

ANNUAL REPORT

FY 21-22

mining3
TRANSFORMING MINING



celebrating 30 years

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Annual Report FY 21-22

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Chair & Interim Executive Director's Report

FY22 has again been a turbulent year for Mining3, with a lot of change in just one year. This resulted from the need for a rapid transition of the business to a new business model after a relatively long eight year membership period, and significant external changes in the 30 years since our establishment as a CRC.

Recognising these external changes, in early 2021 the board commissioned a stakeholder survey and strategic review. One year ago, I delivered Mining3's response to the feedback from an extensive consultation led by our external marketing consultant, Threeby3, and I asked our members to give me one year - a Transition Year - to transform Mining3. You told me that:

1. Mining3 has value and is unique in its model
2. We need to change the way we communicate and deliver projects
3. We need to invest in increased capabilities, resources and relationships

It is critical that our members and key stakeholders see greater value in what we do and improvement in the way we deliver collaboratively. As part of any new business model Mining3 will need to provide members, partners and other stakeholders with:

- Clearer, more differentiated value proposition
- Revised membership fee (if any)
- Increased transparency and accountability
- Better communication with members
- Opening membership wider to include more of the mining tech/ research ecosystem
- Increased capability to enhance commercialisation, sales and project management
- Different ways to attract funding

My focus this year has been on repairing some damaged relationships and rebuilding trust, as well as resetting the internal organisation with the aim of nurturing it to be able to deliver on its full potential.

I made a huge investment in direct and personal engagement with all members and strategic partners to really listen to feedback to drive Mining3's future direction. I appreciate the many honest and deep conversations with each of you. I hope that you are seeing the significant changes that have been happening in order to prepare for this relaunch under the leadership of our new CEO Jack Barnes.



Highlights for the year include:

- Operational Restructure delivering savings to Mining3 of over \$400K
- Transition of UQ seconded staff directly into the Mining3 team
- Stabilisation of the Mining3 team during a period of great change
- External review of the research roadmap and intellectual property approach
- Negotiation and execution of a new member agreement, effective 1 July 2022
- Successful renewal of 6 member companies as continuing members, effective 1 July 2022
- Welcoming Thiess as a new member (early in FY23)
- Successful recruitment process leading to Jack Barnes coming on board as our new CEO.

As we speak strategic initiatives being explored include:

- A new opportunity to bring together our members to jointly invest in a newly-created testing site, with the possibility of further collaboration
- Creating an Innovation Hub with one of our members
- Discussions with other potential mining and non-mining members and customers
- New strategic partnerships with CSIRO, UQ, Curtin, QUT and University of Southern Qld
- 2 to 3 commercialisation opportunities for Mining3 Intellectual Property
- Cave Mining 2040 Horizon 2 for the next phase of research
- Planning Hydra Phase 2b or 3 for the next step in commercialising hydrogen drive trains in Mining
- Investigating ways to create a big research project to honour our CRCTiME commitments

The Mining3 Board of Directors invested in the transition and decided on a model with a lower annual fee, a self-renewing membership agreement and an increased focus on industry funding for projects. Some seed funding will still be available, generated from profits on project delivery and commercialisation revenues (royalties, sales or our cash reserves) and will be used frugally where an idea needs some development to scope up a project. In order to make this model sustainable and to develop impact that is globally relevant to the industry and its members, the board recognised that investment would be required using some of our reserves and that the membership base would need to grow. Under the new membership agreement, the Board sets the membership fee each year after consultation with members - there is scope to bring in a tiered structure at different fee levels if members desire a different model and to appeal to a wider variety of companies.

At the research committee meeting in June 2022, our members committed to help us to co-create the new Mining3, to deliver on the inherent value that members saw in our unique ecosystem - mining companies, OEMs and suppliers and researchers all innovating together to solve issues that affect the industry. The relationships with our research members have now transitioned to strategic research partnerships and we are still negotiating new commercial agreements to underpin these. We are also exploring some exciting ideas for possible future collaborations with universities and mining companies with innovation hubs, test facilities and programs as we imagine new ways of working together.



As we look forward, and now with Jack at the helm, we will be organising a Strategic Direction Workshop with our members in February 2023, to co-create our future plan. This workshop will explore and test new business models for Mining3 moving forward with a focus on independence, commercial sustainability and most of all delivery to mission.

Our commercial partnerships are also undergoing renewal, with a focus on active collaboration during commercialisation of technology:

- The Smartcap sale has been concluded and this product now has the capital behind it to reach its potential. We have recovered some of the investment made by Mining3 to reinvest in innovation and the sale proceeds have been distributed as per our funding agreement with Anglo American.
- Future Fibre Technologies (Ava Group) has made their first commercial sale of the AURA IQ conveyor health monitoring system and we received the first return under our commercialisation agreement. The product is now ready for deployment but we recognise that each application is bespoke and Mining3 will continue to collaborate with FFT and Mining3 on each use case and on further development. FFT has been undergoing site trials and are investing in its future and we are planning to extend this agreement. I acknowledge the huge effort by Karsten Hoehn from CSIRO in leading the Mining3 project team and Dave Apollo and others who are supporting FFT on trials at the Port of Brisbane to provide valuable data and a demonstration site for customers.
- Elexon Mining is continuing to make sales of the Cave Tracker product which was developed based on Mining3 research. We are discussing whether there is a need for investment in the next iteration of this product now that we understand its use cases and can identify improvements.
- We are actively looking at commercialisation pathways for other technologies such as the alternative explosives (hydrogen peroxide) and the uncrushables and remote borehole sensing work which are close to commercial readiness after many years of investment and setbacks.

