements, possibly to deal with an unusual waste, or area of extreme sensitivity.

This paper will, firstly provide some of the above perspective, and then move to considering, the wide range of design tools that are available for producing waste landform designs, including:

- direct measurement of erodibility
- considerations of material amendment, use of rock and tree debris
- management of dispersive materials
- modification of soil/waste properties to achieve target levels of vegetation cover
- application of a range of runoff/erosion modelling methodologies.

One of those tools is the consideration of natural landforms, but, when used as the major focus of design, it can be restrictive and has potential to deliver sub-optimal outcomes.

The paper will also outline an alternative landform using erosion modelling to guide design of natural landforms that are both stable and are consistent with the properties of the materials used in their construction design approach using application of ‘landform design rules’ developed.
Matthew Newton
9:30 AM TO 9:45 AM
Director Compliance Operations
Resources Regulator, NSW Department of Planning and Environment
p 02 4063 6444
matthew.newton@planning.nsw.gov.au

The Resources Regulator's approach to ensure the mining industry meets its rehabilitation obligation.

The Resources Regulator is the state's work health and safety regulator for mines and petroleum sites and is also responsible for compliance and enforcement activities under the Mining Act, including mine site rehabilitation. The creation of the NSW Resources Regulator was designed to ensure a consistent and responsive regulatory approach and provide increased transparency and community confidence.

The NSW Resources Regulator aims to:

- ensure a safe, sustainable and innovative mining, extractive and petroleum industry in NSW
- provide information and guidance about safety, environmental and other regulatory obligations to protect and support industry, workers, the community and the state
- promote confidence in how the industry is regulated
- make regulation transparent
- engage with and educate both industry and the community about best practice
- support industry to meet its regulatory obligations.

The Regulator is implementing a number of operational reforms to compliance and reporting requirements for mining lease holders. The reforms have been developed to address the following key recommendations from the 2017 NSW Audit Office Report – Mining Rehabilitation Security Deposits.

The Regulator’s presentation will focus on the core elements of the reforms and outline the regulatory approach to ensure that mining companies achieve their rehabilitation obligations.

Since joining the Department in 2013, Matthew has been involved in the development of a number of government reform projects that are aimed at improving the environmental and rehabilitation performance across the resources sector. This includes the Rehabilitation Reform project, which is scheduled to commence across the mining industry later in 2019. Prior to joining the Department, Matthew worked as a consultant as well as in site-based mining roles with a particular focus on rehabilitation and mine closure projects. Matthew has approximately 23 years of experience in environmental assessment and management and has been involved in a range of environmental projects relating to mining operations situated throughout NSW, Queensland, Victoria, Western Australia and the USA.

Progressive Certification of Rehabilitated Land

Formal recognition of Progressive Certification of mine site rehabilitation through the operating life of the mine is a tool that is used inconstantly to encourage rehabilitation across State jurisdictions in Australia. Queensland is one State that does recognise, or progressively certify, areas as complete through the life of the mine.

Queensland saw its first area progressively certified in 2012 with a total 631ha certified by July 2017. The areas of mine progressively certified in the past year has more than double this previous figure.

A case study will describe the process followed to achieve progressive certification of over 1,400ha of coal mining areas in the Bowen Basin in late 2018 and early 2019. Post mining land use and standards were confirmed for the areas that were rehabilitated approximately 20 years ago, site visits and discussions between industry and the regulator took place prior to a final application being submitted. Regulator considerations will be discussed.

Stephen is currently working in the field of rehabilitation, biodiversity and contaminated land management in BHP’s Minerals Australia across, coal, copper and iron ore. Prior to that, Stephen spent 6 years managing a team focused on rehabilitation and biodiversity management in iron ore. Stephen has also spent time working in water management and environmental approvals. Prior to joining BHP in 2006, Stephen spent 14 years working in conservation land management and forestry in what was the Department of Conservation and Land Management in Western Australia.

Stephen White
9:10 AM – 9:25 AM
Principal Rehabilitation and Biodiversity Health Safety and Environment Analysis and Improvement
BHP Minerals Australia
stephen.m.white@bhpbilliton.com

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**Zero Quickliming by Swampy Forest**

One of the big challenges in coal mining is how we treat the mine wastewater, which is mostly acid. We need to treat the water with quicklime to comply with regulation before release to public rivers. To treat the acid water with quicklime is an expensive and uncertain process.

Swampy Forest – a constructed wetland incorporating organic matter and planted grass and trees – is one of the new mine water management approaches for increasing the pH from around 4 to 6–9 as compliance criteria by natural processes.

Water from void flows enters the Swampy Forest system and increases the pH from an initial level of 4, releasing water with average pH 7. The debit of water flow averages 1000m$^3$/day without the use of quicklime.

Another benefit of this project is integration of the waste mine water management with a reclamation project to prepare in advance to meet reclamation criteria.

Ihsan Noor graduated from Agriculture Faculty of Soil Science of Brawijaya University, Indonesia, in 1989 and completed his Masters degree in Natural Resources and Environmental Management of Lambung Mangkurat in 2011. He is currently enrolled in a Doctoral Study of Natural Resources and Environmental Management at Lambung Mangkurat University, commencing in 2017. He began his career in the coal mining industry working in environmental engineering and reclamation planning in 1996. Since 2015, Ihsan has been Mine Head / Head of Technical Mining for a coal mining company in South Kalimantan.

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**Clermont Coal Mine Rehabilitation Practices**

This paper details the rehabilitation practices at Clermont Coal Mine in Queensland, Australia, including the planning, implementation and maintenance practices at the site. Learnings from this site are particularly relevant to other mines that have seasonal climates, unpredictable rainfall, large waste rock dumps, dispersive soils, floodplain interaction and deep voids.

The mine has developed a coordinated approach to rehabilitation planning and implementation, founded on the basis of the overarching Glencore procedure, but customised to the unique characteristics of the site. Key elements of the approach include setting realistic rehabilitation targets, providing consistent work to ensure continuity of the rehabilitation workforce and establishing open and meaningful communication at appropriate times. The site adopts a rolling two year rehabilitation cycle, with the initial tasks comprising bulk earthworks and landform shaping, followed by detailed trimming, drainage works and revegetation.

From a design perspective the site presents a number of challenges including a seasonal climate, dispersive soils and high landforms. Measures that have been adopted at the site include the use of tri-linear slopes to stabilise long batters and control erosion, trials of a range of seed mixes and ground stabilisation approaches, different topsoil combinations, use of basalt for armouring and various drainage design techniques.

Many of the approaches applied at Clermont Coal Mine could be applied at other coal and mineral mines to improve rehabilitation outcomes across the industry.

Chris Gimber is a Principal Environmental Engineer with almost 20 years’ experience in broad ranging technical roles, with particular expertise in site rehabilitation, environmental geochemistry and water management. He has been involved in mining projects in a number of geographies including Australia, Thailand, Indonesia, PNG, India, Brazil and New Zealand. He has provided expert testimony on surface water, groundwater and soils matters within Australia and internationally.
**Travis Peake**  
11:25 AM – 11:40 AM  
Umwelt Environmental and Social consultants  
m 0408 115 679  
tpeake@umwelt.com.au

**Ecological Mine Rehabilitation – Preliminary Outcomes of an ACARP-funded Project**

Regulatory agencies increasingly require proponents to demonstrate that mine rehabilitation meets a certain level of ecological function and self-sustainability. But increasingly, mine rehabilitation is becoming a focus for the re-establishment of native vegetation and habitats. Previous studies have provided preliminary but encouraging indications that complex ecological mine rehabilitation is possible, but they have pointed to the need for more thorough investigations. Is it possible for recognisable and self-sustaining ecological communities to be established through mine rehabilitation?

Umwelt, in collaboration with OEH, have sampled a range of field attributes at numerous sites in the Hunter Valley, including mine rehabilitation and reference (analogue) sites. Data have also been sourced from a range of other sites in NSW and Queensland. The recognisability and function of rehabilitation was assessed and compared to native vegetation and threatened ecological communities listed under legislation. Although the full analysis is due to be reported later this year, the preliminary results will be presented and discussed.

