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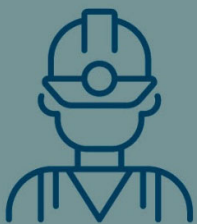


AUGUST 2026



CURRENT PROJECTS REPORT

This report is a summary of
current and completed projects
for the months May, June and July
2026



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UNDERGROUND

Reports Published This Quarter

C24010 Proximity detection systems gap analysis for underground coal mining machines

Simtars

Sean Muller

Link to download the final report:

<https://www.acarp.com.au/abstracts.aspx?repId=C24010>

C28018 Longwall Floor Horizon Sensing

CSIRO

Andrew Strange

Link to download the final report:

<https://www.acarp.com.au/abstracts.aspx?repId=C28018>

C35014 Investigation of Preinstallation of Fibre Optic Cable in Exploration Holes for Longwall Weighting and Coal Burst Monitoring

CSIRO

Joey Duan

Link to download the final report:

<https://www.acarp.com.au/abstracts.aspx?repId=C35014>

Detection and Prevention of Fires and Explosions

C29026 Investigation into the Thermal Ignition Caused by IS Power Supplies

Organisation:	Simtars
Project Leader:	Sean Muller
Value:	\$153,700
Report Expected:	September 2026
Industry Monitors:	Brad Lucke Jarod Chadwick
ACARP Contact:	Patrick Tyrrell

The objectives of the project are to:

- Determine the fault conditions arising in an intrinsically safe electrical circuit that could ignite combustible material on a mining machine;
- Determine the role and extent that combustible material accumulation can cause or contribute to the risk of equipment fires, when ignited by intrinsically safe power supplies; and to
- Determine the parameters to be considered in installing an intrinsically safe circuit in an area where they could be an accumulation of flammable materials.

During the quarter, the following steps were completed:

- Finalised modifications to test regime and test setup;
- Completed Risk Assessment for new test procedure;
- Calibrated equipment for testing;
- Manufactured resistive wire coils for IS PSUs no. 1 and 2;

- Commenced testing with PSU no. 1 using two test methods -
 - resistive wire coil heated prior to immersion into combustible materials,
 - resistive wire coil heated after immersing into combustible materials.

The following steps will be addressed in the next quarter:

- Complete tests for all IS PSUs;
- Determine the minimum energy necessary for the ignition of combustible/flammable materials;
- Conduct T-rating tests;
- Analyse all data and results;
- Commence preparation of final report.

Environment - Subsidence and Mine Water

C33021 Pilot Scale Membrane Distillation Crystalliser (MDC) with Renewable Heat Source for Mine Water Brine Management

Organisation:	CSIRO
Project Leader:	Ramesh Thiruvengkatachari
Value:	\$969,195
Report Expected:	January 2027
Industry Monitors:	Paul O'Grady
ACARP Contact:	Patrick Tyrrell

This project aims to undertake a mine site demonstration of the MDC system for treating saline and acid mine drainage mine impacted water under actual mine site conditions. The main objectives are to develop a modular MDC water treatment plant to mine site specifications, install at the mine site by integrating with onsite infrastructure and to demonstrate the mine impacted water treatment performance. Through this study optimum operating process parameters for AMD treatment will be obtained in maximising reusable water recovery with reduced volume of saturated concentrate.

The pilot test unit has been constructed. The fully constructed unit has been RPEQ mechanical certified. Also, the electrical work compliance has been certified. We are awaiting inspection of the pilot from the mine site personnel. The onsite pilot testing is expected to be carried out after the inspection sign-off from the mine.

C35016 Rehabilitation Options for Ponded Areas Due to Longwall Coal Mining

Organisation: University of Queensland
Project Leader: Louisa Rochford
Value: \$397,200
Report Expected: September 2026
Industry Monitors: Jason Fittler
 Michael Moore
ACARP Contact: Patrick Tyrrell

There has been limited research on the most appropriate options for rehabilitating land subsided by longwall mining in Australia. This project is investigating the environmental outcomes of retaining ponded areas from longwall mining compared to draining them. The approach is to select a study site and conduct the research at that location over a three-year period, providing a template for the assessments that are required to make decisions on rehabilitation options for ponded areas at other mines.

All four rounds of fieldwork have been completed. Post-processing of the camera trapping data and the soil hydrological modelling are complete. The Site Characterisation Report to be delivered at the end of Q3 2026 is in its final stages of development and review by mine site representatives. The report will provide details of the field, analytical and modelling work undertaken for the project and assessment of the rehabilitation options.

The final report to be delivered at the end of Q3 2026 with preparation being underway. This report will include guidance for mine sites conducting studies of ponded landforms and will be de-identified and generalised so that it can be publicly released if mine site representatives decide to keep the study site confidential.

Maintenance and Equipment**C33017 Specialised Instrumentation and Data Processing for Real Time FEA Condition Monitoring of AFC Chain**

Organisation: Vayeron
Project Leader: Ryan Norris
Value: \$185,000
Industry Monitors: Brad Lucke
 Jarrod Sampson
ACARP Contact: Patrick Tyrrell

The draft report is with the industry monitors for review.

C35013 Ex.P Enclosure Designs

Organisation: CSIRO
Project Leader: Peter Reid
Value: \$248,500
Report Expected: September 2026
Industry Monitors: Brad Lucke
 Colin Hoyle
 Dave Young
ACARP Contact: Patrick Tyrrell

During this quarter, work has progressed from evaluation of modified commercial enclosures to a parallel path of developing a new purpose-designed enclosure concept for statically pressurised hazardous-area instrumentation. The new concept is intended to integrate the enclosure body, sealing system, pressure connection, power and data feedthroughs, and internal instrumentation mounting into a manufacturable assembly suitable for subsequent testing and certification assessment.

Long-term pressure testing of the modified commercial enclosure is continuing. The enclosure has now remained under test for over five months without the monitored pressure falling below the nominated 1,200 threshold. An industry monitor was briefed on the results and expressed strong interest in seeing a working demonstration unit deployed within an industry training environment once a suitable prototype is available.

Supplier engagement has expanded substantially during the reporting period. Discussions have continued with a polycarbonate component manufacturer regarding the enclosure body and sealing arrangement. Three additional manufacturing companies with integrated design, manufacturing and testing capabilities have also been approached to assess options for producing complete prototype units, including pressure connections and sealed electrical feedthroughs.

Alternative commercial enclosure products are also being investigated. Following industry feedback, contact was made with the Australian distributor of Appleton hazardous-area enclosures, which may provide improved sealing performance compared to products evaluated previously. The distributor has expressed interest in the project and is providing enclosure samples for evaluation. In parallel, a manufacturing company in Mackay has reviewed the concept and is keen to manufacture an initial prototype as soon as the design is sufficiently mature. These activities are broadening the potential supply chain and supporting rapid progression toward a complete demonstration enclosure and integrated system test.

C38003 Optically Powered Gas Monitoring Network - Yellow Finch - 2000

Organisation: PhoenixZ
Project Leader: Zourab Brodzeli
Value: \$810,332
Report Expected: May 2027
Industry Monitors: Ben McCamley
 Brad Lucke
 Dave Young
 Jonathan Harris
ACARP Contact: Patrick Tyrrell

This project aims to transition the intrinsically safe (IS) Gas Monitoring Network (GMN), Yellow Finch-2000, from a proof-of-concept system into a market-ready product for underground coal mines. The system continuously monitors oxygen (O₂), methane (CH₄), carbon dioxide (CO₂), carbon monoxide (CO), temperature, and barometric pressure using Gas Monitoring Stations (GMSs) that are optically powered and connected via single-mode optical fibre to a Return Terminal Unit (RTU).

During this quarter, PhoenixZ achieved a major project milestone with the successful development and certification of the MK1 prototype of the Yellow Finch fibre-optic gas monitoring system. The prototype was designed and manufactured to demonstrate the technology in a real underground mining environment while meeting the requirements for intrinsic safety certification.

Following certification, the MK1 system was supplied to a customer for operational validation in an underground coal mine. This represents the first deployment of the technology under real mining conditions, where it will be evaluated for performance, reliability, and operational suitability prior to commercial release.

The successful delivery of the certified MK1 prototype significantly reduces technical risk and demonstrates the maturity of the system. Experience gained during the customer validation program is now being incorporated into the design of the next-generation MK2 prototype. The MK2 system will include substantially improved power efficiency, automated optical power control, extended autonomous operating life, enhanced diagnostics, and additional functionality to further improve system robustness and ease of deployment.

Development of the MK2 prototype is progressing to schedule, with delivery anticipated by the end of September. PhoenixZ will continue working closely with industry partners to complete field validation and system optimisation, supporting the project's objective of delivering a commercially viable, intrinsically safe, fibre-optic gas monitoring solution that improves safety and operational capability in the Australian underground coal mining industry.

Mining Technology and Production

C34003 Self-Drilling Bolt Automation

Organisation: OKA Rock Bolt Technologies
Project Leader: Mark Levey
Value: \$2,987,744
Report Expected: September 2026
Industry Monitors: Roadway Development Task Group
ACARP Contact: Patrick Tyrrell

The extended project objectives are as follows:

- Design an improved installer lid and test it;
- Test the technology on a Rib Bolter, remedy any issues found; and
- Prepare and conduct an underground trial during face production.

During the quarter a new Lid design for the Installer has been designed, manufactured and tested. Two more are currently being completed for use in the trial. The new lid allows changeouts of capsules in less than 12 seconds. (previously 40 seconds).

A review of a rib bolter for a Sandvik CM highlighted some minor modifications are required to accommodate the installer and system. These include spacing the drill motor out to align with the greater diameter of the installer.

Preparations have begun to produce the consumables for the underground trial:

- 450 x 1.8m bolts and 300 x 1.2m rib bolts have been prepared;
- Capsules and chemicals are prepared and will be loaded and assembled two weeks before the trial;
- A water pump, hp hoses, headplates, hydraulic bridals (for each bolter to allow our hp injection water to be introduced to the system), system spares are all being prepared for the trial;
- Modifications to the HMI hardware are currently being made.

A mine site has been confirmed for the underground production trial, and the timing is mid-August. The aim is to install around 750 bolts during production from one side of the CM.

C34015 Assistive Shuttle Car: Development of an Industry Ready Guidance System

Organisation: CSIRO
Project Leader: Andrew Strange
Value: \$205,395
Report Expected: Unknown at this stage
Industry Monitors: Roadway Development Task Group
ACARP Contact: Patrick Tyrrell

Stage one complete. Stage two yet to commence.

C34024 Effects of Rock Weathering on Life-of-mine Roadway Stability

Organisation: University of Queensland
Project Leader: Zhongwei Chen
Value: \$312,534
Industry Monitors: Brian Vorster
 Matt Tsang
ACARP Contact: Patrick Tyrrell

The draft report is with the industry monitors for review.

C35004 Advancing Remote and Automated Capability for Longwall and Roadway Development

Organisation: CSIRO
Project Leader: Andrew Strange
Value: \$3,517,000
Report Expected: July 2027
Industry Monitors: Roadway Development Task Group
ACARP Contact: Patrick Tyrrell

This project responds to the industry need to accelerate remote and automated longwall and roadway development capability. The project utilises the flexible industry-directed project model to deliver research impacts to industry through well-scoped work packages.

Further to the previous update on WP6 regarding the use of the dead-reckoning method for Komatsu miner navigation, testing of an LN270 inertial navigation system has continued. This work aims to confirm the ability to achieve less than 100mm navigation error after 100m of roadway development advance and to confidently report pointing performance to industry. Lab-based evaluation of two ranging sensors has also continued and is almost complete. These sensors will next be evaluated at a host mine site to assess their suitability within the target operating environment. These activities are being undertaken to support evidence-based recommendations to industry.

Additionally, in WP6, the new MPMS firmware for Sandvik miner navigation (utilises a pre-movement alarm to inform the INS that the miner is about to commence movement) has been installed and an unofficial trial commenced where data was being logged. However,

since that time the miner has been inaccessible therefore data from the updated firmware is unable to be analysed. It is expected that regular production will resume shortly so that an official trial can be undertaken.

Development of the draft interim project report is in underway.

C36013 Scalable/Ruggedised Planar Reflecting Radio Antenna (PRRA) for Underground Coal Mines

Organisation: Roobuck
Project Leader: Tommy Chaung
Value: \$700,000
Report Expected: March 2028
Industry Monitors: Dave Young
 Jarod Chadwick
 Jonathan Harris
ACARP Contact: Patrick Tyrrell

This project aims to commercialise a passive, intrinsically safe antenna system that extends wireless coverage into non-line-of-sight underground tunnels without the need for power or cabling. Building on the previous stage of this project the research team will ruggedise the Planar Reflecting Radio Antenna for harsh mining conditions, certify it to IECEx standards, and validate it through long term field trials. The antenna improves connectivity for automation, safety systems, and remote monitoring, supporting reduced emissions and enhanced operational efficiency. The project will advance the technology to TRL 9, enabling scalable, low cost wireless infrastructure for underground coal mines.

The draft report is with the industry monitors for review for stage 1, and stage 2 of the project has commenced.

C36014 Roof Support Location using Wireless Ranging

Organisation: CSIRO
Project Leader: Matt van de Werken
Value: \$212,543
Report Expected: October 2026
Industry Monitors: Brad Elvy
 Tom Hudson
ACARP Contact: Patrick Tyrrell

This project aims to develop a prototype system capable of real-time localisation of longwall roof supports using wireless ranging technology. The core objective is to address the roof support left behind problem, improving operational efficiency and reducing production downtime.

During this quarter, development focused on strengthening the localisation software and visualisation platform, with significant effort directed towards debugging and validating the localisation algorithms. Hardware development was paused while we investigate the suitability of a commercially available third-party localisation platform that may meet the project's

requirements as an off-the-shelf solution. An NDA is currently being negotiated with the hardware vendor to enable a detailed technical evaluation of their IEC Ex-ia certified technology. This approach has the potential to significantly reduce development effort, accelerate deployment, and allow focus on software and systems integration activities.

The project also progressed commercialisation activities through engagement with prospective commercialisation partners to better understand market requirements, certification pathways, and opportunities for future industry deployment.

Looking ahead to the next quarter, subject to completion of the NDA, we will undertake a detailed evaluation of the third-party hardware platform and determine its suitability for integration into the prototype system. We will also continue the localisation engine algorithm work, and engagement with prospective commercialisation partners to support the transition of the technology towards industry deployment.

C38001 Investigating 5G Networks for Longwall and Development

Organisation: CSIRO
Project Leader: Mark Dunn
Value: \$90,750
Report Expected: August 2026
Industry Monitors: Roadway Development Task Group
ACARP Contact: Patrick Tyrrell

The objective of this project is to evaluate the suitability of private 5G Standalone communications for underground longwall mining applications. The project examines network range, obstruction tolerance, non-line-of-sight performance, mobility, handover between cells and the ability to support operational data and live video services under representative underground coal mine conditions. The trial was also designed to provide a practical comparison with communications performance previously achieved using Wi-Fi mesh systems.

During May, June and July, the project team completed the analysis and documentation of the underground field trial results. The trial successfully demonstrated operation of a private 5G network in an underground mine environment. Continuous live video transmission was maintained over extended line-of-sight distances, and communications were sustained through representative underground ventilation barriers. Mobility testing demonstrated continuous service while equipment moved along underground roadways, with successful handover between network cells extending coverage beyond the practical limit of a single cell.

The results confirm that private 5G can provide a viable technical platform for underground communications, including video, monitoring and general data-transfer

applications. The trial also identified further validation requirements for higher-criticality applications such as remote control and autonomous operation, particularly in relation to latency, availability, redundancy, fail-safe behaviour and safety-system integration.

The draft final report has now been completed and is undergoing internal technical review. Following completion of the review process, the report will be revised as required and prepared for submission to ACARP.

C38015 Mapping Hydraulic Integrity

Organisation: Gricon Industries
Project Leader: Michael Condie
Value: \$188,000
Report Expected: February 2028
Industry Monitors: Jarod Chadwick
 Sam Thomasson
ACARP Contact: Patrick Tyrrell

This project aims to develop and evaluate a portable, non-invasive system for diagnosing hydraulic flow and pressure performance in underground coal mining equipment. The intended capability is to support rapid integrity mapping and fault localisation across hydraulic circuits without requiring hoses to be disconnected or intrusive flow sensors to be installed, thereby reducing diagnostic time, production disruption and personnel exposure to high-pressure hydraulic systems.

During the quarter the project completed a targeted literature and market review of technologies that may be applicable to this challenge. The review considered complete clamp-on ultrasonic flowmeters, conventional hydraulic diagnostic instruments, pressure and transient data-logging systems, acoustic and thermal condition-monitoring methods, and sensor components that could support a custom-developed solution. Candidate technologies were assessed against key requirements including compatibility with hydraulic oil and reinforced high-pressure hoses, portability, access constraints, data-logging capability, measurement of short-duration flow events, availability in Australia and potential pathways for underground use.

Several technologies have now been selected for practical trials. One shortlisted technology has already been procured, and initial bench investigations are showing promise as a potential non-invasive diagnostic method. Testing is continuing to determine its accuracy, repeatability and sensitivity to hose construction, operating conditions, sensor placement and acoustic coupling. The next phase will establish reference measurements using conventional hydraulic instrumentation, compare the shortlisted technologies under controlled conditions, and identify the most suitable approach for further development and representative field trials.

Health and Safety

C28029 Personal Real Time Dust/Particulate Monitor (Direct Mass Based Measurement)

Organisation:	Lear Siegler Australasia
Project Leader:	Peter Phaendonos
Value:	\$1,521,730
Report Expected:	September 2026
Industry Monitors:	Brad Lucke Glenn Owens Ian Marshall
ACARP Contact:	Patrick Tyrrell

The PDM real time dust monitor is a device that allows miners to accurately track their dust exposure levels in real time. This will allow operators to make decisions on whether to withdraw to areas of lower/no exposure or continue working based on the readings of the device. Standards exist for limiting exposure to the respirable fraction of coal dust in most industrial settings, the PDM will provide the miner with the means to monitor and manage such exposure. It will have a very low detection limit that will meet or exceed current and anticipated exposure limits, and AS2985-2009 requirements for such continuous testing.

Status of project with latest updates are following:

- Following results of bench testing and initial hardware assembly, several hardware components were re-designed better mechanical fit and better access to fasteners;
- PCB component (linear regulator) contributing to LCD artefacts during operational test has been identified, with a re-design of the affected PCBA board nearing completion;
- Root cause of insufficient airflow by the pump (as found during operational test) has been identified. Pump performance to be re-assessed at the next operational test;
- Firmware changes underway to remedy issue affecting ability of batteries to charge.

C33001 Silica Analysis of Dust on PDM filters: Phase 2 Optimisation and Field Demonstration of the Developed Methodology

Organisation:	CSIRO
Project Leader:	Yonggang Jin
Value:	\$516,700
Report Expected:	September 2026
Industry Monitors:	Andrew Lau
ACARP Contact:	Patrick Tyrrell

A methodology has been developed to enable respirable crystalline silica (RCS) analysis of PDM-collected coal dust in phase 1. Phase 2 aims to progress the developed methodology towards industry implementation through optimisation of the methodology by analysis of a variety of laboratory-generated and mine-collected dust samples, setup of dust detachment-redeposition

apparatus and compact FTIR spectrometer at the mine site, and field trials and demonstration of the methodology for RCS analysis of PDM3700 samples at the end of the shift.

During the quarter, the team continued laboratory dust sampling campaigns using a range of mixed-dust feeds to expand the experimental dataset for refinement of the numerical correction models and further optimisation of the developed methodology. Extensive silica analyses were conducted on the collected dust samples containing varying proportions of coal dust, kaolinite and stone dust, representing mineral constituents commonly encountered in coal mining. The expanded dataset was used to improve understanding of mineral interference in FTIR-based RCS analysis and to optimise peak selection and spectral interpretation, thereby reducing analytical uncertainty and enhancing the accuracy and robustness of the methodology. Parallel gravimetric dust samples collected alongside PDM samples were analysed for RCS content and compared to support validation of the methodology. Engagement with the mine also continued during the quarter, with ongoing discussions focused on securing site support for field demonstration and validation of the methodology under operational mining conditions.

C33012 Respirable Dust Reference Testing Method and Dust Chamber Facility

Organisation:	Simtars
Project Leader:	Sean Muller
Value:	\$215,950
Report Expected:	September 2026
Industry Monitors:	Andrew Lau Tony Egan
ACARP Contact:	Patrick Tyrrell

The aim of this project is to establish the methodology for the respirable dust chamber as a reference tool for cyclones and devices used in the coal mining industry. This will be achieved through three objectives:

- Establish that the respirable dust chamber conforms to international testing methodology and accuracy;
- Verify the methodology utilising a selection of respirable dust cyclones and impactor plate devices currently used in underground coal mines; and
- Compare the accuracy of the devices when using a different dust types and dust mixtures (stone dust, coal dust, silica).

During the quarter the project progressed as follows:

- Installation of the bulk vacuum line was completed;
- Installation of the TEOM was completed. Commissioning scheduled with supplier;
- Re-design and troubleshooting of the flow, temperature and humidity controller, and the chamber environment monitoring instruments was completed to address issues observed during calibration;

- Design of the chamber and bulk vacuum line pressure alarm/relief systems completed, awaiting delivery of parts;
- Design of the system for running air through the samplers completed, awaiting delivery of parts; and
- Risk assessments for different aspects of system operation are underway.

The following steps will be addressed in the next quarter:

- Completion of system construction and component installation tasks;
- Testing and commissioning of remaining test instruments and subsystems; and
- Detailed risk assessments and operating procedures for the entire system and finalisation of the chamber validation procedure.

C34006 Resilience and Mental Health in Mining Pilot Program

Organisation: Macquarie University
Project Leader: Rebecca Mitchell
Value: \$476,099
Report Expected: October 2026
Industry Monitors: TBA
ACARP Contact: Patrick Tyrrell

The primary objective of our project is to investigate the work-related factors that influence the resilience of coal mining employees. This endeavour aims to design and evaluate interventions that bolster the resilience of these individuals, thereby improving work practices and experiences that directly contribute to employee resilience in the Australian coal sector.