I'm looking forward to the year ahead and note that our future success rests on:

- efficient and effective program management and project delivery by Mining3 to ensure profits can be reinvested for growth
- active participation by a significant portion of the industry as Mining3 members and partners to grow our global relevance,
- investment by individual companies and the industry generally in research collaborations and projects to drive impact,
- deep and trusting partnerships with research providers to focus on outcomes for industry, and
- strong commercial partnerships for the continued translation of technology into viable products and services for deployment across the industry, generating returns for reinvestment.

I look forward to our Innovation Forum and celebrating our 30th Anniversary Dinner with you, and co-creating our future in our first face to face meeting for 3 years.

Sincerely,



Leeanne Bond
Chair of the Board, CMTE Development Ltd (Mining3).

Our Board

The CMTE Development Limited (Mining3) Board is primarily elected from nominations received from our member companies as well as the Independent Chair and the Chief Executive Officer. In addition to this, the Board nominates up to two additional directors based on a specific skill requirement or to strengthen a strategic partnership. The following people held office as at 30 June 2022:



Leanne Bond

Chair of the Board & Interim Executive Director

Appointed March 2020

Leanne is a prominent engineering leader, advocating for innovation and entrepreneurship, improved project governance, sustainability, gender equity, and workplace diversity and inclusion. Leanne is currently an independent non-executive director of Aurecon Limited, ASX-listed Synertec Corporation Limited (SOP), the Australian government's Snowy Hydro Limited and One Basin CRC. She recently retired from the Clean Energy Finance Corporation board and stepped down from the board of The University of Queensland's JKTech Pty Ltd when she joined Mining3.



Tony Sprague

Non-Executive Director, Chair of the Audit & Risk Committee

Appointed October 2017

Tony is Group Manager - Directional Studies & Innovation at Newcrest and brings a wide variety of experience in surface and underground mining projects gained in both Australian and international mining operations. He leads a team of internal experts, consultants and contractors in a number of mining transformation projects across Newcrest's global operations focused on the use of new technology and innovative thinking to achieve step-change improvements in safety, costs and productivity. Tony has also previously served as Chair of the Research Committee.



Rudie Boshoff

Non-Executive Director and Chair of the People & Culture Committee

Appointed May 2022 (previously Alternate Director for Peter Salditt)

Rudie Boshoff is Vice President Hardrock Mining at Komatsu and works with global teams to develop and implement mining technology and services. Over 25 years in mining, Rudie has developed operational productivity enhancements, global performance improvement strategies, and team-building initiatives to meet and exceed customer goals. Rudie replaces Peter Salditt on the board and was previously his Alternate Director. Rudie chairs the People and Culture Committee.



Professor Michael Bruenig

Non-Executive Director

Appointed December 2021 (Previously a Mining3 Director)

Michael is Head of School of Information Technology and Electrical Engineering at The University of Queensland and brings deep experience in R&D in academia, industry, and government agencies, working in high-tech areas in Europe, the USA, and Australia. After his PhD, he worked at RWTH Aachen University in Germany before coming to Australia in 2007. At CSIRO, Michael established a National Research Flagship on Digital Productivity and then as a member of CSIRO's Executive Management Council, Michael guided this \$90M per annum business unit through a merger process with National ICT Australia to form Data61, a new entity with a focus on data innovation in Australia. Michael was also the Executive Manager of CSIRO's Queensland Centre for Advanced Technologies, in Pullenvale, Brisbane. Michael will chair the new Research and Innovation Committee.



Jim Callahan

Non-Executive Director and Member of the Audit & Risk Committee

Appointed November 2019

Jim is General Manager - Resource Industries Asia Pacific, Caterpillar Inc and has been with Caterpillar Inc. for over 25 years. The bulk of his career at Caterpillar has been in the mining industry with responsibilities and experience spanning from engineering, product development, research and development, manufacturing, supply chain, dealer development, mergers & acquisitions, marketing & sales, technical support, training and mobile equipment consulting. Jim brought great commercial acumen as a member of the Audit and Risk Committee and has retired from the Board, with Paul Bitter appointed (to be endorsed at the AGM).



Luke Sandery

Non-Executive Director and Member of the People & Culture Committee

Appointed October 2018

Luke is the Power, West Musgrave and Carrapateena Expansion Package Manager - OZ Minerals and has over ten years of experience as a mining engineer, including five years in Iron Oxide Copper Gold deposits. Luke previously acted as the Principal Advisor to the CEO at OZ Minerals and now manages the Power, West Musgrave, and Carrapateena Expansion Package. Luke was a member of the People and Culture Committee and has retired from the Board, with Brett Triffett appointed (to be endorsed at the AGM).

Executive Team

Mining3 is led by a strong leadership team with diverse backgrounds in resources industry, engineering innovation, research, technology transfer, commercialisation and financial expertise. The Executive team listed represents the current team as at the date of the AGM with Jack Barnes and Amena Reza being appointed post 30 June 2022.