This ACARP-funded project aims to develop guidelines, criteria and valuation of ecological rehabilitation to incentivise the coal mining industry to improve performance as well as to support regulatory mechanisms for biodiversity offsetting using mine rehabilitation.

Travis Peake is an ecologist with over 20 years of experience in vegetation mapping, threatened ecological community analysis, impact and offset assessment, and ecological management. He has a particular interest in the re-establishment of threatened ecological communities in mining landscapes, and envisages the synergy of biodiversity offsets, ecological rehabilitation, protected area management and agricultural landscape management to provide the framework for the future conservation of species and ecosystems in Australia. Travis is the National Ecology Leader for Umwelt.

**Ingrid Meek**  
11:45 AM – 12:00 PM  
Specialist Ecosystem Reconstruction.  
Energy Resources of Australia Ltd  
ingrid.meek@riotinto.com  
Co-author: Dr Ping Lu, Energy Resources of Australia Ltd

**The revegetation strategy at ERA Ranger uranium mine**

ERA Ranger uranium mine, in Australia’s Northern Territory, ceased mining in 2012 and rehabilitation activities, including revegetation, shall be completed by 2026, followed by a post-closure monitoring and maintenance period.

The final landform will be made from waste rock and is to be revegetated to establish a self-sustaining native ecosystem, similar to the eucalypt savanna woodlands that dominate the surrounding area of the Kakadu National Park. The revegetation strategy is to initially establish framework overstorey species along with a subset of important and predictable midstorey and understorey species. These species form the ‘framework’ for the ecosystems, controlling much of a site’s nutrient and water resources, providing many of the core habitat values for other plants and animals, and contributing substantially to both the overall functioning and long-term stability of the plant communities.

As the initial plantings establish and develop, the soil and litter layer will develop, canopy should increase providing shade, and plants will develop attributes resilient to fires (e.g. stem diameter, lignotubers). It is at this stage that introductions of additional species are planned to improve the composition and structure of the ecosystem.

This two-stage approach to species establishment harnesses ecological processes such as vegetation community and soil development, and species-specific environmental preferences, to underpin the Ranger rehabilitation strategy. This paper reviews the natural ecological processes that govern the eucalypt-dominated ecosystems of the region and discusses the current Ranger Revegetation Strategy and its validation by a 10-year-long field assessment on the Ranger trial landform.

Ingrid has over 18 years’ experience in environmental roles in northern Australian mining operations, including at manganese, bauxite, lead-zinc and uranium mines. With a PhD in development of assessment criteria for mine site rehabilitation, she has technical capability and qualifications in environmental management, restoration ecology, completion criteria, mine site rehabilitation and closure planning. Ingrid has experience in stakeholder and regulatory engagement and environmental monitoring and management program development and implementation. Ingrid has recently joined ERA Ranger mine to assist in preparing and implementing the imminent revegetation of the final landform and other disturbed areas.
The reinstatement of Biophysical Strategic Agricultural Land (BSAL) on post mining landforms – An industry update and future directions.

Since 2013, the impact assessment on BSAL, and its planned rehabilitation, has dictated project approval pathways, influenced operational and rehabilitation commitments, and caused an increased focus on soil management for NSW mining projects. To date, four proposed mining projects have committed to reinstating a total of 672 ha of BSAL post mining.

BSAL verification involves the land and soil profile being assessed against 12 physiochemical soil and land criteria. The question is always raised during the EIS submissions by NSW Government: “Can you demonstrate the achievement of BSAL reinstatement, elsewhere?” To date the answer is “No”, because BSAL criteria is relatively new, and no previous rehabilitation had targeted these specific criteria. However, several mines can demonstrate previous rehabilitation sites meeting most BSAL criteria, more by association than design. That is, targeted land capabilities of Class 2 and 3 rehabilitation tend to also satisfy BSAL criteria. There are lessons to be learned from these sites, as mine rehabilitation improves to achieve strategic agricultural land on post mining landforms. These examples will guide the future endeavours of BSAL reinstatement, to ensure the rehabilitation commitments made, can be fulfilled. The mining industry will then be able to demonstrate the achievement of BSAL reinstatement.

Clayton Richards of Minesoils is a Certified Professional Soil Scientist (CPSS) with 20 years’ experience in Soil and Land Management within the mining industry of NSW and QLD. Clayton specialises in soil survey, land assessment, mine rehabilitation and agriculture impact assessments. Clayton is passionate about the reinstatement of agricultural land on post mining landforms. He has consulted on many sensitive projects, where strategic agricultural land is located within project application areas and he understands the management of this land use conflict requires a robust scientific assessment and a strong appreciation of what is required to rehabilitate agricultural land post mining.

Pre- and post-mine land-use trends in the New South Wales and Queensland coal industry

It is recognised that mining is a temporary land use and there is a need to transition to an acceptable land use after mining ceases. In Australia, this land use typically includes grazing or reinstatement of native ecosystems present prior to disturbance (Maczkowiack et al. 2012, Doley and Audet, 2013, Lechner et al. 2016). However, no published information exists that informs on the collective plans for the coal mining industry’s proposed post-mining land uses.

In this study, datasets were created using publicly available information on pre- and proposed post-mine land uses for coal mines in Queensland (QLD) and New South Wales (NSW). We will discuss what pre-mining land uses are typically identified and how this definition changes post-mining. This information is useful for the identification of future alternative land uses as well as support decision and policy making at a landscape level.

Results indicate that agriculture and biodiversity are the most commonly proposed post-mine land uses compared to agriculture being the dominant pre-mining land use. Sites also commonly nominated multiple post-mine land uses, with over 85% of sites nominating between one and three post-mine land uses. There is limited evidence to suggest that operations are more likely to remain consistent with the land use present at pre-disturbance. Eleven sites (24%) in QLD and five sites in NSW (13%) identified a post-mine land use that was identical to the pre-mine land use. Other sites may reinstate the original land use with the addition of other land uses, with 35 sites (76%) in QLD and 23 (58%) in NSW nominating a combination of post-mine land uses that included at least the pre-mining land use. Furthermore, it was evident that mine sites tend to focus on rehabilitation objectives rather than defining post-mine land use directly.

With over 10 years’ operational experience in the coal mining industry within Queensland and NSW, Karin has worked on a diverse range of technical issues: These include tailings management, biodiversity and conservation offsets, spontaneous combustion, mineral waste management, rehabilitation and mine closure planning and execution. Karin’s passion is aligned with all things relevant to mine rehabilitation and positive whilst efficacious mine closure. Karin currently is completing her PhD in environmental economics at the University of Western Australia. Her research involves undertaking an economic valuation of different post-mine land uses to assist in the decision making of mine closure options. A coal mine in the Central Tablelands of NSW is being used as the case study.
Importance of STEM Workforce Development in Mine Rehabilitation

A vibrant capacity in science, technology, engineering and mathematics (STEM) is pivotal to increasing our nation’s productivity and developing the workforce to service the emerging needs of the Mining Rehabilitation Industry.

Australian students should be performing in the top quartile of Organisation for Economic Cooperation and Development (OECD) countries. International testing shows nationally that our students are performing at about the middle of the OECD pack. Across the board, results in science, numeracy and literacy are slipping. In the Hunter however, we have been able to buck the trend of falling STEM enrolments.

Industry are keen to assist education authorities to engage and enthuse students in STEM. They have a lot to gain by elevating STEM skills and aspiration as these are an important part of the makeup of the future workforce. As 75% of the fastest growing jobs require STEM skills and 65% of these jobs not yet existing, it is time to make STEM workforce development a priority.

In this presentation, Dr Sleap will demonstrate how industry in partnership with educational authorities can develop a continuous pipeline of STEM talent. Using programs that have been recognised nationally and internationally by organisations such as; the OECD, Australian Education Council, and BAE Systems the Mining Rehabilitation industry can help secure a workforce of the future.