During the quarter we continued to engage with mine partners to identify which activities they see as effective in building resilience, with the aim of identifying a program of activities that constitutes a resilience program across the sector. We will continue to seek to secure partnerships with relevant mine sites.

C34023 Advanced Breathing Apparatus with Gas Membrane Modules

Organisation: Monash University
Project Leader: Victor Chang
Value: \$298,436
Industry Monitors: Lee Earnshaw
 Paul Wild
ACARP Contact: Anne Mabardi

The draft report is with the industry monitors for review.

C36006 Advanced Lung Function Assessments for Diagnosis of Coal Mine Dust Lung Disease (CMDLD): The Next Step Towards a Better Health Surveillance Program

Organisation: I-MED Radiology Network
Project Leader: Catherine Jones
Value: \$186,832
Report Expected: September 2026
Industry Monitors: Andrew Lau
ACARP Contact: Patrick Tyrrell

This project aims to evaluate a novel CT-based ventilation-perfusion (CT:VQ) technology for assessing lung function impairment in workers at risk of Coal Mine Dust Lung Disease (CMDLD). The study investigates whether CT:VQ-derived functional measures from inspiratory and expiratory high-resolution CT (HRCT) scans can reliably identify impaired lung function using spirometry as the reference standard. The overarching goal is to determine whether CT:VQ can enhance current health surveillance programs by providing additional functional information beyond conventional imaging.

During the quarter the focus has been on cohort preparation, data validation, and establishing the imaging analysis workflow. An initial cohort of 120 participants with paired inspiratory and expiratory HRCT examinations was identified. Following review of the corresponding spirometry records against the predefined inclusion and exclusion criteria, the final study cohort comprised 108 participants, exceeding the target sample size of 100. The HRCT imaging dataset was reviewed and organised for CT:VQ processing, and the corresponding spirometry records were successfully linked to enable integrated imaging and lung function analyses. Data quality assurance activities were undertaken to verify participant eligibility, demographic information, and imaging completeness, with missing or inconsistent records investigated and resolved where possible.

Current work is focused on establishing the CT:VQ processing pipeline, including data de-identification and secure transfer, analysis of the HRCT imaging dataset using the CT:VQ software to generate quantitative ventilation and perfusion measurements, and retrieval of the processed results for in-house analysis. Preparatory work for the statistical analysis is also underway, including development of the analytical framework for comparing CT:VQ-derived functional metrics with conventional spirometry outcomes. The project is progressing as planned. During the next reporting period, CT:VQ analysis is expected to be completed for more than half of the study cohort (>50 participants), providing the basis for the planned comparative analysis with spirometry.

C37009 Role of Particle Surface Characteristics in CWP Risk

Organisation: University of Tasmania
Project Leader: Graeme Zosky
Value: \$413,709
Report Expected: April 2027
Industry Monitors: Andrew Lau
 Brad Lucke
 Frank Fulham
ACARP Contact: Patrick Tyrrell

In our previous project (C35017), we identified potassium in coal dust as a potential contributor to lung cell toxicity, with possible relevance to the development of Coal Workers' Pneumoconiosis (CWP). Subsequent work suggested that potassium may act as a marker for reactive mineral phases, particularly potassium-bearing aluminosilicates such as illite, which are associated with greater surface iron and stronger oxidative responses. The overarching aim of the current project is to clarify how surface-derived iron contributes to oxidative and inflammatory responses in the context of intrinsic coal-particle chemistry, with the broader objective of identifying mechanistic determinants of coal dust toxicity.

Initial experiments showed that iron released from coal particle surfaces, including Fe^{2+} and Fe^{3+} , was positively correlated with intracellular reactive oxygen species (ROS) generation. Subsequent intervention studies showed that iron chelation with deferoxamine and inhibition of iron-dependent lipid peroxidation with ferrostatin-1 partially attenuated ROS generation and selected inflammatory responses in epithelial cells. In contrast, the mitochondria-targeted antioxidant MitoTEMPO had limited effects, suggesting that the predominant oxidative response is driven by surface iron-mediated processes. Recent experiments have focused on broader antioxidant protection and downstream signalling mechanisms. The broad antioxidant N-acetylcysteine (NAC) produced the clearest protective effects. Signalling analyses also supported a mechanistic role for redox-sensitive inflammatory pathways. These findings indicate that MAPK signalling is involved in the epithelial response to coal dust and can be partially modulated by iron-targeting and antioxidant interventions.

Overall, the findings to date show that increasing coal dust surface iron enhances oxidative and inflammatory responses, particularly in epithelial cells. These responses can be partially modified by interventions targeting iron availability, lipid peroxidation and broader oxidative stress. Together, these results support the concept that surface iron is an important determinant of coal dust bioactivity and a plausible mechanistic contributor to epithelial inflammation and injury. The next phase of the project will focus on completing the remaining experimental work and finalising data analysis.

Roadway Development

C27076 Underground Coal Mine Gateroad Development Continuous Haulage System

Organisation: Premron CHS
Project Leader: Mick Whelan
Value: \$9,773,528
Report Expected: Unknown at this stage
Industry Monitors: Roadway Development Task Group
ACARP Contact: Patrick Tyrrell

This project is on hold as it awaits a site trial.

C38035 Industrial Guideline for Adoption of Lightweight Composite Frame Structures for Mine Environments

Organisation: University of New South Wales
Project Leader: Ganga Prusty
Value: \$512,682
Report Expected: October 2027
Industry Monitors: Roadway Development Task Group
ACARP Contact: Patrick Tyrrell

This project aims to advance the Technology Readiness Level (TRL) of lightweight composite conveyor support structure prototypes through comprehensive field testing, FRAS certification, and the development of industry guidelines.

Work undertaken during the quarter:

- The first project meeting was held with the project partners to discuss the field evaluation of the composite conveyor frames in an underground mining environment. Detailed engineering drawings of the existing conveyor system were provided by the industry partners for the design and planning activities.
- Design optimisation of the FRP composite conveyor frame has been undertaken to enable retrofit installation onto the existing on-site steel conveyor structures for the planned field trial. The optimisation was based on the engineering drawings supplied by the industry partners.
- A detailed three-dimensional (3D) CAD model of the existing steel conveyor system has been completed based on the supplied engineering drawings.
- The first iteration of the optimised composite conveyor frame design has been completed. A technical design review meeting is currently being organised to assess the feasibility of the proposed design and identify any modifications required for field trial.
- In parallel with the design optimisation, a detailed finite element analysis (FEA) of the existing steel conveyor structure is being undertaken to evaluate its

structural behaviour and provide a baseline for comparison with the proposed composite design.

- The Flame-Resistant and Anti-Static (FRAS) certification process for the FRP composite material is also underway. The proposed compliance tests, applicable standards, and specimen requirements are summarised in Table below.
- Preparation of all FRAS test specimens has been completed. The specimens will be shipped to the Tunra Bulk Solids testing laboratory to commence the certification program.

Test Name	Test Standard	Test Piece Requirement
Ignitability and Flame Characteristics	AS 1334.10	150 mm x 13 mm x 13 mm
Oxygen Index	ISO 4589-2	150 mm x 13 mm x 13 mm
Electrical surface and through Resistance	AS 1334.9	300 mm x 300 mm

During the next quarter the project will focus on completing the technical design review of the optimised composite conveyor frame with the industry partners, undertaking a site visit to the proposed mine to plan the field trial and installation, and finalising the detailed design optimisation and FEA. Material procurement for prototype manufacturing will also be completed, followed by the commencement of fabrication and preparation activities for the field installation and testing of the composite conveyor frames.

Strata Control and Windblasts

C29022 Mechanical Investigation of Two Critical Standing Support Systems (Timber Chock and Pumpable Crib) in Underground Coal Mines

Organisation: Monash University
Project Leader: Hossein Masoumi
Value: \$295,000
Report Expected: September 2026
Industry Monitors: Brian Vorster
 Dan Payne
 Patrycja Sheffield
ACARP Contact: Peter Bergin

The main objective of the project is to characterise the mechanical behaviour of two standing support systems including timber chock and pumpable crib which are commonly utilised in underground coal mines in Australia.

The draft of first volume of the project's report on Timber Standing Support System is under review.

To examine the mechanical behaviour of pumpable cribs (PC), six large-scale samples were transported to the Smart Structures Laboratory at Swinburne University in Melbourne. The setup for testing has already been completed, and testing and disposal of the samples were also finalised in which three samples were tested at low displacement rate and other three samples were tested at higher displacement rate.

In addition to the large-scale samples, 15 cylindrical samples with a diameter of 100 mm and a height of 200mm were prepared for material testing. These samples are critical for the numerical modelling process required in the next stages of the project.

For the next round, 12 PC samples will be tested under complex loading conditions, higher aspect ratio and without bag for extensive assessment of its behaviour applicable to field settings.

C33024 Improved Model Upscaling of Overburden Hydraulic Conductivity for Input into Groundwater Models

Organisation: SCT Operations
Project Leader: Yvette Heritage
Value: \$620,000
Report Expected: May 2028
Industry Monitors: Gary Brassington
 Peter Corbett
ACARP Contact: Patrick Tyrrell

The project's key objective is to determine an upscaling method that bridges the gap of detailed geotechnical model fracture conductivity to groundwater model bulk conductivity input requirements. It was found that the issue is not the upscaling technique, and that desaturation is likely the key factor in reducing the relative conductivity of the overburden. Therefore, the saturated hydraulic conductivity values that geotechnical modellers provide to groundwater modellers cannot be used as saturated conductivity inputs in the groundwater models.

This extension's key objective is to validate a proposed new method of determining relative vertical conductivity above longwall panels in a real application of a mine site groundwater model in collaboration with groundwater modellers. The anticipated outcome is that we have a validated new approach to determine site specific hydraulic conductivity above longwall panels for practical input into groundwater models.

Progress in the last quarter has included:

- Collaboration with groundwater modellers on the model validation approach;
- Research into ModFlow capabilities; and
- Research into synergies between FLAC rock failure models and Modflow.

C34022 Risk Based Model for Forecasting Longwall Face Cavity Development

Organisation: University of New South Wales
Project Leader: Chengguo Zhang
Value: \$173,200
Industry Monitors: Rav Goonawardene
ACARP Contact: Anne Mabardi

The draft report is with the industry monitors for review.

C35010 Causes for Swelling and/or Bearing Capacity Floor Failures in a Pillar System Under Varying Geological and Geotechnical Environments

Organisation: University of New South Wales
Project Leader: Serkan Saydam
Value: \$298,300
Industry Monitors: Brian Vorster
ACARP Contact: Anne Mabardi

The draft report is with the industry monitors for review.

C35011 Revolutionizing In-Situ Stress Measurement: Extension - Field Trial of the DilaStress Tool

Organisation: University of New South Wales
Project Leader: Hamid Roshan
Value: \$419,000
Report Expected: April 2027
Industry Monitors: Brian Vorster
 Patrycja Sheffield
ACARP Contact: Patrick Tyrrell

Understanding in-situ stress conditions is paramount for the safety, efficiency, and productivity of coal mining operations. Currently, overcoring is the preferred technique to measure-situ stress in underground mining. However, it is often hindered by the considerable time, investment, operational complexities, and high costs. This challenge was tackled in a previous stage of this project by developing DilaStress to create an efficient downhole stress measurement technique and associated Tool. This study will field test the DilaStress tool for insitu stress estimation.

This quarter, we have assembled the various components of the trailer system. We are currently testing the integrated hydraulic system. We also visited the mine site where the field trial will be conducted and met with the on-site downhole logging team to assess the suitability of the selected boreholes. In parallel, we have engaged an independent third-party assessor to review the trailer and associated equipment for compliance with mine site safety requirements. Once this compliance assessment is completed, we will submit the necessary documentation to the mine operator for site approval, enabling us to proceed with the next stage of the field trial.

C37012 Field Investigations on the Optimum Design of Pillars at Increasing Stress Environments

Organisation: University of Queensland
Project Leader: Mehdi Serati
Value: \$249,720
Report Expected: August 2027
Industry Monitors: Brian Vorster
 Christian Mans
 Peter Corbett
ACARP Contact: Patrick Tyrrell

This project seeks to develop a modified pillar load estimation methodology for optimal pillar design under increasing stress conditions, supported by field stress measurements. The project will assess whether main pillars can be designed using loads lower than the conventional tributary area load, while maintaining safety and potentially improving operational and economic outcomes. The work program combines laboratory benchmark testing, field stress monitoring, numerical modelling and development of an improved design methodology.

In May, a meeting was held to finalise the field investigation instrumentation methodology. Following this meeting, representatives from the participating mine sites were contacted to confirm the suitable dimensions for installing the vibrating wire stressmeters. After the instrument dimensions and monitoring plan were finalised, vibrating wire stressmeters (VWS) and a CSIRO Hollow Inclusion (HI) cells were procured. The instruments are expected to arrive by mid-September.

A detailed literature review was used to finalise the methodology and materials for the large-scale laboratory testing program. The laboratory testing will provide a detailed understanding of the installation, operation and instrument response, while verifying its performance under controlled conditions before field deployment. Three 450mm x 450mm x 450mm specimens will be tested: two sandstone blocks and one synthetic rock block. One sandstone specimen and the synthetic rock specimen will be instrumented with vibrating wire stressmeters, while the remaining sandstone specimen will be tested using the CSIRO HI cell. Two sandstone blocks, each containing a central 38mm diameter borehole, have been prepared. Materials for casting the synthetic rock specimen have been procured, and the large-scale mould has been designed and is currently being constructed. The synthetic specimen is expected to be prepared in the first week of August. Laboratory facilities have been booked, with testing planned to commence once the instruments arrive.

C37015 Investigation to Determine the Influence of Stress Magnitude on the Growth Rate of Hydraulic Fractures

Organisation: SCT Operations
Project Leader: Ken Mills
Value: \$200,000
Report Expected: May 2027
Industry Monitors: Ben Forrest
 Brian Vorster
 Michael Barker
ACARP Contact: Patrick Tyrrell

Hydraulic fracturing is a technique used to pre-condition the overburden strata to improve longwall face conditions and caving behaviour when mining below massive strata. The effectiveness of this technique is well proven in favourable in-situ stress conditions. Cost-effective implementation of pre-conditioning hinges on optimising the layout of injection boreholes based on an understanding of the shape of hydraulic fractures formed. This project aims to investigate, in a laboratory setting, the influence of horizontal stress magnitude on the shape of hydraulic fractures inferred from field measurements of full-scale treatments.

A test strategy based on creating hydraulic fractures in edge-loaded 50mm thick slabs has been developed to overcome some of the challenges of drilling 300mm long, small-diameter holes in the test specimens to monitor fracture growth. A load frame able to be used at SCT's Wollongong offices has been designed and is currently being constructed. Rock and PMMA test samples have been ordered. A sensing strategy based on a pressure pad located below the test slab is expected to enable the shape of hydraulic fractures to be determined externally without the need for small diameter holes.

C37020 Cost Effective, Low Water Sensitivity, and Fast Curing Geopolymer Grout for Cable Bolt Encapsulation to Enhance Cable Bolting Installation Practices

Organisation: University of Southern Queensland
Project Leader: Ali Mirzaghobanali
Value: \$148,010
Report Expected: November 2026
Industry Monitors: Ben Yang
 Samantha Desira
ACARP Contact: Patrick Tyrrell

The objective of this project is to develop a cost-effective, low-water-sensitivity and fast-curing geopolymer grout for cable-bolt encapsulation in underground coal mining. The project aims to provide a sustainable alternative to conventional cementitious grouts while maintaining or improving pumpability, early-age strength development, bond performance and long-term mechanical properties. A comprehensive laboratory program has been undertaken to optimise the geopolymer formulation and

benchmark its performance against two commercially available cable-bolting grouts, TD80 and Stratabinder HS.

To date, 33 geopolymer mixtures have been designed and evaluated through an optimisation program involving more than 200 unconfined compressive strength (UCS) tests. The optimum formulation was identified as a water-to-binder ratio (W/B) of 0.38, an activator-to-binder ratio (Act/B) of 0.10, 5% sodium silicate (by binder mass), a binder consisting of 60% ground granulated blast furnace slag (GGBS) and 40% fly ash, and an activator containing 70% sodium hydroxide solids and 30% sodium silicate solids. Following optimisation, a benchmarking program was undertaken against TD80 and Stratabinder HS, including flow-table testing, ASTM C191 setting-time measurements, early-age (2–24 h) and long-term (1–28 day) UCS testing, Brazilian tensile strength, double shear, V-notch shear, briquet tensile, shrinkage, Scanning Electron Microscopy (SEM) and Energy-Dispersive X-ray Spectroscopy (EDS) analyses. The optimised geopolymer demonstrated excellent workability retention, with flow reducing from 24.9 mm to 21.5 mm over 30 minutes, while exhibiting the shortest initial setting time (39.1 min) compared with 154.4 min for TD80 and 272.1 min for Stratabinder HS. The rapid setting behaviour was reflected in its superior early-age mechanical performance, with the geopolymer consistently achieving the highest UCS throughout the critical 2–24-hour curing period, increasing from 2.44 MPa at 120 minutes to 8.89 MPa at 345 minutes and 38.43 MPa after 24 hours, outperforming both commercial grouts. Although Stratabinder HS exhibited accelerated strength gain after approximately six hours, the geopolymer maintained the highest compressive strength throughout the first 24 hours while also achieving the highest long-term UCS of 86.38 MPa at 28 days. The optimised grout further demonstrated competitive Brazilian tensile strength, double shear resistance, V-notch shear performance, briquet tensile behaviour and dimensional stability, confirming that the enhanced early-age performance was achieved without compromising other key engineering properties. Microstructural characterisation using SEM (Figure 1) revealed a dense and homogeneous geopolymer matrix with reduced porosity and fewer unreacted particles; EDS confirmed the formation of a well-developed calcium-aluminosilicate hydrate (C-(A)-S-H) dominated reaction network. The close agreement between the fresh-state, microstructural and mechanical results demonstrates that the developed geopolymer grout combines rapid setting, excellent workability, superior early-age strength development and robust long-term engineering performance, making it a promising and sustainable alternative for cable-bolt encapsulation underground.

The next phase of the project will complete the small- and large-scale cable-bolt pull out experiments. These tests will investigate bond behaviour, load-transfer mechanisms and failure modes under representative mining conditions, providing the final validation required prior to field implementation.



Figure 1: SEM photo of the optimised geopolymers grout

C37024 Longwall System Health and the Implications to Strata Control and Automation – Improving Industry Understanding, Monitoring Techniques and Numerical Model Validation

Organisation: SCT Operations
Project Leader: Adrian Rippon
Value: \$427,200
Report Expected: September 2027
Industry Monitors: Samantha Desira
 Stephen Giese
ACARP Contact: Patrick Tyrrell

The main objective of the project is to improve the underground coal industry's understanding of the longwall hydraulic system and its impact on strata control. The study aims to highlight the limitations of current hydraulic pressure monitoring techniques that may fail to identify fatal flaws in the longwall system health and may also hinder automation processes leading to poorer longwall conditions and reduced productivity. The study also aims to investigate an alternative monitoring system to accurately measure the force being applied to the roof by the longwall powered supports. Such a monitoring system would also help to validate numerical model outputs, improve longwall automation, reduce production delays, and reduce operator exposure to higher-risk activities conducted on the longwall face for strata control remediation.

Unfortunately, there has been no great progress on the project this last quarter.

C38008 Small Scale Stress Rotation in Coalfields through 3D Geomechanical Modelling: Causes and Consequences

Organisation: University of Queensland
Project Leader: Mojtaba Rajabi
Value: \$259,655
Report Expected: April 2028
Industry Monitors: Brian Vorster
 Matt Tsang
ACARP Contact: David Drakeley

The aim of this project is to develop geomechanical-numerical models to understand, predict, and quantify stress rotations caused by geological structures and rock property variations in coal basins.

Progress during this quarter:

- The project team has commenced a comprehensive literature review and is compiling relevant datasets

documenting stress rotations at both the borehole and intra-basin scales;

- Preliminary analyses of one-dimensional geomechanical models from boreholes exhibiting localised stress rotations have commenced to improve understanding of the mechanisms and controls responsible for these rotations;
- Initial discussions on the numerical modelling framework have been completed, with the aim of commencing three-dimensional geomechanical modelling by the end of 2026.

C38014 Triaxial Full Coverage Instrumented Rock Bolt

Organisation: SCT Operations
Project Leader: Graham Wylie
Value: \$250,000
Report Expected: May 2028
Industry Monitors: Ben Yang
 Brian Vorster
ACARP Contact: Patrick Tyrrell

This project aims to develop a robust, lower-cost, full-coverage instrumented rock bolt capable of measuring axial strain and determining the direction and magnitude of shear-induced bending.

The project team has conducted a detailed review of the proposed production methodology considering the practical requirements for manufacturing, assembling, protecting and installing the triaxial instrumented bolt to achieve reliable performance.

Several sensor configurations and assembly approaches have been assessed with preferred concepts selected for prototype development and comparative testing. The focus has been on optimising measurement coverage, spatial resolution, robustness, repeatability, manufacturability and compatibility with existing rock bolt installation practices. Components and prototype items required for the next development stage have been ordered.

The design of the logging and readout system is also under way. The system is intended to acquire measurements from the complete triaxial sensor arrangement, support temperature compensation and provide sufficient diagnostic information to identify measurement channels that are damaged or not operating correctly. Consideration is also being given to low-power operation and field usability.