Jack Barnes

Chief Executive Officer

Jack Barnes has over 25 years of corporate experience including 10 years in executive leadership roles spanning operational, strategic, commercial, and corporate roles in oil and gas. He has held P&L responsibility and led major capital and commercial business opportunities. Jack joins Mining3 from Shell, where his most recent role was leading cost efficiency across Shell's global businesses through the COVID-19 pandemic crisis. Prior to this, he served on the Shell Australia Leadership Team in several roles including as leader of the post-merger integration of BG-Group in Australia and as VP for the Arrow Joint Venture in Queensland. His career has taken him around the world, and he has spent most of it living and working overseas.



Amena Reza

Chief of Staff/ Chief Financial Officer/ Company Secretary

Amena Reza is the recently appointed Chief Financial Officer, Chief of Staff and Company Secretary at Mining3. Amena is a business leader with over 25 years experience in executive-level positions in both the commercial and not-for-profit sectors. Amena has a demonstrated track record in business improvement, financial performance and change management. Amena was instrumental in running the recruitment process for Mining3's new CEO.

Prior to joining Mining3 she operated her own Business Consultancy working for a portfolio of private and NFP clients as an Interim Executive/Strategic Business Consultant. She was also Managing Director of leading Brisbane based Architecture studio ML Design, who have delivered major projects locally and internationally for over 30 years and CFO of CPL (Choice, Passion & Life) formerly the Cerebral Palsy League of Qld where she was able to contribute her commercial skills and business acumen to an \$150M not for profit.

Amena is a Chartered Accountant and a Graduate Member of the Australian Institute of Company Directors.

Dr Erik Isokangas

Research & Technical Director



Erik is a Program Director at Mining3. He leads research in mine process modelling and simulation, integrated mine process design and implementation, and the development of technologies for future mining systems. Erik previously worked for Metso, a global equipment supplier to the mining industry, most recently as the Director of In-pit Solutions supporting mining customers in the design and feasibility of in-pit crushing and conveying systems. Prior to this, he led a consulting team in Finland, focused on process integration and optimisation for mines in Europe, Russia, the Middle East, and Africa. Erik also worked for Thiess, a major mining contractor, managing and developing new technologies to support mining operations, including productivity monitoring systems, modelling and simulation of complex mining operations, benchmarking, laser-scanning systems, and data visualisation.



Chief Financial Officer Report

CMTE Developments Limited has had a challenging year financially, recording a deficit of \$1.89M. Whilst this is disappointing, it represents the culmination of a series of circumstances that have led to this result.

During FY22, Covid19 continued to impact Mining3 projects, hampering the team's efforts to deliver to project milestones. Site visits continued to be restricted and many projects were delayed as a result. This also affected Mining3's ability to procure new project opportunities.

This has significantly reduced Mining3's revenue from projects in 21/22 (down by \$2.7m on FY21), the impact of which will also roll into 22/23. Covid19 has also impacted Mining3's revenue from royalties as supply issues were affected, reducing sales figures across a number of our licence agreements by \$204,000 (since FY21).

Last year, the Mining3 board reviewed our strategy in preparation for the renewal of our 8 year membership agreement which was due to expire on 30 June 2022. Feedback from members through in depth interviews indicated strongly that the new model needed to include a shorter term, more flexible financial commitment with less emphasis on seed funding and more choice by members through direct investment in projects.

In November and December 2021 the COO and CEO of Mining3 left the business. With those departures, Mining3 lost significant corporate knowledge and business development contacts and has had to divert management's focus to stabilising the organisation. This has meant that Mining3 has had to invest across a range of operational areas including:

- Legal fees increased due to managing executive staff departures and the requirement to review a large number of contracts including the new member agreement
- Consultancy fees incurred around member engagement & feedback and investment in brand, communications, and marketing strategy as we look to the future
- Consultancy fees for an external review and consolidation of the research roadmap and existing and new commercialisation opportunities
- Governance costs increased as a result of an independent governance review and external company secretarial support
- Increased Patent & IP protection costs

Despite the circumstances, Mining3 has been able to hold its overhead expenditure to budget (\$3.5M) for the 21/22 year. Overall overhead expenditure was down by \$613,000 on FY21.

The balance sheet position is still strong, maintaining net assets of \$8m and cash reserves of \$5m available for operations.

Current assets exceed current liabilities by \$7.6m, meaning there are sufficient reserves for Mining3 to carry on its operational activities into FY23 and beyond during our transition to a new business model.

The Board considered various strategic options in response to member feedback and decided to invest in the future sustainability of Mining3, initially under the stewardship of the Chair/Interim Executive Director and subsequently committing to the recruitment of a new Chief Executive Officer to drive the business forward. (Jack Barnes was appointed in September 2022).

To improve the financial situation the FY23 budget focusses on:

- Growth in membership
- An increase in project/consulting revenue
- Project delivery efficiency & accountability
- Maintenance of total overhead budget with a focus on improving operational efficiency and developing capability
- Investment in strategic partnerships and development of talent to increase Mining3's access to strong capability into the future
- Identifying and leveraging Mining3's intellectual property to achieve new revenue from licencing/commercialisation

With the focus above, we are anticipating a deficit to again be incurred in 22/23 with a return to a surplus in 23/24. The team are committed to ensuring Mining3 maintains its financial track record providing quality and viable outcomes for its members and the industry as a whole.



Research Director's Report

The mining industry is facing ever more challenges, not just in terms of finding and mining new resources, diminishing recoveries, and improving productivity, but also engaging with communities, meeting social responsibilities, and being sustainable. The challenges are shared across the industry and there is a growing realisation that they can only be solved through integration and collaboration across the diversity of miners, suppliers, OEMs, and researchers.