Dr Sleap is an educational leader with over 20 years’ experience win education. In 2018 he was awarded a Prime Minister’s Prize for Excellence in Science for teaching. He is currently employed by the NSW Department of Education as the leader of the STEM Industry/Schools Partnership (SISP) program. He is affiliated with the University of Newcastle as a conjoint senior lecturer and completed his PhD in Environmental Engineering at the University.

Formally the Director of the ME Program for Regional Development Australia – Hunter, Dr Sleap has worked extensively with Defence and businesses such as; BAE Systems, Boeing, CISCO, PwC, Google and Thales.
Rebuilding disturbed soils from construction sites to enhance soil biology providing a self-sustaining long-term outcome

The erosion control and rehabilitation industry faces numerous challenges in order to remain economically and environmentally sustainable and relevant, including the high cost of implementation, actual success, and continual scrutiny of its practices due to potential runoff and adverse impact on sensitive ecosystems. We will discuss potential solutions that reside in new management practices that increasingly rely on ecosystem services delivered by biological processes and that are directly linked to improving Soil Health. A promising approach is to harness soil-plant-microbial-nutrient interactions to optimise long-term self-sustainability, soil carbon, plant productivity and nutrient use efficiency (NUE), but with minimal financial cost.

To date, Conventional practices are based largely on the use of water-soluble leachable chemical fertilisers particularly nitrogen (N) and phosphorus (P) to achieve an outcome. These can negatively impact soil health including the physical and chemical environment as well as the beneficial microbial community. These impacts can reduce the soil’s capacity to store and exchange nutrients with plants leading to poor NUE, reductions in productivity and ultimately leaching and runoff. Additional conventional fertiliser applications as compensation may increase soil acidity, further impacting soil biology and root architecture, resulting in even poorer NUE – and then further nutrification of the environment.

However, the recent introduction of the latest cutting-edge technology harnessing microorganism-mediated processes can promote better nutrient efficiency and self-sustainability. For example, utilising specific arbuscular mycorrhizal fungi can form an extensive mycelial system within the soil that is many times larger than the plant root system, and therefore can efficiently acquire substantially more nutrients (such as P and N) and water than normally accessible by the root system alone. This in turn leads to increases in soil organic carbon and soil stabilisation. In addition, atmospheric nitrogen-fixing diazotrophs (free living and endophytic bacteria) can be used successfully to reduce the application of excessive amounts of soluble nitrogen (N) to the soil.

Approaches that use controlled release non-leaching fertilisers such as specifically designed novel mineral fertilisers (coupled with beneficial multispecies microbial inoculum) show great potential for conditioning and stabilising disturbed soils, preventing leaching and for long-term, self-sustaining outcomes. This microbial carbon system is the development of a holistic system designed to produce more efficient healthy carbon rich soils and will be discussed in more detail.

Paul Storer
2:10 PM – 2:25 PM
Lead Scientist
EnviroStraw Pty Ltd.

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Paul is a senior soil microbiologist, plant physiologist, agricultural consultant and researcher. With more than 30 years’ research, publications and field experience investigating the link between soil biology and mineral nutrition in plants, Paul has been instrumental in helping investigate and develop innovative mineral/microbe programs. Key to the success of this approach is the increase in nutrient use efficiency, water use efficiency and improvement in soil carbon (driven primarily through growing soil microbial biomass). Paul continues to assist the revegetation industry with practical ways to enhance project successes and increase economic and environmental sustainability through improving soil health, soil nutrition and increasing beneficial microbe levels.
Christopher Waygood
2:30 PM – 2:45 PM
Principal Mine Closure Specialist
Golder Associates Pty Ltd
Level 5, 450 Hunter Street, Newcastle,
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p +61 2 4925 4911; m +61 409 835 864
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A review of the successes and challenges associated with geomorphic landform design in the Hunter Valley, NSW, Australia

Geomorphic landform design appears to be gaining acceptance within NSW, with seven open cut coal mines currently constructing these landforms. The author has been the designer on all these sites, some dating back to 2012. This paper reviews successes and challenges of the current geomorphological design process and associated construction using feedback from the mines involved. The paper also reflects on the extent to which the methodology used in NSW addresses some of the concerns raised with respect to the Geofluv™ approach in the ACARP study of 2010 (Suitable Landscape Design for Coal Mine Rehabilitation).

Chris is a civil engineer with over 35 years of experience mainly in the fields of mining and water related projects ranging from large river diversions, dam construction, to water management plans, and more recently, geomorphic landform design. Since 2012, Chris has been progressing adaptations of the Geofluv™ design methodology on large open cut mines in the Hunter Valley in NSW, Australia. The adapted technique has been progressing well, and nine mines are currently constructing these landforms and one smaller site completed. Through monitoring and ongoing design improvements, Chris has obtained a unique perspective on the constraints and opportunities associated with this landform design technique.

Maria Eugenia Cola
2:50 PM – 3:05 PM
Chemical Engineer
Anglo American
(Brisbane Corporate Office)
Group T&S

Closure modelling and value creation through planning integration

Mining companies are becoming increasingly aware of the importance of their social licence to operate and how this can be impacted by poor planning and subsequent execution. Anglo American (AA) plc is a multinational mining company with almost 40 operations in Southern Africa, Australia, Chile, Brazil and Canada, employing over 60,000 people. Within AA, Group Technical & Sustainability is undergoing a transformational process that looks to unlock unrealised value through the integration of the Mine Closure Planning and Life of Asset Planning (LoAP) disciplines. Hence, corporate tools such as the ‘LoAP Framework’, the ‘Mine Closure Standard’, the ‘Mine Closure Toolbox’ and the ‘Integrated Closure Planning System’ have been developed to support this outcome.

During the summer of 2018/19, two projects were undertaken with a multi-disciplinary approach aimed at exploiting planning synergies. These projects utilised the Deswik Enviro tool to cost a variety of Waste Rock Dump reshape and treatment scenarios for LoA closure at the Los Bronces Copper Mine in Chile and the Mogalakwena Platinum Mine in South Africa. Progressive rehabilitation options were considered for the WRDs in both mines, and opportunities/recommendations to be integrated in future LoAPs were proposed. These included WRD redesign, waste relocation, changes in dumping schedule, and performing erodibility and geochemical tests. This paper will outline the details of this integrated planning process, which promises to play a part in establishing AA not only as the investment opportunity and the operating partner of choice, but also as the sustainable miner of the future.

Maria Eugenia Cola is a Uruguayan Chemical Engineer, who completed her Master of Engineering Science (Management) at the University of Queensland in July 2018. Having had her first exposure to the resources sector through a commercial junior analyst role in an oil refinery in 2014, her more recent job positions have taken an environmental focus. In November 2018, she joined Anglo American to work in the integration of the Mine Closure and Life of Asset Plans for the Los Broncos mine in Chile.
Vegetative Stabilisation of Batters and Spoil Dumps on Asian Pacific Mine Sites

Vegetative stabilisation of spoil dumps, batters and sub-soil heaps is difficult due to low organic matter, uncompacted material, gradient, deficient or toxic nutrients and lack of rainfall or water holding capacity. These trials use various techniques to apply organic mulch to each batter profile after soil testing has identified any deficient or toxic element. Vegetative species are chosen based on the surrounding analogue sites, government and site requirements. Results to date indicate that correct application of high levels of organic matter through hydraulic application is successful within the climatic zones assessed. The current sites are within Australia, Philippines and India with future sites to be considered in Papua, Malaysia and Pakistan. Significant impacts in vegetative coverage, organic matter increase and a reduction in soil loss has been measured during the first six months after application. Ongoing assessment will measure vegetative coverage, organic matter changes, soil loss and carbon sequestration.

Colin Schiller has over 30 years of hands-on experience with agricultural, mining and construction projects. Col is a Certified Professional in Erosion and Sediment Control (CPESC) with experience in stabilising and rehabilitating mine sites, road, rail and power projects. He is a member of the Central Queensland Mining Rehabilitation Group, President of the Southern Queensland Land Rehabilitation Group, the current President of International Erosion Control Association (IECA) Region 2, and Vice-President for International Development. In recent years Col, has assisted projects in Greece, India, Pakistan, Malaysia and New Zealand.