C38016 Pre-tension Modelling for Rock and Cable Bolts

Organisation: SCT Operations
Project Leader: Gaetano Venticinque
Value: \$181,000
Report Expected: June 2027
Industry Monitors: Matt Tsang
 Patrycja Sheffield
 Samantha Desira
ACARP Contact: Patrick Tyrrell

This project addresses the gap in understanding surrounding the correct application of pre-tension to rock and cable bolt structural elements within geotechnical design software. It assesses current pre-tensioning processes, equipment and methods across Australian coal mines, and reviews how pre-tension is implemented in current modelling practice, identifying common software misconfigurations. A key objective is to deliver a standardised pre-tension modelling methodology for both rock and cable bolts, providing a validated approach to implementing pre-tension in FLAC3D with potential applicability to FLAC2D, 3DEC and PFC, thereby reducing discrepancies between simulated and real world bolt behaviour.

During the quarter, the project progressed as follows:

- Review initiated of current pre-tensioning processes for bolting systems across Australian coal mines, covering the equipment and methods commonly employed for rock and cable bolts.
- Review undertaken of how pre-tension is represented in current modelling practice relevant to Australian coal mines. This has led to preliminary identification of recurring software misconfigurations, including incorrect assignment of pre-tension as an initial axial force without grout activation sequencing, and mismatch between modelled and installed free length.
- Data gathering commenced in preparation for numerical model trial simulations, assembling the input parameters and reference cases required to establish baseline FLAC3D models.

Ventilation, Gas Drainage and Monitoring**C25072 New Approaches to Mine Gas Analysis and Ratios**

Organisation: Simtars
Project Leader: Sean Muller
Value: \$416,192
Report Expected: September 2026
Industry Monitors: John Grieves
ACARP Contact: Patrick Tyrrell

The aim of the project is to identify additional gases for the detection and monitoring of spontaneous combustion. This will be achieved through three objectives:

- Using a medium scale reactor, profile the gases evolved from the heating of a Queensland coking coal with a methane/ethane seam gas composition and a New South Wales coal with a carbon dioxide seam gas;
- Compare these gas profiles to the normal carbon dioxide seam gas and methane/ethane seam mine fingerprints identified in the first stage of this project and project C10015;
- Expand the current “Fire Ladder” to include additional alkanes below the ethylene point which can be used to give earlier warning of a developing heating/spontaneous combustion and incorporated into TARPs.

The work status for the current quarter is as follows:

- Graphing of the VOC and Aldehyde data for coal 3 has commenced;
- Ratios to be used in the final report has been established; calculating and graphing of these ratios for both coals have commenced;
- X-pid validation has been progressing, and data collected has now been processed. This work confirmed which components co-elute on the instrument as well as confirming the identity of a few of the unknown components;
- Comparison of the micro GC data to low level LPG components has been undertaken. The work confirmed the presence of additional alkenes between ethylene and acetylene, which previously have not routinely been identified or quantified by the micro GCs in use by the project;
- Micro GC data has been revisited to confirm correct assignment of components based on the aldehyde and alkene validation work undertaken;
- Updating the Fire Ladders (Micro GC components) for the identified aldehydes and alkenes is in progress;
- Draft of the report has been progressed.

The following steps will be addressed in the next quarter:

- Graphing of the data gathered from the Coal 3 test will continue;
- Graphing of ratios for Coal 2 and 3 will continue;
- Assessment of the additional micro-GC peaks from Coal 2 test will be undertaken using the same strategy as for Coal 3 test with review for aldehyde and alkene components incorporated. The additional peaks will be graphed and evaluated as per Coal 3 test format. Coal 2 test and Coal 3 test additional peaks will be compared to each other, GC-MS and aldehyde data;
- X-pid data will be revisited to confirm correct assignment of components based on the validation work undertaken;
- Comparison of X-Pid data with results generated from micro-GC, GC-MS and HPLC analytical techniques will be undertaken for Coal 3. In addition, comparison of the micro-GC and GC-MS data will be undertaken to identify additional peaks observed in the micro-GC analysis;
- The draft report will be finalised.

C28027 Effect of Occlusions by Coal and Stone Dust on the Sensitivity and Time Response of Methane Gas Detectors in Underground Coal Mines

Organisation: Ampcontrol
Project Leader: Ian Webster
Value: \$90,000
Industry Monitors: John Grieves
 Patrick Tyrrell
ACARP Contact: Peter Bergin

The draft report is with the industry monitors for review.

C34014 Borehole Tools to Deal with Outbursting, Coal Bursting and Gas Drainage

Organisation: Sibra
Project Leader: Ian Gray
Value: \$2,176,576
Report Expected: October 2026
Industry Monitors: Ventilation Task Group
ACARP Contact: Patrick Tyrrell

This project is to produce a survey system for drilling, including a rock recognition system and a packer system to enable coal seam permeability and pressures to be determined. The project is multi-faceted as it involves drilling hardware, sensing equipment, downhole and at the drill rig sensing and electronics. This is in both IS and flameproof form and it also involves a lot of software development.

The technical work in the quarter has involved the finalisation of the circuit board designs that will be put forward for IS approval. Development of firmware for these continues as does the drilling software for the system.

A new mine where trials will be undertaken has been agreed and a cooperation arrangement with the mine drilling contractor achieved.

C35015 Studies of Coal Toughness and Gas Sorption Dynamics for Outburst Risk Management

Organisation: University of Wollongong
Project Leader: Ting Ren
Value: \$275,000
Industry Monitors: Ventilation Task Group
ACARP Contact: Patrick Tyrrell

The draft report is with the industry monitors for review.

C36003 Practical Implications of Oxygen Deficiency on the Determination of Graham's Ratio in Longwall Goafs

Organisation: Simtars
Project Leader: Sean Muller
Value: \$64,350
Report Expected: January 2027
Industry Monitors: David Webb
 John Grieves
ACARP Contact: Patrick Tyrrell

Graham's ratio is a commonly used indicator for measuring the intensity of the oxidation of coal in underground mine atmospheres. The basis of Graham's ratio is the conversion efficiency of oxygen to carbon monoxide. Graham's ratio uses the nitrogen from a sample for the calculation of oxygen deficiency. This allows for dilution by methane and carbon dioxide seam gases. This calculation is made on the basis that nitrogen is an inert gas which is not consumed or created.

The project aim is to investigate the practical implications for the interpretation of Graham's ratio and other indicators in the presence of an oxygen deficient atmosphere (due to natural processes and both added nitrogen or exhaust gases via inertisation). This will be achieved through the following objectives:

- Investigate the magnitude of oxygen deficiency measured in various longwalls and variations due to location, inertisation and longwall retreat over time;
- Provide practical guidelines to assist with using appropriate and effective gas indicators and ratios in longwall mines.

During the quarter the project progressed as follows:

- Data processing has commenced; and
- Data is continuing to be sourced from additional mines.

C36005 Optimisation of Goaf Management Strategies

Organisation: CSIRO
Project Leader: Rao Balusu
Value: \$1,443,557
Report Expected: May 2027
Industry Monitors: Ventilation Task Group
ACARP Contact: Patrick Tyrrell

The project objective is to develop optimum goaf management strategies to maximise goaf gas drainage, reduce oxygen ingress into the longwall goaf, and minimise fugitive emissions. The main focus of the project studies is to: obtain a fundamental understanding of goaf gas distribution; obtain an understanding of the impact of various geological, mining and operations parameters; investigate the feasibility of various goaf gas drainage designs and strategies to maximise gas drainage and minimise oxygen ingress; develop optimum inertisation strategies to minimise oxygen ingress on both maingate and tailgate sides of the longwall goaf; examine the impact of various additional goaf management

strategies; and develop optimum adjacent goaf gas drainage strategies to minimise greenhouse gas emissions into the main return airways.

In the last quarter, extensive transient modelling simulations were carried out to investigate the effect of semidiurnal barometric pressure changes of different magnitude on goaf gas distribution and longwall return gas levels. The effect of sudden barometric pressure changes of different magnitude, which can happen during storm conditions, were also investigated. These transient simulations were carried out under medium and high gas conditions to investigate the effect of barometric pressure changes under different goaf gas emissions scenarios. Results of the above modelling studies are being analysed to evaluate the effectiveness of various goaf management strategies and to assist in the development of optimum goaf management strategies. In the next quarter, studies will focus on the effect of adjacent goaf gas emissions and also aim to investigate the effect of different adjacent goaf gas drainage and inertisations strategies on longwall return gas levels and fugitive emissions.

C36011 Borehole Tools – Caliper Log

Organisation: Sibra
Project Leader: Ian Gray
Value: \$424,160
Report Expected: October 2026
Industry Monitors: Ventilation Task Group
ACARP Contact: Patrick Tyrrell

The project objective is to produce a caliper log to permit the logging of boreholes. The reason for building this is to detect overbreak such as may occur due to the washout of gouge material, indicative of outburst conditions and breakout which is indicative of high stress. The latter being important from a rockburst and general stability viewpoint. In non-intrinsically safe near vertical holes these measurements would be made using an acoustic televiewer. This is not an option in wet and gassy horizontal boreholes.

Work this quarter was conducted in common with project C34014. These two projects share the same electronics so the torque and thrust electronics and survey electronics are used in both tools.

C36012 Rotary Steering System Field Trial and Developments

Organisation: Sibra
Project Leader: Ian Gray
Value: \$449,600
Report Expected: October 2026
Industry Monitors: Ventilation Task Group
ACARP Contact: Patrick Tyrrell

This project is to enable field trials and necessary modifications to be made to the Sibra rotary steering

system (RSS) tool that was developed as part of project C28022 and was completed in 2020 during covid lockdowns and hence without an underground field trial. During this period a drilling trial was conducted using a civil engineering horizontal directional drilling rig and many changes have been implemented as a result of this.

The Sibra RSS is designed to replace down hole motors in underground in seam drilling and in particular to overcome problems faced with 'boggy ground'. The latter is caused by cuttings bed build up around the drill string. The rotary steering system involves the use of a rotating drill string with a non rotating sleeve fitted with pads that deflect the drill bit. The rotating drill string has been shown, in oilfield use, to prevent cuttings buildup. The RSS should also permit greater power at the bit compared to downhole motors that are currently used underground. It is hoped that this will enable faster penetration rates when drilling through stone.

During this period there has been no progress. The main progress has been on project C34014 Borehole Tools to Deal with Outbursting, Coal Bursting and Gas Drainage.

C36015 Intelligent Integrated Distributed Fibre Optic Sensing Technologies

Organisation: CSIRO
Project Leader: Yi Duan
Value: \$568,317
Report Expected: September 2026
Industry Monitors: Ben Yang
 Dennis Black
 Peter Corbett
 Steve Winter
ACARP Contact: Patrick Tyrrell

Temperature, strain, and seismicity monitoring are crucial for managing geotechnical hazards (e.g., spontaneous combustion (spon-com), pillar failure, and strata instability) in underground coal mines. This project aims to advance remote underground mining operational capabilities by targeting specific technological developments in areas of high strategic need and opportunity for industry. The key components of this project are:

- Continuous temperature profiling using distributed temperature sensing (DTS);
- Combined continuous pillar strain and microseismic measurement using optical fibre;
- Real-time distributed acoustic sensing (DAS) data processing based on deep learning pipelines.

Over the quarter the main activities for each key component included:

1. Continuous temperature profiling using distributed temperature sensing: the Non-Disclosure Agreement (NDA) between the DTS supplier and Australia certification body is still being review by the legal teams from both parties. IECEx certification of the DTS interrogator will commence after the NDA is signed

and fully executed by both parties. A field trial was conducted at a mine site using the fibre cable grouted in a borehole. The data shows accurate variations of ambient temperatures related to the changes of environment conditions are obtained along the entire fibre cable (Figure 1). After the IECEx certification of the DTS interrogator is obtained, fibre cables will be installed along the roadways to the longwall face for underground temperature monitoring.

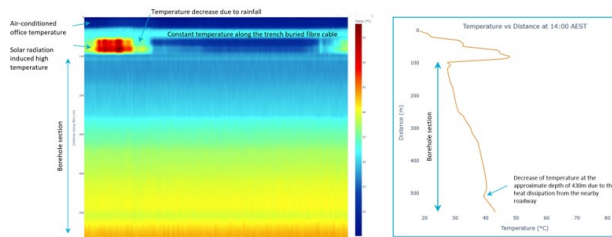


Figure 1. Temperature profile obtained from a fibre cable deployed in a borehole at a mine site. The first 20 m of fibre cable was coiled in an air-condition office; the second section (20 m – 50 m) of the fibre cable was buried in a shallow trench; the third section (50 m – 90 m) of the fibre cable was exposed on the ground surface; the fibre cable from 100 m to 560 m was grouted in the borehole.

2. Combined continuous pillar strain and microseismic measurement using optic fibre: The environmental chamber has not been available due to site works in the building. Testing will commence when the chamber is available. The mathematical calibration routines have been advanced. The process for installing the system has been devised. Some of the installation components have been 3D printed and will be tested on the test rig.
3. Real-time distributed acoustic sensing (DAS) data processing based on deep learning pipelines: the final report for this project is currently being drafted and will be submitted for review upon completion

C37004 Determination of New Criteria for the Approval of P5 Type Permitted Explosives

Organisation: University of New South Wales
Project Leader: Duncan Chalmers
Value: \$273,000
Report Expected: November 2026
Industry Monitors: Andrew Rose
 Brad Elvy
 Paul O'Grady
 Paul Wild
 Russell Thomas
ACARP Contact: Patrick Tyrrell

This project aims to develop permitted explosives with a lower power delivery during detonation. If successful, industry with the support of the researcher will engage with the Queensland Explosives Inspectorate to seek permission for P5 permitted explosives to be used in

underground coal mines. A change in the criteria would allow for the continued development of emulsion-based permitted explosives, further improving the safety of underground coal mine operations.

The project team, the explosives manufacturer representative and an industry representative have been working on the documentation to get trial approval for the new explosive so that it can be imported into Australia. Approval has been given to complete Stage 1 which is a surface investigation to determine powder factors and to demonstrate the reliability of this explosive.

Discussions have been held with the manufacturer with an expected arrival date for the explosives for early October 2026 and the Stage 1 trial will commence as soon as the explosives have been released. A request for a second formulation with a view of an extended shelf life was again made, however no date for the manufacture of this second explosive has been confirmed.

IBC cement blocks are being prepared and shipped to the testing ground and a tentative booking for testing has been made.

C37006 Frictional Ignition – Water Spray Standards, their Basis and Effectiveness with Modern Mining Environment

Organisation: CSIRO
Project Leader: Yong Sun
Value: \$89,814
Report Expected: March 2026
Industry Monitors: David Webb
 Dennis Black
 Steve Winter
ACARP Contact: Patrick Tyrrell

This project aims to investigate the effect of different combinations of water spray parameters relative to modern cutting/operational conditions on frictional ignition control to increase our knowledge and understanding of the mechanisms at work during rock cutting, specifically coal mine roof and floor extraction, that cause frictional ignition and to investigate the characteristics of PBF water sprays that can reduce the risk of frictional ignition.

The project started during the quarter, in July. Based on our literature review and test results with Mine A, we identified critical factors for further investigation and formulated a preliminary test plan. We have started to contact more mining companies to make the research to cover a broader range of the industry. Furthermore, we have collected some new and used picks alongside related spraying system components from Mine B.

C38007 Spontaneous Combustion Hazard Likelihood Assessment and Operational Management for Australian Coal Mines

Organisation: B3 Mining Services
Project Leader: Basil Beamish
Value: \$182,000
Report Expected: September 2027
Industry Monitors: Ventilation Task Group
ACARP Contact: Patrick Tyrrell

The main objective of this project is to provide the Australian coal industry with a multi-module spontaneous combustion management planning package that incorporates leading practice through all phases of operations. The specific objective of the first phase of the project is to provide a succinct description of the self-heating process that is matched by appropriate and valid testing to evaluate self-heating potential. These results can then be classified in terms of hazard likelihood for site-specific conditions. The second phase of the project aims to identify and evaluate leading practice for operational management of spontaneous combustion in underground coal mining, particularly in the areas of monitoring and control.

The initial module materials of the first phase of the project are in the process of being refined and updated. These will be presented at the upcoming International Mine Ventilation Congress in November as part of a workshop to be followed up with a local workshop presentation for Australian coal operations personnel. A series of round robin R70 testing has also been completed across three laboratories (A, B and C) to evaluate the validity of the test results being produced for industry. An initial sample test round of a high volatile bituminous coal produced variable results that showed laboratory A had a major issue with their test procedure, which resulted in an extremely low R70 value of 0.05. Laboratory B tested the sample twice to confirm repeatability, and the results were 2.79 and 2.81. These results also matched previous testing of the same coal over the past five years. Laboratory C obtained a value of 1.79. The reason for the lower value obtained by Laboratory C compared to Laboratory B is still to be determined.

OPEN CUT

Reports Published This Quarter

C33040 Machine Learning for Rockfall Analysis

The University of Newcastle

Klaus Thoeni

Link to download the final report:

<https://www.acarp.com.au/abstracts.aspx?repId=C33040>

C36023 "SCANDY" - A handheld Imaging System for Real Time Spoil Categorisation

University of New South Wales

Simit Raval

Link to download the final report:

<https://www.acarp.com.au/abstracts.aspx?repId=C36023>

C37010 Segregation Testing of Category 2 Explosive Transport Boxes

Blast Ability International

Lee Julian

Link to download the final report:

<https://www.acarp.com.au/abstracts.aspx?repId=C37010>

C38004 Guideline for Groundwater Pressure Measurement Interpretation and Modelling for Slope Stability

Sherwood Geotechnical and Research Services

John Simmons

Link to download the final report:

<https://www.acarp.com.au/abstracts.aspx?repId=C38004>

Geology

C35023 Recovery of Critical Minerals from Coal and Coal Production Waste

Organisation: CSIRO
Project Leader: Nerrida Scott
Value: \$154,000
Report Expected: August 2026
Industry Monitors: Andrew Lau
 Jeremy Byrnes
 Shaun Booth
ACARP Contact: Patrick Tyrrell

This project investigated potential rare earth sources in a coal mine waste and then identified possible techniques for beneficiation.

Samples of mine waste were provided from a mine based on data researched from geological logs which indicated possible section of slightly elevated rare earth concentrations. These samples were then analysed using various processing methods and it was found that some dilution existed in the feed samples, leading to lower-than-expected concentrations. Techniques were considered for physical separation, and a range of options tried. Testing included physical separation, flotation and leaching trials.

All sample results have been received and are being compiled into the draft report. The report is currently being compiled and will be issued to monitors in the coming weeks.

C35047 Real Time Prediction of Coal Top Through Guided Borehole Radar Wave Imaging for Open Cut Blast Hole Drilling

Organisation: CSIRO
Project Leader: Wayne Stasinowsky
Value: \$496,730
Report Expected: November 2026
Industry Monitors: Gareth Johnson
 Jack Woollett
 Troy O'Reilly
ACARP Contact: David Drakeley

The project objectives are to:

- Develop a fully functional real-time coal top guidance system prototype suitable for field demonstration trials where it is fitted to a blast rig drilling production holes;
- Extend and mature the technology and engineering developed in Phase II; and to
- Develop a prototype to the stage that the technology is ready to engage a commercial partner.

Progress during the quarter:

- Several antenna designs were tested using 3D printed models and a successful design has been tested which minimises reverberation; and
- Work has now shifted to debugging some design issues with the radar boards.

C36022 Validation of LIBS Technology for Downhole Resource Evaluation

Organisation: CSIRO
Project Leader: Joe Perkins
Value: \$276,020
Report Expected: September 2026
Industry Monitors: Gareth Johnson
 Jason Schumacher
 Mark Laycock
 Sudipta Nag
ACARP Contact: David Drakeley

This project is a follow-up from C34029 and aims to further validate Laser-Induced Breakdown Spectroscopy (LIBS) as a rapidly deployable technology through expanded lab testing and field trials.

The project aims to.

- Using state-of-the-art laboratory LIBS hardware and multivariate analytical methods, build upon the preliminary findings of project C34029 to develop a comprehensive coal core derived calibration model;
- Integrate LIBS spectral information into washability models using processed core samples;

- Conduct field testing using a prototype/pre-commercial LIBS downhole tool to determine the potential and challenges of optimising LIBS technology specifically for the evaluation of coal resources.

During the quarter it was agreed to test in a more controlled setting, a simulated coal borehole, rather than to continue pursuing a mine site demonstration. Construction of the coal borehole is complete, fabrication of the LIBS tool is underway, and testing is planned at CSIRO in August and September. Following this, a draft report will be submitted.

C37027 Automated Optical and Acoustic Televiwer Drill Data Mapping for Improved Subsurface Analysis

Organisation: University of New South Wales
Project Leader: Simit Raval
Value: \$206,875
Report Expected: April 2028
Industry Monitors: Ben Forrest
 Matt Tsang
 Myf Godfrey
ACARP Contact: Patrick Tyrrell

This project focuses on developing an automated procedure for interpreting televiwer data tailored to mining applications. The primary objective is to design a machine learning-driven framework for analysing Optical and Acoustic Televiwer data from borehole drilling to detect and classify structural and lithological anomalies. Over the last quarter, the project team evaluated Fast Fourier Transform, Local Binary Pattern, and the Sobel operator to assess image complexity and cropped image quality. This evaluation produced a map that flags regions suited for automated structure detection and flags zones that algorithms should ignore. The team also currently working on evaluating pick dictionary verification and creating a dictionary for structural joints, establishing which logged discontinuity classes correspond to genuine geomechanical categories or stress-induced features. This involves cross-checking picks against direct visual inspection of the borehole wall imagery. This comparison separates structurally controlled features, including bedding and joints, from features arising from in-situ stress concentration.

The next phase involves testing whether the classifier's discrimination reflects a genuine acoustic amplitude response to borehole wall enlargement rather than an artifact of depth-related trends. Meanwhile, nondisclosure agreements are under consideration with three mine operators to facilitate access to additional data.

C37028 Multiscale Fracture Analysis and Modelling for Improved Geomechanical Assessments

Organisation: GMEK
Project Leader: Michael Munro
Value: \$197,250
Report Expected: September 2026
Industry Monitors: Leigh Bergin
 Matt Tsang
ACARP Contact: Patrick Tyrrell

This project demonstrates a geology-driven DFN workflow for slope stability analysis. It focuses on integrating borehole, televiwer, and mapping data within realistic fracture models, showing how geology-based interpretation improves the accuracy and usefulness of kinematic and geotechnical assessments.