Mining3 is somewhat unique in that it can provide the conduit to enable collaborations but also the processes and resources to execute the research and draw in the right resources from other research institutes with a sense of urgency.

A great example of this is the Hydra Consortium, founded by Mining3 and Engie, to take a technology, hydrogen fuel cells, and test its application on a mine site to learn how it may play a role in decarbonisation in mining. The project drew in the skills and technologies from suppliers and an engineering company, the access and resources of mining companies, and the methodologies and discipline of our researchers, to deliver new understanding and results to help de-risk the adoption of the technology in mining. The success not only comes from the huge effort of approximately 100 participants but also the framework provided by Mining3 to enable the collaborations to occur, with relative speed.

This project execution model and other variants used at Mining3 will help the industry collaborate to solve some of the challenges for the future of mining.

Another consortium that Mining3 plays a crucial role in facilitating is the Cave Mining 2040 consortium. The four- year Horizon 1 research program is almost complete and the next horizon is being planned with more participants welcome. The aim is to expand the research and draw on researchers globally. Mining3 provides the project leadership for the consortium to continue this important work into the future.

Reviewing over \$4.5M of project value completed this past year, it's difficult to summarise all the research. The work highlights the wide range and depth of work conducted at Mining3.



For example, research into sensors that communicate hundreds of metres through rock and earth structures like tailings dams, stockpiles, cave mining operations and ore bodies in extreme environments, and fibre-optic sensors all help address safety risks in mining.

Research and development of models for simulating and estimating the value of new decarbonisation technologies for mobile fleet, including hybrid and battery systems, helps the industry develop energy transition plans towards their net-zero goals.

Developing concepts for mine design approaches that see value (not cost) in the mine's end-of-life, support a more sustainable future. Finding new ways and technologies to monitor and predict the condition of mining equipment improves productivity. Mining productivity, safety and lowering emissions is being addressed through our work in hydrogen peroxide-based explosives.

All these projects and more, as detailed later in this report, also help to push Mining3's roadmap forward.

Mining3 continues to grow on the international stage, through projects such as Hydra and Distributed Acoustic Sensing (DAS) and other sensor trials, supporting mining company initiatives and relationships with universities in Chile, Canada, South Africa, and more. Mining3 welcomed three new employees in Chile this year on the Hydra project and looks forward to reinforcing our presence and relationships in South America where we are finding new opportunities for growth.

An essential element of research involves supporting talented students, involving them in our research, introducing them to scientific methods, and giving them the opportunity to innovate 'thinking outside the box'.

Mining3 truly values the skills, fresh thinking, and especially the enthusiasm that students bring to the workplace. This past year we have hosted students from the University of Queensland (UQ) Bachelor of Engineering / Masters of Engineering (BEME) course and UQ Master of Data Science Capstone Placement.

We are also pleased to see Nicholas Dendle, our sponsored PhD candidate from the Department of Mathematics at Queensland University of Technology (QUT) Department of Mathematics, recently completed submitting his draft PhD thesis on Mine Optimisation.



Initiatives and collaboration

CRC TiME Foundational Projects

This national consortium led by The University of Queensland and the University of Western Australia secured \$30 million from the Federal Government to help regional communities transition to a sustainable future after their local mines have closed. Mining3 has already completed three projects in CRC TiME's foundational projects portfolio which focussed on bringing groups together to understand what knowledge exists on key topics at the moment (from multiple perspectives); defining the problem and articulating what will transform the area, and determining whether this is something the CRC should invest in or if it is being addressed by other means. As a member of CRC TiME, Mining3 is actively looking for proposals for ground-breaking research that could be included.



Cave Mining 2040

Cave Mining 2040 was developed as an international consortium that advocates for the collaboration to develop and accelerate innovations and new knowledge to ensure cave mining remains a technically viable, sustainable, safe, and profitable business. The objective is to facilitate the development, validation, and demonstration of new technologies and concepts through Horizon 1 projects, each with its own scope of work for the corresponding study areas to be identified, delineated and approved. It aims to engage stakeholders in supporting Cave Mining2040 collaboration and in particular projects leading to transformational technologies. Horizon 1 research projects will be completed by January 2023 and the consortium is inviting new companies to join Horizon 2 to follow.

The projects in Horizon 1 are:

- Total deposit knowledge
- Numerical optimisation- based decision support tool for cave mining operations and the design of ore passes
- Cave Monitoring with Sensor Fusion
- Designing block cave interactions for high recovery
- Cave front tracking using active and passive microseismic data
- Review of global sublevel cave best practice

Hydra Consortium (Phase 2)

The Hydra Consortium in Chile is an international consortium working on validating the business case of utilising a hydrogen fuel cell-based powertrain for heavy-duty mobility within the mining sector. This will enable heavy-duty mining mobile equipment to run on renewable hydrogen, displacing diesel, towards decarbonization in the mining sector.

To achieve this target, several workstreams were executed, including a pre-feasibility and engineering study of a powertrain and the renewable hydrogen value chain. This included designing, manufacturing, and testing a 200kW fuel cell and battery powertrain prototype (a truck without wheels) at a mine site under challenging conditions (altitude, dust, temperature, etc.). The test outcomes provided valuable information to optimise the overarching design that could replace the traditional diesel powertrain. In addition, the project, with the support from a wide range of stakeholders and government entities in Chile, worked towards a set of recommendations for establishing safety protocols for hydrogen use at scale within the mining industry, which will be critical for the successful deployment of hydrogen solutions.