Differences in soil ameliorant types change growth and number of trees

Tall, dense areas of trees are often looked upon by the general public as being more natural, a characteristic desired for the rehabilitation of many mines. The growth of plants on mine rehabilitation areas however is largely determined by the quality of the amelioration applied. There are many ameliorant options available which range from natural substrates like native vegetation topsoil and subsoil through to recycled organic products such as chipped tree mulch and mixed waste organic material (MWOO). We applied combinations of these ameliorants to an experimental restoration site and examined the growth of trees after 4.5 years. All plots received the same number of seeds. There were two broad stories from the data. Firstly, the greatest increase in the number of trees came from applying subsoil and mulch. Secondly, the presence of the commercially produced MWOO organic growth media (OGM) by Global Renewables drastically increased the growth of trees in height and girth. This extra growth suggests that OGM also leads to increased biomass development. We suspect that the differences indicate that the subsoil and mulch foster germination and early survival of seedlings while OGM has provided ongoing nutrient supply for growth.

Rob is a PhD candidate at the University of Newcastle studying how the restoration of ecosystems post mining can be accelerated. He graduated from the University of Newcastle with a Bachelor of Science degree and First Class Honours in 2015. Before beginning the PhD he worked with two consulting companies focusing remote classification of vegetation communities and mine rehabilitation. Rob loves looking at how the biotic world interacts with the abiotic and is looking forward to the discoveries of the future.
Pit lake water quality modelling at Century Mine

The Century open cut zinc mine at Lawn Hill recently changed ownership from MMG Limited (MMG) to Century Mining Limited (CML). Closure planning for the site was initiated by MMG, and is continuing under the new ownership. The waste rock dumps will be covered with low infiltration covers to meet closure objectives. However, the open pit which is partially backfilled with waste rock, is expected to fill with water post closure to form a pit lake. As part of developing the site closure strategy, the final pit lake level (i.e. risk of discharge), and water quality that may develop within the lake post closure, were identified as potential risks to meeting downgradient water quality objectives. To evaluate this risk, a pit lake model has been developed that integrates outputs from geochemical characterisation programmes, water balance studies and hydrogeological modelling. The model quantifies solute production from pit walls and mineralised wastes located within the pit, and accounts for potential influence from out-of-pit waste dumps. Pit lake water quality is calculated over time, allowing assessment of potential impacts to surface and groundwater, and third party receptors. Using the predictions from the model it has been possible to compare potential environmental outcomes for different closure strategies and assumptions, thus allowing prioritisation of forward works and informed selection of optimal closure measures.

Alex is a principal consultant in SRK’s mine waste team based in Sydney, and has over 20 years’ experience in environmental projects. He has worked on projects covering a range of resources including gold, copper, zinc, iron and coal, in various countries and climates across the world. Alex specialises in geochemical characterisation and acid rock drainage prediction and control, metal leaching and water quality modelling.

HUNTER ENVIRONMENTAL INSTITUTE

The Hunter Environmental Institute (HEI) was established in 1988 to provide a forum for the interaction of people working in environmentally oriented fields in the Hunter Region. HEI is a non-profit organisation, managed by a committee and operating under a formal Constitution.

The objectives of the HEI are to:

- Propagate and promote the knowledge and skills of those involved in the environmental field.
- Disseminate information related to environmental disciplines to practitioners and the community.
- Increase environmental awareness.
- Provide impartial comment or assessment, where appropriate, on environmental issues.
- Promote the advancement of environmental management.

Our major events are our bi-monthly seminars featuring presentations by guest speakers (or panels) on a specific issue within the broad range of environmental topics. The meetings are held in a semi-formal setting, providing an opportunity for a presentation on a specialist topic with time for questions. This is followed by discussion and networking with others interested in environmental issues in the Hunter Region. HEI seminars are often held at Newcastle Town Hall, Customs House or the NewSpace building in the Newcastle CBD.

For more information visit:

www.hei.org.au
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For more information visit: www.hei.org.au
THE POSTER PRESENTERS

Lessons from past and present mine rehabilitation to grazing land in the Hunter Valley

Neil Griffiths, Harry Rose – NSW Department of Primary Industries, Paterson NSW
*Justine Cox – NSW Department of Primary Industries, Wollongbar NSW

This 12-month study follows on from ACARP project C23053 A study of sustainability and profitability of grazing on mine rehabilitated land in the Upper Hunter NSW, which found that cattle performance was similar or better on rehabilitated mine pastures than adjacent native pasture analogue areas.

The study is:
1. Reviewing past and present mine rehabilitation pasture work
2. Summarising common practices to identify which are successful and which are not
3. Conducting field work at selected sites to validate the desktop review.

The review indicates that the C23053 monitoring sites have many similarities in species composition to other rehabilitation sites. Monitoring techniques vary between mines and over time, and data on pasture establishment and management is often incomplete. This makes assessment of the success of different practices, and time needed to establish sustainable pastures difficult.

Few rehabilitation sites are grazed within the first 10 years, which affects what grows and the future grazing value of pastures.

While agricultural pasture mixes have evolved over the last 20+ years, many species chosen for mine rehabilitation have poor persistence and appear to be biased towards biodiversity outcomes rather than productivity outcomes.
Screening of Australian native plant species for Rhizoremediation of petroleum hydrocarbon–contaminated soil

Anh Hoang1, Dane Lamb1, Nanthi Bolan1, Balaji Seshadri2, Binoy Sarkar2

1 Global Centre for Environmental Remediation (GCER), The University of Newcastle
2 Department of Animal and Plant Sciences, The University of Sheffield

Eight Australian native plant species (Acacia inaequilateral, Acacia pyrifolia, Acacia stellaliceps, Banksia seminuda, Chloris truncata, Hakea prostrata, Hardenbergia violacea, and Triodia wiseana) were screened for their phytoremediation potential in hydrocarbon contaminated soil. The plants were cultivated under greenhouse conditions for 150 days in pots containing the experimental diesel-oil (1:1) contaminated soil. During plant cultivation, the growth of plants and their biomass were evaluated. Soil respiration, which is usually used to be a sensitivity indicator of organic contamination, was also measured. In addition, the changes in the total petroleum hydrocarbon (TPH) concentration, and soil dehydrogenase activity, which can be used as measure of microbial activity, will be assessed. The preliminary results of the screening experiment revealed that significant variations existed among plant species. Relative Growth (as related to controls) indicated different tolerance to TPH contaminated soil. Moreover, due to changes within the rhizosphere of each species, there was a higher soil respiration in all planted soils than unplanted soils. Interestingly, from our data, TPH contaminated soil stimulated the development of cluster root in members of the Proteacea family, suggesting a possible mechanism for TPH tolerance.

Anh Hoang is a PhD student at Global Centre for Environmental Remediation (GCER), University of Newcastle. He holds a Master and Bachelor degree in Environmental Science. His research interest is the application of phytoremediation technology to mitigate organic contaminants in soil.

Ecohydrology modelling to help design a sustainable post-mining landscape

Hanieh Kosari1, Garry Willgoose1, Min Chen1, Patricia Saco1

1 Discipline of Civil, Surveying and Environmental Engineering, The University of Newcastle, Australia.
2 Now at Department of Ecohydraulics, Three Gorges University, Yichang, China.

Accurate knowledge of soil moisture estimations and forest land-atmosphere interactions can assist in the assessment of mine rehabilitation. Low soil moisture often limits vegetation sustainability. Water holding capacity is a function of the clay content of the spoil and changes as the spoil weathers. For example, if clay is released during spoil weathering then the water holding capacity may increase, but if those clay particles are then flushed down the soil profile the water holding capacity may decrease.

This poster will consider two modelling studies:
1. How does the tree/shrub respond to a change in the limitation of water in the root zone?
2. How does the vegetation ecosystem change as result of changes in water limitation?