This quarter has focused on closing out the technical program and preparing the draft report for submission.

A comparative review of geology-conditioned DFN methodology against conventional statistical methods has also been completed. Other work has focussed on best-practice guidance for the decision-tree workflow, for the collection, analysis, domaining, and modelling methods, demonstrating different aspects using data from Mine Site A and Mine Site B.

Further attention has been given to the application of output parameters derived from the fracture models, and how these are carried through into characterisation and geotechnical models. Presenting this material in a practical, repeatable form is the main remaining task for the report.

Key activities planned for next quarter include:

- Submission of the draft project report for review;
- Engagement with industry monitors and collection of feedback; and
- Modifications and updates to the report as required.

C38006 Transforming Coal Tailings into Sustainable Concrete for Transport Infrastructure

Organisation: Central Queensland University
Project Leader: Hassan Baji
Value: \$208,801
Report Expected: January 2028
Industry Monitors: Andrew Lau
 Luke Dimech
 Nigel Seto
 Shaun Booth
ACARP Contact: David Drakeley

This project aims to repurpose coal tailings as a supplementary cementitious material (SCM) for use in transportation infrastructure concrete, converting a mining waste stream into a high-value resource. During the current reporting period, the variability of coal

tailings properties was assessed using five samples collected on different days from the same BMA site. Characterisation testing commenced immediately upon receipt of the samples.

Summary of the performed tests are:

- Relative density measurements of the thermally treated materials were found to be highly consistent;
- XRD and XRF analyses confirmed the presence of kaolinite in all samples and indicated generally consistent mineralogical and chemical compositions;
- Chloride content testing was completed and showed all samples to be well below relevant limits, further supporting their suitability for SCM production;
- Thermogravimetric analysis (TGA) conducted under an inert atmosphere showed similar kaolinite contents and closely comparable loss-on-ignition (LOI) values across the samples;
- Moisture content and LOI testing identified one sample with a higher LOI, which was attributed to elevated coal content and subsequently confirmed by TGA in inert environment;
- Pozzolanic reactivity testing in accordance with ASTM C1897-20 demonstrated high and repeatable pozzolanic reactivity for all samples, indicating limited variability in performance despite differences in sampling time; and
- Compressive strength and workability testing of mortar mixtures incorporating the coal-tailings-derived SCMs is currently underway to further evaluate mechanical performance.

The results indicate that the coal tailings stream exhibits low temporal variability in key physical, chemical and reactivity-related properties.

C38021 CSR Predictions and Correlations Definition – Moranbah and Fairhills Coal Measures

Organisation:	McMahon Coal Quality Resources
Project Leader:	Chris McMahon
Value:	\$26,680
Report Expected:	February 2027
Industry Monitors:	Graeme Harris Myf Godfrey Shaun Booth
ACARP Contact:	Patrick Tyrrell

This project extends earlier research on predicting Coke Strength after Reaction (CSR) from routine coal quality tests, focusing now on the Moranbah and Fairhill Coal Measures. CSR is a key pricing factor for coking coal but difficult and costly to test directly, especially from borecore samples. Existing prediction models will be evaluated, and new ones developed with better accuracy using statistical analysis of coal quality proxies. Outcomes will help producers assess resource value more confidently and reduce reliance on expensive lab testing. The final guide will support improved marketing, reserve

estimation, and technical decision making for Queensland coking coal deposits.

The project is an extension of project C35025 CSR Predictions and Correlations Definition, completed in May 2025.

That project evaluated Rangal Coal mine based data and shipping data, with application to generic Australian coking coal specifications. The outcomes have created further industry interest for key coking coal mining sequences not enacted in that initial study, namely the Moranbah and Fairhill Coal Measures.

Similarly to the initial project, the objective is to statistically evaluate CSR Predictor performance from various coal quality CSR proxies (CSR Predictors) for the Moranbah and Fairhill Coal Measures.

Data sets for multiple deposits will be attained (two to be provided by industry) containing borecore ply/seam based information and accompanying production/despatch (shipping) data.

To date:

- A start meeting held 9 February 2026, and request for information memorandum issued on 17 February 2026, follow up meeting on the 25 February 2026 and further follow up requests on 20 April 2026;
- A further follow up email to the first party was undertaken on 12 May 2026, with positive reply on 20 May 2026 and further follow up on 21 May 2026 and 25 May 2026 with no further response received;
- A further follow up email to the second party was undertaken on 12 May 2026 and then again on 9 June 2026, with positive reply from the party on 09 June 2026 and further follow up on 10 July 2026 with no further response received.

Two borecore databases are likely to be received within the next month.

The outcomes of the project will be the definition of accuracy (precision and bias) information for varying CSR Estimators (both published and MCQR developed) with differing coal types, and method rules for creating new CSR Predictors for new deposits. This aids industry in correct resource representation and/or lower analysis costs and better quality control. The outcomes then providing a financial risk reduction and/or evaluation enhancement.

Project C35025's final report also produced a guide for use in industry to create and define CSR Predictor methods and accuracy and thus resource/reserve/marketing product potential and confidence and will be augmented in this current project.

Drilling and Blasting

C27024 Evaluation of Production Trials of HP Explosives

Organisation: Mining3
Project Leader: Alan Tordoir
Value: \$477,920
Report Expected: September 2026
Industry Monitors: Andrew Lau
 Brett Domrow
ACARP Contact: Patrick Tyrrell

The project objective is to evaluate the on-site on-demand manufacture and delivery of Hydrogen peroxide (H₂O₂)/oil-based emulsion-style explosive and blast performance in surface mine-site operations with increasing scales of production. This project progresses the research plan for H₂O₂-based emulsion explosives from confirmation of first viable formulations meeting sleep-time and detonation performance (reported in C27023) towards implementation and adoption by focussing on on-site on-demand manufacture and delivery procedures to meet mine-site operational requirements with a central and critical focus on safety.

Work undertaken during the quarter:

- Progress was made with industry collaboration partner on restoring project realignment proposal developed to support scaled site-based trial programs linked to projects C27024, C33041, and C35028 after delay in submission; and
- Renewed engagements are expected to commence in Q3 with revised proposals giving a clear basis to resume coordinated progress and drive practical site-based trial delivery.

C33041 Production Trials in Two States of HP Explosives with Custom MMU

Organisation: Mining3
Project Leader: Alan Tordoir
Value: \$342,034
Report Expected: December 2026
Industry Monitors: Andrew Lau
 Brett Domrow
ACARP Contact: Patrick Tyrrell

The objective of this project is to utilise a prototype Mobile Production Unit (MPU), built within project C27024 and C35028 to expand the blast trials of on-site on-demand Hydrogen peroxide (H₂O₂)-based explosives.

Work undertaken during the quarter:

- Progress has been made with industry collaboration partner on restoring project realignment proposal developed to support scaled site-based trial programs linked to projects C27024, C33041, and C35028 after delay in submission. Renewed engagements are expected to commence in Q3 with revised proposals giving a clear basis to resume coordinated progress and drive practical site-based trial delivery.

C35028 Mining Explosive Sensitisation using Chemical Free Methods

Organisation: Mining3
Project Leader: Alan Tordoir
Value: \$297,256
Report Expected: November 2026
Industry Monitors: Andrew Lau
 Brett Domrow
ACARP Contact: Patrick Tyrrell

The objective of this project is to further enable and improve bulk hydrogen peroxide (H₂O₂)-based emulsion mixtures. This project investigates unique sensitisation methods of H₂O₂-based emulsion mixtures. Success of this project will lead to improved H₂O₂-based explosive performance, reduced material costs, and an in-line reactor for an on-bench, on-site, on-demand emulsion manufacture process within a mobile production unit.

Work undertaken during the quarter:

- Progress has been made with industry collaboration partner on restoring project realignment proposal developed to support scaled site-based trial programs linked to projects C27024, C33041, and C35028 after delay in submission. Renewed engagements are expected to commence in Q3 with revised proposals giving a clear basis to resume coordinated progress and drive practical site-based trial delivery.

Environment

C29049 Saline Pit Lakes as Aquatic Ecosystems: A Design Manual for Closure

Organisation: Edith Cowan University
Project Leader: Mark Lund
Value: \$1,089,226
Industry Monitors: Andrew Lau
 John Watson
ACARP Contact: David Drakeley

The draft report is with the industry monitors for review.

C34025 New Landscape Evolution Model for Assessing Rehabilitation Designs

Organisation: University of Newcastle
Project Leader: Greg Hancock
Value: \$875,391
Report Expected: January 2026
Industry Monitors: Chris Quinn
 Jason Fittler
ACARP Contact: Patrick Tyrrell

The draft report is with the industry monitors for review.

C34027 Microalgae Cultivation as a Low Cost Method for Desalinating Void Water and Generator of Post Mining Bioeconomic Activity from Final Voids

Organisation: University of Queensland
Project Leader: Ben Hankamer
Value: \$3,155,904
Report Expected: September 2026
Industry Monitors: Andrew Lau
 Jason Fittler
 John Watson
 Trudy Mazucco
ACARP Contact: Patrick Tyrrell

The objectives of this stage of this project include:

- Pilot scale production of microalgae using void water;
- Development and confirmation of downstream processing methods to deliver quality target products;
- Target product testing to confirm product quality, market prices and demand; and
- Advance business modelling for the proposed void PMLU.

In the quarter, the project has conducted the following work.

Pilot scale biomass production:

- The production of Arthrospira biomass for the pet food trial has commenced. Around 40% biomass required for the test has been harvested, projected completion by the end of July 2026;
- Biomass production for sequential bio-refinery extraction has been completed for six out of six strains (100%).

Target product testing:

- Downstream processing (DSP) for the multiple product biorefinery has been completed for six out of six strains (100%): Monoraphidium sp., Chlorella CS-41, Chlorococcum sp., Desmodesmus sp., Lobochlamys sp., and Arthrospira platensis;
- The second version of the downstream processing method design and optimisation has been successfully conducted on Chlorella biomass (100% completion). The results showed clear improvement from the first downstream processing design;
- Additional pathogen testing has been identified as being required prior to undertaking feeding trials to evaluate pet food palatability with Big Dog Pet Foods. We are currently liaising with Big Dog to finalise testing requirements; and
- Pet Food Analysis Trial (Biomass production for Pet Food Trials: Chlorella 100 % completed, Spirulina 40 % completed).

Advanced business modelling:

- Verification of Spirulina product prices within the Australian market has been completed;

- We are currently liaising with phycocyanin industry partners to confirm price expectations and evaluate market;
- Evaluation of carbonised biomass product for inclusion within sodium ion batteries has been completed;
- Multiple potential avenues for a circular economy have been identified.

As most of the experimental work has been completed, the team is focusing on writing the final technical reports.

C35021 Delineating Water Tables and Flow Pathways Inside Spoil Piles to Support Water Quality Predictions

Organisation: University of Queensland
Project Leader: Mansour Edraki
Value: \$297,420
Industry Monitors: Andrew Lau
ACARP Contact: David Drakeley

The draft report is with the industry monitors for review.

C35026 Management Strategies for Invasive Leucaena on Coal Mine Sites

Organisation: University of Queensland
Project Leader: Shane Campbell
Value: \$531,528
Report Expected: January 2027
Industry Monitors: Andrew Lau
 Clare Foley
 Craig Bushell
 Hardy Wincen
 Melissa Brunner
 Morné van Zyl
ACARP Contact: Patrick Tyrrell

The primary objective of this project is to develop strategies to effectively manage the invasive species leucaena (*Leucaena leucocephala*) in rehabilitation on coal mine sites in Queensland.

A rate-response trial has completed its first year of monitoring. Based on the observed results and the importance of confirming long-term treatment trajectories, monitoring will be extended to two years. The next assessment is scheduled at 18 months, with a final evaluation at 24 months to complete the analysis of dose-dependent treatment effects over time. A timing-of-application foliar trial has been established to assess seasonal differences in herbicide efficacy. Applications for all seasonal treatments (spring, summer, autumn, and winter) have been completed, and the trial is now in the monitoring phase, with ongoing assessments being conducted for each season to evaluate treatment performance over time. A pot-based boom spray experiment is ongoing at the Tropical Weed Research Centre (TWRC) in Charters Towers, with final assessments scheduled for October 2026. A drone-based herbicide trial has been conducted in the field and is now in the

monitoring phase, with ongoing assessments being undertaken to evaluate treatment efficacy and persistence over time (Figure 1). Additionally, a second pot-based experiment investigating the fumigant dazomet has been established and is currently underway. Following treatment application, the study has progressed to the laboratory phase, where germination tests are being conducted to assess treatment effects on seed viability (Figure 2).

A further dose response trial of four soil persistent herbicide formulations is also underway at the Gatton Campus using both dormant and non-dormant seeds, with the first growth period concluded and the second period (six to eight months post treatment) set to begin in September. The competition trial at TWRC, has now concluded and is being prepared for write up. The crash grazing trial at the Gatton Campus has now also concluded. Currently all materials from the Limestone creek fire trail are also now being written up and prepared for publication. Additionally, the lab-based fire work and the pot-based competition trial using mine collected soil are also being prepared for publication.



Figure 1. Aerial view of a drone applied herbicide trial implemented at the University of Queensland using an old stand of leucaena that had been planted for grazing purposes.



Figure 2. Seeds from the dazomet trial undergoing germination testing to help determine the effect of dazomet on germination and viability.

C35030 Erosion and Sediment Control Framework for Queensland Mines – Calibration and Validation

Organisation: University of Queensland
Project Leader: Robynne Chrystal
Value: \$347,196
Report Expected: December 2026
Industry Monitors: Andrew Lau
 Jason Fittler
ACARP Contact: Patrick Tyrrell

This project is on hold.

C36018 Predicting the Long Term Erosional Behaviour of High Walls

Organisation: University of Newcastle
Project Leader: Greg Hancock
Value: \$443,980
Report Expected: September 2026
Industry Monitors: Andrew Lau
 Chris Quinn
 Jason Fittler
ACARP Contact: Patrick Tyrrell

The project objectives are to:

- Better understand the process and rates of mine highwall erosional failure;
- Develop parameters for input into numerical models for high wall erosional failure; and to
- Calibrate and validate a predictive model (SIBERIA) for the erosion of highwalls.

Several mine sites have provided highwall DEMs in Queensland and New South Wales with data collection complete. Five sites in Queensland were found to be suitable with one in New South Wales suitable. All site survey data processing is now complete.

Erosion and hydrology parameters have been developed for application at all sites in Queensland and one in New South Wales. Modelling is near complete for all Queensland sites. The site in New South Wales has been completed and results finalised. Data analysis is continuing and project writeup well underway. Results demonstrate that a highwall can be subject to erosion from external runoff as well as developing gullies internally. The methodology using a LEM provides plausible outcomes and from this a work flow has been developed. The need to manage external runoff is an initial key finding.

C36020 Semi Autonomous Bulldozers for Mine Site Rehabilitation

Organisation: University of Queensland
Project Leader: Ross McAree
Value: \$498,218
Report Expected: September 2026
Industry Monitors: Allan Mackaway
 Andrew Lau
 Brian Neilsen
 Jonathan Miln
ACARP Contact: Patrick Tyrrell

This project is developing and demonstrating semi-autonomous bulldozers based on Caterpillar's SATS platform, targeting substantial reductions in emissions and costs during mined land rehabilitation. The project extends the SATS Tactical Automated Mission Planner (STAMP) to rehabilitation applications and develops a Bulk Movement Planner (BuMP-R) to autonomously generate work-block and slot layout sequences from the overall rehabilitation plan, reducing reliance on operator decision making and improving compliance with the final landform design. Work on the interim project report is underway.

C36042 Validation of a Landform Design and Management System for Sloped Grazing PMLU

Organisation: Valarion
Project Leader: Leigh Trevaskis
Value: \$688,080
Report Expected: March 2028
Industry Monitors: Andrew Lau
 Clare Foley
 Hardy Wincen
 Melissa Brunner
 Morné van Zyl
ACARP Contact: Patrick Tyrrell

The project's primary objectives are to:

- Characterise the impact livestock behaviour has on stability indicators for sloped grazing PMLU in the Bowen Basin;
- Provide statistical confirmation of an adaptive grazing management system for maintaining the stability of sloped grazing PMLU;
- Obtain evidence that justifies the use of stability indicators for the approval of grazing PMLU rather than a slope gradient ceiling per se;
- Assess the feasibility of using integrated behavioural, landform elevation, and sustainability indicator data for developing a grazing PMLU landform evolution model;
- Use stability indicator data from replicated treatments to evaluate recommendations from previous grazing PLMU studies; and to
- Publish a best-practice guide for managing livestock on sloped grazing PMLU.

In this quarter, the project has continued to work with the partnering mine site to progress planning for the grazing trial's belated commencement in late-2026. Also:

- The partnering mine site is engaging contractors to install trial fencing;
- A second round of pasture cuts was completed to calibrate remotely sensed groundcover and pasture biomass; and
- Initial tagging of livestock to be used in the trial was completed to satisfy animal ethics requirements, in preparation for tagging with on-animal sensors.

C36043 Using Large Floating Islands to Promote Aquatic and Terrestrial Biodiversity in Pit Lakes

Organisation: Edith Cowan University
Project Leader: Mark Lund
Value: \$697,290
Report Expected: March 2027
Industry Monitors: Andrew Lau
 John Watson
ACARP Contact: David Drakeley

Previous projects (C27043 and C29049) demonstrated that closure of pit lakes as aquatic ecosystems is likely a viable, sustainable, and economically responsible option for post-mining land use. Riparian vegetation and littoral areas are critical ecosystem components that cannot be established before the lake is full.

Artificial floating islands (AFIs) can provide habitat for waterbirds and other fauna. Therefore, AFIs may be used to encourage waterbird usage, create habitat for fauna (including turtles, fish, frogs, macroinvertebrates, and terrestrial organisms) and as a source of plant propagules, and general habitat for fauna (aquatic and terrestrial) in pit lakes. Waterbirds are particularly important to aquatic biodiversity because they are vectors of plants, invertebrates, bacteria, fish eggs, and major sources of nutrients (N and P) through excreta. Propagules from AFIs can continually seed the pit lake during filling, potentially removing the need for companies to return after the lake fills to plant a riparian zone, especially as the upland vegetation is normally well-established by then limiting access to the shore.

The broad goal of this research is to develop the use of large-scale AFIs as a tool that can be deployed by miners to develop or improve biodiversity in their pit lakes making them suitable for closure as aquatic ecosystems or demonstrating improvement for NUMAs.

We will investigate the effectiveness of AFIs by testing pairs of pit lakes across Western Australia, New South Wales and Queensland. In each pair, one lake will be treated with an AFI and the other left as a control. Using previous data collected at the sites in C27043 and C29049 and extending this monitoring in this project we can test the effectiveness of AFIs using a Before/After/Control/Impact (BACI) study design.

Islands have been installed at all three sites in Western Australian, Queensland and New South Wales. We have also completed the five proposed rounds of monitoring at all pit lakes (except for Collie which will be completed in the next two weeks). Most sampling processing is up to date. The islands are now starting to show clear differences in vegetation between the different sites, with significant growth at our New South Wales site, reasonable growth in Collie and challenging growth at our Queensland site (possibly due to secondary mineralisation in the water resulting in coating of the roots). Particularly in Collie and New South Wales sites we have seen extensive use of the islands by waterbirds. During the next quarter we will complete fieldwork and finalise data analysis. Draft report writing will commence.

C38002 Investigating *Pittosporum Angustifolium* for Mine Rehabilitation: Key Strain Identification, Medical and Environmental Applications and Germplasm Propagation Investigation

Organisation: RNA Environmental Services
Project Leader: Leigh Trevaskis
Value: \$235,548
Report Expected: March 2027
Industry Monitors: Andrew Lau
 Andrew Micallef
ACARP Contact: Patrick Tyrrell

This project has three objectives, which are to:

1. Confirm the prevalence of anticancer compound producing individuals within natural Gumby Gumby populations;
2. Undertake statistical analysis of the project's genomic and soil parameter datasets to clarify the relative contribution these variables make to the presence of anticancer compounds in tested Gumby Gumby plants; and to
3. Undertake a grafting exercise to create hygienic plant material from the most potent plants identified to safeguard these genetics for future tissue culture propagation.

In this first quarter, the following work has occurred.

Confirmation of the prevalence of anticancer compound-producing individuals:

- Plant material has been delivered to the University of Newcastle for freeze drying and grinding preparation for evaluation of anti-cancer activity.

Propagation to support grafting activities:

- Gumby Gumby seedlings were received by a tissue culture specialist to support the grafting of materials from plants verified as medicinal;
- Initial grafting activities have been undertaken to assess the effectiveness of grafting materials sourced from shrubs confirmed to contain anticancer compounds. This work aims to preserve superior genetics for future PMLU applications.

C38018 Reducing Coal Tailings by Valorisation of Coal Measure Clays for Low Carbon Concrete

Organisation: Central Queensland University
Project Leader: Hassan Baji
Value: \$115,325
Report Expected: April 2027
Industry Monitors: Andrew Lau
 Shaun Booth
ACARP Contact: David Drakeley

This project proposes a new framework for the coal industry by investigating the feasibility of utilising coal-measure clays as supplementary cementitious materials (SCMs) in low-carbon concrete, rather than disposing of them as waste in tailings dams. During the quarter, a second coal-measure clay sample was successfully obtained from a BMA mine site, complementing the sample previously collected from a Glencore operation in Central Queensland. Characterisation of the two samples is currently underway.

Treatment of clay samples includes drying, grinding and calcination at different temperatures. Chemical composition and chloride content tests on Glencore samples showed negligible presence of chloride and below limits sulphur content.

Thermogravimetric analysis (TGA) and XRF/XRD analyses have identified the presence of kaolinite and illite in both coal-measure clay samples, indicating potential for pozzolanic activation following calcination. Mineralogical investigations have also confirmed the presence of quartz in both materials.