Sponsors of the Hydra consortium are Mining3, ENGIE, Mitsui & Co. (U.S.A) Inc., Antofagasta Minerals, Thiess, BHP, Ballard, Hexagon Purus, and Reborn Electric Motors, with support from CORFO and CSIRO Chile.



Centre for METS Business and Technology Innovation – funded by Mining3, Queensland Government and Queensland University of Technology (QUT)

The Centre for METS Business and Technology Innovation has a METS-focused research program aiming to build the capabilities of METS firms for strategic innovation and inform industry development initiatives delivered by industry associations and government organisations. The research centre has a strong focus on industry engagement, communication and research impact pathways.

Projects

Mining3 is a world-class research institute focused on delivering transformative solutions to the mining industry. We do this through a combination of industry funded projects and consortia, government and industry grants from bodies such as MRIWA and ACARP in Australia and CORFO in Chile, and self-funded investment (Mining3 funded – Seed funded projects) in line with our strategic research roadmap and industry needs. Each project, however small, contributes to a larger picture of how we and our members envision mining in the future.

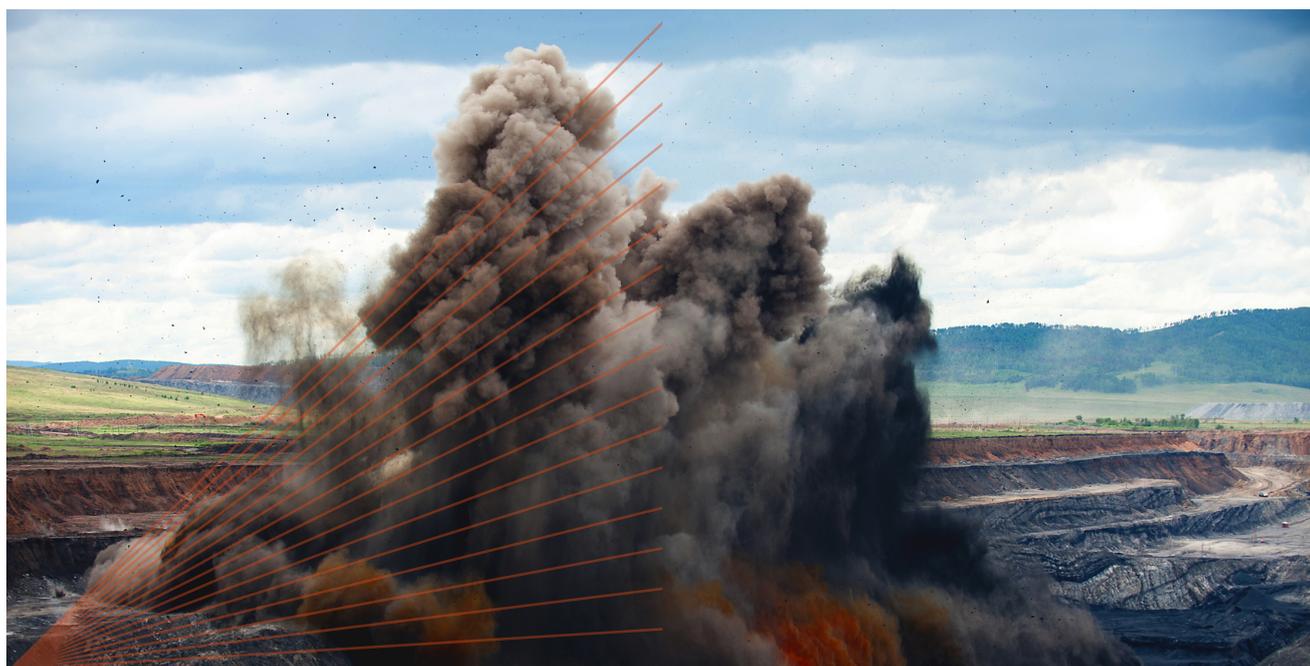
Note: Confidential projects are not listed or described here.

Active Projects

ACARP C27024 - Blast performance evaluation of production-scale trials using hydrogen peroxide-based explosives

This project aims to demonstrate the manufacture and delivery of Hydrogen peroxide (H₂O₂)-based explosives using a specialised Mobile Production Unit (MPU) and evaluate blast performance in surface mine-site operations with increasing scales of production. This progresses the research plan for H₂O₂-based explosives from confirmation of first viable formulations meeting sleep-time and detonation performance (delivered in the C27023 project) towards implementation and adoption by focussing on manufacture and delivery procedures to meet mine-site operational requirements. Mining3 has collaborated with Sydney-based Elquip to assist them to design and manufacture the MPU, achieving the commissioning of the first prototype unit on July 2022 at RUREX, western NSW.

The project delivered successful United Nations-defined explosives classification test results, in January 2022, which were required for authorisation of the explosive formulation and to build confidence with collaborating companies for the commercialisation of the technology. Progressing into the FY 2022-23 period, all focus is upon establishing contracts with an explosives delivery/service company to acquire the Queensland Licence-to-Manufacture for the emulsion in bulk volumes and for the mine trial site.