In the first study an ecohydrology model was used to simulate both the root zone and the above ground vegetation. Many of the plant water use fluxes are not readily observed and alternative calibration variables were used and the results compared.

In the second study a dynamic vegetation model used soil grading and climate data to evolve the ecosystem. How the ecosystem changed depends on the soil properties.

Both of these studies were for natural ecosystems and the poster will highlight how these highlight these approaches can be used for mine rehabilitation design.

Hanieh Kosari has completed her Masters degree in Civil and Environmental Engineering at the University of Newcastle in January 2019. Her thesis was an ecohydrological modelling study of an Australian eucalyptus forest. She also has the B.Sc. and M.Sc. in Agricultural Water Engineering with specialty in Irrigation and Drainage Engineering from the University of Tehran in Iran. Prior coming to Australia, she has worked as an Irrigation Design Engineer in a consulting company and as a Research Officer at the Department of soil-water and agro-industries in Iran. Her interests are on ecohydrological modelling, water resources management and climate change studies.
Evaluation of heavy metals (AS, CD, CU, PB, ZN) uptake factors of native plants in Thai Nguyen mining sites – a study for phytoremediation

Phytoremediation is a green remediation technology that can provide a cost-effective and aesthetic solution for remediation of contaminated soil. Contamination of heavy metal represents one of the most pressing threats to water and soil resources as well as human health. This study evaluated the phytoremediation potential of two most common native plants Erianthus arundinaceus (Retz.) EA and Phragmites australis (Cav.) PA, growing on three selected contaminated mining sites in Thai Nguyen province that falls on the northern region of Vietnam. Total soil As, Cd, Cu, Pb and Zn concentrations varied from 4 to 2605, 0 to 124, 6 to 603, 45 to 5008 and 64 to 31789 mg kg⁻¹ respectively, while those in the plants ranged from 0.02 to 300, 0.1 to 33, 3 to 111, 1.19 to 982, and 27 to 1346 mg kg⁻¹, respectively. The study showed that the native plant EA has high bioconcentration factor (BCF = 6.45), low translocation factor (TF = 0.74) and high enrichment factor (EF = 4.76) is considered to be ideal HM stabilizers for Cd indicating EA has the potential for phytoremediation of contaminated sites as a Cd phytostabilizer especially in extremely high concentrations of mixed contaminants (As, Cd, Cu, Pb, Zn).

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Phytoremediation using exotic and native plants to rehabilitate contaminated soils in mining sites, heavy metals (loids) quality assessment, application using soil amendments, metal pollutants interactions in soils and environmental remediation. He given oral and poster presentations in conferences in these fields. Before joining to the UON, I was fortunate to receive the Thailand Research Fund (TRF) for Master studies in MCC and Australia Awards Scholarships (AAS) to conduct my PhD studies at GCER.
Amalia Rezeki
Lecturer
University of Lambung Mangkurat, Indonesia
amaliarezeki@ulm.ac.id
Amalia Rezeki is a lecturer at Biology Education Study in the University of Lambung Mangkurat, South Kalimantan – Indonesia, she is also a student of Doctoral Program at Environmental Management and Natural Resources at University of Lambung Mangkurat. In addition, Amalia is founder of Sahabat Bekantan Indonesia Foundation that focused for Bekantan (Nasalis larvatus) conservation and its habitat. Amalia received several awards for her social actions in conserving bekantan, bringing her to be Indonesian Inspirational Woman in the “She Can Awards 2015” award, with the environmental category, as the Young Lecturer of the Savior of the Bekantan.

Population structure of mangrove rambai (Sonneratia caseolaris) as the main feed of bekantan (Nasalis larvatus) in Curiak Island – Barito Kuala, South Kalimantan

Agustina Ambar Pertiwi1, Amalia Rezeki2, Ferry F. Hoesain3, Muhammad Ilham Farihi2, Zainudin3
1University of Islam Negeri Antasari Banjarmasin
2University of Lambung Mangkurat Banjarmasin,
3Pusat Studi dan Konservasi Keanekaragaman Hayati Indonesia Banjarmasin,

Curiak Island is one of islands outside the conservation area of the Proboscis monkey (Nasalis larvatus Wurmb.), or bekantan, which located at the delta of Barito River, Barito Kuala Regency of South Kalimantan, Indonesia. The existence of rambai mangrove plants in this area is very important because it is the main feed of Bekantan, and rambai mangrove habitat is threatened with damage due to land conversion activities. Bekantan is an endemic species of Kalimantan whose status is almost extinct.

This research aims to determine the structure of the rambai mangrove population (Sonneratia caseolaris Engl.) in Curiak Island as the main feed of bekantan. This research is field research with descriptive research type and observation method to collect the data. Data analysed with explorative and statistic. Population in this research is all of rambai mangrove plants which found in the research area while the sample is rambai mangrove plants from adult growth phase (diameter> 10 cm), seedlings (diameter <10> 3 cm), and buds (diameter <3 cm) which found in the research plots. Samples form are roots, stems, leaves, fruits, and flowers. The research plot consists of 20 plots (edge zone) and 7 plots (middle zone) with the distance between the observation plots is 20 m. The results showed that there were 148 plants/Ha of adult trees, 141 plants/Ha of seedlings and 30 plants/Ha of buds. Based on these data it is known that the existence of rambai mangrove plants in Curiak island shows the unbalanced population with the pyramid form decreased population. This is indicated that the number of buds is much less than the number of seedlings and adults. Thus, the existence of rambai mangrove in this area need to be conserved for bekantan’s main feed and ecosystem sustainability.

Keywords: bekantan, rambai mangrove, population structure.

Associate Professor
Greg Hancock
School of Environmental and Life Sciences, The University of Newcastle

Landscape design and assessment: latest technology and applications

Greg Hancock and Garry Willgoose, The University of Newcastle

Mining is an essential part of the modern economy. However, during the extractive process there can be considerable landscape disturbance. The disturbance needs to be rectified so that the landscape can be used again. The post-mining landform needs to be erosionally stable and designed to evolve to a self-sustaining ecological system that integrates with its surrounds. Therefore the most important part of the rehabilitation process is designing and constructing a post-mining landscape that will do this. Here we describe state of the art methods for assessing these new landforms as well as the concept of geomorphic design.

Greg has worked in the area of landscape assessment and mining rehabilitation for the past 20 years. He has particular expertise in the use of computer based landscape evolution models for both current and proposed landscape assessment. He has worked across a wide range of projects, sites and climates both here in Australia and internationally for government agencies, mining companies as well as consultancy firms. He has published over 107 research and conference papers as well as numerous industry research reports.
Phycoremediation of acid mine drainage

Abinandan Sudharsanam, Suresh Subhaschandrabose, Mallavarapu Megharaj

The formation of acid mine drainage (AMD) is due to the oxidation of pyrite or iron sulfide (FeS\textsubscript{2}) that is characterised with extreme acid pH (1-4) and metals posing a severe threat to the environment. Current practices involve techniques that involve enormous capital investment such as membrane filtration, chemical agents that tend to create an environmental burden. Microalgae found in the AMD are acidophiles that have developed tolerance to acid pH but found to show less or no active remediation potential. In this study, we developed and tested two acid tolerant microalgae species (ATM) from non-acidophilic environments for Iron remediation from AMD. The strains Demosodesmus sp. MAS1 and Heterochlorella sp. MAS3 exhibited EC 50 values to Fe content up 250 mg L\textsuperscript{-1} and 350 mg L\textsuperscript{-1} in synthetic AMD mixed metal solution at pH 3.5. Subsequently, both the strains showed Fe accumulation (34-36%) from real AMD solution with low cell density. Upon increasing the cell density, both the strains exhibited >70% Fe removal from real AMD solution in live and immobilised culture within 96 hours. Furthermore, the biomass produced from AMD exhibited good yield of biodiesel indicating the dual advantage of AMD treatment and value added product generation.