Pozzolanic reactivity testing has been completed on samples calcined at different temperatures from 600 °C to 900 °C. Results indicate that calcination at approximately 800 °C provides the most favourable balance between pozzolanic performance and processing energy requirements.

Mechanical performance testing is currently in progress. Compression strength and workability assessments are being undertaken on mixtures incorporating the calcined coal-measure clays.

The project remains on schedule, with ongoing work focused on completion of material characterisation and evaluation of performance of coal measure samples as suitable SCMs. Further contact with mining partners is underway to source more clay sample from mining sites.

C38019 Reducing Low Frequency Noise Emitted from Heavy Vehicles and Enclosures in Open Cut Coal Mines

Organisation: University of Technology
Sydney
Project Leader: Paul Williams
Value: \$235,466
Report Expected: March 2027
Industry Monitors: Brendan Wilkins
Tim Gray
ACARP Contact: David Drakeley

The project goal is to reduce low-frequency noise (31–500 Hz) emitted by heavy machinery in open cut mines. A key finding of project C34031 was that conventional acoustic louvres are ineffective at mitigating noise below 500 Hz. This project addresses that gap by developing novel acoustic louver designs, incorporating metamaterial elements to target the low-frequency range. The objectives of this project are to identify efficient materials and designs for reducing low frequency noise, empirically demonstrating the effectiveness of the material in laboratory testing, and the development of a manufacturable low frequency louver design.

In the quarter, the computational work package advanced from unit-cell optimisation to a selected laboratory prototype and parallel studies of further low-frequency resonator concepts. The prototype louver will be fabricated and tested in UTS Tech Lab's acoustic laboratories. This hybrid design consists of a two-resonator configuration combined with traditional dissipative media and has been optimised to improve the mean A-weighted attenuation across the 31-500 Hz frequency range. The louver baffles are currently being fabricated.

In parallel, computational work continues on additional low-frequency resonator ideas. These include three-dimensional designs that could not be investigated using the preliminary two-dimensional models, such as the use of folded quarter wave and segmented Helmholtz resonators. The goal of this ongoing work is to further reduce the effective frequency of the low frequency attenuation while maintaining a reasonable performance above 500 Hz.

Work in the next quarter will complete prototype manufacture and commence laboratory measurements alongside the ongoing computational investigation into optimised louver designs.

Rock Mechanics

C29005 System for Rock Fall Analysis Field Trial

Organisation: CSIRO
Project Leader: Marc Elmouttie
Value: \$321,268
Industry Monitors: Matt Tsang
ACARP Contact: Patrick Tyrrell

The draft report is with the industry monitors for review.

C35022 Quantifying Hoek-Brown Disturbance Factor (D) for Coal Measures Through an Integrated Laboratory and Numerical Modelling Approach

Organisation: University of Queensland
Project Leader: Italo Onederra
Value: \$672,162
Report Expected: November 2026
Industry Monitors: Matt Tsang
Peter Chern
ACARP Contact: Patrick Tyrrell

The primary aim of this project is to validate the blast damage predictive model proposed in the previous stage of this project through a targeted monitoring campaign. Trials were designed to not only assess the effectiveness of the proposed method, which links peak particle velocity, scale effects, and damage extent with disturbance factors (D); but also, to demonstrate its practical application.

In this quarter two blast monitoring campaigns were conducted. The first campaign took place in early May, during which five triaxial accelerometers were installed behind the final blast row at predetermined distances from the blast area. The recorded data were processed and analysed to determine the attenuation characteristics of peak particle velocity (PPV) behind the blast. These measurements were subsequently incorporated into the calibration of the developed prediction tool, which estimates the blast-induced damage factor (D) behind the highwall slope. In this framework, the D factor is evaluated based on the spatial distribution of PPV. Following completion of the first field trial, the monitoring outcomes, data analysis results, and key findings were presented.

A second mine site visit was conducted in mid-July at the same operation. During this campaign, three triaxial accelerometers and a set of geophones were deployed to monitor blast-induced stress wave responses behind the final blast rows. The collected data are currently being processed and analysed to assess the consistency of PPV measurements obtained from the two monitoring systems and to further validate and refine the D factor prediction tool.

In the next quarter, the remaining data analysis will be completed, and the final project report will be prepared and submitted to the industry monitors for review.

C36017 From Open Pit to Pumped Hydro Energy Storage, a Focus on Low Wall Stability

Organisation: University of Newcastle
Project Leader: Olivier Buzzi
Value: \$405,500
Report Expected: October 2028
Industry Monitors: Andrew Lau
 Shaun Booth
 Troy O'Reilly
 Tyron Domenici
ACARP Contact: David Drakeley

The project objective is to identify the fundamental failure mechanisms of a low wall in the context of pumped hydro energy storage (PHES), and to provide guidance to mitigate the geotechnical failure risks.

During the quarter, the following was done:

- 305kg of spoil material, required for the centrifuge tests, were recaptured at Southwest Jiaotong University, Chengdu, China.
- Centrifuge preparation tests were conducted at the University of Newcastle to optimise material placement, assess water seepage rate and test sensors response (see Figure 1).



Figure 1: Photograph of reduced scale spoil pile in a box of similar dimensions that the centrifuge box to be used at Southwest Jiaotong University. Pore pressure sensors and laser displacement sensors are installed in the box to refine the installation method and test the response.

- The series of 300mm direct shear tests on collapsed material was started but it was found, when analysing the specimens post testing, that despite stabilisation of the collapse settlement during the saturation phase, the specimens still contained significant dry areas. An attempt was made to insert thin vertical strips of geofabric in the specimen to act as wick drains and facilitate saturation, but this solution did not entirely remove the pockets of dry material. It was hence decided to use triaxial testing instead, given that achieving saturation in a triaxial cell is easier and can be checked prior to testing. The maximum particle size was reduced to less than 2.36mm, to be consistent with the smaller dimensions imposed by

the triaxial equipment (diameter 50mm, height 100mm). To date, three consolidated undrained tests (confinement of 150, 300 and 600 kPa, with measurement of excess pore pressure) have been conducted (Figure 2). Given that the excess pore pressure is measured during the tests, it is possible to infer both the undrained and effective strength envelope. The series on the collapse material is currently ongoing.

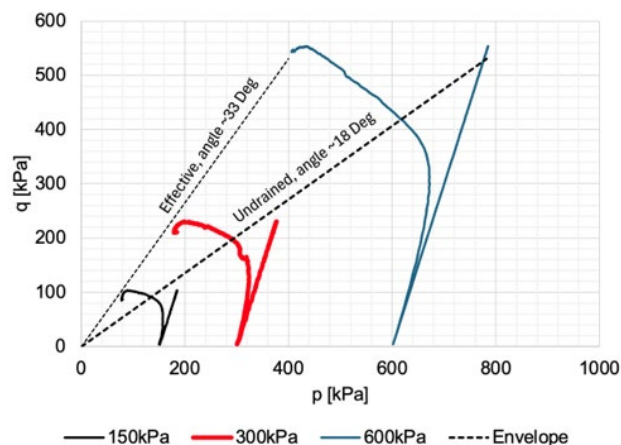


Figure 2: Results of CU triaxial test results with effective and undrained strength envelope showed by the dashed lines. Undrained shearing at a rate of 1mm/min with excess pore pressure measurement, allowing the determination of effective shear strength envelope.

- A double oedometer test (300mm in diameter) was completed to assess collapse potential of the spoil material. For these tests, loose unsaturated material (maximum particle size of 19mm) was first compressed without addition of water. Then, another test was run where the loose material was saturated before being consolidated. For a given normal stress, the vertical distance between the unsaturated and saturated curves presented in Figure 3 provide information about the maximum expected collapse. A third test on saturated material is currently ongoing to evidence the effect of prior compaction on the magnitude of collapse.

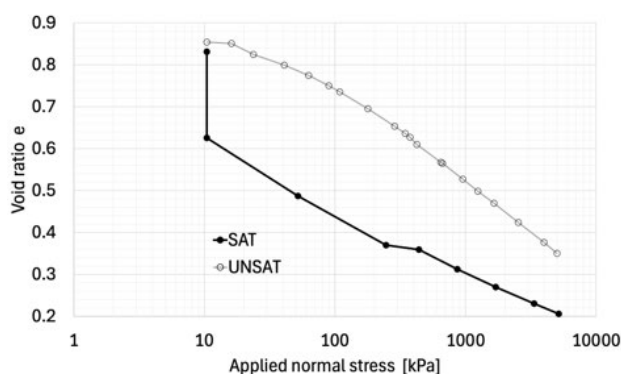


Figure 3: Results of the double oedometer test on specimen placed loose (initial void ratio of 0.85). The vertical distance between the two curves represents the magnitude of collapse.

C36021 Measuring the Tensile Strength of Thin Units in Coal Measure Rocks using a Comminution Approach

Organisation: University of Queensland
Project Leader: Katerina Savinova
Value: \$214,100
Industry Monitors: Andrew Lau
 Jianping Li
 Matt Tsang
ACARP Contact: David Drakeley

The draft report is with the industry monitors for review.

C37011 Improved Change Detection for Low Cost Terrestrial Photogrammetric Monitoring Based on Deep Learning

Organisation: University of Newcastle
Project Leader: Klaus Thoeni
Value: \$273,196
Report Expected: June 2027
Industry Monitors: Ben Forrest
 Gareth Johnson
ACARP Contact: David Drakeley

This project aims to develop a low-cost, AI-enhanced photogrammetric monitoring system to detect rockfalls and potentially also slope instabilities in open cut mines. Building on project C29050, it addresses the current system limitations by integrating Deep Learning to improve detection accuracy, reduce false positives, and eliminate manual analysis. The result will be a reliable, low-cost, near real-time solution that enhances safety, reduces operational delays, and supports long-term geotechnical risk assessment.

Progress during the quarter has been much slower than anticipated. The team was meant to install the monitoring equipment on site in June and collect data. Unfortunately, this was not possible due to some issues at the mine site. The project team has maintained regular communication with the mine site to discuss a new timeline for the installation. According to recent developments, the next time window for the installation is mid to end of August. Planning is underway to make this happen. The project has previously been extended due to delays with the installation. The team is now working with the mine site to avoid any further delays.

Maintenance and Equipment**C37021 Concept to Produce Pure Plant Oil Economically for Captive use at Mine Site to Replace Diesel**

Organisation: Green Biofuels Australia
Project Leader: Charles Easton
Value: \$265,000
Industry Monitors: Andrew Lau
 Myf Godfrey
 Shaun Booth
ACARP Contact: Patrick Tyrrell

The draft report is with the industry monitors for review.

Health and Safety**C36033 Live Monitoring of Workplace Exposures In Surface Mobile Equipment**

Organisation: SafeOperate
Project Leader: Andrew Westaway
Value: \$152,000
Industry Monitors: John Anger
 Shane Apps
ACARP Contact: Patrick Tyrrell

The draft report is with the industry monitors for review.

Overburden Removal**C38020 Enhanced Bulk Movement Planning for Semi-Autonomous Rehabilitation**

Organisation: University of Queensland
Project Leader: Ross McAree
Value: \$687,503
Report Expected: September 2027
Industry Monitors: Allan Mackaway
 Andrew Lau
 Brian Neilsen
 Jonathan Miln
ACARP Contact: Patrick Tyrrell

This project aims to take the automated planning layers developed in C36020 to support semi-autonomous dozing in rehab and evaluate their performance for typical rehab scenarios. The planning layers developed in C36020 include an adaption of the automated mission planning for production dozing and a bulk movement planner that generates the work blocks needed to schedule the progression of dozing activities across the full rehabilitation task. The project will integrate the planning system with established rehabilitation workflows, in particular consuming the rehabilitation design outputs that describe the required terrain transformation. The planned field trials for C36020 are targeted in this project and further validation of the planning system will use a simulation framework.

The project started in April. Work completed in the quarter:

- Refinements to bulk movement planning strategies based on simulation studies across realistic rehab scenarios;
- Functional integration of bulk movement planning (BuMP) of work blocks with the operation of the automated mission planner (AMP). Demonstration in simulation of progressive bulk movement planning and STAMP execution;
- Adapted AMP for the more general pre-conditions associated with rehabilitation work blocks and the different types of missions to be computed for a SATS dozer;
- Use case analysis of functional interactions between automated planning and semi-autonomous dozer systems.

- An engineer/fabricator was engaged to design the water collection and pumping apparatus;
- Materials exposed to mine water in the Bowen Basin were retrieved, providing data for material selection.

Prototype manufacture and assembly:

- Prototype drawings have been produced and provided to workshop for fabrication preparation;
- Specific materials for prototype manufacturer have been ordered and are undergoing delivery;
- Prototype manufacture is expected to commence August.

General

C37013 Thermally Enhanced Floating Solar Still System for Reducing a Mine's Reliance on Raw Water Allocations and Achieving a Drought Resilient Post Mining Land Use for Final Voids

Organisation: Valarion
Project Leader: Leigh Trevaskis
Value: \$83,000
Report Expected: February 2027
Industry Monitors: Andrew Lau
 Angus Ball
 Shaun Booth
ACARP Contact: Patrick Tyrrell

The project objective is to design, and performance test a modular and potentially thermally enhanced floating solar still prototype that:

- Has capacity to scale for application on voids of varying water surface areas and water quality;
- Produces commercially relevant volumes of water (i.e. > 12ML/ha) to supplement mine operational requirements and PMLU agricultural applications;
- Requires minimal maintenance;
- Provides ease of access and functionality for safe system maintenance; and
- Delivers a cost-effective means for avoiding expensive backfilling of final voids.

In this quarter, the project has conducted the following work.

Mini-still design, testing and evaluation:

- The project collaborated with a computational fluid dynamics modeller to optimise and finalise certain prototype design features (eg. condensation pipes, fans, etc), using a created calculator;
- A mechanical/structural draftsman was engaged to finalise the overall prototype design and produce a detailed CAD model of the prototype;

COAL PREPARATION

Reports Published This Quarter

C34040 Optimising the Diesel Droplet Size in Coal Preparation Plants

University of Queensland

Yongjun Peng

Link to download the final report:

<https://www.acarp.com.au/abstracts.aspx?repld=C34040>

C34043 In-plant demonstration of the next-generation flotation system

University of Queensland

Liguang Wang

Link to download the final report:

<https://www.acarp.com.au/abstracts.aspx?repld=C34043>

C34044 Real-time monitoring and control of froth flotation

University of Queensland

Liguang Wang

Link to download the final report:

<https://www.acarp.com.au/abstracts.aspx?repld=C34044>

C34052 Simulation Enabled Digital Twin for the Control, Design and Optimisation of a Teeter Bed Separator

University of Queensland

Kym Runge

Link to download the final report:

<https://www.acarp.com.au/abstracts.aspx?repld=C34052>

C35035 3D particle surface composition analysis for flotation using micro-CT

The University of Newcastle

Rohan Stanger

Link to download the final report:

<https://www.acarp.com.au/abstracts.aspx?repld=C35035>

Maintenance and Equipment

C36027 Coal Stockpile Management for Remote Bulldozers through Enhanced Situational Awareness

Organisation: University of Queensland

Project Leader: Ross McAree

Value: \$734,000

Report Expected: January 2027

Industry Monitors: Bryce Ayscough

Michael Booth

ACARP Contact: Patrick Tyrrell

This project is developing enhanced situational awareness and decision support tools for remotely operated bulldozers on coal stockpiles. It addresses a significant practical barrier in non-line-of-sight teleoperation, where operators lack the perceptual cues needed to work effectively and safely. Building on a series of collaborative projects between the University of Queensland and Caterpillar, the project develops and

evaluates two core capabilities: real-time topography mapping of the stockpile surface using on-board and infrastructure-mounted sensors combined with material movement models, and generation of efficient material movement missions to support operator decision making. These capabilities are integrated with Caterpillar's NLOS teleoperation technology to provide operators with situational awareness and decision support, including suggested push and transition paths, draw-valve location, crest identification, and coal bridging predictions. The effectiveness of the system will be assessed through evaluation trials comparing operator performance with and without the decision support system against a computed optimal material movement schedule, with operator workload gauged through NASA TLX surveys.

During the quarter:

- Targeted field trial site withdrew their involvement in a NLOS study citing a focus on rolling out existing remote dozer operations among crews. Another site identified and process for establishing support for trial is underway.
- GUI design and implementation progressed to functional prototype.
- Software architecture finalised and workflows documented.
- Implemented dozer simulator application to provide 'virtual dozing' and support testing of planning functions.
- DozerPoseServer, DozerTerrainSensorium, TerrainServer, and DozerTacticalPlanner applications refactored to support live operation, as required for field trial. Final form of DozerPoseServer will depend on site-specific requirements to support dozer pose.

Next steps:

- Secure site support for field trials. This will have implication for the final system architecture that can be supported on site, e.g.:
 - LiDAR mounting options,
 - Pose hardware (sensor, computing, comms) on identified trial dozer,
 - site procedures for stockpile activities,
 - accessing site data on stacking and reclaim rates;
- Build, test, and deploy dozer pose system;
- Complete implementation of software components needed to support situational awareness and planning, aligning with site processes for stockpile management;
- Validate site deployment of software and hardware components; and
- Execute field trial.

C36028 Continuous Stockpile Cavity Warning System - Feasibility Assessment

Organisation: CSIRO
Project Leader: Wayne Stasinowsky
Value: \$191,600
Report Expected: September 2026
Industry Monitors: Connor Gregory
 Michael Booth
 Tom Buckby
ACARP Contact: Ben Gill

The project objectives are to:

- Conduct a feasibility assessment for a system that will allow the mine to monitor the stockpile continuously in real time and give real-time warning of a developing void to the dozer operator;
- Model the responses numerically to determine that there is sufficient resolution to detect dangerous voids; and to
- Test the technique using scale models.

During the quarter coordination progressed in the Bowen Basin, to allow testing a radar over a full-size stockpile. This test was in addition to the original scope but considered important additional information ahead of phase 2 full scale design and development.

C38025 Operational Improvements to the Existing Installed TBS Fleet

Organisation: Mineral Technologies
Project Leader: Bob Drummond
Value: \$236,168
Report Expected: September 2027
Industry Monitors: Chris Denyer
ACARP Contact: Ben Gill

Hydraulic classifiers or Hindered Bed Separators (HBS) are an integral part of fine coal processing especially for coking coal applications where they offer the advantage of being able to perform an efficient gravity separation at cut points as low as 1.45.

This research will develop and test innovative engineering solutions in a pilot scale system and aim to address the known operational issues in the existing MEP TBS design promoting improvements in the TBS operational stability and metallurgical efficiency. This will be achieved by carrying out a pilot testing program where the design innovations will be assessed and benchmarked against the sponsor's site existing TBS machines.

Work this quarter involved prioritising and developing preliminary mechanical design concepts for the Next Gen TBS system. Future work next quarter will focus on completing the process and mechanical design and developing the pilot system design to an IFC stage and placing orders on the major mechanical equipment, instrumentation and steel fabrication items.

C38026 Standardising Risk Based Maintenance Execution using a Digital Twin Framework for CHPPs

Organisation: Mincka Engineering
Project Leader: Fidel Gonzalez
Value: \$439,160
Report Expected: January 2027
Industry Monitors: Chris Jackson
 Frank Mercuri
ACARP Contact: Ben Gill

The objectives of the project are to:

- Develop and validate a defect prioritisation engine that converts a site's defect register into a defensible, reproducible and explainable repair campaign, operating strictly inside the site's risk governance framework;
- Integrate SLAM-based 3D scanning and 360° panoramic capture into mobile defect recording;
- Develop and trial AI-assisted generation of draft repair work packs;
- Validate the complete workflow at partner mine sites; and to
- Deliver a standardised, site-ready deployment package supporting independent adoption by CHPP teams.

During the quarter, the prioritisation engine strategy was fully designed, pressure-tested against prior art across a structured research program and confirmed as the build baseline. The engine applies a deterministic ranking and selection core in which identical inputs yield identical campaigns; AI is confined to register ingestion, classification of free-text repair descriptions and plain-language narration, and never ranks, calculates or selects. The validation program was defined across two environments, retrospective against a historical defect register under an information-parity rule and prospective on a digital twin and structural inspection register generated for the project, and includes:

- A consistency workshop measuring inter-planner agreement against the engine's determinism;
- A contemporaneous planner-versus-engine comparison on identical inputs;
- Face-validity review with site engineers and planners; and
- Shadow and assisted-use phases alongside live campaign planning.

Preparations for site capture works also progressed during the quarter.

In the next quarter, the engine build will progress, mobile scanning and panoramic capture works will commence on site, and development of the platform front end will begin.

Dewatering

C33051 Hybrid Microwave Technology for Dry Stacked Tailings Applications

Organisation: University of Queensland
Project Leader: Christian Antonio
Value: \$121,335
Report Expected: September 2026
Industry Monitors: Connor Gregory
 Frank Mercuri
ACARP Contact: Ben Gill

One of the most pressing challenges facing the mining industry today is the increasing frequency of catastrophic tailings dam collapses. Such events are known to cause significant environmental damage as well as loss of life. There is a strong industry push to move away from wet tailings dams to drier and safer options. A viable alternative to tailings storage in dams is Dry Stack Tailings technology.

This project proposes a new approach that could reduce tailings moisture contents to levels required for dry stacking – the use of Hybrid Microwave Technology. This approach combines microwave treatment with conventional dewatering techniques. This method could bridge the moisture content gap between conventionally dewatered material and Dry Stack Tailing requirements.

The project aims to evaluate the feasibility of a continuous process and measure the energy requirements to achieve different product moisture content. Finally, it will provide a concept for a microwave-assisted dewatering process for future research studies.

During this quarter the preparation of the final report has progressed.