ACARP C29052 - Autonomous Sensors for Evaluation of Groundwater Pressures in Spoil Dumps and Tailings Dams

The geotechnical integrity and stability of a mine spoil dump or tailings dam can be weakened, by factors including abnormal pore pressures and movement induced by groundwater permeating the embankment or the foundation of these structures. These factors greatly affect the design, layout, safety, and potential for slope failure to affect surrounding areas.

After a successful initial stage, the objective of the current phase of the project is to continue the development and validation of an autonomous sensor system, using the knowledge gained to create a geotechnical model from the field data to further provide information and certainty on spoil dump or tailing dam stability, and develop a reporting and alarm system to notify of increased or high risk. This will culminate in a long-term trial to monitor the pressures and movement of a spoil pile and predict instability



ACARP C34018 – Carbolt 2: Fixed Length Carbolt

The Mining3 Carbolt development program is currently researching the next generation of advanced rock support in the form of a carbon fibre rope that can either be manufactured in pieces of pre-determined length, or in bulk and be rolled onto a drum for deployment into a drill hole by a to-be-designed machine before being cut to length as needed during the installation. The manufacturing technique of the rope includes a novel design (Mining3 patent pending) which introduces a ductile phase to the Carbolt under tension prior to ultimate failure.

ACARP C34019 – Longwall Bretby Cable Handling Fibre Optic Monitoring

The main objective of the project is to develop, test and evaluate a Bretby monitoring system that can automatically detect major failures of the cable handling system, such as its dislocation, and to determine how early this detection can be made in practice.

As mines start to integrate standard optical telecommunication fibres into their HV cables for shearer control, an additional dark fibre could be interrogated remotely to determine the Bretby shape in real-time.

A secondary objective of the project is to investigate the possibility of detecting changes in the interface between coal and roof/floor material through the utilisation of Fibre Optic based Distributed Acoustic and Vibration Sensing methods.

Anglo-Measure While Drilling (MWD) at Sishen and Mogalakwena

This project aims to evaluate Measure While Drilling (MWD) systems on reverse circulation (RC) drill rigs and apply the data to improve blasting processes, as well as for geotechnical stability analyses and the geo-metallurgical applications at the mines. Data collected by RC drills at a mine need to be processed and linked to the geological and geotechnical characteristics of rocks to be able to use them for the classification of rocks. If calibrated properly, the rock mass geotechnical and geo-metallurgical data can be approximated based on the MWD Data.

The data can then be used to inform blast designs to improve fragmentation outcomes as well as for the plant performance predictability, further improving mine planning capabilities.



Caving 2040 - H1 - Cave Monitoring Phase 1: Sensor Fusion

Successful ground control is an integral part of any well-managed surface or underground mining and the geotechnical conditions that exist in the rock mass, together with the influence of mining activity, should be well understood and monitored during operation. Depending on the type of operation, the ability to influence ground behaviour movement can be very limited as it is in cave mining operations.

The aim of this project was to showcase the application of distributed fibre optic sensing technologies for ground movement monitoring. It included the installation and commissioning of 3 x 500m Fibre Optic Axial Strain Gauges downhole and a fibre optic subsidence monitoring system at the OZ Minerals Carrapateena mine in SA. These installations have been used to determine the distributed strain in the rock mass surrounding the cave for over a year now.

Further, a short-term trial of a fibre optic seismic monitoring system has been conducted utilising the already installed fibre network. This trial demonstrated that the technology is capable of observing micro-seismic activities in the rock caused by the mining operation.

The ongoing support from OZ Minerals for field installs and trials has been excellent so far. Great appreciation goes to the OZ Minerals Carrapateena Team led by David Cox.



Fibre Optic Sensing (FOS) – Smart Composite Cable

The FOS Smart Composite Cable project is a joint Research and Development project with Connec to develop and commercialise the next generation of High Voltage (HV) Coupler Systems. The aim is to enhance the availability of fibre optic networks in mines in general and in underground coal mines, particularly through the integration of fibre optic networks into HV cables and connectors.

Underground coal mines often have limited network capacities due to environmental constraints and the need to utilise only Intrinsically Safe equipment. Consequently, automation and/or remote operation is less common than in metalliferous mines. Providing a fibre optic network throughout the mine, even to mobile machineries, i.e., to Continuous Miners through trailing cables, will enhance the available bandwidth (up to Gbps) and so act as an enabling technology for automation and remote tele-operation.

Furthermore, the Mining3 Fibre Optic Sensing team sees a significant opportunity to utilise this network in the future for distributed mine-wide sensing applications. The project is a key activity towards the strategic task of developing “Reliable high-bandwidth UG comms anywhere & anytime” and the visionary task of “Mine wide high-bandwidth comms connecting all mine systems” of the Mining3 roadmap. In addition, it is an enabling technology towards the strategic “Mine Safety Systems” enabling the “Emergency location of personnel with distributed sensing” and many other distributed sensing applications, e.g., temperature and ventilation condition, as well as equipment-specific monitoring tasks, e.g. Bretby condition monitoring for long-wall shearers.

Mine-to-Mill-to-Mine (M2M2M)

In this project, a software application was applied to track material flows at Newcrest’s Lihir gold mine by linking mine data through the CSIRO VoxelNET data fusion engine with the Outotec HSC SIM code to allow material flows to be tracked or simulated from the blast through to the mill and, most importantly from mill back to the mine, to provide suitable blends of material as required for production, selected breakdown or shutdown scenarios. The combination of codes will provide a closed loop of information from Mine to Mill to Mine (M2M2M). This software will allow users to track material flow in real time through a three-dimensional digital twin of their mine.