Capture and utilisation of gaseous emissions from coal-fired power stations

Chien-Ying Yang\textsuperscript{1}, Hai Yu\textsuperscript{2}, Rajarathnam Dharmarajan\textsuperscript{1}, Balaji Seshadri\textsuperscript{1} and Nanthi Bolan\textsuperscript{1*}

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Global gaseous emissions have risen dramatically nowadays, approximately in parallel with increased fossil fuel use. Coal-fired power is the most common energy source from fossil fuel in the world but it is also the largest contributor to global greenhouse gaseous (GHG) emissions. Among the various types of GHGs, carbon dioxide (CO\textsubscript{2}), methane (CH\textsubscript{4}), Sulfur dioxide (SO\textsubscript{2}), and N oxides (NO\textsubscript{x}) are the most prevalent ones, and these are derived from various sources including mining activities, transport, power plants, and agricultural activities. It is presumed that these GHG emissions contribute to climatic change.

This study aims to demonstrate that potential value of aqueous ammonia (NH\textsubscript{3(aq)}) to capture CO\textsubscript{2} and SO\textsubscript{2}, and subsequent utilisation of the by-product produced during the coal combustion process. The pilot plant results have shown that the designed capture process is effective in the removal of both SO\textsubscript{2} and CO\textsubscript{2} from flue gas stream, and also in the recovery of NH\textsubscript{3} for reuse. Meantime, a high purity CO\textsubscript{2} (99-100 vol%) was obtained at the stripper gas outlet. More tests will be carried out to understand the key parameters for GHGs capture in coal-fired power stations and to evaluate the utilisation of by-products in mine site revegetation.

Keywords: aqueous ammonia, GHGs capture, coal-fired power station

Chien-Ying Yang is a currently PhD student of Global Centre for Environmental Remediation at the University of Newcastle, Australia. Her research is about capturing and utilisation of gaseous emissions from flue gas in coal-fired power station. She is also an author of the book chapter “Back to basic slags as a phosphorus source and liming material”. She completed her master degree in National Taiwan University. Her research interests include greenhouse gases capture and utilisation, biotechnology for pulp and paper industry, plant uptake model with organic compounds and utilisation of nanotechnology in soil remediation.
Towards sustainable management of acid mine drainage: the two-step neutralisation ferrite-formation process and ground-sealing technology

Carlito Baltazar Tabelin1, Toshifumi Igarashi2, Shingo Tomiyama2,3

1 UNSW, Sydney, NSW
2 Hokkaido University, Sapporo
3 Mitsubishi Materials Corporation

Acid mine drainage (AMD) is one of the most serious environmental problems after the closure of mining and mineral processing operations. If released to the environment without treatment, AMD rapidly pollutes the surrounding soil and water bodies and destroys affected ecosystems. The most widely used approach for AMD management is chemical neutralisation, a technique whereby basic materials like limestone or lime are mixed with AMD to raise its pH and remove most of the contaminants via precipitation. Although effective, it is unsustainable in the long-term because this process requires the continuous supply of chemicals, energy and manpower. Unfortunately, promising alternatives to chemical neutralisation are still unavailable for large-scale applications. In this study, we introduced two promising and more sustainable AMD management strategies: (1) two-step neutralisation ferrite-formation process; and (2) ground-sealing technology. The two-step neutralisation ferrite-formation process, as the name suggests, produces a final sludge rich in magnetic ferrites, which could be used as raw materials for the manufacture of paints, magnets and adsorbents. Meanwhile, ground-sealing technology involves completely/partially covering a small fraction of critical recharge areas in a mine site that limits infiltration of groundwater into the old underground mine workings.

What can teabags tell you about your restoration

On mining land, many native ecosystems are constructed using a single application of nutrients which must sustain the ecosystem through the rest of its life. With the uptake of nutrients by plants and leaching over time, plants will eventually rely on the release of nutrients from processes such as decomposition. We looked at the tea bag index (Keuskamp et al., 2013) as a method of comparing the rates of decomposition on different restoration substrates. Green tea indicates how much material can be decomposed as it breaks down quickly and stabilises. Rooibos tea is used to estimate the rate at which the recalcitrant material breaks down as its decomposition is very slow. The experiment used spoil as a control and three combinations of ameliorants which were compared with three separate references in old rehabilitation and in native vegetation. Our results find that pure spoil not only slows the rate of decomposition but may also inhibit the decomposition process. The addition of ameliorants improves the ecosystems ability to decompose to a point where it approaches or matches the reference ecosystems. Over the years the small, non-significant differences in decomposition observed between ameliorants could lead to large differences in outcomes for restoration.

Rob is a PhD candidate at the University of Newcastle studying how the restoration of ecosystems post mining can be accelerated. He graduated from the University of Newcastle with a Bachelor of Science degree and First Class Honours in 2015. Before beginning the PhD he worked with two consulting companies focusing remote classification of vegetation communities and mine rehabilitation. Rob loves looking at how the biotic world interacts with the abiotic and is looking forward to the discoveries of the future.
Is your site contaminated by PFAS?

Some firefighting foam used for many years at airports and fire training facilities contained the potentially toxic per- and poly-fluoroalkyl substances (PFAS) PFOS and PFOA. In many cases, these chemicals have spread to groundwater, drinking water, plants and animals. This is affecting local communities and is the focus of investigations by regulatory bodies.

There is a solution.

Ensure the safety of your air facility through remediation of soil and water with matCARE.

Developed by CRC CARE, matCARE is a proven on-site solution that remediates PFAS-contaminated soil and wastewater. matCARE has been used successfully at four large air facilities across Australia, with each site benefiting from a site-specific remediation plan that could be implemented quickly for optimal results.

matCARE does a far better job than granular activated carbon and other technologies currently available, with a much smaller amount required. Around 90% cheaper than landfill, matCARE remediation is a cost-effective solution. And with CRC CARE’s scientific foundation, matCARE provides the safest solution to ensure toxins are removed from soil and water, protecting everyone who comes in contact with the facility.

To find out more about matCARE™, email matcare@crccare.com or call 02 4921 5201.
Biogeochemical interactions of minerals and metallophytes in abandoned mine tailings

There are over one million abandoned mines worldwide, and more than 55,000 abandoned mine sites in Australia. This calls for effective approaches to remediate mineral processing tailings that pose environmental risks. Legacy tailings originating from base metal mining often contain a range of contaminants (such as As, Cu, Pb, Zn, Cd, Se), as well as potentially valuable elements (such as Re, Tl). The release of these contaminants through airborne particles, runoff and seepage from tailings may lead to detrimental effects on ecosystems. An ecofriendly technique to deal with an excess of contaminated tailings is phytoremediation, which uses metallophytes (metalloid tolerant plants). Understanding the different properties of the soil and plants occurring on abandoned wastes offer a solid framework of integrated management options to inform the closure strategy of currently operating mining projects.

I hold a chemical engineering degree. At an early stage of my career, I was focused on the improvements of the grade and recovery of metals. I worked in different polymetallic mine companies in a chemical and metallurgical laboratory. After witnessing the difficult relationship among mining companies and peasant communities, I decided to study a Master’s degree on environmental development. Currently, I am a PhD candidate of the Centre for Mine Land Rehabilitation (CMLR), at the Sustainable Minerals Institute, at The University of Queensland.

Dr Balaji Seshadri
Research Fellow
Global Centre for Environmental Remediation, University of Newcastle, New South Wales, Australia

The common heavy metals in the legacy mine sites at potentially toxic concentrations in New South Wales (NSW) are cadmium (Cd), copper (Cu), manganese (Mn), lead (Pb) and zinc (Zn). Risk assessment of these metals for toxicity was carried out in the laboratory using aquatic algal species (Chlorella sp. and Selenastrum sp.). Samples were collected from four different mine sites across NSW (Halls Peak, Web Consuls, Emu Creek, Mt Cositgan) to study metal mixture toxicity in the organisms using laboratory studies and the effect of humic substances on cation binding and accumulation using WHAMF tox model. Based on the laboratory results on heavy metal toxicity, the binding and accumulation of these metals were calculated with WHAMF tox model by assuming that the cation binding sites in the organisms were represented by humic acids. Zinc was found to be the most significant metal at all sites, which is attributed to the chemical competition of metal accumulation and toxic effects between the metals.

Balaji Seshadri is a researcher in environmental remediation since 2007 with experience in soil chemistry, waste management, rehabilitation of derelict mine site, wastewater utilisation, bioenergy generation and carbon sequestration. Balaji holds a Master’s degree in Biotechnology and PhD in Environmental Remediation and Public Health. Balaji’s past research experiences include Plant Biodiversity assessment in Western Ghats (prominent Mountain ranges in south western part of India) and coordinated a project on the “Restoration of agricultural lands in Tsunami affected coastal areas of South India.” He also had a brief stint at Salim Ali Centre for Ornithology and Natural History (India) for a project entitled “People’s Biodiversity Register” where he gathered information on the traditional wisdom of the rural communities by coordinating school students for the task. Balaji’s recent interests include community engagement and communicating contamination science to the common man.
Creating artificial soils for mine rehabilitation through industrial symbiosis

Alena Walmsley, Mohan Yellishetty, Likhitha Mundodi
Department of Civil Engineering, Monash University

The Latrobe Valley is host to several open-cut coal mines which pose an environmental risk if poorly managed. To reduce risks associated with acid mine drainage and fire, progressive rehabilitation of batters is recommended. A lack of topsoil in this area has led to development of artificial topsoil via industrial symbiosis, utilising waste product from 3 industries: mining (overburden – OB, subsoil – SS, brown coal dust – BC and fly ash – FA), paper mill industry (effluent sewage recovery – ESR), green waste collection (compost – C). Previous experiments have shown that the mixture of OB, FA, BC and ESR can mitigate acid mine drainage and support plant growth, however suffers from relatively high salinity and alkalinity. Addition of green waste compost and subsoil from the mine foreground was beneficial for the salinity reduction, nutrient supply and the soil physical properties as well. We constructed greenhouse and field experiments to establish the mixture that would support a stable pasture plant community and that would be the most profitable in terms of costs to the mine. Once part of the routine mine rehabilitation practice, these artificial soils will not only help to regenerate the landscape after mining, but also enhance carbon sequestration and reduce waste load in the whole area.

Urunga wetland remediation

Over 40 years ago, an antimony processing plant was abandoned leaving behind 30,000 tonnes of tailings on the foreshore of a protected wetland. The impacts from the heavy metals (antimony & arsenic) and chemical reagent residues caused the NSW EPA to enforce a clean-up notice on the owners.

The Soil Conservation Service undertook the $10M project over 2 years to return the wasteland back into a wetland. The highly constrained 6ha site was surrounded by residential neighbours, some 10 m away, including a pre-school. Over 60% of the land was contaminated leaving little space for remediation operations, and dredging was not possible. Key challenges were:

- Control of large volumes of contaminated water
- Accessing and excavating wet sediments
- Stabilising a complex mix of heavy metals
- SCS adopted both innovation and best practice during works including:
  - in-situ mobile water quality treatment
  - use of floating excavators
  - installing sheetpiles from water without a barge (first in Australia)
  - low ground pressure wide tracked machiner
  - XRF heavy metal detection
  - Soil mixers and laboratory controlled reagent treatment.

Once completed, the site was extensively revegetated and reopened to the community and converted into a parkland with a stunning boardwalk out over the wetland, known as the ‘Urunga Wetlands’.

Clayton Colmer
Senior Environmental Engineer
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Clayton Colmer is a Senior Environmental Engineer with the NSW Soil Conservation Service and has over 22 years’ experience delivering rehabilitation projects in Australia and the UK. He runs a team of Soil Conservation Officers across the north coast of NSW who can be found wandering around dérèlict-mings, contaminated sites and eroded riverbanks delivering rehabilitation works, as well as operating machines on fire trails, coastal breakwalls, and access track repairs to maintain infrastructure which supports the states natural resource base. Clayton loves his work and believes that the future of environmentalism is to repair when it is no longer possible to protect.
WORKSHOPS

WORKSHOP 1

Wednesday, 19 June 2019
9 am to 3 pm
Room X202, NewSpace City Campus, University of Newcastle,
Cnr Hunter Street and Auckland St, Newcastle
Cost $300 Ex GST per person

Pathways to relinquishment and opportunities to transition to productive alternate land uses

Background

Using the relinquishment process to transition to alternate productive land uses potentially has significant benefits for all parties; mining companies, regulators and communities. However, there are also challenges in achieving this transition including:

• Current regulatory and land tenure frameworks
• Providing for the long-term management of residual risk / liability for a site if a future land use fails
• Lack of current mechanisms to facilitate the alignment of mining companies and investors in post mining land uses, with regional development plans.

Workshop outline

An initial workshop explored this topic at the University of Newcastle’s 2017 Mine rehabilitation Conference in Muswellbrook. The aim of this workshop is to build on the findings of the initial workshop and further explore the opportunities, barriers, enablers and responsibilities for establishing pathways to:

• More productive end land uses post mining
• Enabling miners to successfully relinquish their responsibility for their mine lease
• Assisting the transition to the next landholder.

Donna Pershke
Director
Pershke Consulting Pty Ltd

Donna has been working in mine closure for over 20 years. Drawing on approaches used by the land and infrastructure development sector, Donna has recently been working with mining companies to challenge conventional thinking and identify innovative approaches that result in a post closure land uses that have positive socio-economic value.
WORKSHOP 2

Wednesday, 19 June 2019
9 am to 3 pm
Room X207, NewSpace City Campus, University of Newcastle,
Cnr Hunter Street and Auckland St, Newcastle
Cost $300 Ex GST per person

Understanding acid mine drainage / acid rock drainage and
the implications for rehabilitation and closure

Background
Rehabilitation is an important part of mine closure and our understanding and
implementation of rehabilitation practices has developed significantly over the last
three decades. Most mining companies now aim to leave a post-mining legacy with a
sustainable land-use, with rehabilitation playing a key role. However, mine closure is a
complex and multi-disciplinary process which presents a diverse range of major risks.
When sulphides are present in the ore body, the formation of acid and metalliferous
drainage (AMD) or acid rock drainage (ARD) can result and this is regarded as the
main environmental concern of the mining and minerals industry today. Unmitigated,
ARD/AMD can result in water quality impacts that could well be the industry's most
significant financial and credibility risk. The long term impact and treatment cost of
AMD/ARD can delay and prevent mine closure and subsequent relinquishment. It has
also historically left a global legacy of abandoned mines which still require attention.
The aim of this short course is to help attendees develop a better understanding of the
fundamentals of AMD/ARD generation processes and management options through to
closure. The topics will be presented in an interactive manner, using real case studies
from around the world. The course, could be regarded as introductory for some and as a
refresher for others, will be ideal for mining industry environmental and mine planning
practitioners, mining regulators and post graduate students.

Workshop outline
This short course will include presentations by leading AMD/ARD specialists from
Australia and overseas. Discussion topics will include:
- Overview of AMD/ARD issues and global resources (e.g. GARD Guide)
- Waste management
- Remediation measures
- Closure planning with focus on risk management
- The AMD/ARD management plan
- Abandoned mines.

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

Gilles Tremblay is the Technical Manager of the International Network for Acid
Prevention (INAP), an organization of international mining companies that
seeks the prevention of mine-impacted waters through collaborative research,
information transfer and networking in support of responsible mineral
development. Mr. Tremblay also coordinates activities jointly with the
Global Alliance, which has organizations working on acid prevention in Australia,
Canada, Europe, South Africa, South America and USA. Prior to joining INAP
Gilles worked for the Government of Canada for more than 33 years
coordinating large multi-party R&D consortia related to environmental issues
affecting the mining industry (e.g. MEND and NOAMI).
WORKSHOP 3
Wednesday, 19 June 2019
8:30 am to 3 pm
Room X205, NewSpace City Campus, University of Newcastle,
Cnr Hunter Street and Auckland St, Newcastle
Cost $300 Ex GST per person

Harnessing hyperaccumulator plants to phytoremediate contaminated mining sites

Workshop objective
Over the past 20 to 25 years, hundreds of plant species have been used to remove contaminants from soil and water. Hyperaccumulator (HA) plants can take up huge amounts of metals in their shoots without showing any toxicity impacts on the plants. For metals, these plants are capable of accumulating metals above the threshold concentrations of 10,000 mg/kg dry weight of shoots for Zn and Mn, 1,000 mg/kg for Co, Cu, Ni, As, and Se, and 100 mg/kg for Cd. Phytoremediation using HA plants is an exciting and promising biotechnology because of the following features: relatively inexpensive; considered an eco-friendly and sustainable technology; aesthetically pleasing; and ability to achieve complete breakdown of toxic materials. The objective of the workshop is to provide participants with the theory and practical skills on how to use phytoremediation to clean up mining sites that are contaminated with metals.

Workshop outline
The workshop will cover:

- Background of hyperaccumulator (HA) plants
  > Review of types of HA plants available for phytoremediation
- Phytoremediation processes
  > Rhizofiltration, phytodegradation, phytostimulation, phytoextraction, phytostabilisation
  > Review of types of contaminants
- Advantages and limitations of phytoremediation
- Case studies
  > Using a fern (Seldum alfredii) to uptake metals. 5 years field trials co-cropped with corn in China
  > Australian native vegetation for remediation covering heavy metals and TPH
- Exercise
  > Use of a phytoremediation database containing 120 contaminants & more than 1000 plant species.

Dr Charles Lee
Program Convenor and Senior Lecturer
University of Newcastle

Dr Charles Lee is the Program Convenor and Senior Lecturer at the University of Newcastle (Australia), Singapore. He has more than 25 years’ experience in environmental research, education and consulting in North America, and Asia-Pacific countries. He has soil science degrees from the University of Guelph (BSc) and University of Hawaii (MSc and PhD). At the Agency for Science Technology and Research, he was the lead co-author of a patent for the photocatalytic degradation of halogenated compounds. Recently, he was invited as a keynote speaker at the 7th International Cleanup conference, September 2017 (Melbourne, Australia), and conducted a phytoremediation workshop at the Global Cleanup Congress, October 2018 (Coimbatore, India), both organized by CRC-CARE. He was also sponsored by the Chinese Research Academy of Environmental Sciences (Beijing, China) as a remediation expert to conduct a workshop on “Risk-based Corrective Action and Bioremediation of Contaminated Sites”. Dr Lee is an associate editor of three research journals: International Journal of Environmental Pollution and Remediation (ASET, Canada), Environmental Geochemistry and Health (Springer, USA), and American Journal of Environmental Sciences (USA).
Prof Nanthi Bolan
Professor of Environmental Chemistry
University of Newcastle

Professor Nanthi Bolan’s teaching and research interests include agronomic value of manures, fertilisers and soil amendments, soil acidification, nutrient and carbon cycling, pesticide and metal pollutants interactions in soils, greenhouse gas emission, soil remediation, mine site revegetation, and waste and wastewater management. Nanthi is a Fellow of American Soil Science Society, American Society of Agronomy and New Zealand Soil Science Society, and was awarded the Communicator of the Year award by the New Zealand Institute of Agricultural Sciences. He has supervised more than 50 postgraduate students, and was awarded the Massey University Research Medal for excellence in postgraduate students’ supervision. He has published more than 400 book chapters and journal papers, and is one of the Thomson Reuters Highly cited researchers for 2018.
**WORKSHOP 4**

**Wednesday, 19 June 2019**
1:00 pm to 4:00 pm

Room X204, NewSpace City Campus, University of Newcastle
Cnr Hunter Street and Auckland St, Newcastle
Cost $100 Ex GST per person

**Issues in tropical forest rehabilitation post mining**

**Workshop objective**

The objective of the workshop is to provide participants with an understanding of the issues facing miners and government in the development of resource extraction in the tropical forest environment, in particular in the Indonesian Kalimantan States of Borneo. The extraction of coal is occurring on a massive scale in virgin rainforest in the face of conditions of heavy rainfall, acid forming soils and difficult terrain. Such mining is regulated strictly by strong national Forestry Law that regulates the management of the three categories of forests (conservation forests, protection forests and production forests) in Indonesia. Participants will learn how such regulation is bringing about exemplary practices in dealing with acidic water treatment, reforestation, conservation of threatened and displaced fauna, and the generation of post-mining support in the form of new agricultural and commercial enterprises to provide employment for local peoples.

**Workshop outline**

This short course is coordinated by Emeritus Professor Tim Roberts and will include presentations by leading mining practitioners and forest and fauna experts from Indonesia. Discussion topics will include:

- National regulations governing forest mining in Indonesia, including requirements for end of lease mine closure
- Treatment requirements, constructed wetlands and other technologies used for acidic wastewater
- Reforestation, succession and recovery
- The threat to endemic fauna including proboscis monkey and orangutan due to conversion of tropical rain forest.
- Community development through establishment of new local industries for economic support post mining.

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**Tim Roberts**

School of Environmental & Life Sciences, University of Newcastle

Emeritus Professor Tim Roberts took up the position of Tom Farrell Institute Director, following the completion of his tenure as Dean of Research at JCU Singapore. His previous tenure was as inaugural Dean of the Singapore campus of the University of Newcastle, Australia. In line with his appointment as Conjoint Professor in Biology he continues to be active in research in the laboratory of his long-time collaborator, Associate Professor Hugh Dunstan, at the University of Newcastle. He has published 100 papers. In 2018 Tim was appointed Emeritus Professor in Biology at the University of Newcastle.
Yudi Firmanul Arifin
Lambung Mangkurat University, Banjarmasin, South Kalimantan, Indonesia

Yudi Firmanul Arifin is a Professor of Forest Ecology and also Head of Research Center for Innovation, Technology, Commercialization, and Management of Forest and Wetland, Lambung Mangkurat University. He is a forestry scientist interested in rehabilitation of post-coal mining areas. All environmental management efforts have been undertaken in accordance with applicable standard procedures. Selection of species is one strategy to measure the success rate of revegetation and rehabilitation land in the post-coal mine areas. All environmental management efforts have been carried out in accordance with applicable standard procedures. However, species selection is one strategy to measure the success rate of revegetation and land rehabilitation in the post-coal mining areas.

Amalia Rezeki
Lambung Mangkurat University, Banjarmasin, South Kalimantan, Indonesia

Amalia Rezeki is a lecturer at Biology Education Study in the University of Lambung Mangkurat, South Kalimantan – Indonesia, she is also a student of Doctoral Program at Environmental Management and Natural Resources at University of Lambung Mangkurat. In addition, Amalia is founder of Sahabat Bekantan Indonesia Foundation that focused for Bekantan (Nasalis larvatus, the proboscis monkey) conservation and its habitat. Amalia received several awards for her social actions in conserving bekantan, bringing her to be Indonesian Inspirational Woman in the “She Can Awards 2015” award, with the environmental category, as the Young Lecturer of the Savior of the Bekantan.

Ihsan Noor
Lambung Mangkurat University, Banjarmasin, South Kalimantan, Indonesia

Ihsan Noor, graduated from Agriculture Faculty of Soil Science of Brawijaya University, Indonesia in 1989 and Masters degree of Natural Resources and Environmental Management of Lambung Mangkurat in 2011 and continued a Doctoral Study of Natural Resources and Environmental Management at Lambung Mangkurat University which commenced in 2017. He started career in coal mining industry of Environmental Engineer and Reclamation Planning in 1996. Currently, Ihsan Noor is Mine Head / Head of Technical Mining of PT Jorong Barutama Greston a coal mining company in South Kalimantan since 2015. Ishan is a PhD candidate at Lambung Mangkurat University.
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