C34051 Cost Effective Approach for Coal Tailings Dewatering using Semi Inverted (SIV) Hydrocyclones

Organisation: University of Queensland
Project Leader: Christian Antonio
Value: \$174,500
Report Expected: September 2026
Industry Monitors: Connor Gregory
 Jenny Goh
 Tom Wilson
ACARP Contact: Ben Gill

The application of coagulation, flocculation, and mechanical dewatering units such as belt press filters, centrifuges, and horizontal belt filters is currently used by industry as a practical approach for dewatering coal tailings. However, there are still challenges that limit dewatering of coal tailings which affects the performance of these dewatering processes. These include the presence of clay materials, elevated fines and ineffective coagulation and flocculation methods, amongst others.

This project aims to develop a technologically and economically viable approach to reduce moisture content and capture fine clay particles in tailings to improve tailings dewatering outcomes, by using Semi-Inverted Hydrocyclone Technology, followed by coagulation, and flocculation. The study aims to use the SIV to split a tailings sample into a coarse stream (underflow product), with reduced moisture content, and a clay-rich fines stream (overflow product). This will enable targeted processing of the two streams that could consequently improve the efficiency of downstream dewatering units. A potential tailings sample has been received for evaluation for use in this project.

During this quarter the preparation of the final report has progressed.

C36025 Green and Effective Reagents for Centrifugal Dewatering

Organisation: University of Queensland
Project Leader: Liguang Wang
Value: \$198,982
Report Expected: September 2026
Industry Monitors: Chris Denyer
 Connor Gregory
 Jenny Park
ACARP Contact: Ben Gill

The objectives of this project are to:

- Screen and develop green reagents for dewatering of coals and tailings over a broad size range to achieve low product moisture level and high solids recovery; and to
- Provide a guide for reagent selection in dewatering of Australian black coals and tailings.

Testing the flotation tailings sample supplied by the participating CHPP using the established experimental framework, has continued. This framework involves initial reagent screening through settling tests, followed by single-leaf filtration and screen bowl and solid bowl centrifuge testing using selected reagents.

Settling and single-leaf filtration tests have now been completed for the tailings sample using both conventional and green reagents. Across the thermal coal, metallurgical coal and tailings samples, settling and filtration performance showed broadly consistent trends. However, among the better-performing reagents, faster settling did not always correspond to shorter filtration times. Furthermore, reagent rankings differed between the two tests and among the sample types. These findings confirm that settling tests are suitable for preliminary reagent screening, while filtration tests remain essential for identifying the most effective reagent for each sample.

Ten green reagents were evaluated for the tailings sample. None matched the performance of the conventional PAM-based anionic flocculants, which

consistently delivered superior performance in the settling and filtration tests.

In the next quarter, screen bowl and solid bowl centrifuge tests will be conducted using the selected reagents. The settling, filtration and centrifugation results will then be compared to determine whether reagent performance is consistent across the different dewatering processes and to support the development of a comprehensive reagent selection framework. The project team will also finalise the draft project report.

Environmental Improvement

C29042 Tailings to Topsoil

Organisation:	University of Newcastle
Project Leader:	Ken Williams
Value:	\$765,300
Report Expected:	September 2026
Industry Monitors:	Bill Baxter Paul O'Loughlin
ACARP Contact:	Patrick Tyrrell

The project objectives are to develop a co-utilisation and soil improvement program that addresses the environmental challenge of tailings management for mining operations. This transformational alternative for tailings management research optimises existing technologies for dewatering, delivery, and soil remediation processes into an integrated "pit to paddock" mobile plant emplacement and cultivation system.

Field Trials – Two Site Trials:

- Field trials at Site 1 and Site 2 continue to show ongoing plant growth across all established plots;
- Growth trends remain consistent with previous reporting periods, with no significant divergence between treatment ratios at this stage;
- Plant assessments are scheduled following the 2026 summer growth period.

Ex-Situ Trials – Glasshouse (Sticky Hopbush):

- The glasshouse trials using sticky hopbush (*Dodonaea viscosa*) have now been completed for all tailings treatments, including mixed tailings-to-soil ratios, 300 C pyrolysed tailings and pelletised tailings products.

Final destructive harvest data for fresh shoot and root biomass have been assessed. The results of the shoot and root weights for the control and each treatment can be seen below in Figure 3 with the ration between shoot and root weight shown in Figure 4.

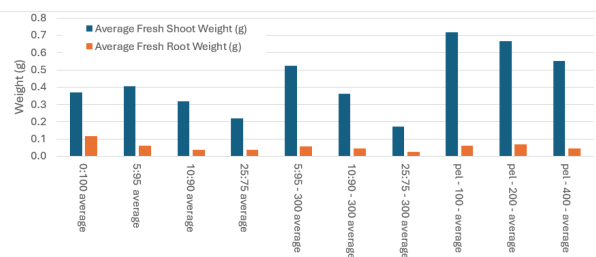


Figure 3: Sticky Hopbush shoot weight and root weight

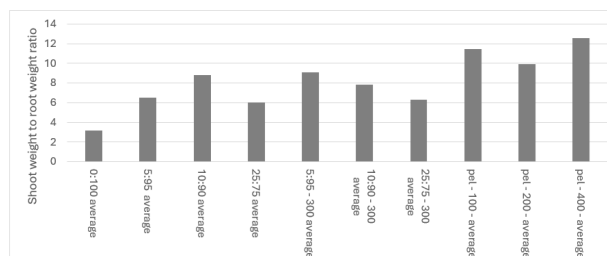


Figure 4: Sticky Hopbush shoot to root weight ratio

- Low-level mixed tailings at 5:95 improved shoot and root biomass relative to the control treatment.
- Pyrolysed tailings, particularly 5:95 at 300 C, further enhanced shoot growth compared with the control and untreated equivalents.
- Pelletised treatments produced the strongest shoot response, with pel-100 recording the highest above-ground biomass; pel-100 and pel-200 were the highest-performing pellet rates.
- Findings indicate that sticky hopbush responds positively to selected coal tailings amendments. Pelletised products can support rapid early establishment, while incorporated tailings support balanced shoot-root development.

Column Leaching and Chemical Analyses:

- Chemical assays on leachates and solid phases have been completed and will be reported in Q3 2026.

Regulatory Progress – Resource Recovery Exemption (RRE):

- The Resource Recovery Order and Exemption (RROE) submission to the NSW EPA was formally lodged in December 2025.
- Supplementary information was provided as requested for the RROE assessment in February 2026, which was accepted as sufficient to proceed to the draft RROE.
- The NSW EPA are currently drafting the Resource Recovery Order and Exemption (RROE) for review.

C35033 Non-invasive and Real Time Monitoring of Slurry Tailings Density and Velocity in the Transmission Pipeline using Electrical Resistance Tomography Method

Organisation: University of Queensland
Project Leader: David Williams
Value: \$259,000
Report Expected: September 2026
Industry Monitors: Peter Shumack
ACARP Contact: Patrick Tyrrell

The objectives of the project are to:

- Develop a resistivity inverse model that converts the longitudinal and cross-sectional resistivity tomography of coal slurry to its density and velocity, accounting for the effects of temperature, EC, air content and coal tailings mineralogy;
- Test the system at a coal transmission pipeline for in situ and real-time monitoring of the slurry transport conditions; and to
- Verify the monitored results with those obtained using concurrent technologies.

During the quarter further analysis was carried out on Kynch model parameter estimation and interface prediction for the coal tailings settling tests. Each batch settling test lasted for more than 200 h. In the early stage of settling, the measured interface showed a nonlinear drop, which may be related to channel formation, residual internal flows and other start-up effects. Based on the relevant literature, the raw interface data were first corrected for early-stage effects. The 0–20 h data were then selected as a conservative hindered-settling calibration window for Kynch model calibration.

For this stage of the work, a systematic parameter-space scan was carried out for the Richardson–Zaki-type Kynch solids flux function. The scanned parameters were v_{∞} , n and $\phi_{\max}$. Interface-height RMSE, numerical convergence, and mass conservation were checked during the scan. Parameter combinations that did not meet these checks were excluded from further assessment.

The scanning result is shown in Figure 1. The low-RMSE solutions did not collapse into a single best-fit point. Instead, they formed a continuous low-error valley in the three-dimensional parameter space. This shows that the interface curve alone cannot uniquely determine one set of Kynch flux parameters. Different combinations of v_{∞} , n and $\phi_{\max}$ can compensate for each other and produce similar interface responses.

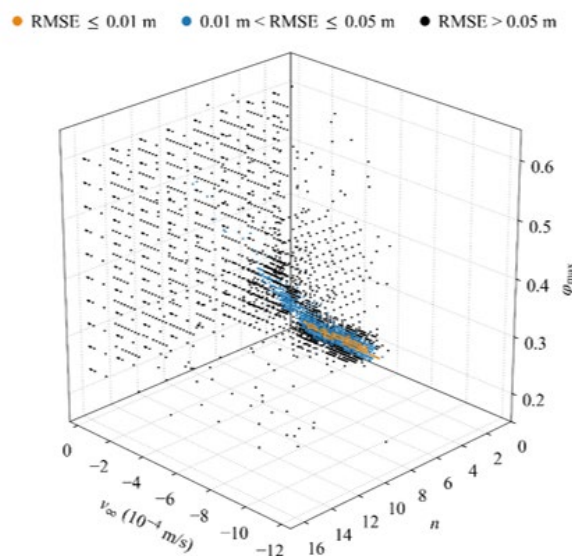


Figure 1 Three-dimensional parameter-space scan for a representative coal tailing settling test.

To check the interface prediction performance of this parameter family, 30 representative parameter sets were selected along the main compensation direction of the parameter valley. The model was then run to 80 h using these parameter sets. Figure 2 compares the retained model-family predictions with the measured interface data. During the 0–20 h calibration period, the model-family predictions generally matched the measured interface, and the median RMSE in each available 5 h interval remained below 0.01 m. Although the parameter values were different, these parameter sets produced similar early-stage interface predictions. This further confirms the non-unique nature of interface-based Kynch model inversion.

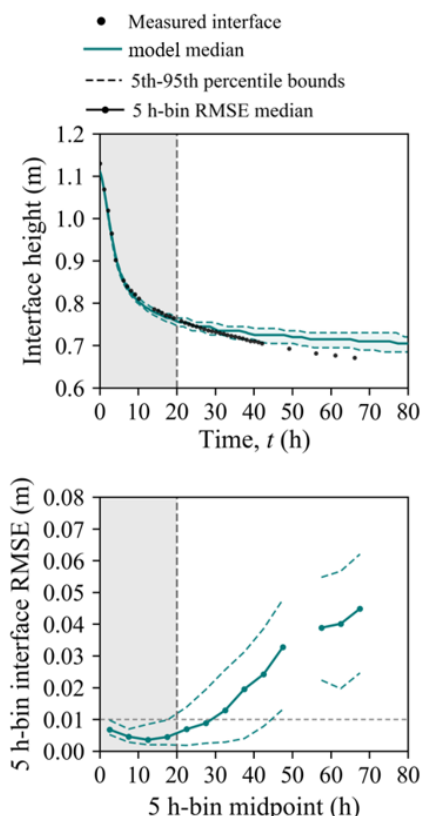


Figure 2 Interface prediction and error assessment using the retained Kynch model family.

Overall, the work in this reporting period moved the Kynch analysis from single best-fit parameter selection to parameter-family identification. This provides a stronger basis for the next stage of work, where ERT-based internal concentration measurements will be used to check whether the interface-derived Kynch model family is also consistent with concentration changes inside the settling column.

C35048 Cost Effective Rehabilitation of Tailings Dams

Organisation: CSER Research
Project Leader: Mike Cole
Value: \$973,580
Report Expected: March 2027
Industry Monitors: Andrew Lau
 Brooke York
 Pearl Garrett
 Shaun Booth
ACARP Contact: Patrick Tyrrell

This research program incorporates the work undertaken in projects C27009, C29041, C34030 and thus far in C35048 towards developing cost-effective rehabilitation and closure of tailings dams. It aims to assist in developing mine-specific final land use plans, and further test tailings amelioration techniques to maximise success for the native vegetation used. In addition, it will work towards maximising plant and soil biodiversity of the dams and their surrounds.

This quarter has seen significant progress in establishing research activities at our new field site whilst identifying and responding to several site-specific challenges that will influence future research efforts and direction.

Field activities commenced with the establishment of two key experiments. A pot size experiment using *Melaleuca quinquenervia* was implemented to further evaluate the relationship between plant size, establishment success, and production costs. In addition, a species transects experiment extending from the dam edge to the waterline was established to investigate how varying tailings conditions (ecotones) influence the survival and performance of four native species. Baseline measurements, including plant height, stem diameter, and surface strength, were collected to support future monitoring.

As new site water levels declined during April, widespread surface salt accumulation became evident. Subsequent laboratory analysis confirmed water salinity (~ 4.3%), exceeding typical seawater, while investigations of the tailings profile demonstrated that salinity was concentrated within the surface layer. These findings identified elevated surface salinity as a major constraint to successful plant establishment on site.

Project efforts subsequently focused on characterising the extent of the salinity issue and refining future experimental direction. Further water and tailings

sampling were assayed to better understand the chemical and physical conditions of the site, while the implications for plant survival and rehabilitation methods were assessed. The findings indicate that successful revegetation will require either modified planting techniques capable of overcoming the saline surface conditions or additional remediation measures before large-scale planting can proceed.

During June, project activities centred on planning and preparation. Several planned field and plant growth facility experiments were refined and are now ready to commence as seasonal conditions improve. These experiments will investigate more precisely the mechanisms by which elevated salinity affects plant survival and evaluate planting methods designed to improve establishment under saline conditions.

Preparation of the project final report also became an increasingly significant focus during the quarter.

Fine Coal

C34002 Full Scale Beneficiation of Coal Fines by Novel Agglomeration

Organisation: University of Newcastle
Project Leader: Kevin Galvin
Value: \$4,624,256
Report Expected: January 2027
Industry Monitors: Ben Gill
 Chris Jackson
 Jack Lauder
 Jason Schumacher
 Jenny Goh
 Luke Dimech
 Paul Sainsbury
 PeiPei Wang
ACARP Contact: Patrick Tyrrell

The objective of this project is to investigate the scale-up of a novel fine coal agglomeration technology through a study at full-scale. The project involves the design, commissioning and operation of the novel agglomeration technology. The feed source is expected to be a fine coal tailings stream suitable for the thermal market. The study will quantify the scale-up at up to 500m³/h in terms of yield, ash, moisture and economic benefits. The novel agglomeration technology offers the prospects of a low capital investment for processing the fine coal tailings stream normally sent to the thickener.

This project involved a substantial scale-up from a 25mm diameter pipe configuration to a 350mm diameter pipe system requiring the flow of the slurry and binder through a single hole in an orifice plate to produce agglomerates. The early results suggested that the system does not scale directly, and that the collision efficiency with the emulsion binder is impacted negatively. Additional funding was secured to develop further understanding of the scale-up of the technology.

The current standard pipe configuration, with a diameter of 350mm, was replaced by a new design standard based on a 100mm diameter pipe configuration. The oil dose was significantly lower than that achieved in the larger scale study. The work strongly indicates the potential for separation at an even lower oil dose.

It was then agreed the work should be extended to a final phase by inserting a pipe-bundle arrangement within the main 350mm pipe configuration. This approach would then allow the single pipe performance to be scaled to a multi-pipe arrangement to support higher flow rates. The installation of the agglomeration facility was finally completed through the previous quarter. Changes to the piping led to higher pressure drops, which then reduced the feed supply rate to around 200m³/h. These changes were introduced to reduce the risks associated with supporting the elevated pipe with scaffolding. Instead, the feed was piped to ground level and then elevated back to the supply tank. The agglomeration facility incorporating the new pipe bundle arrangement was commissioned following its installation, allowing the experimental campaign to be undertaken.

The goal was to establish a stable and scalable operating window for multi-pipe agglomeration. The work focused on changes in the orifice plate hole size, feed rate and pipe velocity, pressure drop across the orifice plates, and binder dosage. This work was successful in reproducing the single 100mm diameter pipe agglomeration from the previous phase of work and was also successful in supporting the agglomeration through two parallel pipes. Poor performance was then observed in moving to a third pipe, attributed to poor distribution of the emulsion binder. The emulsion binder was then introduced prior to the pump to improve its distribution. The agglomeration performance improved significantly and was found to be robust. Product ashes ranged between 9.9 and 11.7%, with combustible recoveries between 82.3 and 92.8%.

Clear conclusions were formed on the essential requirements for achieving scalable and robust performance of the agglomeration, distribution of the emulsion binder with the feed slurry through the pump, utilisation of a pipe bundle formed from 100 mm diameter pipes, and a nominal multi-hole orifice plate with typical hole size of 12mm.

The project is currently proceeding towards completion.

C34040 Optimising the Diesel Droplet Size in Coal Preparation Plants

Organisation: University of Queensland
Project Leader: Yongjun Peng
Value: \$231,157
Industry Monitors: Chris Denyer
 Han Hooi
 Jason Schumacher
ACARP Contact: Ben Gill

The draft report is with the industry monitors for review.

C36026 Side-by-Side Analysis of Coal by Automated Micro-CT and Commercial Laboratory Testing

Organisation: University of Newcastle
Project Leader: Rohan Stanger
Value: \$167,432
Industry Monitors: Mel Robbins
 Michael Saxby
 Tom Wilson
ACARP Contact: Ben Gill

The draft report is with the industry monitors for review.

C36029 Testing a Novel Flotation Concept for Coal

Organisation: CSIRO
Project Leader: Nerrida Scott
Value: \$88,204
Report Expected: September 2026
Industry Monitors: Frank Mercuri
 Jenny Goh
 Michael Saxby
ACARP Contact: Ben Gill

This project involved the testing of a new prototype flotation rig as a proof of concept. So far, a number of samples have been trialed and early indications are that the samples tested are floating inertinites and some coarse coal fractions, with acceptable ash quality for a concentrate stream. A two-stage flotation was also tested using a Jameson cell as the first stage with the novel flotation rig processing the J-cell rejects. A faulty dosing pump resulted in low first stage yields with product coal reporting to the first stage flotation tailings, however the prototype flotation rig was able to pick up a considerable amount of this lost tailings as a scavenger cell.

Denver Flotation tests were used to provide a direct comparison with the novel flotation device with CSIRO's Coal Grain Analysis techniques used to assess the maceral components in the product and reject streams. We now have sufficient data from the test work and a draft report is currently being compiled.

C37016 Industrial Particle Sampling Systems for the Particle Profiler in Fine and Ultra-Fine Circuits

Organisation: University of Newcastle
Project Leader: Rohan Stanger
Value: \$178,404
Report Expected: December 2026
Industry Monitors: Chris Denyer
 Jenny Goh
 Michael Saxby
ACARP Contact: Ben Gill

This project is based on developing two sampling systems for the Particle Profiler analyser to suit two different coal circuits. The intention is to conduct industrial trials and a coal preparation plant.

In the quarter, the Particle Profiler system has been completed and is undergoing laboratory testing (Figure 1 and 2). A slurry test circuit has been constructed to cycle slurry from a 200 L drum, through a 20m hose and back. This allows the Profiler system to take controlled sub-samples whilst keeping the slurry in suspension (and topped up with water). The beta-testing to date has been centred on optimising the sampling sequence with the new pump.

In the next quarter, we will aim to demonstrate the unit in the laboratory with coal slurry samples; then install the unit at a coal preparation plant in the Hunter Valley.



Figure 1. Particle Profiler proto-type unit mounted on frame (left) and slurry cycling equipment (right).

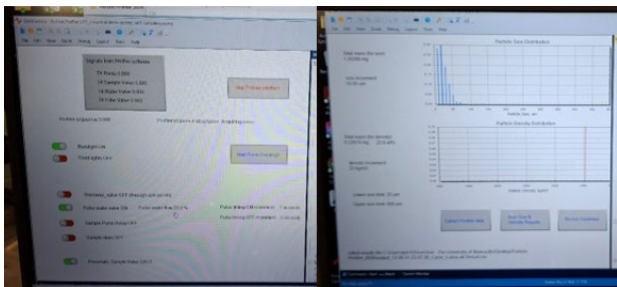


Figure 2. Particle Profiler control software showing sequenced actuator control (left) and analysis screen (right).

C38023 Handling Effectively with Swelling Clays to Reduce the Ash Content of Coal Flotation Concentrates

Organisation: University of Queensland
Project Leader: Ngoc Nguyen
Value: \$295,586
Report Expected: March 2028
Industry Monitors: Chris Denyer
 David Hensley
 Tom Loweke
ACARP Contact: Ben Gill

This project aims to reduce ash content in coal flotation concentrates by targeting swelling clays using magnesium-based clay depressants. We investigate effective chemical reagents (known as clay suppressants) to reduce the ash content of fine coal flotation concentrate.

Specific objectives include:

- Characterise clay types and compositions in coal flotation feed;
- Identify and test clay suppressants to remove clay slime coatings and/or clay entrainment; and
- Design and conduct experiments using mechanical cell, Microcel, and Jameson cell for evaluating and benchmarking the effectiveness of chemical reagents on ash removals.

The ultimate goal is to deliver higher-quality products and opportunities to increase overall plant recovery by avoiding high ash/clay entrainment.

In the quarter, the research team has proactively liaised with the industry monitors and managed to obtain samples from the first site for the planned experiments. Following the receipt of samples, the research team has liaised with the central laboratory at the University of Queensland for clay mineral analysis, researched and purchased clay depressants (reagents), and classified the received site samples for flotation tests. This preparatory work will ensure comprehensive experimental investigations to be conducted in the next quarter.

C38024 Mitigating Fine Ash Entrainment in Coal Flotation Through Innovative Lamella Plate Integration

Organisation: University of Queensland
Project Leader: Yongjun Peng
Value: \$152,024
Report Expected: June 2027
Industry Monitors: Frank Mercuri
 Luke Dimech
ACARP Contact: Ben Gill

The objectives of this project are to:

- Adapt and test lamella plate structures in pilot-scale flotation systems to reduce fine ash entrainment while maintaining combustible recovery;
- Develop and validate computational fluid dynamics models to understand the effects of lamella plate

geometry on flotation hydrodynamics and optimise plate length, spacing and inclination;

- Apply CFD-AI optimisation framework to accelerate the evaluation and optimisation of lamella plate designs using experimental and CFD-generated data;
- Develop scalable design and operational guidelines to support the future implementation of lamella plate technology in full-scale coal flotation systems.

During this quarter representative flotation feed samples were collected and delivered to the university, where initial sample characterisation, including ash analysis, has been completed. Based on the sample characteristics and site operating conditions, the baseline flotation test program and reagent scheme have been established.

To ensure that the pilot-scale test program is representative of current industrial practice, a technical review was undertaken with a leading flotation equipment supplier recommended by the industry monitors. The review identified an opportunity to upgrade a key component of the existing UQ pilot-scale flotation system to better replicate the latest industrial equipment configuration. The upgrade is currently underway and will provide a robust platform for both the baseline flotation tests and the subsequent evaluation of the lamella plate technology.

In parallel, the initial lamella plate design has been developed based on previous laboratory-scale research. A prototype has been fabricated using 3D printing and is currently being refined to optimise component fit, assembly and installation within the pilot-scale flotation cell. Following completion of the equipment upgrade, baseline flotation testing will commence, after which the pilot-scale performance of the lamella plate design will be systematically evaluated for its ability to reduce fine ash entrainment while maintaining combustible recovery.

Gravity Separation

C34048 Using Clay Stabilised Medium for the Separation of Small Coal in a Dense Medium Cyclone

Organisation: CSIRO
Project Leader: Andrew Taylor
Value: \$204,432
Report Expected: September 2026
Industry Monitors: Chris Denyer
 Frank Mercuri
ACARP Contact: Ben Gill

This project involved establishing a comparison between small coal run through a DMC, spiral and a hydro cyclone for the same coal type. Care was taken to ensure that the relative % non-magnetics in the sample was held consistent in the samples. The objective was to demonstrate to industry the option of processing small coal, (-2.0mm +0.1mm) in a Dense Medium Cyclone with good cut point control, magnetite recovery and

comparative efficiency when compared to spirals and hydro cyclone.

All test runs have been completed. The spiral run was redone due to a data glitch which prevented mass balancing on the first run. The second run was ok, however, we did encounter some problems with sample processing and with the spiral runs due to beaching in the spiral and as a result are expecting the spiral to have a degree of positive bias in results. Manual removal of non-magnetics was also a more time-consuming process than expected.

The draft final report is being prepared.

C36024 DMC Efficiency Improvement Using an Applied Magnetic Field

Organisation: University of Queensland
Project Leader: Quentin Campbell
Value: \$344,872
Industry Monitors: Frank Mercuri
 Harry Lee-Jones
 Jenny Park
 Tom Loweke
ACARP Contact: Ben Gill

The draft report is with the industry monitors for review.

C36030 Measurement of DMC Wear using 3D Laser Technology

Organisation: CSIRO
Project Leader: Nerrida Scott
Value: \$175,422
Report Expected: September 2026
Industry Monitors: Dan Perkins
 Luke Winkelman
ACARP Contact: Ben Gill

This project aims to scan the internal dimensions of a dense medium cyclone over its wear life without the need for confined space entry. In the previous project, numerous scanners were trialled, proving the concept. Technology has moved forward from the original work, and new scanners have been sourced. The intention of this project is to measure the internal wear of DMCs in a real plant situation over the course of their entire service and to link this information to the DMC operational performance as measured by the plant. The combination of off-the-shelf laser technology with CSIRO software enhancements will be used to digitally map DMC internal wear in a plant situation. The researchers have engaged with a DMC supplier to support this work and a trip to their manufacturing facility occurred in early June to trial the scanner in a DMC. Modifications to the scanner have now been made and final testing in late February before mine site trials commence. A record of the measured wear of a DMC over the life of a cyclone will be mapped and linked to the performance of that DMC over time.

Use of this new instrument will remove the need to enter the confined space of the DMC to take measurements.

Scans have commenced at the selected Queensland mine site, and they will continue over the coming months. A new DMC is set to be installed in the CHPP in August/September which will enable measurement of wear from new to be done in addition to the other scans done on new DMCs scanned at the DMC supplier that have now been sent out to a mine in the Hunter region.

The final report is being compiled concurrently.

C37008 Banana Screen Capacity and Efficiency

Organisation: CTE Coal
Project Leader: Chris Thornton
Value: \$299,160
Report Expected: November 2026
Industry Monitors: Dan Delahunty
 Jenny Park
ACARP Contact: Ben Gill

This stage of this project builds on previous research showing that particle residence time—not bed depth—is the key factor affecting drainage efficiency in banana screens. Current screen designs focus on bed depth, which has minimal impact, leading to suboptimal performance. The study proposes reducing screen frequency and installing weirs in the drain section to slow particle velocity and improve drainage. Trials will be conducted at various sites using dual-module plants to compare modified and unmodified screens side by side. The staged trial will optimise screen stroke, frequency, cross dams, and spray water, aiming to define accurate operating windows and improve moisture control. Unlike the full proposal, this version retains existing screen apertures and focuses solely on cross dam installation. If successful, the findings could lead to industry wide improvements in screen efficiency across varied coal types and plant configurations.

Site testing has occurred on all three sites with optimisations being applied at all of them. Results have begun to be analysed with good correlation between the pilot scale and practice. A final round of testing needs to occur on two of the sites and then final analysis can occur and a final report issued.

General

C37017 Improved Measurement of Coal Bulk Density

Organisation: University of Newcastle
Project Leader: Aleksej Lavrinec
Value: \$90,377
Report Expected: September 2026
Industry Monitors: Mel Robbins
 Tom Buckby
 Tom Wilson
ACARP Contact: Ben Gill

The aim of the project is to improve the accuracy of the test method used in determining the loosely poured bulk density of Australian full-size coal. The objectives are as follows:

- Quantify and compare loosely poured bulk density measurements for coal samples using multiple container sizes and methodologies;
- Establish a repeatable and standardised experimental procedure consistent with relevant Australian and international standards;
- Prepare coal samples in a representative manner to minimise segregation, degradation, and handling bias; and
- Generate reliable bulk density data to support downstream handling, processing, and modelling activities.

Work undertaken during the quarter:

- The fourth coal sample has been received and stored awaiting preparation; and
- The testing of two coals is fully complete with the third sample being 60% complete.

TECHNICAL MARKET SUPPORT

Reports Published This Quarter

C36031 Structural Optimisation and Reactivity Evaluation of Ferro-Coke Produced using Australian Coals

The University of Newcastle

Arash Tahmasebi

Link to download the final report:

<https://www.acarp.com.au/abstracts.aspx?repId=C36031>

Maritime Regulation

C38032 Streamlining Moisture Management Procedure Submissions: An Industry Led Approach

Organisation: Goodwin Port Solutions

Project Leader: Ash Goodwin

Value: \$73,800

Report Expected: September 2026

Industry Monitors: Graeme Harris

Jane Lawson

Jeremy Byrnes

Jonas Good

ACARP Contact: Patrick Tyrrell

This project aims to streamline the development and approval of Moisture Management Procedures (MMPs) for coal export terminals, by developing a standardised MMP template informed by current industry practice.

During the quarter, the project progressed consultations with coal producers to gather input on MMP preparation and approval experience. Discussions covered changes made in recent MMP iterations and the reasons behind them, challenges encountered during preparation and approval, areas where additional guidance would be valuable, and de-identified examples of moisture management issues encountered in practice. Producers have also shared current MMP documentation on a confidential basis to help inform the standardised template.

Engagement with producers is ongoing, with further consultation meetings being arranged.

In the next quarter, the project will complete the remaining producer consultations and begin drafting the updated MMP template incorporating the findings gathered to date.

Metallurgical Coal

C35040 Changes in Combustibility of Coal when Co-Combusted with Hydrogen Rich Fuels in PCI

Organisation: University of Newcastle

Project Leader: Liza Elliott

Value: \$218,367

Industry Monitors: Cameron Tasker

James Bottle

Oliver Scholes

ACARP Contact: Ashley Conroy

The draft report is with the industry monitors for review.

C35042 Physical and Chemical Interactions Between Charcoal and Coal During Coking

Organisation: University of Queensland

Project Leader: Karen Steel

Value: \$135,694

Industry Monitors: Graeme Harris

ACARP Contact: Ashley Conroy

The draft report is with the industry monitors for review.

C35044 What We Now Know about Coking Coals and Coke

Organisation: CSIRO

Project Leader: Lauren Williamson

Value: \$96,284

Industry Monitors: Graeme Harris

Jonas Good

ACARP Contact: Ashley Conroy

The draft report is with the industry monitors for review.

C36032 Impact of Biomass on Coke Microstructure Evolution and Gas Diffusion During CO₂ Gasification

Organisation: University of Newcastle

Project Leader: Arash Tahmasebi

Value: \$169,000

Industry Monitors: Graeme Harris

Sean Flanagan

Shaun Booth

ACARP Contact: Ashley Conroy

The draft report is with the industry monitors for review.

C36035 Microstructure Characterisation and Simulation of Bio-additives in Coke

Organisation: University of Newcastle

Project Leader: Edward Bissaker

Value: \$114,200

Industry Monitors: Graeme Harris

Sean Flanagan

Shaun Booth

ACARP Contact: Ashley Conroy

The draft report is with the industry monitors for review.

C36036 Biochar-Coke Integration for Improved Coke Strength and Performance

Organisation: University of New South Wales
Project Leader: Pramod Koshy
Value: \$244,400
Report Expected: November 2026
Industry Monitors: Graeme Harris
 Sean Flanagan
 Shaun Booth
ACARP Contact: Ashley Conroy

This project is focussed on analysing the impact of higher biochar addition levels and coal type on the quality of the resultant cokes for ironmaking. This project is part of a set of concurrent projects investigating different aspects related to the addition of biochar to coals.

The aims of the project are as follows:

- Understand the impact of biomass addition (5-20 wt%, possibly 25-30 wt%) to coals (with varying vitrinite contents) on the resultant macrostructural, microstructural, and microtextural features of the cokes;
- Analyse the physical, microstructural, and interfacial features of the biochar-coal components in blended cokes through fractography and microtextural analysis after mechanical testing, and
- develop associations between biomass addition levels with coal type and coke performance under potential blast furnace conditions using standard coke quality indicators.

The production of the following blends has been delayed owing to issues in obtaining sufficient volumes of biochar (torrefied) from ALS:

- Coal C1 + 10 wt% biomass (-0.125 mm)
- Coal C1 + 15 wt% biomass (-0.125 mm)
- Coal C2 + 10 wt% biomass (-0.125 mm)
- Coal C2 + 15 wt% biomass (-0.125 mm)

Work on fabrication is believed to occur over the next quarter.

C36037 Exploring the Effects of Bio-char and Torrefied Biomass Addition on the Microtexture of Bio-coke

Organisation: Royal Melbourne Institute of Technology
Project Leader: Soonho Lee
Value: \$155,000
Report Expected: October 2026
Industry Monitors: Graeme Harris
 Sean Flanagan
 Shaun Booth
ACARP Contact: Ashley Conroy

This project investigates the microtextural interactions between biochar (produced at 800°C) and torrefied biomass (produced at 350°C) with coal macerals in bio-

coke, using anisotropy quotient (AQ) mapping and bireflectance analysis to characterise reaction zones at particle interfaces.

Bio-cokes prepared from a torrefied bamboo and acacia blend with a premium mid-rank coal (Rvmax 1.18%, vitrinite 58%), using a 400 kg coke oven, were sent to an external laboratory for AQ mapping. Torrefied acacia and bamboo particles and their interfaces with Reactive Maceral Derived Components (RMDC) were identified across five regions per CSR lump, with a boundary thickness of approximately 30 µm selected based on where the microtexture stabilises.

Interface analysis is ongoing. Once complete, results for the premium coal blended with biomass char and torrefied biomass will be compared, with particular focus on IMDC–RMDC and biochar/torrefied biomass–RMDC interactions in bio-cokes, referenced against IMDC–RMDC in the base coke.

Preparation of a further set of bio-cokes is also under way, combining a second mid-rank premium coal (Rvmax 1.25%, vitrinite 84%) with bamboo char, torrefied bamboo, hardwood char and torrefied hardwood. These CSR lumps will be sent for AQ mapping next quarter, with microtexture boundary analysis then compared against the lower-vitrinite coal set to assess the impact of coal properties on bio-coke quality.

C36039 Alternative Thermal Processing of Coal Pilot Extruded Coke and Supercapacitor Demonstration

Organisation: University of Newcastle
Project Leader: Rohan Stanger
Value: \$157,178
Industry Monitors: Graeme Harris
 Peter Austin
 Sean Flanagan
 Shaun Booth
ACARP Contact: Ashley Conroy

The draft report is with the industry monitors for review.

C36041 Quantifying Biochar Interactions with Coal for Coke Making

Organisation: CSIRO
Project Leader: Lauren Williamson
Value: \$141,683
Report Expected: December 2026
Industry Monitors: Graeme Harris
 Sean Flanagan
 Shaun Booth
ACARP Contact: Ashley Conroy

The objectives of this project are to:

- Prepare cokes for consistent analysis of different aspects of biomass addition (including coke standard coke quality determinations) for use across a suite of biomass related projects commencing in 2024 and

retain material for future projects in the ACARP Coal Bank; and to

- Quantifying the relationship between biomass char surface area, size distribution and their impact on coke properties.

A total of eight cokes for three projects (C30036, C36037 and C36041) will be prepared in early August 2026 following the delivery of all remaining biomasses (torrefied and char). Following that the draft report will be prepared for submission to the monitors in Q4 2026.

C37018 Mechanism of Biocoke Formation in Stamp Charged Cokemaking

Organisation: University of Newcastle
Project Leader: Arash Tahmasebi
Value: \$170,200
Report Expected: April 2027
Industry Monitors: Jane Lawson
 Stephen Brant
ACARP Contact: Ashley Conroy

The objectives of this project are to:

- Evaluate the influence of torrefied biomass and biochar addition on plastic layer dilatation and permeability and the development of internal gas pressure under stamped charged coking conditions using test facilities at UoN;
- Prepare coke samples in the 8kg coke oven at UoN to investigate the impact of biomass addition on the quality (CRI/CSR) of top-charged and stamped cokes;
- Explore the carrying capacity of Australian premium and weakly coking coals in blends with biomass at elevated charge densities;
- Analyse the changes in the microstructure of stamped cokes in the presence of biomass-derived components using the micro-CT image analysis technique and draw correlations with biocoke quality indices;
- Investigate the influence of higher caking density on bonding quality at the biomass/RMDC interface; and to
- Evaluate the impact of biomass addition and charge density on the development of anisotropy in coke microtexture and carbon matrix.

Progress in the quarter:

- Dilatation testing and IGP testing in the 4kg coke oven test facilities at UoN for completed for all single coals and biomass blends;
- Preparation of biocokes in the 8kg oven and subsequent CSR/CRI testing were completed; and
- Progress was made in the 3D micro-CT image analysis of plastic layer and final coke samples.

Work in the next quarter will involve preparing polished blocks for Pearson microtexture analysis and microscopy testing of biocoke lumps.

C37019 Reactivity of Coke RMDC, IMDC and Biochar with H₂O Under Hydrogen Reduction Blast Furnace Conditions

Organisation: University of Newcastle
Project Leader: Arash Tahmasebi
Value: \$169,900
Report Expected: January 2027
Industry Monitors: Lauren North
 Stephen Brant
ACARP Contact: Ashley Conroy

The main objectives of this project are to:

- Examine the factors that influence the relative reactivity of the RMDC, IMDC and biochar components of coke and biocoke under gasification with CO₂ and with H₂O. This will include linking results to the degree of anisotropy within microtextural constituents and the Brunauer–Emmett–Teller (BET) specific surface area of these components.
- Measure the kinetics of the reaction of the individual coke and biocoke microtextural constituents with CO₂ and with H₂O at the CSR test temperature of 1100°C using thermogravimetric analysis (TGA). The additivity of any effects, as well as the effects when the RMDC, IMDC and biochar are isolated from each other, will be examined.
- Compare lump reactivity with the intrinsic reactivity of the RMDC, IMDC and biochar in CO₂ and H₂O reaction environments.
- Examine the role of accessible porosity at the surface of individual IMDC and biochar components on coke and biocoke reactivity and identify differences as a function of the reactive gas atmosphere.

In the quarter three head coals and a bamboo biochar sample were selected for this project. Maceral concentrates were prepared at UQ. In the last quarter, small-scale carbonisation of maceral group concentrates from each coal was carried out – both individually and as 50:50 blends of the vitrinite concentrate with either the inertinite concentrate or biochar. Coking of the head coals was also carried out.

Gasification tests were conducted on the carbonised samples in a TGA at 1100°C – in either H₂O or CO₂. Clear differences in the reaction kinetics as a function of gas atmosphere were observed. Moreover, differences in reactivity were observed between samples as a function of the properties of the parent coals, with coal rank showing a dominant influence for the lump samples.

Next quarter, preparation of coke samples for microtextural analysis and Brunauer–Emmett–Teller specific surface area analysis will be carried out. Whole coal reflectograms will be undertaken to assess whether different distributions exist across the selected coals and thereby determine whether these can help explain the rank dependence of the gasification reactivity for cokes produced from single maceral groups, i.e. either the vitrinite group concentrate or inertinite group concentrate.

C37022 Fate of Bio-alkalis During the Carbonisation of Coal and Biomass Blends

Organisation: University of Newcastle
Project Leader: Salman Khoshk Rish
Value: \$95,740
Report Expected: January 2027
Industry Monitors: Graeme Harris
 Jonas Good
ACARP Contact: Ashley Conroy

Partial substitution of coking coal with renewable biomass has been identified as a potential method to lower emissions in BF ironmaking. However, woody and grass biomass resources contain a high concentration of alkali and alkaline earth metals (AAEMs) which negatively impact the reactivity and structural strength of coke within the blast furnace. Since there are stringent limitations on AAEM content in biocoke intended for use in blast furnaces, it is essential to develop a comprehensive understanding of the true nature of biocoke's inorganic matter by characterising all aspects of biocoke minerals and understanding the retention of these harmful elements within the biocoke.

Project objectives include:

- Evaluate the volatility and retention behaviour of bio-AAEM species in coal blends during the cokemaking process up to 1000°C;
- Explore potential variations in behaviour of different AAEM species;
- Evaluate the impact of parent coal properties and biomass on the retention of AAEMs in bio-coke;
- Explore the potential role of volatile matter in coal on driving off the volatile AAEM during cokemaking at high temperature; and
- Investigate the potential interactions between bio-AAEM species and the mineral matter in coal.

Work continued using the three selected Australian coking coals (175, 006 and 032) and the bamboo char received in Q1 2026. Coke-making in the 8kg dual-heated oven is complete for the three base coals and the three 10 wt.% bamboo char blends, six of the fifteen planned blends. Interrupted carbonisation tests from 500 to 1000°C in 100 °C increments are complete for the same six blends, 36 of 90 planned runs. Low-temperature ashing, XRF and XRD have been completed on this sample set, and interpretation is underway, focused on potassium retention relative to the base coals and the temperature range over which volatilisation occurs.

Sample supply remains the principal schedule constraint. At the May review meeting, torrefied bamboo and sorghum char were agreed as the third and fourth biomasses following availability issues with the originally proposed species. Hardwood char arrived on 23 July and interrupted tests have commenced. Torrefied bamboo and sorghum char remain outstanding; each will follow the same blending, coking, ashing and XRF/XRD analysis. TIMA analysis will follow once a representative sample set is available.

C37025 Mechanism of Reactivity and Microstructure Evolution of Stamp Charged Cokes During Reaction with CO₂

Organisation: University of Newcastle
Project Leader: Arash Tahmasebi
Value: \$169,825
Report Expected: April 2027
Industry Monitors: Graeme Harris
 Lauren North
ACARP Contact: Ashley Conroy

The objectives of this project are to:

- Investigate the gasification behaviour of stamp charged coke made from Australian coking coals;
- Investigate the impact of increased anisotropy of stamped cokes on its reaction rate with CO₂;
- Study the impact of lower density in stamped cokes on gas diffusivity into the microstructure;
- Evaluate the evolution of coke microstructure during gasification with CO₂, benchmarked against gravity charged coke;
- Analyse the susceptibility of IMDC/RMDC in top charged and stamp charged cokes to reaction with CO₂ by exploring changes with the progression of coke gasification;
- Investigate the mechanism of stamp charge coke gasification with CO₂, i.e., the balance between local carbon reactivity vs. gas diffusion;
- Determine carbon reactivity and gas diffusion in stamped cokes using a developed reaction-diffusion model;
- Quantify the impact of lower charge density on the reaction mechanism.

Progress in the quarter:

- Two sets of matched top-charged and stamped coke samples were sourced from ACARP coal bank for the project;
- Coring of the coke lumps, including a repeat sample, was completed;
- Unreacted coke samples prior to TGA gasification tests were imaged at the micro-CT lab at ANU;
- Cored samples were returned to UoN, where TGA gasification tests to 30% mass loss are currently underway.

Next quarter will involve completion of the TGA tests, the second stage of CT imaging, and image registration to calculate radial mass loss profiles and determine the mechanism of local mass loss. The generated results will be used for the reaction-diffusion kinetics modelling in the second part of the project.

C37026 Coal and Biomass Properties Affecting Cokemaking for Coal-Biomass Blends

Organisation: University of Queensland
Project Leader: Karen Steel
Value: \$127,047
Report Expected: January 2027
Industry Monitors: Geoff O'Meley
 Stephen Brant
ACARP Contact: Ashley Conroy

This project builds on project C35042 in which we identified key reasons why fluidity is reduced when charcoal is blended with coal for cokemaking; namely oxygen content and mesoporosity. We also found that the extent that mesopores form was different for different biomass materials and depended on the pyrolysis conditions; this project aims to elucidate the factors affecting mesopore formation by examining different biomass types and varying the pyrolysis conditions. In addition, project C35042 found that the extent that fluidity reduced also depended on the coal type such that for the same charcoal, fluidity was preserved for one coal but destroyed for another; this project also aims to identify the coal properties responsible for this. Finally, this project examines the effect of charcoal on coke reactivity (CSR), examining whether some combinations of coal and charcoal have higher or lower CSR and the extent that mesopores in charcoal influence CSR.

During this quarter we prepared a manuscript containing results for the char production and characterisation work which has received support from industry monitors for publication. Further char production work has been carried out on cotton (cellulose-rich) and we plan to study lignin-rich materials to compare the behaviour of cellulose and lignin with regards to density and porosity development. We have completed the char-coal blending testing work and are focusing now on completing the wetting and ¹³C NMR work.

In the next quarter we plan to identify the blend combinations suitable for the reactivity work and to start that work, which is the final task for the project.

C38027 Mechanisms of Fluidity Reduction During Coking of Coal-Biomass Blends: A Microtexture Analysis Approach

Organisation: Royal Melbourne
 Institute of Technology
Project Leader: Soonho Lee
Value: \$231,400
Report Expected: March 2028
Industry Monitors: Graeme Harris
 Jonas Good
 Stephen Brant
ACARP Contact: Ashley Conroy

This project investigates the mechanisms of fluidity reduction and microtexture evolution during the coking of coal-biomass blends, using anisotropy quotient (AQ) mapping to characterise interactions between carbonising coal macerals and biochar/torrefied biomass from the plastic layer through to bio-coke. Microtexture changes will be correlated with Gieseler fluidity measurements to assess the influence of coal rank, maceral content and biomass pre-processing method (charring versus torrefaction) on bio-coke quality.

During this quarter, two low-rank and one mid-rank coal samples (coal 1, coal 2 and coal 3) were sourced and selected, in consultation with project monitors, to represent a range of vitrinite content and fluidity characteristics. Bamboo char and torrefied bamboo biomass were prepared and, together with the selected coal samples, sent to the University of Newcastle with the support of QCAT CSIRO for plastic layer sampling using the 4 kg coke oven facility.

In the next quarter, basic property analysis of the coal samples will be conducted via ALS. Gieseler plastometer analysis will also be carried out on the single coals and their blends with bamboo char and torrefied bamboo to assess fluidity changes. Plastic layer samples will be prepared for each of the three coals individually (base case) and for their 10 wt.% blends with bamboo char and torrefied bamboo, using interrupted coking tests in the 4 kg coke oven. The plastic layer samples will include characteristic layered structures such as loose coal, plastic layer and coke/semi-coke. The resulting plastic layer samples will be resin-embedded, cross-sectioned and polished in preparation for AQ mapping and microtexture analysis.

C38028 Lateral Distribution of Coking Coal Across a Charge

Organisation: ACIRL
Project Leader: Callum Mainstone
Value: \$138,045
Report Expected: January 2028
Industry Monitors: Cameron Tasker
 Geoff O'Meley
 James Bottle
ACARP Contact: Ashley Conroy

This project seeks to trial the targeted placement of highly inert Rangal coal in the centre of a coke charge to diffuse coking pressure and lower stresses applied to coking ovens. ALS's pilot scale coking oven will be used to produce five charges containing varying proportions and positioning of a high swelling coal and inertinite-rich Rangal coal.

All coals have been sourced.

C38029 Optimising the Performance of Australian Semi-Soft Coking Coals

Organisation: ACIRL
Project Leader: Callum Mainstone
Value: \$121,525
Report Expected: December 2027
Industry Monitors: Graeme Harris
 Tori Hill
 Emily Eastman
 Oliver Scholes
 Jane Lawson
ACARP Contact: Ashley Conroy

This project will compare coke produced in a pilot scale oven at 850 kg/m³ and when stamped to a high density. Further process changes including grind size will seek to identify optimal coking conditions for two weakly coking Australian coals, one from the Hunter Valley and one from the Bowen Basin.

All coals have been sourced.

C38030 Mechanism of Microtexture Formation under Stamped Coking Conditions

Organisation: University of Newcastle
Project Leader: Arash Tahmasebi
Value: \$257,400
Report Expected: May 2028
Industry Monitors: Graeme Harris
 Jonas Good
 Stephen Brant
ACARP Contact: Ashley Conroy

The objectives of this project are to:

- Evaluate the mechanism of microtexture evolution during stamped coking using the plastic layer AQ mapping technique;

- Study impacts of coal measures (Moranbah and Rangal) and properties (rank and petrographic composition) on coke microtextural changes at elevated bulk densities;
- Link the change in microtexture anisotropy to thermoplasticity and IGP under stamped conditions;
- Investigate microtexture development in blends simulating commercial stamp-charged cokemaking operations;
- Explore potential interactions between blend components and impacts on microtexture transformation and carbon matrix of resultant coke; and to
- Analyse the carbon structure changes at high charge densities using Raman spectroscopy and link to carbon forms identified in microtexture evaluation.

Progress in the quarter:

- Eight coal samples ranging in rank and maceral composition were selected in consultation with industry monitors and three samples were received in June;
- Initial testing will involve the eight single coals with blend design to be decided based on initial test results;

Work in the next quarter will involve sourcing the remaining coal samples and preparation of plastic layer samples using the fast sampling apparatus in the 4kg oven at UoN, followed by preparation of polished samples for Pearson texture analysis.

C38031 Impact of H₂O Gasification on Coke Breakage Mechanisms and Size Distribution of Fines

Organisation: University of Newcastle
Project Leader: Hannah Lomas
Value: \$169,760
Report Expected: January 2028
Industry Monitors: Graeme Harris
 Stephen Brant
ACARP Contact: Ashley Conroy

The hydrogen enriched blast furnace (BF) is emerging as a viable alternate technology to reduce the carbon footprint of BF ironmaking, during which injected hydrogen reduces the ferrous burden, generating water vapour as a by-product. It is thus important to understand how coke degradation under such conditions differs in comparison with conventional ironmaking and thereby identify the impact of hydrogen enrichment on coke quality requirements.

This project will focus on the impact of the different reaction conditions on coke abrasion resistance and breakage behaviour during tumble drum testing.

Project objectives include:

- Evaluate the impact of reaction conditions on coke strength evolution during drum testing;

- Link results to the coke components that were degraded or damaged during testing and identify whether the extent of the damage was accentuated by the reaction conditions; and
- Develop correlations between conventional coke quality indices and mechanisms of coke degradation during drum testing following partial gasification in CO₂ or in H₂O.

Cokes will be pre-gasified at 1100°C to 20 wt.% and 40 wt.% mass loss. For each coke type and test condition, three lumps of a specific shape (to enable recognition) will be selected. After each set of 120 revolutions in a tumble drum, the selected lumps will be weighed and imaged using micro-CT, to determine their degradation characteristics over time. The fines will be sieved to measure their size distribution (from which the approximate IMDC:RMDC ratio can be inferred) and then added back to the drum for the next revolution.

The planning meeting for this project took place in February and three RCO cokes were selected and supplied for this project. The project is currently undergoing safety clearance with the UoN. Rohan Stanger has joined the project team to conduct the micro-CT scanning and assist with analysis and interpretation of the data.

C38033 Combustion Performance of Higher Swelling Coals under HELE (High Efficiency, Low Emissions) - Supercritical Conditions

Organisation: ACIRL
Project Leader: Tom Finn
Value: \$167,353
Report Expected: April 2028
Industry Monitors: Cameron Tasker
 Fiona McKenzie
 Graeme Harris
 Greg Wickman
 Jane Lawson
ACARP Contact: Ashley Conroy

Thermal coals may exhibit swelling behaviour, commonly quantified by CSN. Concerns exist from consumers as to the impacts of swelling on performance. However, there remains a question as to what extent this concern is based on operational risk, and mere perception. This project aims to generate real operational performance data and quantify the limits and effects of swelling on thermal coal performance.

Three higher swelling coals are in the process of being sourced:

1. Hunter valley high volatile (CSN 2-3)
2. Hunter valley high volatile (CSN 4-7)
3. Bowen basin high volatile (CSN 4-7)

The test program will examine milling behaviour, carbon burnout efficiency, gaseous and particulate emissions, ash deposition under pilot-scale supercritical High-

Efficiency, Low-Emissions (HELE) conditions. A post mill inspection will be conducted to observe any signs of caking which would suggest that mill performance might be impacted by swelling; while a post burn inspection of the burner will be conducted to observe any buildup caused by swelling. Where such evidence is found this will be collected and further analysed. The scope was revised to maximise the opportunity for any effects from swelling to be observed: a higher firing rate will be used to increase the heat radiating back to the burner, an extended burn time will allow more time for deposits to develop.

The findings from these three coals will help direct a fourth trial. This may investigate if limits can be overcome by blending; or a change in milled product size; or, if limits are not found for this swelling range, if there are limits for the highest swelling coals.

No experimental work was conducted during this period. The Industry Monitors have been invited to propose coals for this test program which is proposed to commence in October 2026.

Thermal Coal

C37023 Comparison of Ash Deposition of Coal and Biomass Blends in Laboratory, Pilot Scale and Industrial Scale

Organisation: University of Newcastle
Project Leader: Liza Elliott
Value: \$690,040
Report Expected: September 2028
Industry Monitors: Chris Urzaa
 Jane Lawson
ACARP Contact: Ashley Conroy

With increased public demand for regulation to limit the effects of climate change to 1.5°C, there is a strong demand to reduce net carbon emissions from the combustion of coal. One way this can be achieved is by replacing a proportion of coal with biomass. There are several issues associated with replacement of coal with biomass, but a strong theme of biomass use is the tendency for deposition. Due to the variety of compositions, it is difficult to predict deposition behaviour. Additionally, much of the work that is usually completed on deposition studies is completed at laboratory scale. It is unclear how these relate to industrial scale, and how the experimental setup impacts results.

This project will seek to examine the impact of biochar/biomass addition on ash deposition during the combustion of Australian thermal coals. The changes in deposition for Australian coal-biomass blends will be assessed at small scale and pilot scale and will be compared to industrial scale performance to show the impact of scale on test results.

The project is the basis of PhD studies for Tom Finn, who has started readings for a literature review.

All coal and biomass samples have been received. One coal sample and one biomass sample have been crushed to size. Milling of the biomass sample has been more difficult than expected with a large-scale mulcher required to reduce the particle size significantly before using a knife mill, crusher then raymond mill. To get the mulched material to -4mm for torrefaction a hammer mill was used. Trial mill runs of the second coal have been completed with the final milling to be completed soon.

Initial test feeds of the two biomass samples into the extruder for production of torrefied sample have occurred and full production of the torrefied sample of sorghum is underway.

The first pilot scale burn of the first coal has been completed and fouling probe and slagging panel samples have been collected and mounted in resin for later analysis.

General

C25053 Coal Sample Bank

Organisation: CSIRO
Project Leader: Aedita Crouch
Value: \$668,939
Report Expected: February 2028
Industry Monitors: Technical Market Support Committee
ACARP Contact: Ashley Conroy

The objective of this project is to operate the ACARP Sample Bank to make coal, coke and biomass samples available to researchers and to enhance the systematic provision of the samples for technical market support ACARP projects.

To date, 89 coal samples have been delivered, stored at -18°C and their details recorded in a database, there are also 39 cokes, seven biomasses and one fly ash stored. Of the coal samples stored coal quality data has been provided by coal producers for 79 of the samples.

In the most recent quarter, five coal samples and seven biomass samples were provided to projects. To date during 2026 34 samples (coal/coke/biomass) have been provided to projects.

C26003 Management of SA and ISO Coal Technical Committees Work Programs

Organisation: Carbon Connections Consulting
Project Leader: Barry Isherwood
Value: \$457,750
Report Expected: December 2026
Industry Monitors: Graeme Harris
 Jonas Good
ACARP Contact: Anne Mabardi

This project is a continuation of support for the management and input into Australian and ISO Coal Sampling, Coal Preparation and Analysis Standards.

The quarter has been relatively quiet, with SA Committee MN/1/1 convening a thrice yearly hybrid meeting in Brisbane, along with the annual MN/1 meeting. Most work centred on general housekeeping, discussion and review of ballots from both ISO and ASTM as well as discussing Chair transition handovers

Discussions were held with MCA regarding an industry request to update AS 3980 Determination of Gas Content in Coal Seams, to align with latest NGERS reporting and to address some inconsistencies in analysis techniques used by different laboratories. It has been reported that some laboratories choose not to follow the procedure set out in the Standard preferring to use their own in-house methods. Problem is that there are different schools of thought as to how the Standard could/should be changed. This is work in progress and it will not be easy to obtain consensus or to update the Standard.

Assistance and guidance was provided to John Kelly in his initial organisation of the next TC27 meeting, scheduled for July/August next year.

Advice was provided on accepting an offer from China for an all expenses paid trip for a number of ISO delegates (including from Australia) to attend a Standards seminar in China

C26037 Australian Participation in Development of ISO Methods for Sampling, Analysis and Coal Preparation and National Technical Committee Support

Organisation: Standards Australia
Project Leader: Ben Russell
Value: \$448,625
Report Expected: December 2026
Industry Monitors: Graeme Harris
 Jonas Good
ACARP Contact: Anne Mabardi

Since 2005 ACARP has supported Australian representation on key International Standard Organization (ISO) committees of relevance to coal exports and to the Standards Australia National Mirror Committee MN-001. This investment enables Australia to

influence and shape the international development of methods for sampling, analysis and coal preparation standards.

SA support for Australian Mirror Committee—Schedule of meetings.

MN-001 (Coal and Coke)—Mirror Committee for ISO/TC27

Chair: Barry Isherwood

Last meeting: 14 August 2025

Next meeting: 23 July 2026

MN-001-01 (Coal analysis) —Mirror Committee for ISO/TC27/SC3 and SC5

Chair: Barry Isherwood

Last meeting: 26 March 2026

Next meeting: 23 July 2026

Meeting objective: Review ISO/TC27/SC5 and SC3 documents including systematic reviews and finalise Australian mirror Committee position on ISO ballot (and comments).

MN-001-02 (Coal Preparation) —Mirror Committee for ISO/TC27/SC1 and SC4

Chair: Darren Mathewson

Last meeting: 14 April 2026

Next meeting: 19 November 2026

Meeting objective: Review of ISO/TC27/SC1 and SC4 documents including systematic reviews and finalise Australian Mirror Committee position on ISO ballot (and comments). Review update on national Standards and projects.

C33065 Digital Petrographic Atlas of Australian Coals - Maintaining the Knowledge

Organisation: University of Queensland

Project Leader: Joan Esterle

Value: \$197,537

Industry Monitors: Graeme Harris

Sean Flanagan

ACARP Contact: Ashley Conroy

The draft report is with the industry monitors for review.

MINE SITE GREENHOUSE GAS MITIGATION

Reports Published This Quarter

C35049 Optimisation of operational parameters of catalytic reactors for the oxidation of VAM

University of Technology Sydney

Michael Stockenhuber

Link to download the final report:

<https://www.acarp.com.au/abstracts.aspx?repId=C35049>

C36007 Assessment of Sensors and Airflow Modelling for their Suitability to Quantify Methane Emissions in Open Cut mines

Organisation: University of New South Wales

Project Leader: Simit Raval

Value: \$534,880

Report Expected: September 2026

Industry Monitors: Iain Hornshaw
Jim Sandford
John Grieves
Sandy Tickell

ACARP Contact: Patrick Tyrrell

The project aims to establish evidence based guidelines for the coal industry, covering the selection of sensors, strategies for data capture, and the influence of airflow modelling, leading to the utilisation of machine-learning-based mathematical models to estimate total methane emissions.

Over the past three months, outcome of the experimental observation drive was presented to the industry monitors. Current efforts are focused on compiling and writing the final outcomes, integrating all observational, experimental, and modelling analysis in form of scientific publications.

C36008 Low Cost Precious Metal Free Honeycomb Monolithic VAM Catalysts and their Catalytic Activity and Stability Under Water and Dust Bearing Conditions

Organisation: CSIRO

Project Leader: Yonggang Jin

Value: \$352,820

Report Expected: April 2027

Industry Monitors: Jim Sandford
Paul Wild
Russell Thomas
Victoria Longley

ACARP Contact: Patrick Tyrrell

The objective of this project is to develop low-cost honeycomb monolithic catalysts (HMCs) based on the high-performance precious-metal-free catalyst material newly developed by CSIRO in project C29069 and

evaluate HMCs' catalytic activity and stability with a simulated VAM stream containing water vapour and simulated ventilation air dust. Success of the proposed project is a stepping-stone to progressing the development of low-cost high-performance VAM catalysts for the structured catalytic VAM mitigator.

During this quarter, work focused on investigating the interactions between ventilation air (VA) dust and mitigator bed materials. Both VA dust samples, collected from mine ventilation fan ducts, and stone dust samples were sourced from the mines in Australia. Two types of ceramic bed media were evaluated, including the material used in the CSIRO pilot units and a commercial ceramic media provided by an RTO supplier. Thermogravimetric analysis-differential scanning calorimetry (TGA-DSC) was conducted to examine the thermal interactions between the ceramic media and VA dust. The measured weight loss and heat flow (endo/exothermic) profiles were used to assess the thermal stability of the materials and identify potential thermal reactions between the dust and ceramic media. X-ray diffraction (XRD) analysis was performed on both fresh and pos-test samples to investigate changes in the crystalline structure of ceramic media. To further evaluate the potential impact of stone dust on media performance, mixtures of stone dust and ceramic media was treated for up to 48 hours in a furnace, respectively at 700 and 1000°C, followed by XRD analysis. These studies aimed to identify any crystalline structure changes in the ceramic media and assess the potential for sintering and ceramic corrosion with calcium oxide generated from stone dust decomposition over 800-850°C. The laboratory catalytic reaction testing rig used for evaluating commercial-scale monolithic VAM catalysts was further modified to enable catalytic testing under simulated VAM conditions with coal dust injection. Detailed laboratory testing is currently underway to assess catalyst performance and durability under dust-laden VAM conditions.

C37014 Effect of Reactor Size and Operating Parameters on Intrinsic Safety of Catalytic Oxidation Systems for Mitigation of VAM Emissions

Organisation: University of Technology Sydney

Project Leader: Michael Stockenhuber

Value: \$952,512

Report Expected: September 2026

Industry Monitors: Helen McCarthy
Jim Sandford
Russell Thomas

ACARP Contact: Patrick Tyrrell

Underground mining operations use high-flow ventilation to dilute uncontrolled releases of methane below flammability limits. This leads to large volumes of diluted Ventilation Air Methane (VAM) leaving the mine shafts, which is difficult to mitigate. Due to the high global warming potential of methane, these fugitive emissions

account for approximately 2% of all anthropogenic greenhouse gas emissions; converting this methane to carbon dioxide significantly lowers its overall environmental impact. Thermal oxidisers are being tested at mine shafts to combust methane at elevated temperatures exceeding 750°C, however thermal oxidisers have difficulty maintaining self-sustained combustions with concentrations below 0.2%. Catalytic oxidation offers a suitable alternative to conventional thermal options, which demonstrates high catalytic activity over a wide range of methane concentrations, as low as 0.1%, while providing a smaller footprint, lower operating temperatures and reduced energy requirements, while maintaining a low system pressure drop. Catalytic oxidation relies on surface-initiated oxidation of methane rather than a free-radical reaction pathway through the gas phase, as seen in thermal combustion. It is proposed this surface mechanism mitigates the risks of flame propagation and thermal runaway caused by sudden methane excursions in thermal systems.

To evaluate the safety and efficiency of catalytic technology, the current project has focused on establishing a dedicated experimental facility and aligning procedures with necessary risk management frameworks. This involved updating local risk assessments tailored to the experimental procedure to ensure full compliance with safety standards, including completion of infrastructure, incorporating the necessary tubing and instrumentation. With the completion of laboratory setup, experimental work examines the robustness of a novel catalytic system by subjecting it to controlled methane excursions. Experimentation involves dynamically altering methane concentrations to simulate the natural unpredictability of methane levels within ventilation air and monitor resulting conditions.

C38010 Nitrogen and Other Uncertainties in the Gas Content of Coal

Organisation:	McMahon Coal Quality Resources
Project Leader:	Chris McMahon
Value:	\$118,680
Report Expected:	February 2027
Industry Monitors:	De Nicholls Dennis Black Jim Sandford Murray Little
ACARP Contact:	Patrick Tyrrell

This project investigates how the origin of nitrogen, and sampling and testing methods affect the quantification and treatment of nitrogen measurements in coal-seam gas, which are critical for greenhouse gas reporting. The study will review literature, ACARP guidelines, and emissions calculation methods, and assess borehole classification and uncertainty modelling. It will also incorporate findings from industry workshops and feedback from ACARP monitors to refine

recommendations. The expected benefits arising from the examination of effects and review of calculation methodology will be better definition of methods of sampling, testing and evaluation for use, with consideration of nitrogen origins.

Bodies of work for five subject areas have been identified for separate review; each cascading in series, with mentor review, input and subsequent upgrades prior to advancing to subsequent stages as follows:

1. Nitrogen and Air Contamination Evaluation;
2. Method 2 vs 3 Definition;
3. Gas Drillhole Data Definition;
4. Uncertainty Calculations Review; and
5. Carbonaceous Gas Bearing Strata Definition (Testing Materiality).

Research references supplied, sourced and coal origins research commenced. Site visits to GeoGAS and an interview with a key author for multiple gas papers, were undertaken.

Interviews with the ALS gas lab, GM3 gas lab, Murray Little and Jim Sandford (gas experts) were undertaken, and a draft report issued on Stage 1 findings issued, which is currently under review.

The outcomes of this project will be a summary of current theories and practice on the effects of sampling and testing methods for the determination of nitrogen outcomes in gas testing in accord with the five listed objectives.

The expected benefits arising from the examination of effects and review of calculation methodology include better definition of methods of sampling, testing and evaluation for use; and more accurate representation of potential resource of greenhouse gasses.