MRIWA M545 - Evaluation of ISR in-situ barrier technology for risk mitigation and extraction optimisation

Mining3 is a sponsor of this project for evaluation of in-situ barrier technology for risk mitigation and extraction optimisation for in situ recovery operations. The project involves 2 PhDs at Curtin University. The research will further Mining3’s understanding of the in-situ mining process and improve future applications with improved lixiviant formulas.

Mining Development at Great Depth

This research will test an excavation damage hypothesis used to develop a global methodology for safe (and most economical) development construction at depths not yet reached by the current mining operations. This will enable the sustainability of underground mining even in conditions of very high stress, where failure can occur very soon after the construction of the underground openings.



Wireless Remote Borehole Temperature Sensing - Newcrest

This project involves the research and development of a prototype system that can wirelessly measure underground temperature and pressure in geothermal regions. The benefit of a wireless system is that there are no underground sensor cables that can be damaged by hole shear or surface blasting activity. The prototype system can be operated autonomously or linked to a site's LAN for remote operation and data collection.

This wireless sensing system is the first of its type in the world, with single-hop underground sensor to surface-receiver transmission distances of 100m and 200m max respectively, for the two models of the sensor.

The underground sensor transmission circuitry is entirely solid-state, so there are no moving parts. The first iteration of the underground embedded sensor has a working temperature of up to 150 degC making it uniquely suited to monitor underground geothermal conditions, where high temperature and saturated steam environments are common. This will give mine site staff and other stakeholders the ability to deploy the sensors, gather and analyse sensor data, comply with governance and reporting, and most importantly feedback to mine site personnel on the effectiveness of current geothermal cooling strategies.

Phase 2 of this research project is focused on the development and testing of prototype units, to be trialed at Newcrest's Lihir Gold Mine. The surface elements of this system are being prepared now for immediate shipment to Lihir. The underground pressure and temperature sensors will follow shortly after, for onsite testing planned for Feb 2023.

Tramp Metal Detection for Conveyors & Feeders

This project is leveraging off the successful development of the "Uncrushables" metal detection system for loader and excavator buckets to detect tramp metal objects in conveyors and apron feeders, where current metal detectors are unable to operate. Early trials have shown promising results that could provide significant benefits to mine operators through increased productivity, and reduced maintenance and repair costs.



Annual Safety Report

Mining3's mission is to partner with the mining industry and research organisations to deliver breakthrough innovative technologies and equipment that transform mining productivity, safety, and sustainability. Mining3 believes all injuries and occupational illnesses can be prevented, and that safety is a fundamental responsibility of everyone. The organisation is committed to the well-being of all workers and to meeting its obligations to Work Health and Safety laws with the establishment of measurable objectives and targets to ensure continual improvement.

Mining3 aims to ensure, as far as reasonably practicable, the health and safety of employees it has engaged and other stakeholders whose activities in conducting their work are influenced or directed by the organisation. To achieve this aim, a certified safety management system has been continually maintained since 2007, demonstrating the organisation's ongoing commitment to the health and safety of our staff, contractors, visitors, and members.



Mining3 is certified to 'ISO 45001:2018 – Occupational Health and Safety Management System' for; evaluation of the technical concepts for development and application in the mining industry; and development of commercially viable equipment and associated safe operational procedures prior to being placed into industry control. Released in 2018, the standard was subsequently adopted within Australia as the Australian Standard for health and safety management systems and is the foremost industry standard. Prior Mining3 was certified to AS/NZS 4801:2001 since 2007-01-22.

The goal of the safety management system is 'Safety Always' with four key objectives to drive the safety system, with the objectives embedded in the Health and Safety Policy and measured through our annual strategic plan.

1. Implementing the right systems for continual improvement
2. Engaging with our Members and workers
3. Controlling our WHS Risks
4. Demonstrating Due Diligence

Mining3 believes all workers have a duty to care for their personal welfare and the welfare of others. To meet this commitment each worker implements safe systems of work always and takes all reasonable care to prevent personal injury or injury to others and damage to plant and equipment. It is the responsibility of persons directing work to ensure that safe working procedures are clearly understood and consistently observed. Directors of work shall also ensure that all plant and equipment in use is in safe working order and that workplace conditions are maintained at a high standard.

Implementing the right systems for continual improvement

- Framework & mapping
- Policies
- Procedures
- Tools
- Resourcing

Engaging with our members and workers

- Awareness campaigns
- Competency training
- On-the-job training
- Consultation
- Meetings & forums

Controlling our WHS risks

- Standard operating procedures
- Audit & inspection programmes
- Safe work instructions
- Project safety plans & risk assessments



Demonstrating Due Diligence

- Management review
- Performance reporting
- Risk registers & tools
- Audit programmes

Goals

Mining3 achieved the following set goals: safety certification compliance was retained, and the yearly audit successfully passed; WHS Committee was established and has continued to meet monthly, with a new WHS Safety Chair elected; WHS Policy updated and executed by Mining3 Chair, and Critical Incident Management Plan developed.

Safety Record	Safety Target	Outcome
Audit compliance	Retain safety certification	Certified

Key Safety Performance Indicators

Mining3 developed a WHS Strategic Plan, describing key performance indicators and objectives required to achieve the target of 'Safety Always'. The plan is supported by a WHS Improvement Plan, which monitors specific WHS tasks to be completed for compliance. The process is overseen in consultation with Senior Management stakeholders.

Programmes have been established to ensure monitoring of key performance indicators and compliance to AS/NZS ISO 45001 Occupational Health and Safety Management System requirements. These include Workplace inspection programs; Internal and external audits; WHS performance reviews; Management review; Incident data analysis; Preventative maintenance programs; and Health monitoring programs.

Safety Record	Target	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Outcome
Total Audits / inspections ¹	-	9	14	8	8	39
Take Five Checklists completed	100	11	15	28	14	68
Active projects with Project Safety Plans	90%	100%	100%	100%	100%	100%
Fire Training Compliance ²	90%	95%	100%	96%	92%	96%

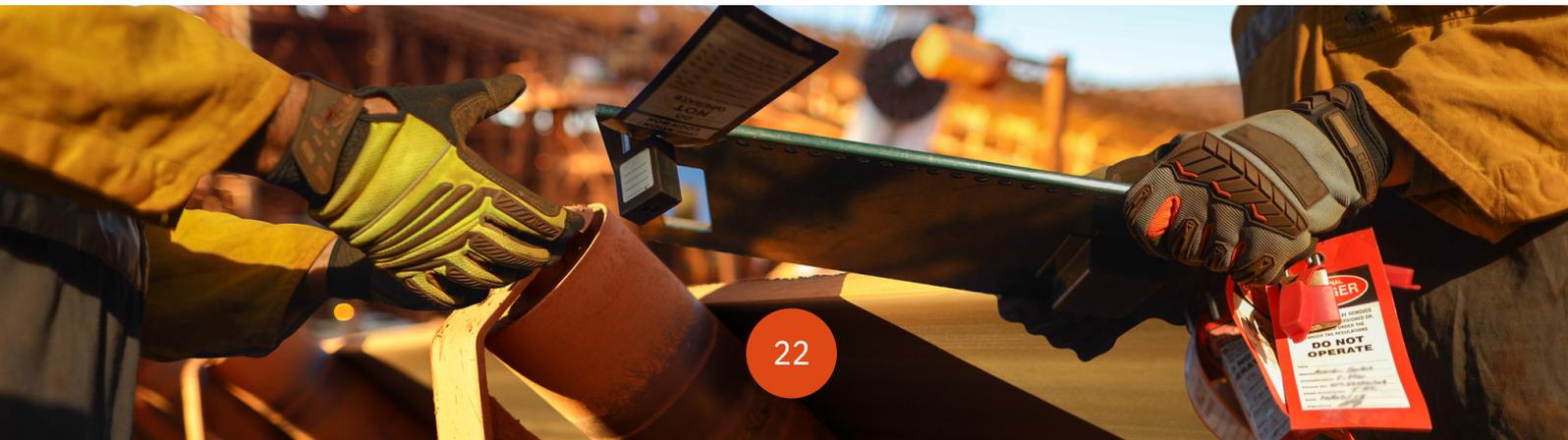
[1] Total includes internal audits/inspections, project audits/inspections or external audits.

[2] Fire training compliance is only measured for staff at Pinjarra Hills base workers only.

Summary of Incidents, Near Misses, and Hazards

There have been five incidents reported this year and four hazards. Each incident and hazard was investigated. No incidents resulted in a lost time injury or medical treatment case.

2021-2022	Target	1 st Qtr.	2 nd Qtr.	3 rd Qtr.	4 th Qtr.	Total	Freq Rate (%/FTE)	Incident Rate (%/Employee)
Hazard	0	0	3	1	0	4	12.82	13.33
Near Miss	0	0	1	2	1	4	12.82	13.33
Minor Incidents	0	1	0	0	0	1	3.21	3.33
Major Incidents	0	0	0	0	0	0	0.00	0.00
LTI	0	0	0	0	0	0	0.00	0.00
Total	0	1	4	3	1	9	28.85	30.00



July 2021	Incident	A worker caught their thumb in the door of building 103C due to inattention. First aid treatment only.
October 2021	Incident	Whilst rushing to leave a laboratory, a tenant, failed to hang a safety mask on a hook correctly resulting in it falling onto a Mining3 hydrogen peroxide experiment, smashing the glass container. The laboratory was re-organised to prevent a repeat occurrence.
October 2021	Hazard	Heavy rain resulted in an uprooted tree partially blocking access to the site. UQ facilities team removed the hazard.
October 2021	Hazard	Overflowing gutters on the 103 buildings resulted in very slippery walkways. Replacement downpipes has reduced the risk of slippery surfaces.
November 2021	Hazard	Broken window on the upper level of building 101. Window replaced.
January 2022	Hazard	Fallen tree on the entrance road to the site, reported to UQ who engaged a contractor to remove the fallen tree.
February 2022	Work Related Incident	A worker had a bicycle accident on the way into work, resulting in minor skin damage.
March 2022	Incident	A B-double, triple axel, truck dropped the rear trailer when the fifth wheel was not correctly engaged resulting in site access being blocked for 15-30 minutes. The trailer was recovered, and the truck left under its own power.
April 2022	Incident	Haul truck jack failure: Contractor, working for a Mining3 project, suffered equipment failure resulting in the haul truck dropping back onto axle stands from a jacked-up position. The failure occurred due to a timber block failing. No injuries or damage to Mining3 equipment.

Incident History

Overall history of CMTE and Mining3 incidents over the previous twenty calendar years from 2002 – 2022:

