

Baseline works for mine rehabilitation and closure collaboration project



Contact person

Claire Côte, SMI | The University of Queensland
Phone: +61 7 3346 4061 | Email: c.cote@uq.edu.au

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Submitted by:

PROJECT TEAM'S GENERAL INFORMATION

Lead business name	The University of Queensland ABN 63 942 912 684 a body corporate constituted under the <i>University of Queensland Act 1998</i> (Qld) of Brisbane in the State of Queensland 4072
ABN	63 942 912 684
Business type	University
Contact person (authorised to negotiate and enter into a contract)	Director, Research Partnerships
Registered business office address	The University of Queensland, Brisbane Qld 4072
Email	director.partnerships@research.uq.edu.au
Phone	+61 7 3365 3559

Authors

This report has been produced by a multidisciplinary research team from the Sustainable Minerals Institute (SMI) at the University of Queensland, Australia. The team was drawn from across three SMI centres: Centre for Water in the Minerals Industry (CWiMI), Centre for Mined Land Rehabilitation (CMLR) and Centre for Social Responsibility in Mining (CSRM). The authors are:

Dr Sandy Worden, Research Fellow CSRM

A/Prof Claire Côte, Director CWiMI

Dr Kamila Svobodova, Honorary Research Fellow CSRM

Andrea Arratia-Solar, Research Assistant CWiMI, PhD Candidate CSRM

Dr Jo-Anne Everingham, Honorary Senior Research Fellow CSRM

Dr Pascal Asmussen, Postdoctoral Research Fellow CWiMI

A/Prof Mansour Edraki, Principal Research Fellow, Group Leader Environmental Geochemistry CMLR

A/Prof Peter Erskine, Director CMLR

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SMI is made up of six research centres and an international centre of excellence. We have a strong track record across all areas of mining - in exploration, mining, mineral processing, workplace health and safety, mine rehabilitation, water and energy, social responsibility, and resource governance. Our core business is deeply rooted in the minerals industry and our researchers have experience working across the sector to support industry, governments, communities and civil society through analysis and thought leadership.

We offer future focused professional development and customise courses to suit industry trends or company needs. We supervise Higher Degree by Research students and are proud that many of our alumni are now in influential roles in resource companies, non-government and government organisations around the world.

Project funding

The project was funded by the Queensland Resources Council (QRC) and the International Council on Mining and Metals (ICMM).

QRC

The Queensland Resources Council (QRC) is the peak representative organisation of the Queensland minerals and energy sector. QRC's membership encompasses minerals and energy exploration, production, and processing companies, and associated service companies. QRC works on behalf of its members to ensure Queensland's resources are developed profitably and competitively, in a socially and environmentally sustainable way.

ICMM

The International Council on Mining and Metals (ICMM) is an international organisation dedicated to a safe, fair and sustainable mining and metals industry. It brings together 27 mining and metals company members and more than 35 national, regional and commodities association members. Every ICMM member company adheres to ICMM's mining principles, which incorporate comprehensive environmental, social and governance requirements, robust site-level validation of performance expectations and credible assurance of corporate sustainability reports.

¹ QS World University Rankings and Performance Ranking of Scientific Papers for World Universities, 2020.

² The University of Queensland ranks third in the world for mining and mineral engineering, 2019 Shanghai Rankings by subject.

List of symbols and abbreviations

Acronym	Definition
>	Greater than
<	Less than
%	Percentage
~	Approximately
°C	Degree Celsius
ABS	Australian Bureau of Statistics
ACARP	Australian Coal Association Research Program
ARRI	Appalachian Regional Reforestation Initiative
CDR	Anthropogenic removal of carbon dioxide
CMLR	Centre for Mined Land Rehabilitation
CO ₂	Carbon dioxide
CQU	Central Queensland University
CRC TiME	Cooperative Research Centre for Transformations in Mining Economies
CSRM	Centre for Social Responsibility in Mining
CWiMI	Centre for Water in the Minerals Industry
DHPW	Queensland Department of Housing and Public Works
DIDO	Drive in, drive out
DNRM&E	Queensland Department of Natural Resources and Energy
DPI&F	Queensland Department of Primary Industries and Fisheries
DSDILGP	Department of State Development, Infrastructure, Local Government and Planning
DSDTI	Queensland Department of State Development, Tourism and Innovation
EA	Environmental assessment
EIS	Environmental impact study
FIFO	Fly in, fly out
GW3	Greater Whitsunday Alliance
ha	Hectares
hd	Head
HV	High voltage
IBRA	Interim Biogeographic Regionalisation for Australia
ICMM	International Council on Mining and Metals
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
km	Kilometre
kV	Kilovolt

LGA	Local government area
m	Metre
M	Million
m/s	Metres per second
mg	Milligram
mm	Millimetre
Mtpa	Million tonnes per annum
MW	Megawatt
NUMA	Non-use management area
NWMP	North West Minerals Province
OC	Open cut
PHES	Pumped hydro energy storage
PMLU	Post-mining land use
PRCP	Progressive rehabilitation and closure plan
QFC	Queensland Future Climate
Qld	Queensland
QRC	Queensland Resources Council
QTC	Queensland Treasury Corporation
RDM	Research Data Manager
SMI	Sustainable Minerals Institute
UG	Underground
UQ	The University of Queensland

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Executive summary

This report presents the findings from the project Baseline works for mine rehabilitation and closure collaboration, which was commissioned by the Queensland Resources Council and the International Council on Mining and Metals.

The project aims to establish a baseline from which the mining industry can make rehabilitation and PMLU decisions across 4 mining regions: the North West Minerals Province, North Queensland, Bowen Basin and Clarence Moreton/ Surat. In line with project scope, the report provides a high-level assessment of the current landscape rather than detailed analysis of closure and post-closure issues. Information required to understand committed and future potential PMLU options in these four regions has been gathered, the long-term community priorities and planning constraints identified, and research priorities that will support development of beneficial PMLUs established. A literature review was undertaken, covering land use planning, its applicability to selection and implementation of PMLUs, and global mine rehabilitation methods. It identified that most research studies have focused on developing rehabilitation methods that deliver pre-determined outcomes with little investigation of all potential PMLUs. Holcombe and Keenan (2021), however, illustrate that better outcomes are possible.

The importance of this project lies in its novel and holistic approach to post-closure planning. Through understanding community priorities, government development goals, technical feasibility and collaboration opportunities, this approach draws together crucial ingredients for longer-term and more sustainable outcomes for Queensland's mining regions. Shifting closure thinking from a mine-by-mine basis to a regional context will help stakeholders consider the cumulative impacts of multiple mine closures, adopt a strategic approach to post-closure planning and identify collaborative potential of suitable PMLU options beyond a single mining lease.

The project was undertaken in 4 key stages:

1. Establishment of the project context – international, regulatory, regional socio-economic, regional technical and environmental contexts
2. Production of a shortlist of suitable post-mining land uses (PMLUs) for each region based on technical and environmental data collected at regional level
3. Suitability assessment of PMLUs against technical, environmental criteria and socio-economic indicators
4. Engagement with regional stakeholders via a facilitated workshop and survey to ground-truth PMLU suitability, assess collaborative potential of the PMLUs and identify prospective collaborators to inform the development of a collaboration framework.

The project identifies several PMLU options assessed as suitable for the study regions – grazing, native ecosystems, renewable energy, cropping and regenerative agriculture, protected horticulture and intensive livestock production, phytomining, manufacturing hub and tourism. Not all PMLU options are applicable for each region. Findings show that stakeholders' local knowledge can inform expert-driven assessments of PMLU suitability and provide valuable insights into the collaborative potential and collaborative opportunities for each option. Through the scoping work, research participants indicated their preference for PMLU options that incorporated multiple, inter-related activities that operated as an integrated system rather than single land uses. The suitability analysis also identifies related opportunities and collaboration potential.

The suitable PMLU options could be pursued where there is broad support and a collaboration framework with principles, strategic questions and process has been developed to assist that endeavour. However, there will be a requirement to include existing site-level closure obligations to ensure that selection of regional PMLU options does not preclude mines from meeting their existing requirements.

Mine rehabilitation and the selection of PMLUs have an important role to play in regional transitions to post-mining futures and PMLU decision-making needs to be integrated into the regional planning process for

post-mining transitions. Considering PMLU alternatives in isolation may overlook regional aspirations, for example, in relation to economic development and employment. Furthermore, an overarching strategy is needed to guide decision-making, develop a shared vision for the future, harness regional expertise, optimise collaboration opportunities and articulate a coherent action plan.

The report presents 9 recommendations. These recommendations are that:

1. QRC presents project findings to the Queensland Government.
2. In collaboration with the mining industry and regional stakeholders, the Queensland Government develops a vision for the state's post-mining futures and transition pathways, including policies, programs and incentives/ funding.
3. The Queensland Government drives the establishment of regional post-mining transition forums, with ownership of the forums to remain with the regions. Regions would select forum participants and develop their own governance mechanisms and operational structures.
4. The Queensland Government collaborates with regional governance networks (e.g. Central Queensland Regional Organisation of Councils and Mount Isa to Townsville Economic Development Zone) and local governments on post-mining transition initiatives, ensuring regular, transparent engagement with other stakeholders, including community groups, and fostering their participation in regional decision-making.
5. QRC joins Cooperative Research Centre for Transformations in Mining Economies (CRC TiME) to leverage advances being made and avoid duplication of effort around PMLU and post-mining transition. CRC TiME brings together more than 70 leading mining and mining service companies, regional development organisations, state and federal governments and research partners to drive transformational change in mine closure.
6. The Queensland Government and relevant local governments utilise the Bowen Basin regional hub being established by CRC TiME. The CRC is establishing seven regional hubs across Australia to bring together stakeholders who share the same geography to collaborate on transformation initiatives. Although in the early stages of development, the Bowen Basin hub offers a framework for the development of one of Queensland's regional forums and provides an opportunity to pilot the forum concept.
7. QRC member companies, community groups and enabling stakeholders collaborate to undertake simple PMLU pilot projects to get 'runs on the board' and build momentum.
8. Regional governance networks, local governments and mining companies encourage regional champions to instigate pilot projects and facilitate collaboration.
9. The Queensland Government and the mining industry develop and fund a PMLU and post-mining transition research program that addresses the research priorities suggested in Section 6.

1. Introduction

Queensland site-specific mines are transitioning into the Progressive Rehabilitation and Closure Plan (PRCP) framework in accordance with the *Environmental Protection Act 1994*.³ These legislative reforms are providing a much clearer rehabilitation trajectory through to surrender. They also present an opportunity for the mining industry to review current rehabilitation practices and approaches to post-mining land use (PMLU) planning.

A key statutory obligation within the PRCP framework is the selection and justification of appropriate and viable PMLUs. Mine operators are required to propose suitable land uses following consideration of the surrounding landscape, community views and the objectives of local and regional planning strategies. There are opportunities for early strategic planning, identification of innovative PMLU options and collaborative use of post-closure mine assets, such as infrastructure (power, road/rail, buildings), dams and voids.

Valid data and sound science are needed to drive the mining industry's closure and post-closure commitments. As a first step in gathering that data, the Queensland Resources Council (QRC) and the International Council on Mining and Metals (ICMM) commissioned the Sustainable Minerals Institute (SMI) at The University of Queensland (UQ) to undertake the Baseline works for mine rehabilitation and closure collaboration project across 4 Queensland mining regions (the study regions). The regions are:

- North West Minerals Province (minerals)
- North Queensland (minerals)
- Bowen Basin (coal)
- Clarence Moreton/ Surat Basin (coal).

The aim of the project is to establish a baseline from which the mining industry can make rehabilitation and PMLU decisions. Information required to understand committed and future potential PMLU options in these four regions has been gathered, the long-term community priorities and planning constraints identified, and research priorities that will support development of beneficial PMLUs established. In line with project scope, the report provides a high-level assessment of the current landscape rather than detailed analysis of closure and post-closure issues.

The importance of this work lies in its novel and holistic approach to post-closure planning. Through understanding community priorities, government development goals, technical feasibility and collaboration opportunities, this approach draws together crucial ingredients for longer-term and more sustainable outcomes for Queensland's mining regions. Shifting closure thinking from a mine-by-mine basis to a regional context will help stakeholders consider the cumulative impacts of multiple mine closures, adopt a strategic approach to post-closure planning and identify collaborative potential of suitable PMLU options beyond a single mining lease.

This report is 1 of 4 research outputs generated from the Baseline works for mine rehabilitation and closure collaboration project. See also:

- Supplementary report – socio-economic data
- Supplementary report – technical assessments
- Thematic maps supporting the technical assessments.

³ 'Site-specific mine' is the term used in the EP Act. There are three types of applications for an environmental authority – standard, variation and site-specific. In the legislation, the PRCP framework only applies to site-specific mining operations/applications. Most mining projects applied for by QRC members are site-specific.

The report is structured into 7 chapters that address international trends, innovations and transformational opportunities (Chapter 2); regulatory context (Chapter 3); regional context (Chapter 4); regional suitability of PMLU options and their collaborative potential (Chapter 5); and research priorities (Chapter 6). Conclusions and recommendations are presented in Chapter 7.

1.1 Methodology

A mixed method convergent design was adopted for this project with qualitative and quantitative analyses conducted in parallel across the international, regulatory, regional socio-economic and regional environmental contexts. Outputs from each contextual analysis converged in the suitability assessment and subsequent stages of the project.

We approached the work using 7 key steps:

1. Understanding the context (international, regulatory, regional socio-economic and regional environmental context)
2. Summarising this understanding and shortlisting PMLU options
3. Conducting a suitability assessment of shortlisted PMLU options using socio-economic indicators and environmental criteria
4. 'Ground-truthing' the PMLU options and their collaborative potential via facilitated stakeholder workshops and survey
5. Developing a collaboration framework based on the project analyses and stakeholder feedback
6. Establishing research priorities
7. Providing conclusions and recommendations.

A graphical representation of the methodological approach is provided in Figure 1 (over page). The steps of the methodology are linked to the relevant report chapter.

A more detailed description of the methodological steps is provided in Chapter 4: Regional context and Chapter 5: Regional suitability of post-mining land uses and collaborative potential.

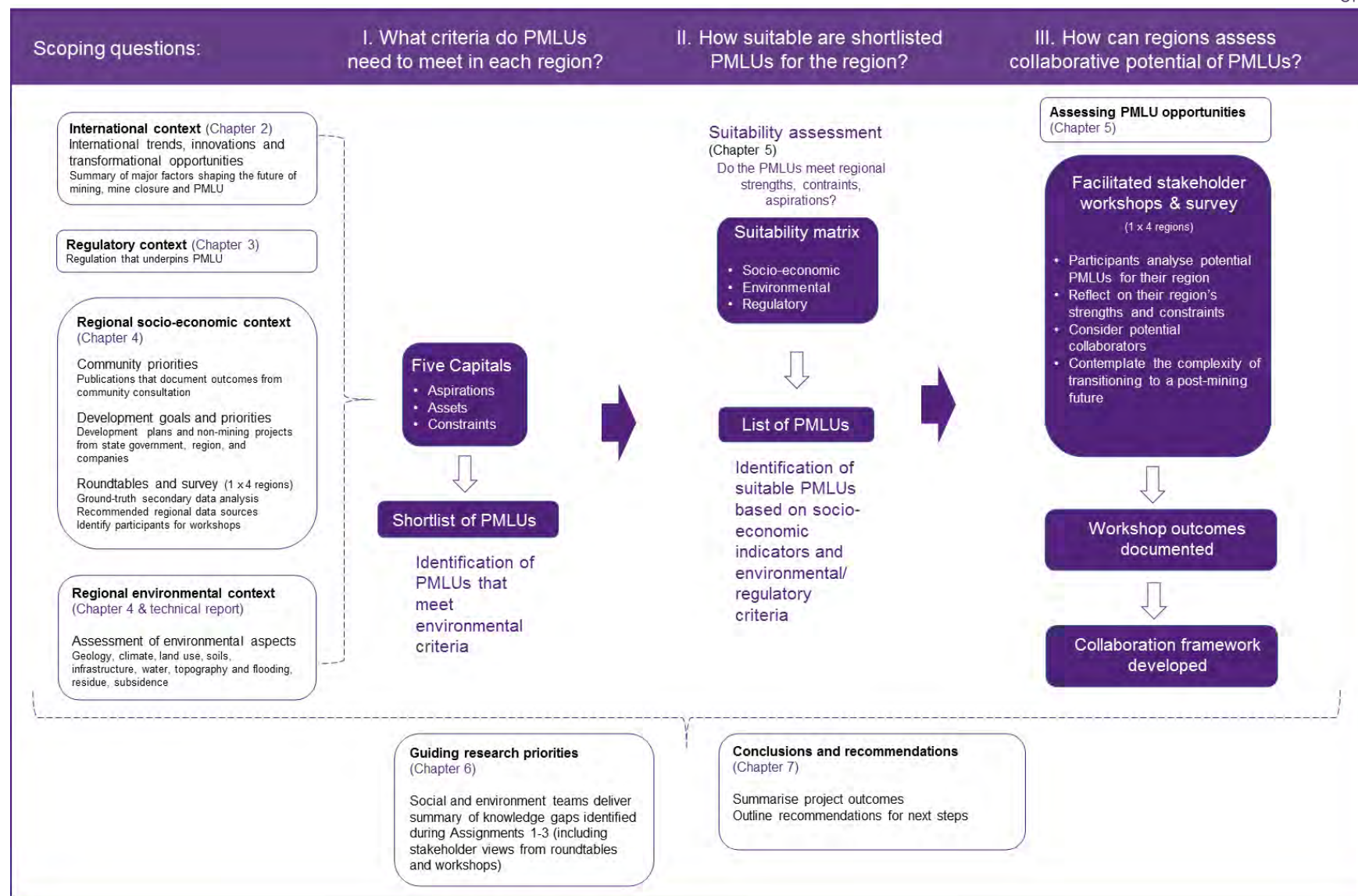


Figure 1: Graphical representation of the project's methodological approach

2. International trends, innovations and transformational opportunities

There are myriad factors that can affect the planning and execution of mine closure and PMLU decision-making in Queensland, such as the regional context, state and federal regulatory requirements and mining business considerations. This chapter summarises the global trends that can influence selection of PMLUs, with the trends classified according to the five capitals framework, where relevant; highlights some international standards; discusses national trends that were identified from a review of existing land use planning approaches, both in Australia and overseas; and presents a summary of an extensive literature review focused on identifying current practices for identifying and implementing PMLU and associated rehabilitation practices.

2.1.1 International trends

This section outlines seven broad global trends that are shaping the future of mining and the consequences for mine closure and PMLU.

2.1.1.1 Climate change

The Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) clearly states that human influence has warmed the climate at a rate that is unparalleled in at least the past 2000 years. The scale of recent changes across the climate system is unprecedented in many thousands of years. Human-induced climate change is already affecting many weather and climate extremes in every region across the globe, with strong evidence of observed changes in heatwaves, heavy precipitation, droughts, and tropical cyclones.

In Australia, land areas have warmed by around 1.4°C; heat extremes have increased, cold extremes have decreased, and these trends are projected to continue. Relative sea level has risen at a rate higher than the global average. Frequency of extreme fire weather days has increased. At many locations, the duration of the fire season is prolonged, with the longest seasons being recorded since 1950. The intensity, frequency and duration of fire weather events are projected to increase. Heavy rainfall and river floods are predicted to increase while sandstorms and dust storms are forecast to increase.

In eastern Australia, where the Bowen Basin and Surat Basin are located, there is a projected decrease in mean rainfall, but with more extreme rainfall events. In northern Australia, where the North West Minerals Province and most of the North Queensland region are located, an increase in heavy rainfall and river flooding is predicted, with a decrease in cyclone frequency but an increase in the proportion of severe cyclones. In central Australia, the projected warming is greater than in coastal regions and an increase in heavy rainfall and river flooding is forecast (IPCC, 2021). Selection of PMLUs will need to take these projections into consideration. PMLUs will need to (1) be adapted to rainfall variations; (2) be able to handle extreme rainfall and flooding; (3) be able to sustain extreme temperatures; (4) be fire resilient; and (5) adopt infrastructure standards that withstand severe cyclonic activities, where required.

Under international climate agreements, Australia has two targets to reduce greenhouse gas emissions:

- 5% below 2000 levels by 2020 (under the Kyoto Protocol) and
- 26-28% below 2005 levels by 2030 (under the Paris Agreement).

In terms of potential mitigation strategies, anthropogenic removal of carbon dioxide (CDR) is a way of removing carbon dioxide (CO₂) from the atmosphere and durably storing it in reservoirs. CDR methods can have wide-ranging effects on biogeochemical cycles and climate, and can influence water availability and quality, food production and biodiversity. CDR methods include afforestation, agricultural practices that sequester carbon in soils, bio-energy with carbon capture and storage, ocean fertilisation, enhanced

weathering and direct air capture when combined with storage. Some of these CDR methods could be investigated as a way of delivering not only mine rehabilitation outcomes but also climate change mitigation and biodiversity investment.

2.1.1.2 Biodiversity investment - increasing natural capital

Developments at the international level are likely to become more influential over time as there are increasing expectations around risks from the loss of natural capital, biodiversity and ecosystems need to be correctly assessed. For example, the United Nations adopted a [new statistical framework](#) in 2021 to better account for biodiversity and ecosystems in national economic planning and policy decision-making, allowing countries to use a common set of rules and methods to track changes in ecosystems and their services. Additionally the [Dasgupta review](#) suggests that the UK national accounting systems need to include natural capital estimates to accurately measure economic progress. Investors in the near term are therefore going to be required to assess the financial risk associated with impacts on nature and will need to find new opportunities to invest in nature-positive projects which enhance ecosystems.

The period 2011-2020 has been declared as the United Nations Decade on Biodiversity to promote the implementation of a strategic plan on biodiversity and its overall vision of living in harmony with nature. Governments are encouraged to develop, implement and communicate the results of national strategies for implementation of the strategic plan for biodiversity. This can influence the selection of a PMLU as the land use will need to align with national approaches to biodiversity investment.

Photosynthetic carbon capture by trees is likely to be the most effective CDR strategy. Consequently, international initiatives, such as United Nations Environment Program Bonn Challenge or the New York Declaration on Forests, have established ambitious targets to promote forest conservation, afforestation and restoration at a global scale. A recent study analysed the potential to re-establish tree cover across terrestrial ecosystems, using a predictive model based on dominant environmental drivers of tree cover. It shows that eastern Australia has enormous potential for re-establishing tree cover and tree planting can co-exist with grazing (Bastin et al., 2019). As it is a high-level assessment, it does not consider the constraints imposed by land capability or the legislative context. However, it indicates that restoration of mined land to woodland can present opportunity for carbon capture and sequestration.

Successful examples of restoration of mined land to woodland can be found in the USA. In 2004, the Office of Surface Mining Reclamation and Enforcement created the Appalachian Regional Reforestation Initiative (ARRI), a coalition of groups, including citizens, the coal industry and government. ARRI is dedicated to restoring forests on land in the eastern United States that has been mined for coal. This sort of initiative could be explored in Australia given the right legislative setting and using tested frameworks, such as the Rotterdam School of Management's holistic framework for ecological restoration (Ferwerda, 2015).

2.1.1.3 Carbon markets – financial capital transformed into natural capital

A truly global trading program is currently unlikely. Because a unit of CO₂ emitted anywhere has a uniform impact on global climate, a single global market would be economically desirable, equalising incentives to reduce emissions everywhere. In practice, there are multinational, national and subnational markets, including the European Union, California, Québec, the Regional Greenhouse Gas Initiative in the U.S. northeast, New Zealand, as well as various pilot programs (Newell et al., 2014). Climate policy and carbon markets are constantly evolving. Carbon markets are now a key part of an emerging, complex and global policy framework that mixes trading programs and other policies at the subnational, national and multinational level. Fresh research and policy initiatives are grappling with new issues: linking programs, the consequences and comparability of mixed policies and managing market evolution as policies inevitably change. The future of carbon markets will depend, in part, on how well such efforts address these challenges.

In Queensland, the state government is committed to looking for “innovative ways to transition to a low carbon, climate resilient and environmentally sustainable economy”.⁴ As part of this commitment, the Queensland Treasury Corporation may issue two different types of green bonds in accordance with the QTC Green Bond Framework: (1) Climate Bonds Initiative: certified green bonds issued in line with the Climate Bonds Standard, and (2) green bonds consistent with the International Capital Market Association green bond principles. The funds are supposed to focus on regional areas, any areas with unemployment rates higher than the state average and on sectors such as agriculture, resources, tourism, manufacturing and construction. Green bonds offer collaborative opportunities secured by external funding, but the proposed projects need to have clear benefits for the state. So far, proceeds from QTC Green Bonds have been allocated mostly to projects establishing low carbon transport (electrified light rail on the Gold Coast, some cycleways), renewable energy (Sunshine Coast and Warwick solar farms) and water infrastructure (desalination plant, South-East Queensland drought resilient network). There are opportunities for green bonds to finance establishment of innovative PMLUs such as:

- Upgrade of existing water infrastructure networks to establish schemes for beneficial reuse of mine water
- Establishment of renewable energy projects.

2.1.1.4 Decarbonisation – natural capital transformed into built capital

Growing environmental and climate concerns are prompting a global shift in energy use, from a reliance on fossil fuels towards low-carbon energy. This shift is known as the energy transition.

An unexpected consequence of the transition is a strong market for ‘critical’ minerals and metals, as low-emission energy and transportation systems are mineral/metal intensive (Maennling & Toledano, 2019). Electric storage batteries, for example, require aluminium (bauxite), cobalt, iron, lead, lithium, manganese, and nickel. Meeting climate targets adds another dimension to market dynamics, with the World Bank Group (2017) forecasting a rapid rise in critical metals to constrain temperatures to 2°C-4°C above pre-industrial levels. These forecasts raise questions about the mining industry’s capacity to meet demand. Analysis by Lèbre et al. (2019) identifies significant supply risks, particularly for copper, iron and aluminium.

Decarbonisation initiatives being undertaken by the industry include installation of renewable energy generation on site, replacement of diesel-powered equipment with electric-powered vehicles and the integration of recycling into value chains (Maennling & Toledano, 2019). Some major mining companies, such as BHP and Anglo American, are divesting some of their thermal coal assets, while others are collaborating in the development of carbon alternatives for industrial processes. Rio Tinto and Baowu Steel, for example, have signed a memorandum of understanding to develop a hydrogen reductant to replace coking coal in the steelmaking process (Deloitte Insights, 2021). Other companies are setting targets to drive change. Glencore, for example, has set net zero greenhouse gas emission targets for 2050.

The international trend towards decarbonisation has a number of implications for closure and PMLU. The growth/decline scenarios for critical metals and thermal coal leads to rapid development of mines for the former and rapid closure of mines for the latter. Rapid or unplanned closure increases the likelihood that mine rehabilitation will be unfinished and unstable, investments in social development funds will be inadequate, workers will not have secured alternative employment and regions will not have diversified their economies, resulting in major adverse socio-economic and environmental consequences.

With some major mining companies exiting from thermal coal in parts of the world, small and mid-tier companies move in, acquiring assets. With less financial resources than the majors, these companies may not have the capacity to meet their closure commitments over time nor the established relationships to effectively collaborate with communities and other stakeholders on closure planning and PMLU decision-making.

⁴ <https://www.qtc.com.au/institutional-investors/green-bonds/>

As mines reach the end of their operating life, their revenue stream declines. Leading companies will have put aside closure funds during the operational stage of the mining lifecycle. The longer the company has to invest in closure, the less impost it will have on the business. Acquiring mature assets, such as the thermal coal mines being divested by some majors, shortens the closure investment timeline. In addition, companies acquiring assets are more focused on operational life than on closure.

However, in the Queensland context, the coal industry continues to enjoy key advantages, including its geographic location and the quality of its coal, compared with most of its global competitors. In [A Study of Long-Term Global Coal Demand](#), Queensland Treasury's analysis of the International Energy Association's projections highlights that Queensland's future coal demand will continue to be primarily linked to key economies in North-East and South-East Asia. It is likely that international demand will support Queensland's coal exports over the coming two decades with the long-term prospects for the state's metallurgical coal likely to be more robust than for thermal coal.

There also are safeguards in place to avoid or significantly minimise the risk of companies defaulting on rehabilitation obligations or inappropriate transfers in Queensland. This includes financial and technical capability assessments and re-evaluations undertaken by the administering authorities and the requirement for a company to pay financial provisioning.

On a related matter, with diversification in the energy mix, solar farms and other renewable energy systems are being considered as potential PMLUs. Bringing significant capacity into the grid could lead to oversupply, a scenario playing out in British Columbia, Canada. New low-carbon energy projects are struggling to break into the market because they can't secure supply agreements with BC Hydro, the provincial utility. PMLU planning requires the same due diligence as other business decisions.

2.1.1.5 Greater focus on overcoming the social trust deficit – social capital

Social trust is a significant issue facing the mining industry. EY's annual review of global mining and metals top 10 business risks and opportunities consistently identifies social trust (using the controversial term 'social licence to operate') as the number 1 issue facing miners. Local opposition to mining is likely to increase if no new business models are developed that benefit the impacted communities and other stakeholders. This scenario is equally likely at the mine closure stage of the mining lifecycle as social trust is critical for mine closure planning and making decisions around PMLU. Transparent communication and engagement, participatory dialogue, procedural fairness and stakeholder collaboration are required to overcome the social trust deficit.

2.1.1.6 Geopolitics⁵

The global geopolitical environment is shifting. EY (2021) highlights the changing role of the US in the international system, EU stability and US-China relations as significant geopolitical trends. These trends and the fallout from the COVID-19 pandemic have contributed to increased economic protectionism, such as the introduction of tariffs, increasing royalties and taxation, protection of strategic minerals, changed licensing arrangements, export bans or the requirement for minerals to be processed prior to export, reserving production for domestic use, import restrictions on semi-finished products such as steel and aluminium, and market consolidation of the critical minerals sector among a few players (Maennling & Toledano, 2019; EY, 2021). Geopolitics and economic protectionism have the potential to affect the timing of planned and unplanned mine closures.

⁵ While a process rather than a capital per se, geopolitics is closely linked to institutions and their interrelationships, which are examples of social capital.

2.1.1.7 Modern mining workforce – human capital

Disruptive technologies and technological innovations are driving smaller, increasingly flexible and more highly skilled workforces (WEF, 2015). From a mine closure perspective, this trend raises questions about the skills required to support closure planning and execution, upskilling employees and local residents during the operational phase of the mining lifecycle in preparation for closure, and implications for mining companies' community investment programs.

2.1.2 International standards and guiding material

There is increasing societal attention being given to the environmental and social impacts of mining. Effective mine closure and reclamation processes and practices reduce potential mining impacts over the full mining life cycle and beyond. The sooner that effective closure and reclamation management processes are initiated, planned and designed, the more efficient the outcomes are for mines, governments, communities and other stakeholders.

The significance of the topic is reflected by the number of international standards and guiding materials that have been developed, for instance the ICMM Integrated Mine Closure Good Practice Guide or the Australian Government Leading Practice Handbook on Mine Closure. It is worth noting that guidance is also being developed by entities with a broader reach. The International Organization for Standardization (ISO) established the intent to develop voluntary, consensus-based, market relevant material that supports mine closure and reclamation management. To aid this initiative, in 2014 the ISO TC 82 (mining) committee launched a specific sub-committee, ISO/TC 82/SC 7. In 2016, Standards Australia created a mirror committee to provide formal input directly to the ISO process.

The sub-committee is to develop standards, guidelines and complementary documents that address all lifecycle stages of resource development which, when applied, will prevent and mitigate long-term mining impacts and create environmental and socio-economic value through the mine closure and reclamation management process. This material is currently under development and is to focus on the following themes:

- Mine closure knowledge
- Management, risk and opportunity
- Mine closure reclamation management terminology
- Mine closure reclamation management planning
- Financial and economic aspects
- Closure performance
- Social aspects
- Stakeholder engagement
- Alternative post closure land use
- Abandoned mine management.

Given the relevance of the standards and guiding material to this project, future efforts to progress any collaborative opportunities should have regard to and align with (to the extent possible given jurisdictional requirements) key principles once the standards, guidelines and complementary documents are finalised.

2.1.3 National trends in land use planning

Land use planning refers to the reasonable preparation, arrangement and allocation of future land use to enable more significant comprehensive benefits in a specific area. Various terms can be used to refer to this concept, including 'land planning', 'regional planning', 'territory planning', 'land use planning' and 'urban planning' in the specific case where it is applied to urban areas. A recent study undertook a comprehensive

literature review of 1771 land use planning articles published between 1990 and 2019 (Lv et al., 2021) and found that:

1. The number of papers related to land use planning has shown an overall growth trend
2. Land use, geographic information system (GIS), urban planning, spatial planning and climate change are some high-frequency keywords used in land use planning
3. The current research hot spots mainly focus on the relationship between land use spatial planning and regional planning, public participation, urban sprawl, and sustainable development
4. The themes show 8 evolutionary paths related to the following four topics: ecosystem protection, climate and natural change, urban sprawl and agricultural development, and GIS development.

The review concludes that land use planning could be further improved by strengthening integration of the various disciplines. The baseline works for mine rehabilitation and closure project has included many of the core aspects outlined by this literature review, with a methodology deliberately based on strong discipline integration and reliance on GIS analysis. It is well aligned with current best practice.

The literature review also showed that Australia was at the forefront of land use planning research. However, despite this large body of research work, land use policy and planning in Australia has recently been described as being in disarray, lacking focus, determination, coordination and leadership. Like other similar federalist nations with an extensive area and dependence on natural resources, such as Canada and the USA, the responsibility in Australia for land use policy and planning primarily resides at the sub-national level, with no national policy on land use (Walcott, 2019).

To address this gap, a government panel produced a multiple land use framework (MLUF), primarily as guidance for the mining industry. The MLUF (SCER, 2013) is intended to be used where land access and land use conflict has the potential, real or perceived, to arise. While it has been developed with the minerals and energy resources sectors in mind, the underlying concept can extend to all sectors, including agriculture, environmental and heritage protection, tourism, infrastructure and forestry. The framework supports the ability of local and regional communities and governments to maximise land use in a flexible, environmentally sustainable manner over time. Conceptually, the objective is to maximise the net benefits to present and future generations from a combination of land uses which benefit the wider community, now or in the future. It is intended to influence the way in which land use planning and policy are applied by governments but mostly only provides aspirational policy ideas. It introduces the concept of 'multiple and sequential land use': multiple land use is where land is used for different purposes simultaneously and sustainably with a view to maximise the benefits for all Australians; sequential land use involves different use of land over time and may include a return to a former use or the development of an alternative land use.

The concept of multiple and sequential land use has strong applicability to the selection of PMLU and there is evidence it has influenced actions at state, industry, community and individual levels (Walcott, 2019). Recent examples of interest to the baseline works include:

Latrobe Valley Regional Rehabilitation Strategy

The Victorian Government developed the strategy for future land uses around the Latrobe Valley coal mine area, which will undergo significant change through the closure and rehabilitation of the three major open-cut coal mines and associated power stations. The strategy was prepared by the Department of Jobs, Precincts and Regions in collaboration with the Department of Environment, Land, Water and Planning and had input from many partners. It does not prescribe final landform or final land use, to enable the consideration of rehabilitation options that can be demonstrated to deliver a safe, stable and sustainable outcome. This allows for adaptability and consideration of environmental conditions, and community and stakeholder views. It focused on the technical aspects that are required to deliver safe, stable and non-polluting landforms, rather than the PMLU that could be achieved with these landforms.

Hunter Valley Synoptic Plan

The Synoptic Plan: Integrated Landscapes for Coal Mine Rehabilitation in the Hunter Valley of NSW was prepared in 1999 by the NSW Department of Mineral Resources in collaboration with state agencies, local government and academic contributors. It set out the principles for an integrated approach to landscape management and post-mining rehabilitation for the Hunter coalfield. The NSW Government has since launched the Hunter Regional Plan 2036, which commits to reviewing the synoptic plan, in conjunction with the Upper Hunter Biodiversity Assessment to ensure best-practice rehabilitation and visual impact management for closed mines. The review is currently progressing.

In absence of a national land use policy to strongly guide land use planning decisions, the state government and its departments have led development of regional land use planning vision and strategies. There are examples in mining regions, most notably in the Hunter Valley, where a vision for mine rehabilitation was established as early as 1999 (recognising that this vision is evolving).

In Queensland, local government is primarily responsible for land use planning, but there are state regional plans that assist them to ensure broader regional outcomes are achieved. Regional plans set the long-term strategic direction for how the regions will grow and respond to change over time. They support growth and development in the regions while protecting each region's natural resources along with the interests of the state. They do not include consideration of PMLU and there is a great opportunity to influence further developments of these regional plans.

2.1.4 PMLU planning trends

The study regions are situated in complex social, economic and environmental landscapes that will invariably influence mine closure outcomes. For this and other reasons, planning for mine closure and transitions to PMLU have become hot topics among scholars (Hendrychová et al., 2020; Beckett & Keeling, 2019; Kivinen, 2017), government agencies (Queensland Government Department of Environment and Science, 2019; Australian Government Department of Resources and Department of Foreign Affairs and Trade, 2016; ANZMEC, 2000) and other organisations (ICMM, 2019; Sánchez et al., 2014). Some scholars (such as Everingham et al., 2020b; Svobodova et al., 2020; Svobodova et al., 2019) contend that greater collaboration is required between mining companies, regulators, local governments, ecologists, communities and other stakeholders to tackle the complexity associated with mine closure planning and post-closure transitions. Sánchez et al. (2014) argue that incorporating stakeholders into companies' post-mining planning significantly increases the likelihood that beneficial outcomes will continue long after closure. Other commentators consider continuous reassessment of PMLU options to be critical. While ICMM (2019) and Mineral Council of Australia (2016), for example, call for early agreement on proposed PMLUs, they support the need for flexibility so that options can be reassessed as new opportunities emerge over the life-of-mine.

2.1.4.1 Status of current research on selection of PMLUs

There have been several reviews conducted at the global scale to identify the major factors considered in the selection of a PMLU (e.g., Mborah et al., 2016; Limpitlaw et al., 2014; Soltanmohammadi et al., 2009). These studies show that the choice of PMLU is primarily driven by government legislation.

The reviews examined the most commonly practiced and accepted techniques for selection of PMLU. Factors identified as important in the selection process include land resources (physical, biological, and cultural), ownership, type of mining activity, legal requirements, location, needs of the community, economic, environmental, technical and social factors. In a broad categorisation, almost all PMLUs are one of 7 types: agriculture, forestry, water source, intensive recreational land-use, non-intensive recreational land use, conservation or construction, as summarised in Table 1. Not all types are equally suitable for every context, however this summary provides a starting point for categorising land use options. The distinction between intensive and non-intensive recreation is not well-defined and seems to relate to the level of exertion rather than pressure placed on the landscape. A general category of 'recreation' is therefore more suitable.

Table 1: Categorisation of post-mining land uses

Land-use types	Typical post-mining land use in each category
Agriculture	Arable farmland, garden, pasture or hay-land, nursery
Forestry	Timber production, woodland, shrubs, and native forestation
Water source (e.g. lake or pool)	Water supply
Intensive recreation	Sport field, sailing, swimming, fishing, hunting
Non-intensive recreation	Park and open green space, museum, or exhibition of mining innovations.
Construction	Residential, commercial (shopping centre), industrial (factory), educational (university)
Conservation	Wildlife habitat, water supply (surface and groundwater)

Recently, Holcombe and Keenan (2021) conducted the first global study of repurposed mine sites by collating repurposing and co-purposing activities by industry and non-industry groups in a database containing 141 cases. They showed that there were a range of potential opportunities for repurposing mine leases and infrastructure. Post-mining activities can contribute to mitigating the impact of mining and maximising sustainable development in diverse ways. Environmental and ecosystem focused projects sought to redress (some of) the environmental impacts of mining. There were several examples of significant ecological restoration projects which became community assets via transfer to government authorities or community organisations for their perpetual management, and community use as learning spaces or community infrastructure such as recreation areas. Conversion from private to public land and enduring protection of these spaces counters the trend of globally diminishing green space and can play a role in protecting and conserving native ecosystems.

Additional literature searches were conducted to categorise current research in terms of:

- The types of PMLUs that were selected globally (where, when and how)
- The most common PMLU options
- The social, environmental and economic impacts and benefits of PMLU options
- Future trends in PMLU choices (considering pressure from society and anticipated upcoming legislative changes).

The key words that were used for the search were 'post mining land use' with various optional qualifiers, such as rehabilitation, mine, cost, benefit, scenarios, current, future, expectations, impact, legislation. The project team obtained 293 documents, which were sorted for applicability. For instance, selection of key words such as 'mine' and 'impact' yielded records related to health hazards: these were discarded. There are about 60 peer-reviewed publications that discuss PMLU and they can broadly be classified as:

- Technical studies that investigate the performance of rehabilitation activities, often with reference to completion criteria. These represent the majority of the research, with about 80% of the articles belonging to this category. Rehabilitation activities cover a wide range of technical aspects: flora and fauna re-colonisation, metal mobility, soil fertility and microbial communities, fire impacts and management, erosion.
- Studies that outlined requirements to include various stakeholders, including traditional owners, in decisions about post-mining land uses.

- Policy papers that outline required legislative changes to reduce financial liability of the state
- Development of methods for post-mining land use planning within the mine planning framework: there are very few of these (2 papers) and they lack methodological details.

Most of the international research is still largely focused on developing rehabilitation methods that will deliver pre-determined outcomes (the selected PMLU, often associated with specific completion criteria) without questioning the selection of the PMLU.

2.1.4.2 Status of current research in Queensland

In Queensland, there is an example of Central Queensland-based PMLU research collaboration with a two-year project funded by the Australian Coal Association Research Program (ACARP project C25032). The SMI's Centre for Social Responsibility in Mining (CSRSM) and Central Queensland University (CQU) considered the potential for commercially viable uses of coal mining leases once mining had ceased. The project explored models for stakeholder involvement in PMLU planning (Rolfe et al., 2018). The main research findings related to utility of land and to stakeholder processes. The findings are that:

- grazing is regarded as the most suitable PMLU in central Queensland but there are risks associated with it, related to soil quality and water availability
- post-mining land can have ecological, social, and economic functions
- native vegetation adds value as part of a grazing property.

More broadly, over the past 20 years, ACARP has funded many research projects focused on mine rehabilitation and closure. These projects are almost all concerned with:

- **Management of salinity for closure of open cut coal mines:** Many sites face salinity issues. Upon closure of coal mines, there is re-pressurisation of the groundwater tables with potential for continued mobilisation of salts in underground workings, in spoil piles and within the mined landscape, with progressive accumulation of salts in sink areas like final voids.
- **Suitability of agricultural systems as post-mining land uses:** Most of these studies have focused on the suitability of grazing, as it is the most commonly listed PMLU in environmental permits. However, forestry (hardwood plantation) and agroforestry (wide spaced hardwood plantation trees co-located with pasture) have also been assessed. This research can support the development of more diverse PMLU agricultural options.
- **Pasture based rehabilitation:** Many investigations to define the most appropriate techniques for re-establishing pasture on mined land (tested on 130 sites across nine mines). The research achieved close to 70% of vegetation cover and demonstrated reduced erosion.
- **Application of ameliorants and fertilisers**
Research into the most appropriate options for creating suitable growth media over reshaped spoil piles, investigating various combinations of topsoil ameliorants, fertilisers, amendments and processes that can speed up the transformation of spoils to functional soils to address topsoil deficits.
- **Erosion and management of dispersive spoils:** Development of frameworks for the rehabilitation of dispersive spoils.

Most of the Queensland-based research has also been focused on developing rehabilitation methods that will deliver pre-determined outcomes, but it has sought to address key barriers to successful rehabilitation, such as difficulties in re-creating sustainable growth media and minimising risks to the receiving environment. This is a large body of research that has produced technical findings that can support successful implementation of some PMLUs.

3. Regulatory context

Regulatory conditions in the regions are subject to the requirements of the jurisdiction of the State of Queensland, which has statutes, regulations, policies and ministerial orders. There are also fewer formal standards, guidelines and codes of conduct, such as regulatory instruments imposing expectations on mining companies. Some federal legislation is also relevant to activities, such as the *Environment Protection and Biodiversity Conservation Act 1999* and *Aboriginal and Torres Strait Islander Heritage Protection Act 1984*.

Queensland's different approval pathways for resources are complex. QRC has published detailed flowcharts for the [overall resource project approval](#) and [mining lease applications](#).

3.1 Rehabilitation and surrender requirements

Since 2018, the Queensland Government has progressively reformed the financial assurance (provisioning), rehabilitation and residual risk frameworks to deliver:

- a higher level of environmental performance
- rehabilitation investment in the state's resources industry
- better protection of the state's financial interests.

This is accompanied by the existing EIS and surrender framework.

Prior to this, rehabilitation and the transition to post-mining land outcomes was not always well considered. However, under the new legislative regime, largely established by the *Environmental Protection Act 1994*, post-mining land outcomes are considered initially during a project's development and assessment. For existing mines, there are provisions for transition to the new framework.

For a site-specific application, proponents must prepare a PRCP to establish how and where activities will be carried out on the land in a way that maximises the progressive rehabilitation. It must identify the PMLUs and any non-use management areas, having regard to the criteria in the *Environment Protection Regulation 2019*, and be accompanied by time-based milestones and any conditions imposed by the administering authority. For all other mining applications, a PMLU is typically stated in an EIS.

The most common PMLUs are:

- grazing
- native bushland/woodland
- dryland cropping
- watercourse
- water storage.

After mine closure, and as part of the surrender process, the administering authorities certify that the requirements of a PRCP and/or environmental authority (EA) have been achieved and any residual risks accounted for by means of a payment to the state's pooled fund and delivery of a post-surrender management report.

As well as direct attention in mining laws and environmental laws, issues relevant to PMLUs can receive fragmented attention from a range of state government departments, such as finance, health, indigenous affairs, labour and employment, social welfare, planning, and infrastructure.

3.2 PMLU and the regulatory environment

Prior to the introduction of the PRCP framework, the administering authority adopted a rehabilitation hierarchy, as stated in the (now superseded) *Guideline: Rehabilitation requirements for mining resource activities*, to prevent or minimise environmental harm and guide PMLU priorities:

1. Avoid disturbance that will require rehabilitation
2. Reinstatement a 'natural' ecosystem as similar as possible to the original ecosystem
3. Develop an alternative outcome with a higher economic value than the previous land use
4. Reinstatement previous land use (e.g. grazing or cropping)
5. Develop lower value land use
6. Leave the site in an unusable condition or with a potential to generate future pollution or adversely affect environmental values.

The rehabilitation hierarchy was not supported by the mining industry as it often contradicted stakeholder expectations, such as when a company has consulted and agreed on the next land use with relevant stakeholders consistent with local planning instruments.

The hierarchy was subsequently removed with the introduction of the PRCP framework. The accompanying *Guideline: Progressive Rehabilitation and Closure Plans (PRC Plans)* provides that a PRCP must identify what the final use of all land within the relevant tenures will be and how rehabilitation outcomes will be achieved progressively throughout the life of the mine. Selecting and justifying appropriate PMLUs is fundamental to the PRCP framework and underpins the statutory obligations in the PRCP schedule.

The Mined Land Rehabilitation Policy and the Environmental Protection Regulation 2019 sets out the government's expectations that mine operators will propose suitable land uses following consideration of the surrounding landscape, community views and the objectives of any local and regional planning strategies. This new approach provides flexibility by not prescribing a PMLU. As such, it is possible that any of the PMLUs identified in Chapter 5 could be approved by the government having regard to site-specific and regional contexts and where supported by appropriate evidence.

For existing mines, there are transitional arrangements for the shift to the PRCP framework. Existing PMLUs and areas with no intended use, non-use management areas (NUMAs), stipulated in a *land outcome document* (see definition in section 750 of the *Environmental Protection Act 1994*) will be preserved in the transition. Typical land outcome documents include EAs and documents made under conditions of environmental authorities. In the preparation and approval of a PRCP, rehabilitation conditions will be removed from an EA and inserted into a PRCP as relevant.

Changes to PMLUs and NUMAs can occur as part of the transition, however, the application will generally be subject to other legislative provisions of the assessment and approvals process, such as public notification, to the extent of the change. However, public notification does not apply where an authorised NUMA is changed to a PMLU. The mining industry is concerned that the legislation provides a right for third parties to make a submission at public notification for minor amendments to a PRCP schedule. Once a decision is made by the administering authority, any submitters (for submissions made during the notification stage), if unhappy with the decision, can request that their submission be taken to be an objection for the application, also requiring referral to the Land Court. Industry stakeholders have commented that this pathway has been used for frivolous and vexatious matters by environmental groups to object to, delay and stall mining projects.

For changes from 1 PMLU to another, applied for after the transition period (November 2022), this will trigger the major amendment process under the *Environmental Protection Act 1994* and fees. However, public notification is not required where the change either reduces the area of a NUMA or is likely to reduce, or cause no change to, the impacts on environmental values caused by the activities stipulated in the schedule.

While there is the ability for proposed changes to PMLUs or NUMAs throughout transition or thereafter, companies will need to consider the benefits of the change, having regard to the legislative provisions that such application may be subject to along with other implications.

3.3 Queensland's planning system

Queensland's planning framework (see Figure 2 below) is established under the *Planning Act 2016*. It is the main instrument for managing how towns and regions grow and change in a way that ensures positive outcomes for regional people, places, environment and economy. The framework comprises 3 main systems: plan-making, development assessment and dispute resolution. State and local governments share the responsibility for delivery and operation of these systems.

In the system, regional plans are key documents reviewed in this project, considering their scale and focus on aspirations desired in the regions by addressing existing or emerging regional issues. They are prepared in collaboration with local governments, key industry groups and the wider community to ensure the aspirations of all regional stakeholders are considered. As the pre-eminent plan for the region, the regional plans are implemented by the coordinated actions of state and local governments and the communities.

Besides the Queensland's planning framework, relevant land use regulations (e.g., Declared Fossicking Areas, Important Agricultural Areas, National Parks and Protected Areas) need to be considered.

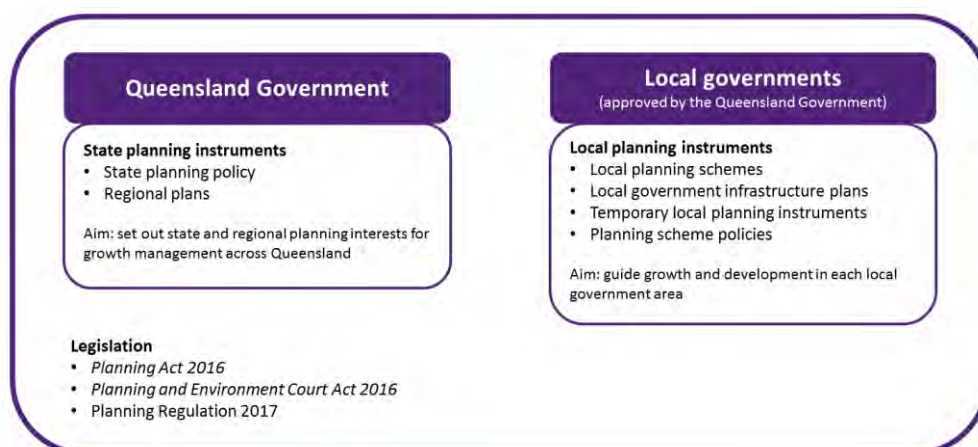


Figure 2: Queensland's Planning framework and the set of state and local planning instruments.

4. Regional context

The level of dependence on mining is an important indicator of a region's capacity to transition to a post-mining future. Economic diversification builds resilience, enhances sustainability and supports the maintenance of a critical population mass needed for regional viability. Understanding the regional context and critically assessing a region's existing strengths, constraints and aspirations provides a strong basis from which to identify post-closure opportunities.

The aim of this chapter is to profile each of the study regions. The chapter introduces key regional strengths and constraints; highlights post-mining considerations revealed in the review of regional plans, a preliminary survey and roundtable discussions; and captures major development projects by region. The environmental context of each region is also described, providing an overview of climate, ecosystems and land uses. The description are based on an analysis of the thematic maps accompanying this report:

- [Biodiversity \[Corridors and Protected Areas\].pdf](#)
- [Biodiversity \[Pre- and Post clearing\].pdf](#)

- [Climate \[Compilation 1\].pdf](#)
- [Climate \[Compilation 2\].pdf](#)
- [DAWE_Interim Biogeographic Regionalisation for Australia \[Version 7\].pdf](#)
- [Land Use.pdf](#)

Before profiling the regions, we note the challenges associated with defining regional boundaries. Spatial boundaries are rarely specified according to geolocatable parameters. Some regions, such as the Bowen Basin and Clarence Moreton/ Surat Basin, are defined according to geological conditions. Identifying the surface boundary between these regions is somewhat arbitrary as the Surat Basin lies over the Bowen Basin. Based on the availability and type of data analysed, 3 different regional boundaries that broadly lie within the study regions are used in this report. These boundaries are explained on first use. A recent article by Everingham et al. (2021) identifies common characteristics used to define mining regions in the literature. These characteristics include: the dependencies that form around a narrow economic base, disparity in wages between mining employees and workers in other industries, widespread modification of the local landscape, and a distinct mining identity (Marais, 2017; Fleming-Munoz et al., 2020; Boldy et al., 2021; Svobodova et al., 2021). This literature also notes that globally, a majority of mining regions are isolated and sparsely populated.

4.1 Materials and methods

Quantitative socio-economic data were drawn from the **ABS Census** – 2016 Census of Population and Housing Time Series Profile at LGA level. Because the focus of this study is on mining and transition to post-mining futures, local government areas (LGAs) that do not host mining or coal seam gas operations were excluded. As a result, one of the study regions – North Queensland – was divided into two zones: Charters Towers Shire, Mareeba Shire and Townsville City in the south and Cape York in the north.

The LGAs considered in each region are listed below:

- **North West Minerals Province:** Mount Isa City and Cloncurry Shire
- **North Queensland:** Charters Towers Shire, Mareeba Shire and Townsville City
- **Cape York:** Aurukun Shire, Napranum Aboriginal Shire, Mapoon Aboriginal Shire and Weipa Town
- **Bowen Basin:** Isaac Region, Central Highlands Region, Mackay Region and Banana Shire
- **Clarence Moreton/ Surat:** Western Downs Region, Toowoomba Region and Ipswich City.

The data for the specified LGAs of each region have been aggregated. For example, the total population of the North West Mineral Province represents the sum of statistics from Mount Isa City and Cloncurry Shire LGAs. At the state level, data from all Queensland LGAs have been aggregated.⁶ Section 1 of supplementary report (socio-economic data) provides details on socio-economic data sourced from the Australian Bureau of Statistics (ABS).

Another important source of socio-economic data used in the study was the Department of State Development, Infrastructure, Local Government and Planning's (DSDILGP's) **regional plans** and its other **strategy documents**. These documents are listed in the references and cited in relevant sections below. The regional boundaries used in these documents differ from those used in the statistical analysis. The DSDILGP regions are outlined below and categorised according to study region:

- North West Region, comprising the LGAs of Mount Isa City, Cloncurry Shire, McKinlay Shire, Richmond Shire and Flinders Shire – **North West Minerals Province**
- Cape York Region + Far North Queensland Region + North Queensland Region, comprising the LGAs of Torres Shire, Northern Peninsula Area, Aurukun Shire, Napranum Aboriginal Shire, Mapoon

⁶ *Unincorporated QLD and No usual address (Qld)* ABS LGAs were not considered in this analysis.

Aboriginal Shire, Lockhardt River Aboriginal Shire, Pormpuraaw Aboriginal Shire, Kowanyama Aboriginal Shire, Cook Shire, Hope Vale Aboriginal Shire, Wujal Wujal Aboriginal Shire, Douglas Shire, Yarrabah Aboriginal Shire, Cairns City, Mareeba Shire, Tablelands Shire, Cassowary Coast Region, Hinchinbrook Shire, Townsville City, Burdekin Shire and Charters Towers Shire – **North Queensland**.

- Mackay, Isaac and Whitsunday Region + Central Queensland Region, comprising the LGAs of Whitsunday Region, Mackay Region, Isaac Region, Livingstone Shire, Rockhampton Region, Gladstone Region, Central Highlands Region, Woorabinda Aboriginal Shire and Banana Shire – **Bowen Basin**.
- Darling Downs Region + South East Queensland Region, comprising the LGAs of Maranoa Region, Balonne Region, Western Downs, North Burnett, South Burnett, Noosa Shire, Sunshine Coast, Moreton Bay, Brisbane City, Redlands City, Logan City, Ipswich City, Somerset, Lockyer Valley, Toowoomba, Southern Downs and Goondooindi – **Clarence Moreton/ Surat**.

The roundtables (online discussions) and **accompanying surveys** provide a third source of regional data: information and insights from stakeholders who work and/or live in the study regions. Participants were initially drawn from a QRC stakeholder database, which was supplemented by the project team's stakeholder database and further expanded using the snowball method (following up referrals from participants). Due to the small sample size (27 people), the roundtables are considered preliminary scoping discussions rather than an in-depth exploration of mine closure and post-closure issues. They represent a very limited, rapid engagement to gain insights into the general landscape as a precursor to future engagement.

The online survey, designed in Survey Monkey, was sent to each participant approximately 5 days before the roundtables were held. The survey aimed to map participants' visions for their region's future, as well as their views on regional strengths, constraints and opportunities for post-mining development. The survey also focused their attention on the issues to be discussed during the roundtables. The survey took participants approximately 8 minutes to complete and contained 4 sections: demographics, vision for the region, opportunities for future development and nomination for online workshops. Eighteen surveys were completed: 7 from the North West Minerals Province, 1 from North Queensland, 5 from Bowen Basin and 5 from Clarence Moreton/ Surat). Survey results are summarised in Section 2 of the supplementary report (socio-economic data).

The 2-hour long roundtables were conducted via videoconference (Zoom) and video-recorded. Separate roundtables were held for each region. Participants' aspirations and their perspectives on regional strengths and constraints were discussed and documented. The discussion focused on six core topics considered critical for regional development (e.g., OECD 2019; Hajkowicz et al. 2011): infrastructure and utilities, economic factors, environmental factors, employment, skilled/trained workers, and healthcare and education. Other considerations that participants highlighted as important for their region's post-mining future were also captured. Their insights and regional knowledge enabled the study team to 'ground-truth' the data it had identified in the document analyses. The roundtable results are summarised in Section 3 of the supplementary report (socio-economic data).

In parallel to the gathering of socio-economic data, a technical assessment was undertaken for each mining region to define which PMLU was feasible solely from a technical perspective. Information was collated about biophysical parameters (biodiversity, geology and soils, climate and water availability) and infrastructure networks, as most PMLUs would require specific biophysical characteristics, inputs of energy or water, and the means to export their production. This information was collated in the form of thematic maps. A critical methodological constraint was that the mining regions cover large areas, with mines sometimes concentrated in small portions of the region, particularly in north and west Queensland. The technical assessments could not be undertaken at the same scale as that adopted for the analysis of socio-economic data. The resulting maps would not have clearly displayed the features of interest. As such, the thematic mapping adopted boundaries that facilitated spatial analysis for six major 'focus areas' within the four mining regions. The delineation for these focus areas aimed to include the majority of mine operations

within the region and capture the characteristics and features of the wider region, such as geology or infrastructure.

To characterise biodiversity features of each region or focus area, the Interim Biogeographic Regionalisation for Australia (IBRA) provides a comprehensive, adequate and representative framework for classifying the land surface, endorsed by all levels of government. There are 89 IBRA regions across Australia, shown in a map provided in the supplementary report on technical assessments. The environmental context of a region is shaped by the IBRAs that it overlays.

The technical suitability of a PMLU is dictated largely by the nature of the biophysical characteristics within the area of interest and/or by the area's proximity to specific features. Technical suitability was assessed for each of the focus areas by undertaking spatial analyses to overlay relevant biophysical parameters and perform distance calculations. Qualitative assessments were also undertaken when a quantitative approach was not applicable. Findings were used to provide an overview of the strengths and constraints of each region with respect to its potential for supporting PMLUs, to develop a suitability ranking for each PMLU and to select the most suitable PMLUs in each region, based solely on technical aspects. This constituted a key input into defining the regional suitability of PMLU, as discussed in Chapter 5. Detailed methodology and results are provided in the supplementary report (technical assessment).

Analytical framework

Regional strengths and constraints were analysed using the **five capitals framework**. The framework is widely used in exploring community capabilities to address local as well as global environmental challenges (Reddy et al., 2004; Sayer et al., 2007; Brown et al., 2010) under the assumption that 5 forms of capital serve as proxy indicators of community capabilities. Lin (2001, p. 3) defines capital as “an investment of resources with expected returns in the marketplace”. The five capitals are:

1. **Social capital:** the social relationships that enable individuals and groups to act collectively (Goodwin, 2003; Moore et al., 2006; Voora and Venema, 2008).
2. **Natural capital:** encompasses a spectrum of natural assets (e.g. land, water, clean air, wildlife and forests) that people can access for lifestyle or livelihood purposes and that provide ecosystem services.
3. **Financial capital:** money (currency) or wealth that enables the other capitals to be owned or traded.
4. **Human capital:** people's health, knowledge and skills that are either inherited or acquired through education or training. Human capital enables individuals to work, earn a living, contribute to society and, thereby, build other forms of capital.
5. **Manufactured or built capital:** physical infrastructure and engineered outputs, such as computers, cars, houses and highways.

4.2 North West Minerals Province



Figure 3: North West Region (DSDIP, 2010, p. 4).

4.2.1 Description

The North West Minerals Province (NWMP) is located in north-west Queensland, around 300km south-west of Townsville and 2000km north-west of Brisbane, the state's capital (see Figure 3).

The NWMP has the second lowest population of the study regions with 21,703 and the second highest percentage of residents who identify as being of Aboriginal and Torres Strait Islander heritage (17.7%). There is a large percentage of males (52.35%), a high percentage of children (23.45%) and a low percentage of elderly residents (7.40%) compared with the rest of Queensland. The mean age is 31.42 compared with 37.69 across the state. The predominant family composition is families with children (25.98%) followed by lone person households (20.64%) and families with no children (19.91%).

This region is highly dependent on mining (see Figure 4 and Figure 5). Mining is the largest sector employer (employing 29.84% of the workforce) and the most common employment types feature prominently in the mining industry (technicians and trade workers, 21.22%; machinery operators and drivers, 16.16%; professionals, 15.46%; and clerical and administrative workers, 10.80%). Other major employment sectors are health care and social assistance (10.16%), education and training (8.03%), retail trade (7.64%) and public administration and safety (6.57%). The North West Minerals Province has a higher rate of unemployment (7.19%), higher percentage of full-time employees (75.02%) and lower percentage of part-time employees (18.50%) than state-wide.

The most common education level obtained is secondary education of year 10 or higher (25.86%) and Certificate III/ IV (17.23%). Higher education levels are lower than the state average.

Median personal gross weekly income levels are higher (\$700.01) and median family gross weekly income levels are lower (\$1581.51) than Queensland figures (\$679.07, \$1718.88).

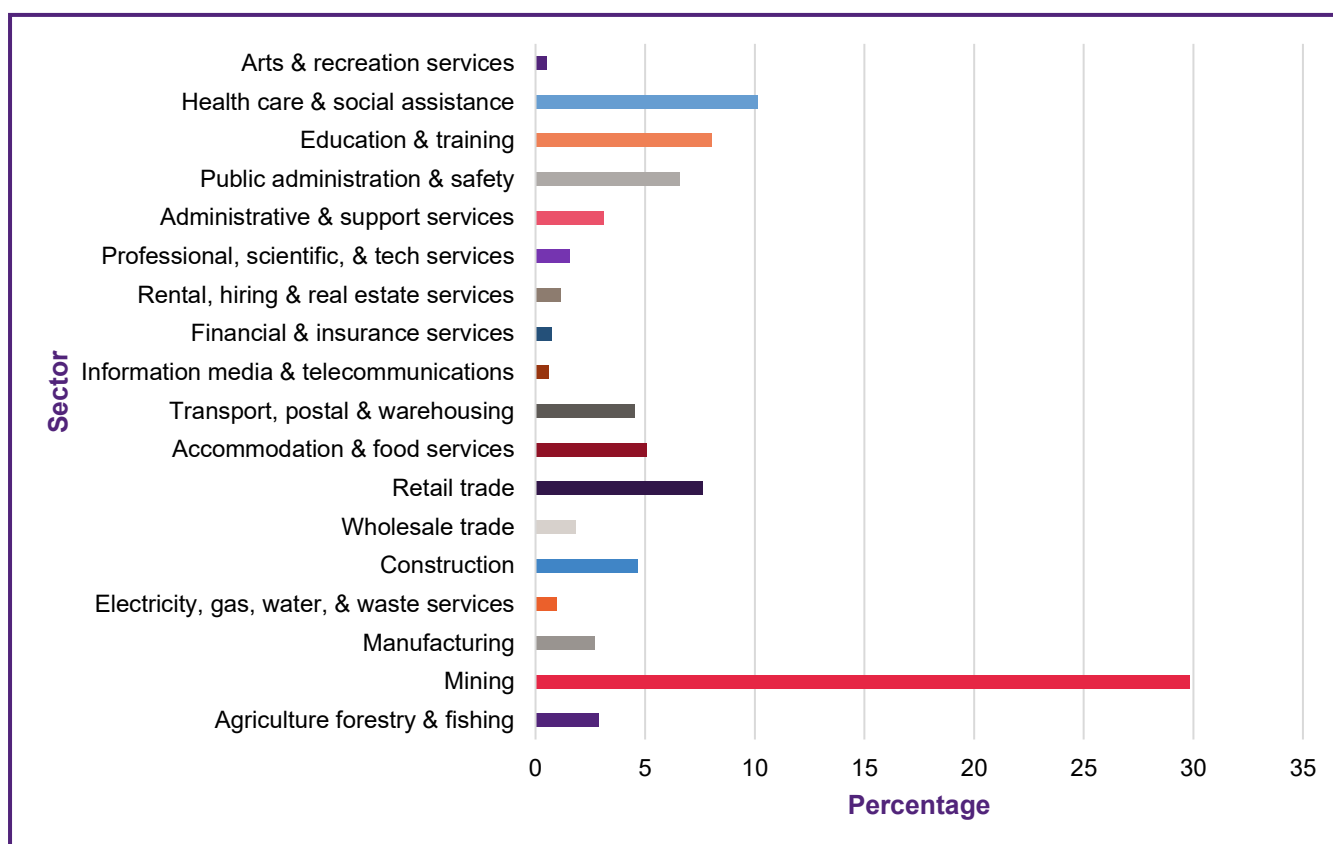


Figure 4: Employment by sector

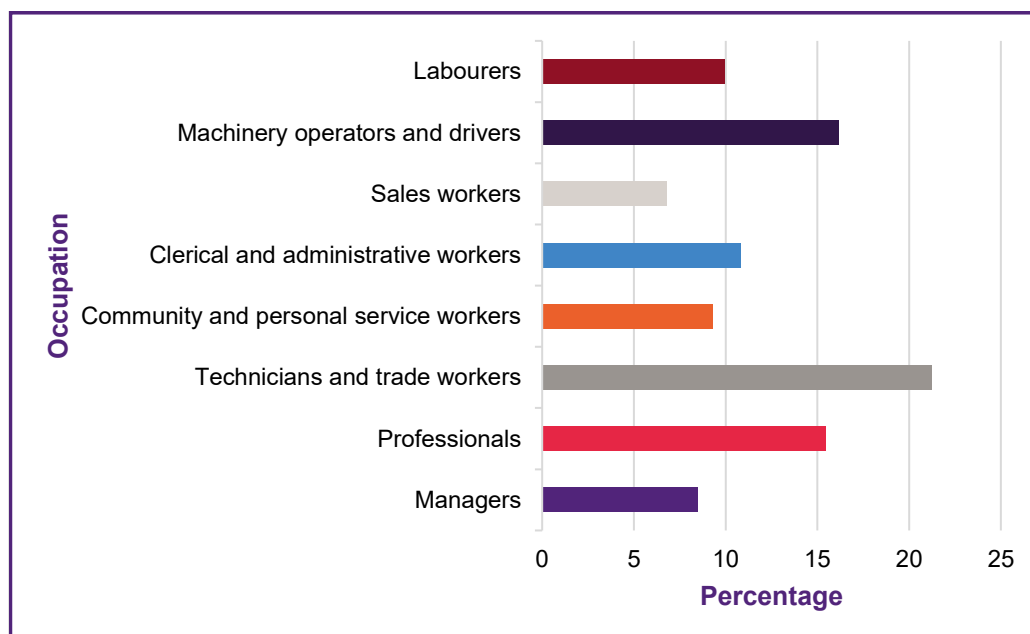


Figure 5: Employment by occupation

4.2.2 Environmental context

This region has experienced relatively limited large-scale alteration of ecosystems, apart from within the mining areas. Land use is mainly native grazing vegetation and the regional ecosystems are generally in good condition. However, due to the low productivity of native grasses, several pasture species have been sown, creating some potential weed issues. As cattle need to graze across large areas, the impact can be widespread.

The predominant ecosystems are low open woodlands dominated by snappy gum (*Eucalyptus leucophloia*), Cloncurry box (*E. leucophylla*), and silver box (*E. pruinosa*), with spinifex communities (predominantly *Triodia pungens*) in the open woodlands of the Mount Isa Inlier and Desert Uplands IBRA. Biodiversity corridors are mainly concentrated on recent Quaternary alluvial river and creek systems, which are endangered and could be linked to Dugald River and Mt Isa lease areas. There is some concern about high rates of land clearance in south-eastern parts.

The region has very high solar radiation, low average annual rainfall (<500mm), and very hot summers, which poses constraints for agriculture and attracting visitors. The geology is complex, with a variety of mineral-enriched zones. There are many open-cut and underground mining operations with large tailings footprints, potential for acid mine-drainage and metal mobilisation. There are well-documented lead contamination issues in Mount Isa. Soils are generally not conducive to supporting cropping except in the north-east part of the region.

4.2.3 Regional aspirations

This section summarises the region's long-term aspirations and strategic direction; that is, where it will grow and how it will respond to change over time. Two types of aspirations are considered: the state government's vision⁷ informed by the North West Regional Plan (2010), and stakeholders' aspirations⁸ revealed in the preliminary survey and roundtables.

Government's vision: The region has a robust, diverse and sustainable economy and well-planned and coordinated infrastructure and services, built through the economic benefits of mining and agricultural industries. It is a place where people choose to live and visit due to its liveability, well-managed natural resources and the community's strong sense of cultural identity.

Stakeholders' aspirations for the region's post-mining future are reflected in the word cloud below:



⁷ The government's vision is a summary of visions articulated by one or multiple regional plans covering each study region.

'Government' in this context primarily refers to the Queensland Government, the author of the plans, carried out in consultation with the relevant LGAs.

⁸ Stakeholders' aspirations were identified during roundtables where stakeholders used keywords or short sentences to describe what they hope their region will be like when mining eventually finishes there. Here, we present word clouds created from their responses. The larger keywords, the larger frequency in the responses.

There is some alignment between stakeholder aspirations and the government visions: common themes and objectives include an economically viable, resilient and liveable region. Differences include the government's focus on growth via mining and agricultural industries and stakeholders' emphasis on economic stability and achieving a non-polluting, stable environment.

4.2.4 Regional strengths and constraints

The strengths and constraints of the NWMP are summarised according to the five capitals framework. Further details are provided in Section 2 and 3 of the supplementary report (socio-economic data).

Social capital: The NWMP has a strong mining culture, multicultural history and identity. Compared with the rest of Queensland, it has a young population, represented by a higher percentage of families with children. It also has a significant Indigenous population. The region's social capital is constrained by its geographic isolation and its small, declining population base.

Natural capital: The NWMP has globally significant mineral resources, national parks,⁹ high solar radiation and good air quality across most of the region. The key constraints to natural capital relate to the region's mining activities and climate. The open-cut and underground mines have long operating lives and extensive zones of impact, including large tailings storage facilities. Natural capital is also affected by temporal variance of climate with limited rainfall (<500mm). Natural capital must be protected if sustainable alternative industries are to eventuate.

Financial capital: The regional economy is underpinned by mining and supported by the healthcare, education and retail sectors which are also influenced by mining. Although not a significant primary employer, the agriculture sector features prominently in the government's vision for the region. The major constraint is a lack of economic diversity. Flow-on effects include the vulnerability of the mining and agriculture industries to fluctuations in climate, commodity prices and changes to employment and work practices; and the heavy dependence of small and medium-sized enterprises (SMEs) on the resources sector.

Human capital: Almost a third of NWMP residents are employed in the mining industry. Consequently, the region has a substantial pool of technicians, trades workers, machinery operators and drivers, and professionals. Historically, the mining hub of Mount Isa has been at the forefront of designing and commercialising mineral technologies. Another regional strength highlighted by roundtable participants is the high-quality staff in healthcare and education sectors, although it is challenging to recruit and retain them. The region's remoteness from urban centres is a significant constraint on human capital. It results in worker shortages; a high proportion of fly-in and fly-out (FIFO) workers; and very limited tertiary education and availability of apprenticeships and traineeships in the region.

Built capital: The NWMP is connected to the urban centre of Townsville and beyond by air, road and rail infrastructure. These transport links are integral to the regional economy; workers, tourists and supplies in, and commodities out. The region has well-established water supply schemes with trading mechanisms. Constraints include a lack of social services and affordable housing, low communication connectivity and high cost of providing infrastructure (electricity, water, transport, etc). Land in the region is largely dominated by pastoral leases, which in Queensland are considered under the *Land Act 1994*, allowing a large area of land to be rented from the Crown for pastoral purposes for a fixed period of time. The leases are generally held for a long period of time but remains in the ownership of the state.

⁹ The location of Queensland national parks is shown in the biodiversity corridors thematic map (supplementary information), under the appellation of "protected area".

4.2.5 Projects and the mining context

Capturing data on the mining, energy and infrastructure projects proposed across the study regions will help inform assessments of the potential for economic diversification. Detailed project data are provided in Section 4 of the supplementary report (socio-economic data).

Three major projects are proposed for the NWMP; a vanadium mining project (Saint Elmo), the Cloncurry solar farm, and the CopperString electricity transmission project. Saint Elmo, located 15km east of Julia Creek in McKinlay Shire, gained federal government approval in April 2021 and Queensland Government approval in September 2021. Once operational, it has a projected mine life of 30 years. Saint Elmo will provide jobs and boost the regional economy. A 30MW solar farm is proposed for Cloncurry Shire. The CopperString high-voltage overhead electricity transmission line will link the region to the National Electricity Market grid, south of Townsville. CopperString will provide industrial customers with more competitively priced power, enhancing economic viability of local industries. The project is scheduled for completion by 2024.

These projects will enhance the existing mining and energy context. NWMP is home to 31 operating mines, most of which are extracting copper. Other commodities mined in the region include gold, zinc, quarry rock, silver, limestone, phosphate rock, quartz and gravel. There are also 6 gas-fired power generation plants in NWMP. Further information is available from the thematic maps that accompany this report: [Mine locations \[commodity\]](#), [Mine locations \[area\]](#), [Infrastructure \[energy\]](#).

4.2.6 Post-mining considerations

NWMP is dependent on mining. Regional stakeholders have suggested an array of options to diversify the economy as part of its transition to a post-mining future. These include opportunities in agriculture (beef cattle production, cropping, feral animal and kangaroo harvesting, forestry, wheat and forage hay harvesting, lot feeding, dry land agriculture, aquaculture), tourism (predominately drive tourism, strong focus on outback experience), small business/ supply chain and manufacturing. Tourism is an emerging industry in the region but requires greater diversity of agencies involved. In Mount Isa, for example, this role is being driven by council. Economic diversification is on the Mount Isa City Council's agenda, having commissioned the Centre for International Economics to prepare an economic development strategy which was published in 2017. One of the 5 strategic pathways is to diversify the economy (mining and non-mining sectors) to build greater social and economic resilience. There is also an interest in establishing a university campus in Mount Isa or a hybrid system with some courses offered online. The NWMP roundtable noted demand for employment opportunities that could be carried out online. Communication connectivity would need to be improved.

Identifying incentives for people to study, train, work and live in the NWMP and to build links between educational levels and employment requirements will be an important consideration in transition planning as a stable population base is necessary for maintaining vibrant communities, the provision of essential services and supporting local businesses.

From a natural capital perspective, the region has vast potential as a producer of solar and geothermal energy. In addition, the region is home to pockets of high-value ecosystems. Mapping is required to understand where the region's key natural features are located and how to protect them. Landscape modification from mining will also need to be addressed.

4.3 North Queensland

4.3.1 Description

North Queensland is located in northern-most end of eastern Australia. It is a large region, spanning more than 1200km north to south. The southern-most tip is around 1200km north of Brisbane (see Figure 6).

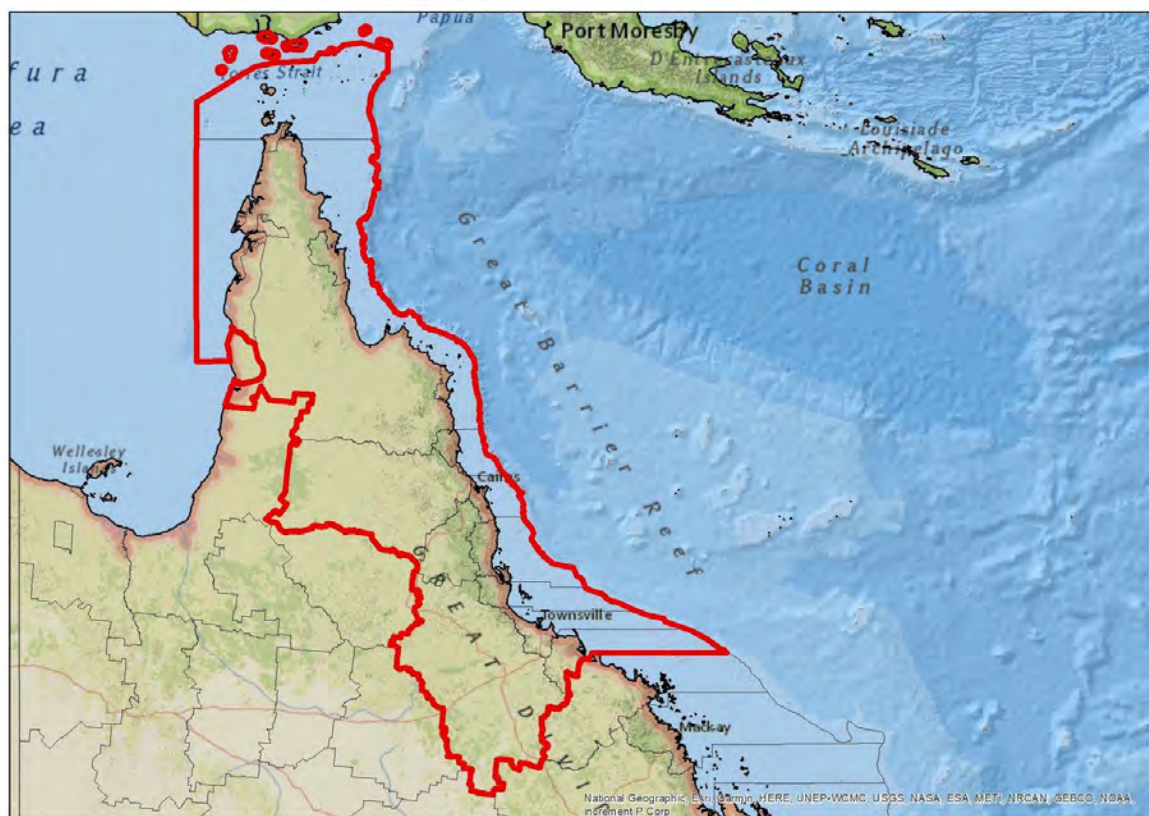


Figure 6: North Queensland region.

North Queensland (excluding Cape York) has a population of 220,190, an even distribution of males (50.21%) and females (49.80%), and a small percentage of Aboriginal and Torres Strait Islander residents (7.66%). The percentage of children (20.05%) and elderly residents (13.09%) is comparable with state-wide statistics. The mean age is 35.20. There is an even distribution of family types: couples with children account for 26.88% of the population, couples with no children (25.03%) and lone person households (22.24%).

North Queensland is one of the regions least dependent on mining, with only 2.75% of people employed in the mining sector. The main employment sectors are health care and social assistance (14.23%), public administration and safety (12.81%), retail trade (9.80%), education and training (9.63%) and construction (8.00%) (Figure 7). There is also a relatively even distribution of employment by occupation, with professionals accounting for 18.13% of the population, technicians and trades workers (14.98%), community and personal workers (14.33%), clerical and administrative workers (13.13%), managers (10.51%), and labourers (10.34%) (Figure 8). North Queensland has a lower rate of unemployment (6.66%), higher percentage of full-time employees (64.05%) and lower percentage of part-time employees (30.20%) compared with Queensland statistics.

Like elsewhere in the state, the most common education level obtained is secondary education of year 10 or higher (28.19%) and Certificate III/ IV (15.97%). Higher education levels are also comparable with state-wide statistics.

Median personal gross weekly income levels (\$618.67) and median family gross weekly income levels (\$1454.68) are lower than Queensland figures (\$679.07, \$1718.88).

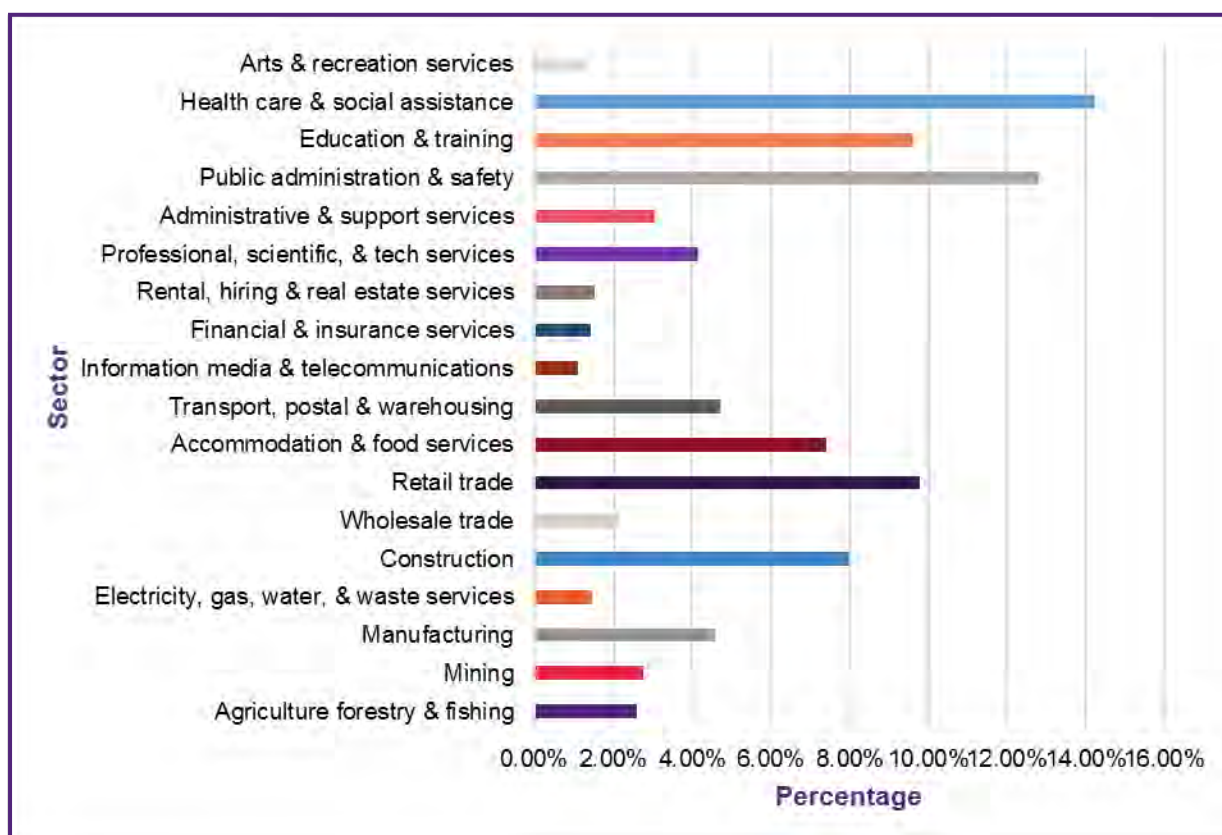


Figure 7: North Queensland employment by sector

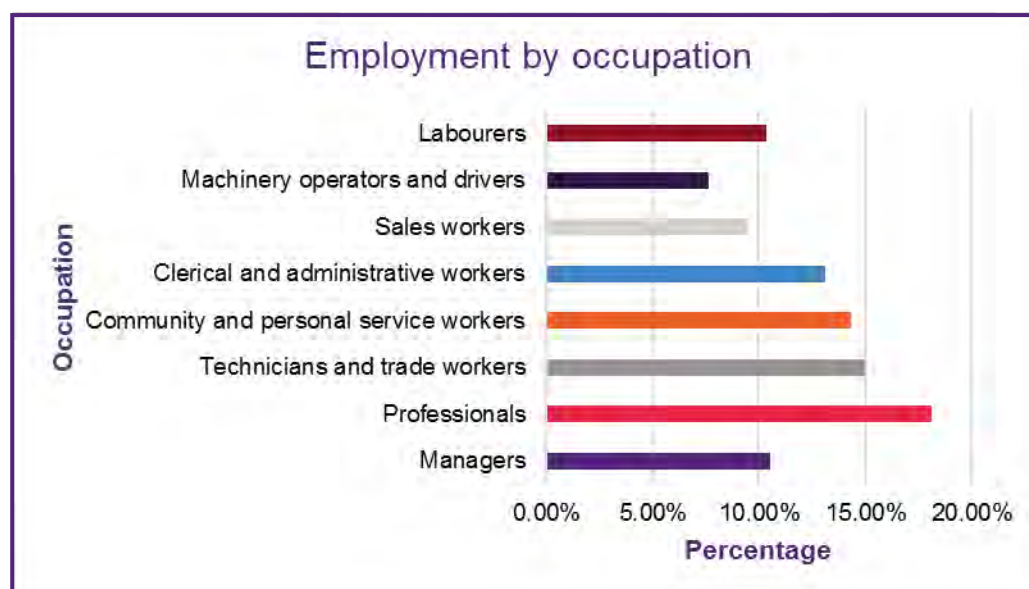


Figure 8: North Queensland employment by occupation

Cape York

Compared with the other study regions, Cape York has a small population (6441). Almost half the residents (48.04%) identify as being of Aboriginal and Torres Strait Islander heritage. There is a large percentage of males (52.40%), a high percentage of children (27.74%) and a very low percentage of elderly residents (3.17%) compared with the rest of Queensland. The mean age is 29.32 compared with 37.69 across the state. The primary family composition is families with children (35.36%) followed by families with no children (18.47%) and lone person households (16.11%).

Cape York is highly dependent on mining. The mining sector is the primary employer, accounting for 36.67% of the population and the most common occupations are related to mining (technicians and trades workers, 23.72%; machinery operators and drivers, 21.73%). Of the study regions, Cape York has the highest percentage of people employed in mining. Other significant employment sectors, which also rely on mining, include education and training (8.75%), healthcare and social assistance (8.40%) and public administration and safety (8.21%) (Figure 9). Other sizeable occupational categories are professionals (14.09%), community and personal workers (9.97%), and clerical and administrative workers (9.05%) (Figure 10). Compared with Queensland-wide statistics, Cape York has a lower percentage of unemployment (6.33%), higher percentage of full-time employees (75.21%) and lower percentage of part-time employees (18.03%).

Educational levels in the region are comparable with those across the state. A significant number of residents (25.47%) have attained secondary education of year 10 or higher and 16.87% have completed education to Certificate III/ IV level. There is a lower percentage of residents with higher education levels and a higher percentage of residents with secondary education of years 9 and below compared with the Queensland average.

Income levels are higher than the state average. Personal gross weekly income is \$717.05 (\$679.07) and family gross weekly income \$1788.94 (\$1718.88).

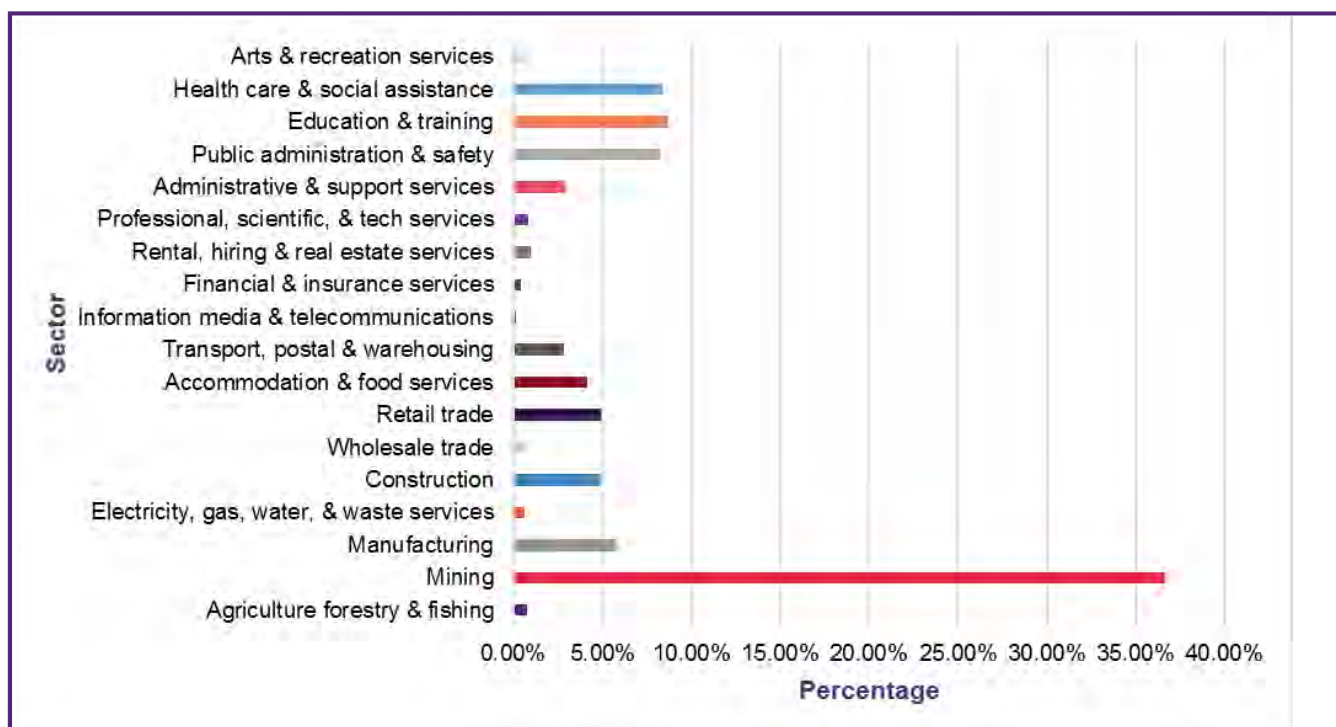


Figure 9: Cape York employment by sector

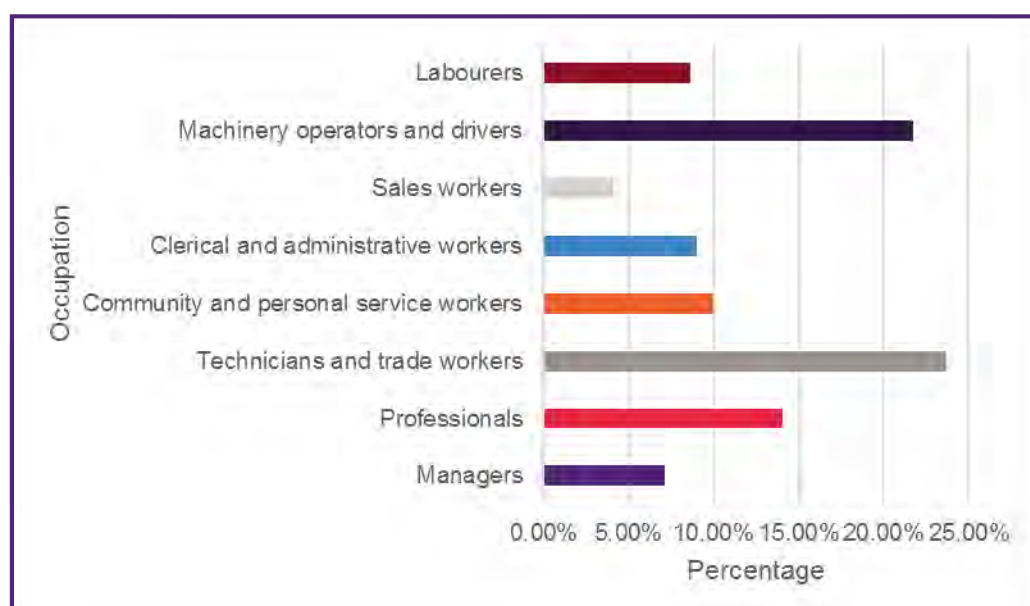


Figure 10: Cape York employment by occupation

4.3.2 Environmental context

The north of the region (Cape York Peninsula bioregion) is characterised by limited large-scale alteration of ecosystems outside of mining areas. The ecosystems are generally in good condition but some of the tropical savannas have experienced considerable degradation from cattle grazing. Inappropriate fire regimes associated with grazing management and invasive species (Gamba grass and feral pigs) raise serious concerns about the long-term trajectories of some ecosystems. Soils have low fertility. The region is low lying, receives high average yearly rainfall (>1900mm) and is subject to regular cyclonic activity, which requires adherence to specific building codes and can severely impact on infrastructure. Most people find the heat and humidity in summer very uncomfortable.

To the south, the Tablelands denotes the area located on a large plateau inland from the North Queensland coast, with vegetation consisting of savanna and woodland. The area has long been used for cattle grazing. Apart from the heavily farmed Atherton Tableland, this area is thinly populated so the landscape is generally well preserved, noting it has been modified by overgrazing, clearance for agriculture and the introduction of weeds. Mine lease areas are scattered and cover a very small part of the district, with little impact on 'of concern' ecosystems. Soils tend to have low fertility. Average annual rainfall is 1000mm, concentrated in the summer months. Rainfall is lower in the western part of the district.

4.3.3 Regional aspirations

This section summarises the region's long-term aspirations. Two types of aspirations are considered: the government's vision informed by the Far North Queensland Regional Plan 2009–2031 (2009), North Queensland Regional Plan (2020) and Cape York Regional Plan (2014) and stakeholders' aspirations revealed in the preliminary survey and the North Queensland roundtable.

Government's vision: North Queensland thrives as a diverse, liveable and progressive region in the tropics, set around a leading regional economy of northern Australia. People, industry and government work collaboratively to support sustainable economic development of the region, providing benefits for communities through employment opportunities, access to services and new local industry. The region's unique and diverse environmental values are protected and enhanced, with the liveability of the region's towns improved through increased prosperity.

Stakeholders' aspirations for the region's post-mining future are reflected in the word cloud below:



There is some alignment between stakeholder aspirations and the government visions: common themes and objectives include economic diversity, attractiveness (visual amenity), and business development. Differences include a stakeholder emphasis on transformation and mine rehabilitation. The government's vision highlights growth in all three pillars of sustainability (environment, community and economy), building on uniqueness and exceptional regional assets.

4.3.4 Regional strengths and constraints

The strengths and constraints of the broader North Queensland region (including Cape York) are summarised according to the five capitals framework. Further details are provided in Section 2 and 3 of the supplementary report (socio-economic data).

Social capital: The region has a number of distinct zones, 3 of which were captured in the roundtables (Charters Towers, the urban centre of Townsville and Cape York). Although these zones have their own social identity, roundtable participants affirmed that there is also a strong overarching North Queensland identity. Other social capital includes significant Indigenous cultural values attached to the natural environment. Constraints include the region's remoteness (particularly Cape York and the Torres Strait islands) and dispersed population.

Natural capital: North Queensland has globally significant mineral resources, including critical metals (such as cobalt and nickel) and rare earths. It hosts nationally significant wetlands, tropical rainforests, ranges, rivers, coastal plains, estuaries, bays and islands. There are good quality soils, water availability and a warm climate with high solar radiation and excellent wind speeds. Key constraints relate to the region's long mining history. There are many abandoned mines and there is a lack of certainty around contamination from abandoned mines and tailings. North Queensland's tropical wet season (4-5 months) impacts travel, economic and social activities in some regional areas (e.g. Weipa).

Economic capital: Economic health varies across the region with remote and smaller towns having less economic assets than larger centres. The primary strengths of the region's economy are mining, agriculture, health, education, tourism, manufacturing and defence industries. North Queensland has a well-established supply chain and logistics linkages with Asia-Pacific and domestic markets. Constraints include competition for land (e.g. mining, agriculture), access to water and infrastructure, and the health of SMEs in less populous areas.

Human capital: North Queensland has good health and education facilities and opportunities, as well as world-renowned research facilities, including tropical medicine, public health, marine sciences, agricultural sciences, engineering and environmental studies. However, human capital varies across the region; for example, Weipa offers good quality healthcare while Charters Towers is a major catchment for education and trades training. The main constraints lie outside urban centres; such as inadequate population numbers to sustain services; difficulties in recruiting and retaining employees locally; and the availability of professional development training (e.g. for SMEs).

Built capital: Like economic and human capital, the quality of built capital varies across the region. Strengths include an international airport at Cairns, an international port and domestic airport in Townsville, and a port and regional airport at Weipa. There is good connection to the HV grid in many parts of the region. However, other areas, such as Weipa, are reliant on diesel power generators. Outside the urban centres, the standard of road, air and rail infrastructure is poor and services can be expensive. Another constraint is inadequate internet and mobile phone connectivity.

4.3.5 Projects and the mining context

There are 30 major projects proposed for North Queensland: 2 mining projects, 25 energy projects and 3 water infrastructure projects. These works will help address some of the constraints identified above. The mining projects are the Aurukun bauxite project (25-year mine life) and Galalar silica sand project (15-year mine life).

The energy projects cover 20MW to 1000MW-capacity wind, solar, hydro and battery storage projects, located across 6 LGAs. The largest capacity energy projects are the 1000MW Desailly Renewable Energy Park solar farm and 400MW battery storage facility in Mareeba Shire and the 800MW Forsayth wind farm in Etheridge Shire.

Sunwater is proposing to increase the storage capacity of the existing Burdekin Falls Dam by raising it at least 2m. Construction is scheduled for 2025. Studies are being undertaken to assess the feasibility of 2 other water infrastructure projects: the Hills Gate dam project, a new dam and irrigation scheme in the Upper Burdekin catchment, and the Hughenden irrigation project, which aims to enhance the region's drought and flood mitigation capacity.

These projects will support an already diverse mining and energy environment. North Queensland has 153 mines across 23 commodities, including 43 gold, 28 quarry rock, 12 gravel, 12 marble, 8 bauxite, 8 sand, 8 building stone and 7 zinc operations. Other commodities mined in the region are copper, diatomite, earthy lime/ dolomite, limestone, sapphire, silica sand, aggregate, calcite, garnet, iron, peat, perlite, slate, tin and tungsten. In addition, there are 34 power generation plants in North Queensland, comprising 13 solar, 7 bioenergy, 5 wind, 4 battery storage, 3 hydro and 2 gas. Further information is available from the thematic maps that accompany this report: [Mine locations \[commodity\]](#), [Mine locations \[area\]](#), [Infrastructure \[energy\]](#).

4.3.6 Post-mining considerations

North Queensland's competitive advantage is its geographic position, coupled with its abundance of natural resources and diverse economic drivers in the south-east. The region can take advantage of growth in the Asia-Pacific via its well-established supply chain and logistics linkages across northern Australia and beyond.

To diversify its regional economy, North Queensland has an opportunity to build on its established comparative strengths in mineral resources and related processing, agriculture, tourism, microbusinesses and bioproducts sectors. As the number of proposed renewable energy projects indicates, the region is well placed to capitalise on this growth industry. From a PMLU perspective, there is potential for solar and wind farms in the south-east part of the region; however, the lack of mine sites with significant footprint to host these projects is a 'limiting factor'. The region boasts a vibrant tourism sector but, in some areas, the wet season is a constraint. North Queensland has established smart businesses and services and has a small core group of skilled people with potential to establish the region as a knowledge and innovation centre of excellence. This brings opportunities to expand professional development and skills training for SME owners/ staff locally. Cape York's high dependence on mining will require strategic long-term planning to enable successful transition to a post-mining economy.

Future development of North Queensland requires consistent water resource planning to provide security and certainty for water users. Mining legacies (abandoned mines) remain an issue in some regional areas.

4.4 Bowen Basin

4.4.1 Description

The Bowen Basin is a major coal mining region located in central Queensland, around 500km north of Brisbane (see Figure 11).

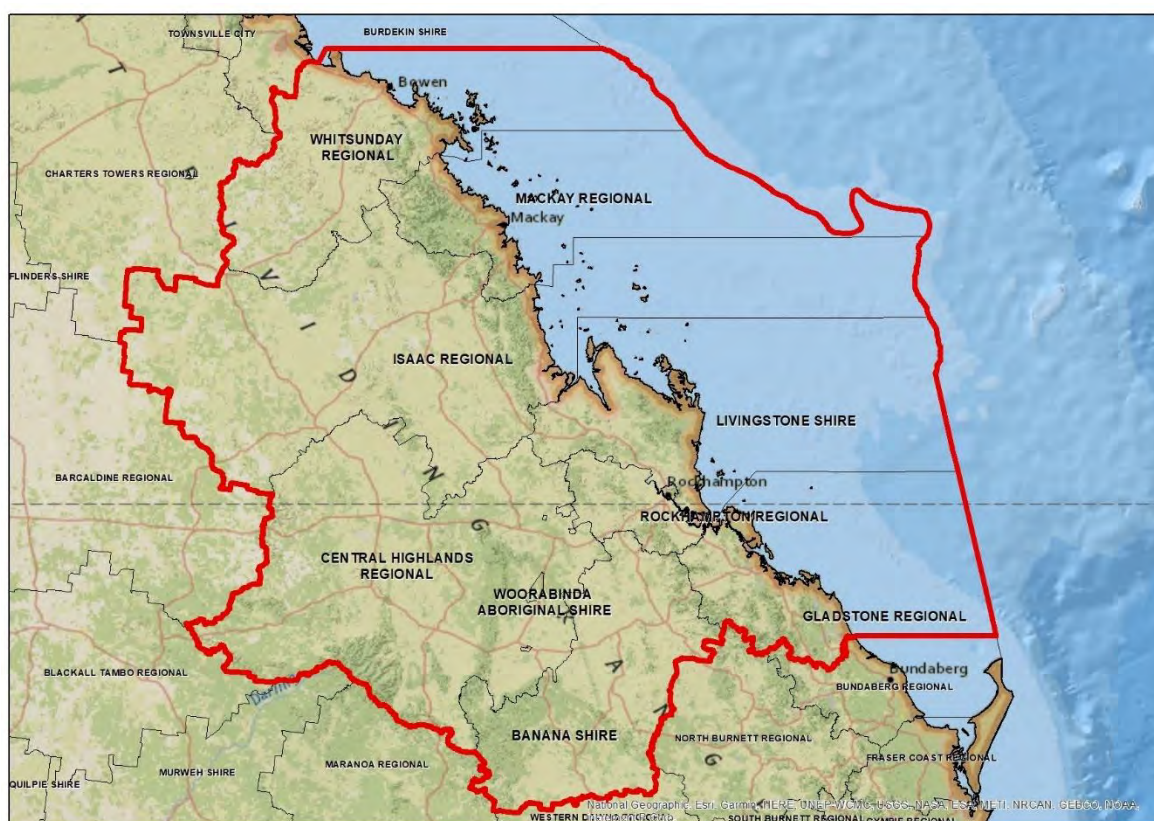


Figure 11: Bowen Basin region.

The Bowen Basin has a population of 178,227, comprising 51.52% males, 48.48% females, 21.97% children and 11.42% elderly citizens. It has the highest mean age (35.78) of the study regions. Aboriginal and Torres Strait Islander residents account for 4.74% of the population. The predominant family composition is couples with children (30.01%), followed by couples without children (25.40%) and lone person households (21.02%).

While mining accounts for the highest percentage of employees in the Bowen Basin (17.53%), it is significantly less than in Cape York and the North West Minerals Province. Other major employment sectors are retail trade (8.85%), health care and social assistance (8.65%), and education and training (7.37%) (Figure 12). There is a diversity of occupations in the region, from technicians and trades workers (19.34%), to machinery operators and drivers (15.18%), professionals (12.95%), managers (12.34%), labourers (11.26), and clerical and administrative workers (11.19%) (Figure 13). The Bowen Basin has a lower rate of unemployment (4.75%), higher percentage of full-time employees (66.82%) and lower percentage of part-time employees (27.03%) compared with state-wide statistics.

Educational levels in the region are comparable with those across Queensland. A significant number of residents (27.68%) have attained secondary education of year 10 or higher and 17.98% have completed education to Certificate III/ IV level. There is a lower percentage of residents with higher education levels compared with the Queensland average.

Median personal gross weekly income levels are higher (\$743.89) and median family gross weekly income levels are lower (\$1684.44) than the Queensland percentage (\$679.07, \$1718.88).

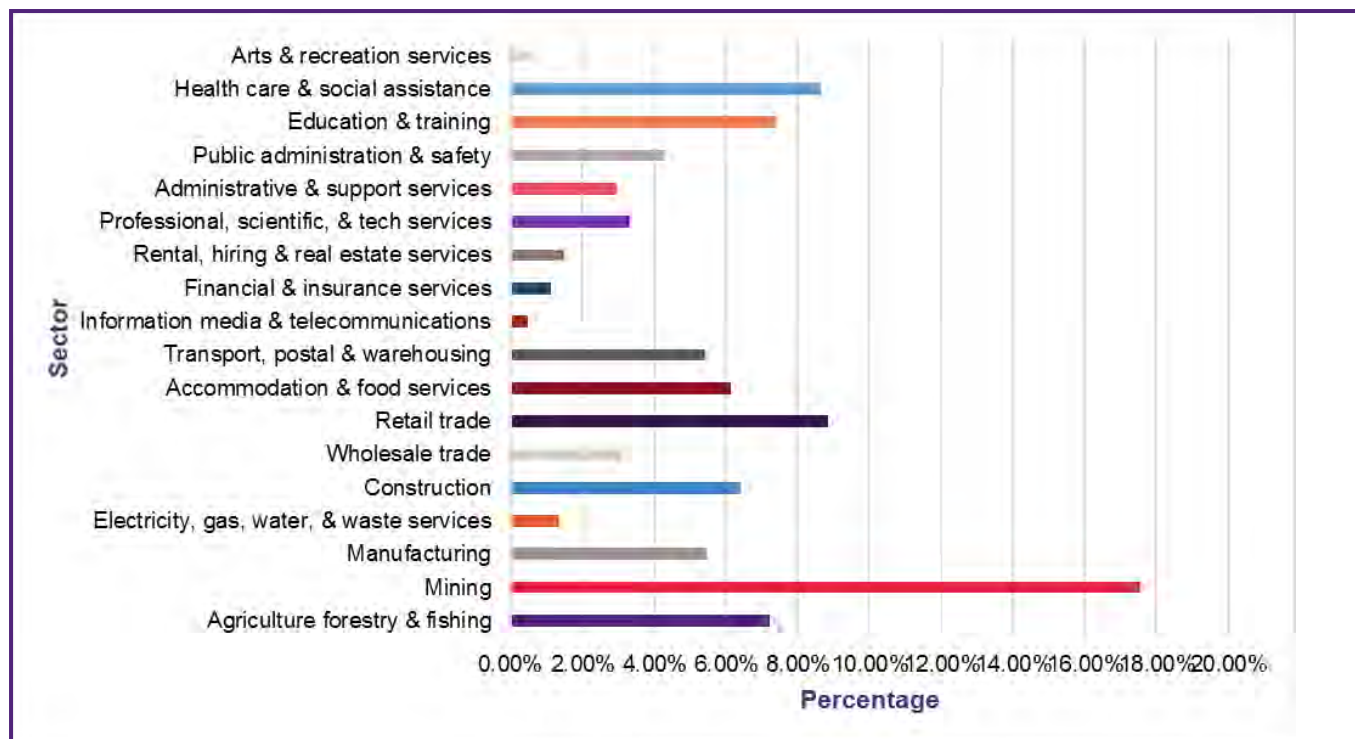


Figure 12: Bowen Basin employment by sector

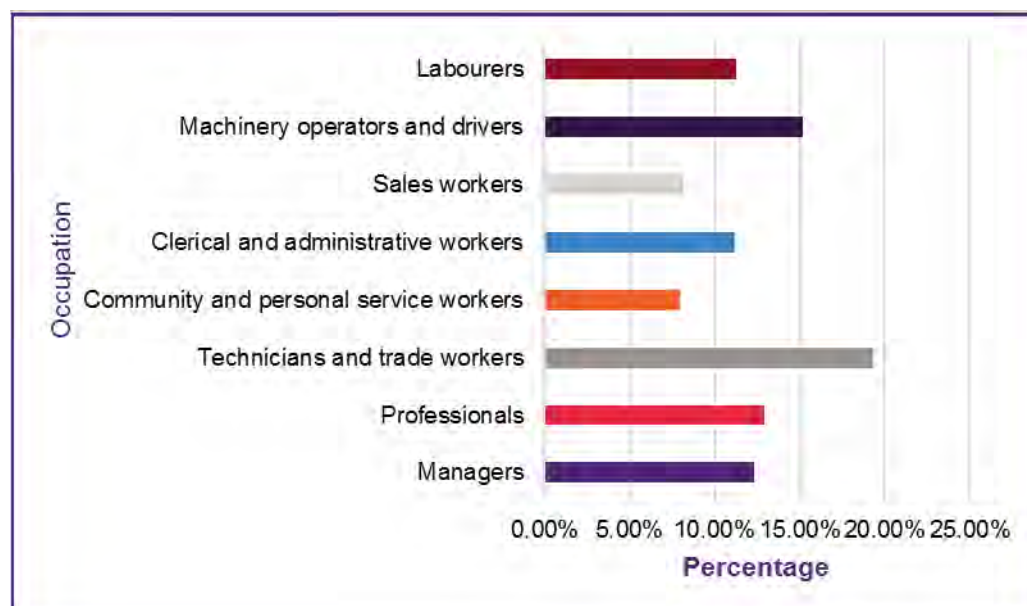


Figure 13: Bowen Basin employment by occupation

4.4.2 Environmental context

The Bowen Basin is located in the Brigalow Belt bioregion, a wide band of acacia-wooded grassland that runs between tropical rainforest of the coast and the semi-arid interior. The characteristic plant is the highly water-stress tolerant brigalow (*Acacia harpophylla*), a slender acacia tree which thrives on clay soils which once covered much of the area, especially the fertile lowlands. Most of the brigalow has been cleared for grazing and agricultural land. This has created a landscape where only relatively small tracks of endangered ecosystems and of concern ecosystems remain. This region is one of the most in need of biodiversity connectivity to be reinstated and perhaps the largest opportunity for mining leaseholders to contribute to reversing habitat loss.

The region has a hot to warm subhumid climate with summer-dominant rainfall (around 500mm/year on average, with large variations from year to year). Large areas have soils suitable for agricultural systems but the region is also characterised by large extent of dispersive soils, which contain high levels of sodium, have a low-nutrient status and are very vulnerable to erosion and dryland salinity when vegetation is removed.

4.4.3 Regional aspirations

This section summarises the region's long-term aspirations. Two types of aspirations are considered: the government's vision informed by the Mackay, Isaac and Whitsunday Regional Plan (2012) and Central Queensland Regional Plan (2013), and stakeholders' aspirations revealed in the preliminary survey and the Bowen Basin roundtable.

Government's vision: The region is vibrant and progressive. The values of the community and industry are respected and in balance with the natural environment. The region's natural assets and abundant resources will be responsibly managed for the benefit of residents, visitors and future generations. It achieves its potential with a range of industries, employment and learning opportunities for everyone. The region has a resilient and inclusive community that respects and offers diversity and choice, and where residents and visitors enjoy a healthy, active and safe lifestyle.

Stakeholders' aspirations for the region's post-mining future are reflected in the word cloud below:



There is alignment between the two types of aspirations. The government's vision highlights growth in all three pillars of sustainability (environment, community and economy), building on diversity of regional assets and resilient communities. Stakeholders' aspirations include these factors but emphasise diversified industry and innovation.

4.4.4 Regional strengths and constraints

The strengths and constraints of the Bowen Basin are summarised according to the five capitals framework. Further details are provided in Section 2 and 3 of the supplementary report (socio-economic data).

Social capital: The region has young population and a family-oriented culture. It is considered a safe place in which to raise children. The region builds on strong mining and pastoral cultures, histories and identity.

Natural capital: There is an abundance of natural assets in the Bowen Basin, including climate with high solar radiation, favourable soil attributes in places, and reasonably uniform geology with generally a low risk of contaminants being mobilised. Note that there are locations in the south of the basin where mining waste can generate acid mine drainage and high levels of sulfate, as explained in Section 3.7.5 of the supplementary report on technical assessments. The key contaminant of interest throughout the basin is salt. The region is constrained by extensive clearing of native vegetation, severe weather events (flooding, drought and bushfires), and variability in rainfall (extended dry periods) and water levels.

Economic capital: The Bowen Basin is positioned at the gateway to the Asia-Pacific and has close economic ties with expanding markets in that region. The strongest industry sectors are agriculture and mining, followed by services such as health care and social assistance, retail trades, accommodation and food services, education and training. The Bowen Basin is home to Australia's largest coal deposits, including prime coking coal. The region has a strong manufacturing base supported by the presence of original equipment manufacturers, international engineering firms and ASX-listed companies. Constraints include that the regional economy is largely driven by the coal industry with much of the engineering and manufacturing businesses linked to mining.

Human capital: The region has good quality primary and secondary education, high levels of trade-qualified residents and strong employment in mining. Constraints include limited opportunities outside urban centres for tertiary education, health services and employment diversity. Growing and fluctuating non-resident workforces put pressure on all spheres of community infrastructure and social cohesion in the region.

Built capital: The Bowen Basin has access to three regional airports, two deep water seaports, three bulk shipping terminals and reliable freight service rail networks. There are well-established water supply schemes with trading mechanisms, excellent connection to the HV-grid, and pipeline connections to south-east Queensland. Challenges include ageing infrastructure (particularly in the areas of water, transport, telecommunications, health, power, waste), poor internet and mobile phone connectivity, housing affordability and diversity, and limited availability of unconstrained land. Water supply is highly reliant on industry allocations of water.

4.4.5 Projects and the mining context

There are significant developments proposed for the Bowen Basin, including 10 coal mining projects, 30 renewable energy projects and 4 other major works. The mining projects are primarily greenfields open-cut metallurgical coal operations, although there are some thermal coal projects and some proposed underground mines. The Ensham extension project is an underground (bord and pillar) operation planned to extend mine life to 2037. The other projects range in mine life from 8 years at Walton to 75+ years at Olive Downs.

The solar and wind projects range in capacity from 20MW at the Paget solar farm in the Mackay region to 450MW at the Smoky Creek solar farm in Banana Shire. These projects span 6 LGAs.

The other projects include upgrades to road infrastructure and a dam (Urannah project). Stanwell is seeking to establish a consortium for the development of a large-scale green hydrogen production facility aimed at the export market. Studies have found that the project is technically feasible but not currently commercially viable. Although not strictly in the Bowen Basin, a coal gasification plant is being designed at Gladstone to covert coal into ammonia, synthetic natural gas and electrical power. Detailed project data are provided in Section 4 of the supplementary report (socio-economic data).

These projects will enhance the existing mining and energy context. The Bowen Basin is home to 195 operating mines, most of which are extracting sapphires, coal, gravel, gold and sand. Other commodities mined in the region include building stone, chrysoprase, earthy lime/ dolomite, magnesite, opal, thunder egg and zeolite. There are 17 power generation plants in the Bowen Basin, comprising 10 solar, 5 bioenergy and 1 gas and 1 coal. Further information is available from the thematic maps that accompany this report: [Mine locations \[commodity\]](#), [Mine locations \[area\]](#), [Infrastructure \[energy\]](#).

4.4.6 Post-mining considerations

The mining industry accounts for the highest percentage of employees in the Bowen Basin. Significant strategic thinking is required to start diversifying the regional economy in preparation for the post-mining transition. Regional stakeholders have highlighted the need for infrastructure to keep pace with economic diversification. Access to water will be pivotal to attracting major industries to the region. Stakeholders also identified a need to retain existing mine employees and young people in the region post-mining. The value of future land use was considered a key factor and suggestions were made for the development of a retraining and upskilling framework. Support for SMEs is also required. In Dysart and Moranbah, smart transformation readiness initiatives are under way to enable businesses in these mining dependent communities to capitalise on rapid technological change.

Increasing societal demand for biodiversity and wildlife conservation will shape post-mining considerations in the Bowen Basin. Good links between existing protected areas provides opportunities to support wildlife corridors as a PMLU option, although significant modification to the local landscape from deep open-cut mines will need to be addressed.

4.5 Clarence Moreton/ Surat

4.5.1 Description

Clarence Moreton/ Surat is located in south-east Queensland and encompasses the urban centres of Brisbane, Ipswich and Toowoomba (see Figure 14).



Figure 14: Clarence Moreton/ Surat region.

Clarence Moreton/ Surat has the largest population of the study regions with 387,956 and the lowest percentage of residents who identify as being of Aboriginal and Torres Strait Islander heritage (4.32%). The percentage of males (49.26%), females (50.74%) and elderly residents (14.06%) is comparable with Queensland-wide statistics but there is a slightly larger percentage of children in the region (22.14% compared with 19.44%). The mean age is 34.92, which is below the state mean. The most prevalent family composition is families with children (30.10%), followed by families with no children (24.93%) and lone person households (21.79%).

Compared with the other study regions, mining in the Clarence Moreton/ Surat employs the lowest percentage of people (1.55%). The health care and social assistance sector employs the greatest number of people (13.34%), followed by retail trade (9.96%), education and training (9.32%), construction (8.48%), manufacturing (8.24%) and public administration and safety (7.76%) (Figure 15). There is also a diversity of employment types. Professionals (16%) account for the largest percentage, followed by technicians and trade workers (15.18%), clerical and administration workers (13.78%), labourers (12.53%), community and personal workers (11.68%) and managers (11.34%) (Figure 16). Clarence Moreton/ Surat has a higher rate of unemployment (7.53%), higher percentage of full-time employees (64.15%) and lower percentage of part-time employees (30.47%) compared with the rest of the state.

Educational levels in the region are comparable with those across Queensland. A significant number of residents (27.56%) have attained secondary education of year 10 or higher and 15.36% have completed education to Certificate III/ IV level. There is a lower percentage of residents with higher education levels compared with the Queensland average.

Median personal gross weekly income levels (\$645) and median family gross weekly income levels are lower (\$1491.23) than the Queensland average (\$679.07, \$1718.88).

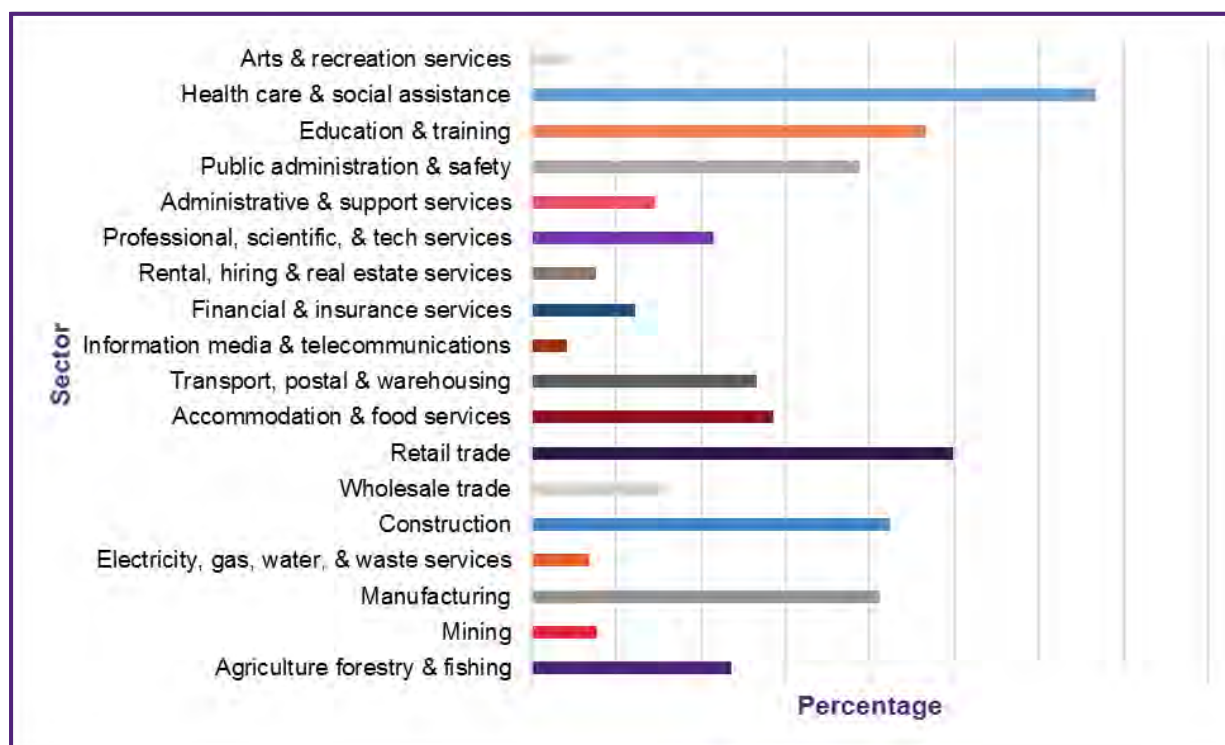


Figure 15: Clarence Moreton/ Surat employment by sector

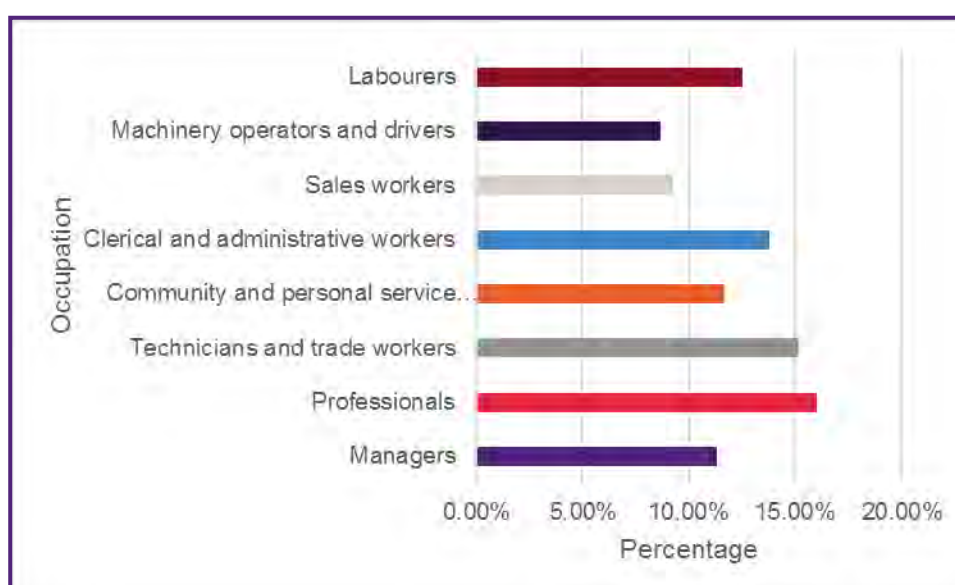


Figure 16: Clarence Moreton/ Surat employment by occupation

4.5.2 Environmental context

The Surat is located over the Brigalow Belt and Mulga Lands bioregions. While much of the area has been extensively cleared for agriculture, it still contains significant areas of native vegetation. National parks and state forests are spread across the region and contain important intact examples of the region's biodiversity. The Barakula and Dunmore state forests contain habitat for several rare and threatened species and provide strategic ecological connections.

The climate is subtropical with no dry season conditions: while rainfall is greater in the summer months, it is distributed throughout the year. There are areas with fertile soils, often classified as strategic cropping land (land that is, or is likely to be, highly suitable for cropping due to a combination of soil, climate and landscape features). There are significant environmental values associated with water. The Condamine–Balonne River basin is home to nationally important wetlands such as Lake Broadwater, the Gums lagoon, Balonne River floodplain and a number of salt lakes and claypans. The groundwater resources are significant and extensively developed. They are comprised of aquifers of the Great Artesian Basin, as well as fractured and alluvial systems. Groundwater supports a range of water supply purposes, including irrigation, commercial, industrial, aquaculture, stock and domestic use.

4.5.3 Regional aspirations

This section summarises the region's long-term aspirations presented in two types of aspirations: government's vision informed by the South East Queensland Regional Plan (2017) and Darling Downs Regional Plan (2013) and stakeholders' aspirations revealed in the preliminary survey and the CMS roundtable.

Government's vision: The region is recognised globally as a unique subtropical region where people love to live, learn, work, invest and visit. Its global reputation is built on our enviable climate; exceptional natural assets and biodiversity; strong and diversified economy; the quality of buildings, places and events; public transport system; and the many choices that the region offers.

Stakeholders' aspirations for the region's post-mining future are reflected in the word cloud below:



Overall, there is general alignment between stakeholders' aspirations and the government vision for sustainability, although the emphases are different. The government's vision highlights growth in all three pillars of sustainability (environment, community and economy) building on unique subtropical environment, while stakeholder aspirations focus on achieving a healthy, diverse and stable region with good infrastructure and positive mining legacies.

4.5.4 Regional strengths and constraints

The strengths and constraints of the Clarence Moreton/ Surat are summarised according to the five capitals framework. Further details are provided in Section 2 and 3 of the supplementary report (socio-economic data).

Social capital: There is a strong agriculture identity outside the urban centres. Rapid expansion of industrial sectors has led to a decline in social cohesion in some areas of the region. The availability of social services declines to the west.

Natural capital: The Clarence Moreton/ Surat includes some of Queensland's most productive agricultural land, nationally significant waterways and extensive deposits of thermal coal, coal seam gas, petroleum and other minerals. There is a strong focus on mine rehabilitation in the Oakey area with good examples of rehabilitated mine sites, while other areas (e.g. in Ipswich) face legacy issues from mining, including large volumes of overburden and associated waste materials that have not been rehabilitated.

Economic capital: Overall, Clarence Moreton/ Surat has a high-performing regional economy, generating almost two-thirds of the state's gross domestic product and high diversity of industries. There is also significant capacity within the agriculture, resources and energy sectors and strong education (including tertiary institutions) and health sectors. However, this industry diversity decreases to the region's west, where the economies rely on the resources sector and agriculture.

Human capital: There is good quality education at secondary and tertiary level, good employment opportunities for tradespeople and farm workers and good services in the region's urban centres, although the unemployment rate is higher than the Queensland average. The availability of these assets decreases to the west, with limited access to services, less education and job opportunities, and increasing isolation of work. The agriculture and health sectors, in particular, have difficulty attracting and retaining employees. Roundtable participants commented that the level of FIFO/DIDO work arrangements meant skills were exported out of the region.

Built capital: Eastern parts of the Clarence Moreton/ Surat have good access to interstate and global markets, port and processing facilities, strong and well-maintained infrastructure, prominent electricity sector and well-established water supply schemes. However, the standard of infrastructure declines to the west, particularly road quality. Improved water infrastructure is required to mitigate drought impacts, particularly in the Darling Downs. Internet and mobile phone connectivity is not reliable across the region.

4.5.5 Projects and the mining context

There are 33 projects proposed for the Clarence Moreton/ Surat, most of which are for renewable energy facilities (wind, solar, battery storage and bioenergy). The energy capacity ranges from 13MW at the Rabbit Ridge wind farm in the Southern Downs to 1500MW at the Bulli Creek solar farm in the Toowoomba LGA and 1500MW at Harlin solar farm (supported by 500MW battery storage) in the Somerset LGA. Australian Rail Track Corporation Limited is planning to upgrade 344km of rail line in 4 stages, from the Queensland/ New South Wales border to Calvert in the Ipswich LGA. The upgrade is scheduled for completion in 2025. Other projects are the REMONDIS Australia waste-to-energy facility, which will convert non-recyclable waste into 50MW baseload power, and the Scenic Rim Agricultural Industrial Precinct which will also convert waste to energy. Detailed project data are provided in Section 4 of the supplementary report (socio-economic data).

These projects will enhance the existing mining and energy context. The Surat Basin is home to 26 operating mines which are extracting gold, quarry rock, bentonite, coal, sand, gravel, kaolin/ kaolinite and sandstone. There are 13 power generation plants in the Surat Basin, comprising 5 gas, 3 coal, 3 solar, 1 hydro and 1 wind. Further information is available from the thematic maps that accompany this report: [Mine locations \[commodity\]](#), [Mine locations \[area\]](#), [Infrastructure \[energy\]](#).

4.5.6 Post-mining considerations

Transitioning to a post-mining future will require a shift in skills and qualifications towards traditional sectors (agriculture). In some areas of the region, mining is buoying population growth. It is likely that there will be negative population growth in these areas post-mining with fewer healthcare and other services as populations decline. The availability of services and amenities required for families will be a key factor in attracting people to live and work in the region. The cultural heritage of the Darling Downs region presents economic and social opportunities.

Roundtable participants did not consider the Clarence Moreton/ Surat to have abundant natural assets, which signals opportunities to promote outdoor recreation and nature conservation as potential PMLUs.

5. Regional suitability of post-mining land uses and collaborative potential

Chapter 4 provided an analysis of the regional context for the NWMP, North Queensland, Bowen Basin and the Clarence Moreton/ Surat. Understanding community priorities, government development goals, technical feasibility and collaboration opportunities is important in fostering longer-term and more sustainable outcomes for Queensland's mining regions. Shifting closure thinking from a mine-by-mine basis to a regional context will help stakeholders consider the cumulative impacts of multiple mine closures, adopt a strategic approach to post-closure planning and identify collaborative potential of suitable PMLU options beyond a single mining lease. This chapter connects the suitability of PMLU options with the regional context.

Section 5.1 provides an overview of mine operators' existing PMLU commitments specified in their EAs. These PMLUs are regulatory obligations. The PRCPs that are under development aim to deliver these committed PMLUs.

Section 5.2 presents the results from a suitability assessment of PMLU options for each of the study regions. The assessment is based on regional data and does not reflect conditions that are specific to sites. As such, the PMLUs that are presented are to be considered as 'regional' in the sense that they would be suitable based on regional biophysical aspects, but their suitability based on specific site aspects was not assessed.

The suitability assessment shifts closure thinking from strictly aiming to meet PMLU commitment listed in permits to a regional context, thereby enabling consideration of the cumulative impacts of multiple mine closures, facilitating the adoption of a strategic approach to post-closure planning and identification of collaborative potential. Potential collaborators for each PMLU option are highlighted. A collaboration framework incorporating principles, strategic questions and a process is provided at the conclusion of the chapter.

5.1 Committed PMLU

The companies participating in this project provided a copy of their EAs, which listed similar conditions in relation to rehabilitation requirements and stipulated PMLUs. The most commonly listed PMLUs are:

- grazing
- native bushland/woodland
- self-sustaining vegetation

However, the EAs provide to the research team only constituted a small sample of operations and did not provide an overview of currently committed PMLU at the scale of all 4 mining regions. To derive a more comprehensive understanding of the status of committed PMLU, all existing EAs were queried for information. The methodology is described in Section 4 of the supplementary report on technical assessments and the status of currently committed PMLU is presented in Figure 17 of that document. There

is little diversity in committed PMLU. The predominant PMLU is grazing, especially in the Bowen Basin and Clarence Moreton/ Surat region. The most common listed term is 'native', demonstrating an expectation that rehabilitation is expected to lead to re-establishment of some form of native ecosystems in at least 63 EAs.

The committed PMLU reflects the lack of diversity of land use in Queensland generally, as shown in Figure 3 of the supplementary report on technical assessments, with most of the EAs listing "grazing" and "native ecosystems" as PMLU.

5.2 Regional suitability assessment

The first step of the suitability assessment was to identify the PMLU options, reviewing all types of land uses and their potential suitability for the region. Selected PMLU options were:

- **Native ecosystems:** land used primarily for conservation purposes, based on maintaining the essentially natural ecosystems or investing in re-establishing the natural ecosystems. In the context of PMLU, the latter is more relevant and will often take the form of creating native ecosystem corridors that aim to reverse habitat fragmentation.
- **Grazing:** of native or modified pastures. The assessment did not include consideration of the type of livestock, with cattle the most widespread in Queensland. There is no significant difference in pasture species suitable for cattle, goats, or other potential livestock, so the results of the suitability assessment would be equally applicable to most types.
- **Cropping:** which is used in a generic sense and refers to most agricultural land uses. Cropping refers to the planting of trees, shrubs or suitable crops in a dryland farming setting, with the option of access to irrigation when feasible. It also refers to types of cropping that will enhance carbon sequestration.
- **Regenerative cropping:** refers to the use of a combination of techniques to restore soil health, such as planting cover crops and perennials to protect the soil, not using tillage, pesticides or synthetic fertilisers, and establishing multiple crop rotations. Generally, regenerative cropping is only applicable to land that is free from severe soil constraints. There is no precise definition of what it entails, with a range of practices being implemented. Its suitability is similar to that of general cropping but it is worth outlining it as a separate PMLU option, as it attracts interest in some of the regions.
- **Phytomining:** the harvest of metals from the living tissue of a group of plants known as hyperaccumulators, which retain metals in high concentrations after absorbing them through their roots. These plants can absorb metals from mining wastes and tailings facilities that contain valuable metals, such as cobalt. Phytomining is an innovative solution because it can complement the global supply chain for critical minerals while promoting circular economy concepts by utilising mining waste. For phytomining to be suitable, there needs to be presence of valuable elements in the waste materials, which could also be extracted by re-processing tailings and waste with conventional mineral processing technologies. For the purpose of this study, we have only assessed the potential of phytomining as it represents an innovative land use. Where phytomining is possible or suitable, re-processing waste with conventional technologies would also be possible or suitable, as valuable elements are present in the waste. Re-processing waste can lead to related opportunities, outlined in our findings.
- **Protected horticulture:** the intensive growing of food products, mainly fruit and vegetables, in structures that protect the crops, mostly greenhouses, but mine buildings could be adapted for this purpose. It is the fastest growing food producing sector in Australia. Modern approaches to protected horticulture include a range of technologies, such as automatic control of temperature and of water and nutrient delivery. As such, climate conditions should not prevent implementation of such PMLU. Mine sites usually have water storage facilities that could be re-purposed to support requirements for water.
- **Intensive livestock:** feedlots, piggeries, poultry farms and dairies. It requires buffers or setbacks to avoid/mitigate potential impacts to other land users, standard utilities (water, sewage, electricity, gas and telecommunications) and transport infrastructure. Temperature control might be required in areas

where temperatures are high in summer but there are technologies available to mitigate this constraint. As intensive livestock relies on the presence of building and associated infrastructure, the suitability assessment will be similar to that of protected horticulture.

- **Renewable energy:** solar and wind.
- **Manufacturing:** a manufacturing hub is a section of a town or city that has been designated, planned and zoned for industrial development. It is structured to bring together complementary services and features that benefit the companies that occupy space there. In theory, there is potential to set up manufacturing hubs throughout the region, with the exception of the Tablelands, where mine leases are small and scattered. This option was only retained for Charter Towers as there is an established network of small and medium enterprises with trained workforce. It could also be an option in Mount Isa, the Bowen and Surat basins but it would require development of a SME network.
- **Tourism:** advancing tourism is a key aspiration for many local governments across the study regions. There is potential to enhance tourism opportunities post-mining by connecting with mining heritage and leveraging off existing tourism destinations.

A spatially based suitability analysis was conducted to assess the potential for agricultural use (grazing, cropping), renewable energy potential (solar and wind) and native ecosystem development potential. This PMLU suitability assessment was based exclusively on the spatial extent of the mine leases within each area, as these are the critical boundaries for the examination of PMLU.

Qualitative assessments were undertaken for the remaining PMLUs, based on the information gathered as part of other project tasks and the analysis of strengths and constraints for each focus area.

To enable comparison of the PMLU options, they were assigned a rating against selected technical indicators, which were then used to assign a qualitative rating. Options related to agriculture were assessed against access to water or suitable rainfall and suitable soil types; options related to renewable energy were assessed against suitable climate characteristics; options for biodiversity investments were considered by assessing which areas would derive the most benefits and could re-connect existing corridors. The suitability of the other options (e.g. intensive livestock, manufacturing, tourism) was based on a qualitative assessment of the presence of required features. Details are provided in Section 6 of the supplementary report on technical assessments.

The outcomes of the technical suitability analysis are summarised in Table 2 below. Not all options were suitable for each region.

The PMLU options were then subjected to a **suitability assessment** by the project team using both the technical and environmental criteria (discussed below) and 6 qualitative socio-economic indicators (see Table 4). A matrix similar to those used in risk assessments (see Table 3) was used to guide the process.

Table 2: Rating of PMLU technical feasibility

Potential PMLU	Mount Isa	Weipa	Tablelands	Charters Towers	Bowen Basin	Surat Basin
Native ecosystems	Very suitable	Very suitable	Possible	Suitable	Very suitable	Present challenges
Grazing	Suitable	Present challenges	Very suitable (for coastal areas) Present challenges (for inland areas)	Possible (with amelioration)	Suitable	Suitable
Cropping	Possible (pasture species and cereals with amelioration)	Possible (sugar cane with intensive amelioration)	Suitable (for coastal areas) Present challenges (for inland areas)	Possible (pasture species and cereals with intensive amelioration)	Suitable (pasture species, pulses and cereals with intensive amelioration in some parts)	Possible (pasture species, pulses and cereals with intensive amelioration)
Solar energy	Very suitable (export opportunities)	Suitable (for local use)	Suitable (for local use)	Suitable	Very suitable (export opportunities)	Suitable
Wind energy	Very suitable (export opportunities)	Suitable (for local use)	Suitable (for local use)	Very suitable (export opportunities)	Very suitable (export opportunities)	Very suitable (export opportunities)
Phytomining	Suitable, with irrigation (base metals)	Present challenges	Possible	Possible (metals)	Present challenges	Present challenges
Protected horticulture Intensive livestock	Present challenges	Present challenges	Present challenges	Possible	Very suitable	Very suitable
Manufacturing	Possible	Possible	Present challenges	Possible	Possible	Possible
Tourism	Possible	Possible	Possible	Possible	Possible	Possible

Table 3: Suitability assessment matrix

Socio-economic suitability						
Technical and environmental suitability		Very suitable	Suitable	Possible	Presents challenges	Unsuitable
	Very suitable					
	Suitable					
	Possible					
	Presents challenges					
	Unsuitable					

Table 4: Socio-economic indicators used in the suitability assessment

Socio-economic indicators					
Alignment with regional aspirations	Contribution to regional economy	Number of jobs for regional workers	Adverse impact on existing regional infrastructure (demand, maintenance costs)	Adverse impact on regional utilities (demand, cost of service to residents)	Alignment with regional population's existing skills, education/ training and other socio-economic assets to support PMLU
Very strong	Very high	Very high	Very low	Very low	Very strong
Strong	High	High	Low	Low	Strong
Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Weak	Low	Low	High	High	Low
Very weak	Very low	Very low	Very high	Very high	Very low

Suitability	Description
Very suitable	Achieves very positive ranking across most indicators
Suitable	Achieves positive ranking across most indicators
Possible	Achieves moderate ranking across most indicators
Presents challenges	Achieves negative ranking across most indicators
Unsuitable	Achieves very negative ranking across most indicators

The outcomes of the suitability assessment were then ‘ground-truthed’ with research participants via an **online survey** and 4 **online workshops** (1 for each region). The survey was administered prior to the workshops to collect participants’ knowledge on existing stakeholder collaborations in the regions, their views on PMLU collaboration potential (using a 5-point Likert scale of very low to very high), and what collaborations are required to support each PMLU option. The surveys also helped to prepare participants for the workshops. Sixteen surveys were completed. Participants from the roundtables who were unable to participate in the workshop were able to complete the survey. The results were incorporated into the workshop discussions.

The 2-hour **workshops** were conducted online via the Zoom platform. Participants explored the complexity around transitioning to post-mining futures and which stakeholders were required for transition planning. They then assessed whether the PMLUs presented were suitable for their region based on their own perspectives, regional strengths and constraints and collaboration opportunities. They also provided suggestions on how QRC could progress the research findings. The attendance of participants in the workshops was not high (a total of 15 participants, about 4 participants per region). The data is scoping in nature and should not, therefore, be considered representative. Further stakeholder engagement and detailed research is required to draw substantive conclusions.

The results from the suitability assessment, the survey and workshops are summarised for each study region in the following tables. The PMLU options are regarded as the most suitable and transformational at the time of preparing this report. The report does not seek to exclude nor constrain economic, social and environmental development opportunities that have not been identified here. New PMLU opportunities should be explored over time as global trends, local comparative advantages or economic and social drivers change.

Stakeholders will need to undertake a range of individual actions, projects and initiatives to realise the PMLUs presented. As a starting point for more detailed discussion, they can use the framework we have provided for identifying and profiling PMLU opportunities (the following tables). The framework includes suitability ranking, strengths and constraints of each PMLU option, related opportunities, the collaborative potential of each option (a high-level assessment made by workshop participants) and potential collaborators. Stakeholders can consider how/ whether the constraints could be mitigated, identify where further work is required to enhance collaboration potential and who to approach when initiating a collaboration process. Further guidance is provided in the collaboration framework. Note that the assessment of the technical feasibility includes indicators that can be considered as factors that encourage collaboration:

- proximity to specific features: for instance, the assessment of the suitability of renewable energy PMLU calculated distances to HV grid; the assessment of the native ecosystems PMLU calculated the proximity of mine leases near to and within mapped biodiversity corridors.
- co-location: the technical assessment showed that several PMLUs could be feasible at a given locations, with options for establishing a mosaic of land uses within a precinct (e.g. protected horticulture can co-exist with native ecosystems investment).

In this study, these aspects are considered as technical indicators, rather than collaboration criteria.

5.3 North West Minerals Province

Seven PMLU opportunities were identified for the NWMP, based on the suitability assessment. Collaborative potential and opportunities related to these six PMLU options were assessed and explored through workshop with regional stakeholders. The suitability and collaborative potential of six suitable PMLUs are summarised in Table 5.

The workshop indicated that stakeholders in the region tended to operate independently. Participants said that regional stakeholders were uncertain about how and where to collaborate. The participants suggested that collaboration should be led by the organisation with the largest economic interest in the region. Once that entity was involved, a NWMP planning committee (including local and state governments and commercial companies) could search for other collaborators more broadly.

As shown in Table 5, while the project team identified native ecosystem corridors, solar energy and phytomining as suitable PMLUs, participants in the workshops considered tourism, cropping and grazing as PMLU to have moderate-high collaborative potential. Additional collaborative opportunities were indicated in relation to each PMLU. Most of these opportunities related to native ecosystem corridors and tourism.

Other PMLU options raised by participants included a pit lake for water storage and water infrastructure, marketing Mount Isa as a retirement destination and making the city a capital of the north-west, with an opportunity to move some of the state agencies there.

Table 5: PMLU opportunities and collaborative potential – North West Minerals Province

	Native ecosystem corridors/ biology hub	Solar and wind energy	Phytomining	Tourism	Cropping (cereal, cotton)	Grazing
Suitability ranking – socio-economic	• Very suitable	• Suitable	• Suitable	• Possible	• Presents challenges	• Possible
Suitability ranking – technical/ environmental	• Very Suitable	• Very suitable	• Possible (with irrigation)	• Possible	• Possible (with amelioration)	• Suitable
Strengths	<ul style="list-style-type: none"> Added ecosystem value to the region Regional aspiration to maintain rich biodiversity and increase educational potential Environmental benefits, such as improvements of water and air quality, beneficial 	<ul style="list-style-type: none"> Pipeline connections to SEQ – potential for hydrogen generation/ export Low price of electricity in the region which could help in growing other industries (community members as end-users) 	<ul style="list-style-type: none"> Remove lead from soil UQ-SMI experience and leadership in phytomining Well-established water supply schemes with trading mechanisms that could support irrigation. 	<ul style="list-style-type: none"> Linked to outback drive Kakadu/Uluru Big skies tourist attraction Regional aspiration – develop region as “a distinctive tourist destination” Existing interest of Mount Isa City Council One of government’s 	<ul style="list-style-type: none"> NE of region only area with good soils that could support cropping Traditional adjacency for the region Possible in large areas under mine tenure that are relatively undisturbed and 	<ul style="list-style-type: none"> Traditional economic driver Possible in large areas under mine tenure that are relatively undisturbed and suitable for agricultural use

	Native ecosystem corridors/ biology hub	Solar and wind energy	Phytomining	Tourism	Cropping (cereal, cotton)	Grazing
	ecosystem services			priority sectors in the region <ul style="list-style-type: none"> Some existing infrastructure, e.g. hiking trails recently built 	suitable for agricultural use <ul style="list-style-type: none"> Existing interest (projects looking at cropping) 	
Constraints	<ul style="list-style-type: none"> Low employment potential after establishment Not well mapped and understood (more research and case studies need to be done) Extensive mine lease areas compared with ecosystem corridor (8%) Insufficient rainfall for establishment Low economic benefit compared to other land use options Ecosystem services are often undervalued 	<ul style="list-style-type: none"> Low employment potential HV grid limited to large operations but there are about 4,000 ha of mined land within 2km of the HV grid with the potential to generate renewable energy Limited appetite for generating own power due to specific skills, limited appetite to enter long-term power agreements Energy storage remains problematic. An integrated industrial solution and education are needed to fill the knowledge gap Risk around instability of markets and oversupply 	<ul style="list-style-type: none"> Low employment potential Likelihood of commercial result, not core to operations or immediate cost savings Relatively few examples across industry to date 	<ul style="list-style-type: none"> Costly repurposing infrastructure Poor road conditions Limited tourism agencies (council-led) Local communities are not trained in hospitality and related sectors 	<ul style="list-style-type: none"> Low employment potential Low economic contribution to the region Lead soil Soil quality in north Limited rainfall in north 	<ul style="list-style-type: none"> Low employment potential Low economic contribution to the region Soil quality Rainfall viability - <500mm in south Base temperatures limits agriculture in the south Lead soil

	Native ecosystem corridors/ biology hub	Solar and wind energy	Phytomining	Tourism	Cropping (cereal, cotton)	Grazing
Related opportunities	<ul style="list-style-type: none"> Aboriginal employment in native seed collection and greenhouses for seedlings; commercial plant products Carbon sequestration opportunities, which could bring jobs (monitoring, new technologies) and offer education and technology learning links with native ecosystem corridors Opportunity for university students to be taught locally about what is needed to set up the corridors in a variety of post-mining conditions Very strong opportunity to create protected areas (mine leases more than order of magnitude larger) 	<ul style="list-style-type: none"> Integration with protected horticulture, given the industry's large requirement for energy and water. Protected horticulture has the added benefit of providing local fresh produce for the region (note that the potential for re-purposing mine infrastructure for supporting protected horticulture is uncertain in this region) Manufacturing solar equipment in region (e.g. battery manufacturing) 	<ul style="list-style-type: none"> Re-processing waste material could lead to synergies with other industries (e.g. producing cobalt for battery manufacturing) Mount Isa – UQ-SMI research hub Aboriginal employment in plant collection, including Aboriginal re-training and education 	<ul style="list-style-type: none"> Indigenous tourism as a largely untapped opportunity (in interest of Mount Isa City Council) Opportunity for Indigenous rangers to manage potential environmental impacts Connect Lake Moondarra with PMLUs on mines. The Water Board has an interest in increasing tourism opportunities there (including camping, walking trails, birdwatching) with an older tourist demographic A package deal for tourists to stay 5 days could bring more business opportunities Training opportunities in hospitality sectors 	<ul style="list-style-type: none"> Protected cropping for high value products (an opportunity for flat areas, i.e. tailings dams that have been capped and sealed off). With the introduction of clean soil protected cropping may be an option being close to water and power infrastructures Opportunity for graziers around Mount Isa and Cloncurry to diversify their businesses 	<ul style="list-style-type: none"> Potential for a government subsidy for new farmers (motivation to train and stay post-mining; e.g. young people in agriculture subsidy)

	Native ecosystem corridors/ biology hub	Solar and wind energy	Phytomining	Tourism	Cropping (cereal, cotton)	Grazing
Collaborative potential¹⁰	<ul style="list-style-type: none"> Low to moderate 	<ul style="list-style-type: none"> Low to moderate 	<ul style="list-style-type: none"> Low to moderate 	<ul style="list-style-type: none"> Moderate to high 	<ul style="list-style-type: none"> Moderate to high 	<ul style="list-style-type: none"> Moderate to high
Potential collaborators	<ul style="list-style-type: none"> Regulators State government departments Local governments Mount Isa City Council Aboriginal groups with Native Title claims or land holdings Research organisations and universities Neighbouring landholders Mines Conservation groups Southern Gulf NRM Bush Heritage Australia Stakeholders for re-forestation of ecosystems Commercial groups interested in carbon capture projects 	<ul style="list-style-type: none"> Regulators State government departments Local governments Mount Isa City Council Mount Isa Water Board Mines (e.g. Mount Isa Mines) CopperString 2.0 developers Energy providers Major energy users Economic & development organisations Research organisations and universities Enabling infrastructure owners Community members Landholders Aboriginal groups with Native Title claims or land holding 	<ul style="list-style-type: none"> Regulators State government departments Local governments Mount Isa City Council Mines Research organisations and universities (e.g. UQ-SMI) Landholders Aboriginal groups with Native Title claims or land holding 	<ul style="list-style-type: none"> Regulators State government departments Local governments Mount Isa City Council Mines Tourism Queensland North West Tourism MITA Commercial Tourism operators Mount Isa Water Board Enabling infrastructure owners Glencore community sessions Local SMEs Landholders Aboriginal groups with Native Title claims or land holding Economic & development organisations 	<ul style="list-style-type: none"> Regulators State government departments Local governments Mount Isa City Council Mines Local farmers Agriculture associations (AgForce) State and federal cropping agencies Research organisations and universities Commercial businesses groups Enabling infrastructure owners Landholders Aboriginal groups with Native Title claims or land holding 	<ul style="list-style-type: none"> Regulators State government departments Local governments Mount Isa City Council Mines Local farmers and graziers Agriculture associations MITEC Agriculture associations (AgForce) State and federal grazing agencies Commercial businesses groups Enabling infrastructure owners Landholders Aboriginal groups with Native Title claims or land holding

¹⁰ This ranking was captured via the online survey using a 5-point Likert scale of very low to very high. Participants did not complete the option to provide a rationale for their evaluation.

5.4 North Queensland

Eight PMLU options were identified for North Queensland based on the suitability assessment. Phytomining was not included as there are uncertainties related to the quantity of waste material in the Tablelands and Charter Towers. The collaborative potential of the PMLU options was explored through a workshop with regional stakeholders. The assessment and workshop findings are summarised in Table 6. The subregions of Weipa, Tablelands and Charters Towers are used in the table to reflect the diversity of regional conditions and suitability of PMLU options. In addition to the 8 options identified, workshop participants considered ecotourism and aquaculture viable PMLU options in Weipa, and there was interest for regenerative agriculture in Charters Towers.

Workshop participants indicated that stakeholders in North Queensland tended to operate independently, although there was some collaboration at a regional-to-local scale. The collaborative potential of wind energy, solar energy, manufacturing hub, tourism and protected horticulture projects was considered 'high' by workshop participants, while the collaborative potential of native ecosystem corridors, grazing and cropping was ranked 'moderate', in part, due to mining lease conditions and the length of time required to achieve relinquishment.

Participants recommended that the Queensland Department of State Development, Infrastructure, Local Government and Planning take the lead on post-mining transition 'conversations' to provide a more coordinated approach.

Table 6: PMLU opportunities and collaborative potential – North Queensland

	Native ecosystem corridors	Wind energy	Solar energy	Manufacturing hub	Tourism	Grazing	Cropping	Protected horticulture
Suitability ranking – socio-economic	<ul style="list-style-type: none"> • Very suitable 	<i>Charters Towers & Tablelands</i> <ul style="list-style-type: none"> • Suitable <i>Weipa</i> <ul style="list-style-type: none"> • Suitable • Suitable 	<ul style="list-style-type: none"> • Suitable 	<ul style="list-style-type: none"> • Suitable 	<i>Weipa</i> <ul style="list-style-type: none"> • Very suitable <i>Tablelands</i> <ul style="list-style-type: none"> • Suitable <i>Charters Towers</i> <ul style="list-style-type: none"> • Possible 	<ul style="list-style-type: none"> • Possible 	<i>Weipa</i> (sugarcane) <ul style="list-style-type: none"> • Possible <i>Charters Towers</i> <ul style="list-style-type: none"> • Presents challenges <i>Tablelands</i> <ul style="list-style-type: none"> • Presents challenges 	<i>Weipa</i> <ul style="list-style-type: none"> • Possible
Suitability ranking – technical/environmental	<ul style="list-style-type: none"> • <i>Weipa</i> Very suitable • <i>Tablelands</i> Possible • <i>Charter Towers</i> Suitable 	<ul style="list-style-type: none"> • <i>Weipa</i> Suitable (local use) • <i>Tablelands</i> Suitable (local use) • <i>Charter Towers</i> 	<ul style="list-style-type: none"> • <i>Weipa</i> Suitable (local use) • <i>Tablelands</i> Suitable (local use) 	<ul style="list-style-type: none"> • Possible 	<i>Weipa</i> <ul style="list-style-type: none"> • Suitable <i>Tablelands</i> <ul style="list-style-type: none"> • Suitable <i>Charters Towers</i> <ul style="list-style-type: none"> • Suitable 	<ul style="list-style-type: none"> • <i>Weipa</i> Present challenges • <i>Tablelands</i> Very suitable for coastal areas 	<i>Weipa</i> (sugarcane) <ul style="list-style-type: none"> • Possible with amelioration <i>Charters Towers</i> <ul style="list-style-type: none"> • Possible with amelioration 	<ul style="list-style-type: none"> • <i>Weipa</i> Very suitable • <i>Tablelands</i> Possible • <i>Charter Towers</i> Suitable

	Native ecosystem corridors	Wind energy	Solar energy	Manufacturing hub	Tourism	Grazing	Cropping	Protected horticulture
		Very suitable (export)	<ul style="list-style-type: none"> <i>Charter Towers</i> Suitable 			<ul style="list-style-type: none"> <i>Tablelands</i> Present challenges for inland areas <i>Charter Towers</i> Possible with amelioration 	<ul style="list-style-type: none"> <i>Tablelands</i> <ul style="list-style-type: none"> Suitable for coastal areas <i>Tablelands</i> <ul style="list-style-type: none"> Presents challenges for inland areas 	
Strengths	<ul style="list-style-type: none"> High density of Aboriginal population Already skilled Aboriginal people from mining 	<p><i>Charters Towers</i></p> <ul style="list-style-type: none"> Good connection to regional HV-grid: export opportunities 2 established large wind farms Local technical expertise <p><i>Tablelands</i></p> <ul style="list-style-type: none"> Excellent wind speeds in SE (>7k ha of wind farms within 5km of mine leases) <p><i>Weipa</i></p> <ul style="list-style-type: none"> Excellent wind speeds (>6.5 m/s) 	<p><i>Tablelands</i></p> <ul style="list-style-type: none"> Good connection to grid 	<ul style="list-style-type: none"> Skilled tradespeople and trades training Local market potential 	<p><i>Weipa</i></p> <ul style="list-style-type: none"> Established industry Established market, experience Potential to repurpose building for accommodation and expand cooking potential <p><i>Tablelands</i></p> <ul style="list-style-type: none"> Close to Cairns History of mining Tourism focus <p><i>Charters Towers</i></p> <ul style="list-style-type: none"> History of mining 	<ul style="list-style-type: none"> Existing skills, experience Most soils support pasture species 	<p><i>Charters Towers</i></p> <ul style="list-style-type: none"> >500mm annual rainfall <p><i>Tablelands</i></p> <ul style="list-style-type: none"> >500mm annual rainfall Sporadic potential for forestry and horticulture in coastal areas <p><i>Weipa</i></p> <ul style="list-style-type: none"> Rainfall adequate for sugar cane 	<ul style="list-style-type: none"> Access to mining infrastructure (buildings, dams etc) in Weipa and Charter Towers Local production – fresh fruit and vegetables at reasonable prices

	Native ecosystem corridors	Wind energy	Solar energy	Manufacturing hub	Tourism	Grazing	Cropping	Protected horticulture
					<ul style="list-style-type: none"> • Geological heritage • /Tourism focus 			
Constraints	<ul style="list-style-type: none"> • Low employment potential • Low ratio of mine lease areas to ecosystem corridor and protected areas (~5%) but potential to add ecosystem value • Risk of mismanagement; There are regional examples of mismanaged regional national parks due to resources constraints, resulting in increased numbers of weeds and feral animals. 	<ul style="list-style-type: none"> • Low employment potential • Availability of mined land (small footprint) • Noise • The size of the wind turbines may have an adverse impact on visual amenity <p><i>Weipa and Tablelands</i></p> <ul style="list-style-type: none"> • Lack of HV-connection to regional grids – local use only 	<ul style="list-style-type: none"> • Low employment potential 	<ul style="list-style-type: none"> • Noise • May have an adverse impact on visual amenity 	<p><i>Charters Towers</i></p> <ul style="list-style-type: none"> • Insufficient infrastructure • Long-term capacity building is needed to support regional tourism, particularly around small business management, business governance and professional development more generally • More work needs to be done in identifying a range of tourist attractions (e.g. food, reef, hunting, eco-tourism) 	<ul style="list-style-type: none"> • Not much mined land erosion, rainfall viability • Abandoned mines, contamination 	<p><i>Charters Towers</i></p> <ul style="list-style-type: none"> • Soils in mined areas require amendment • Erosion <p><i>Tablelands</i></p> <ul style="list-style-type: none"> • Soil in in mined areas mostly unsuitable • Sporadic potential for forestry and horticulture in coastal areas <p><i>Weipa</i></p> <ul style="list-style-type: none"> • Soil amendment required 	<ul style="list-style-type: none"> • Wet season, cyclone • Transport of produce out during wet season • Market fluctuations (domestic & export)

	Native ecosystem corridors	Wind energy	Solar energy	Manufacturing hub	Tourism	Grazing	Cropping	Protected horticulture
					and then marketing them. Long-term residents are not aware of all the attractions in their region.			
Related opportunities	<ul style="list-style-type: none"> • Employment of Aboriginal people • Medicinal plants/ native flora • There is potential for seeds of local species to be collected and seedlings grown on for use in the corridors • The corridors could include walking tracks • Linking corridors with carbon credits has potential as an education piece • There is potential for 	<ul style="list-style-type: none"> • Opportunity to move away from diesel generation in Weipa • Harnessing storage of green energy • The workforce for wind farms could be drawn from the region with little upskilling required (these types of skills are found locally; former mine employees would also have the requisite skills) 	<ul style="list-style-type: none"> • Opportunity to move away from diesel generation in Weipa • Harnessing storage of green energy • The workforce for solar farms could be drawn from the region with little upskilling required (these types of skills are found locally; former mine employees would also have the requisite skills) 	<ul style="list-style-type: none"> • Incorporation of onsite wind or solar energy production would provide cheap power • Re-processing waste materials from zone delimited by Cairns, Townsville and Cloncurry can produce new economy minerals that support renewable energy and smart technologies. 	<ul style="list-style-type: none"> • Tourism fits readily into an integrated approach to PMLU (i.e. multiple uses to increase economic diversity to the region.) as it can work hand-in-hand with other industries (e.g. agriculture). Each PMLU would use the same land, infrastructure etc. • Wet season tourism has not been explored. How could tourists be 			<ul style="list-style-type: none"> • In Weipa, potential to set-up a mine rehabilitation hub for bauxite operations in tropical context that produces seedlings on site (protected horticulture) for biodiversity investment. Expertise can be exported to mining regions with similar context.

	Native ecosystem corridors	Wind energy	Solar energy	Manufacturing hub	Tourism	Grazing	Cropping	Protected horticulture
	Indigenous tourism Traditional plants could be manufactured into commercial products to enhance the economic value of the corridors				encouraged to visit during the wet season?			
Collaborative potential¹¹	• Moderate	• High	• High	• High	• Moderate to high	• Moderate	• Moderate	• High
Collaborative opportunities	<ul style="list-style-type: none"> Landholders could become "rangers" for native habitat to complement their agricultural practices Regional vision rather than site-by-site to provide larger corridor / ecosystem planning Adjoining mines 	<ul style="list-style-type: none"> Energy providers Major energy users (manufacturing, hydrogen fuel etc) Regulators Federal government agencies State government departments Local governments Economic & development organisations 	<ul style="list-style-type: none"> Energy providers Major energy users (manufacturing, hydrogen fuel etc) Regulators Federal government agencies State government departments Local governments Economic & development organisations 	<ul style="list-style-type: none"> Local governments Local manufacturing SMEs Local / regional manufacturing customers Industry groups Small business groups Economic & development organisations Chambers of Commerce 	<ul style="list-style-type: none"> State government departments Local governments Economic & development organisations Tourism organisations Local tourist operators and affiliates (travel, accommodation, services) Chambers of Commerce 	<ul style="list-style-type: none"> Local graziers Grazing associations/producer organisations Regulators State government departments Local governments Research organisations 	<ul style="list-style-type: none"> Local farmers Agriculture associations Regulators State government departments Local governments Economic & development organisations Education providers 	<ul style="list-style-type: none"> Regulators Local governments Infrastructure owners Economic & development organisations Beef industry Farming industry Commercial markets Neighbouring landholders Mines (e.g. Ensham) that have mining, solar, grazing

¹¹ This ranking was captured via the online survey using a 5-point Likert scale of very low to very high. Participants did not complete the option to provide a rationale for their evaluation.

Native ecosystem corridors	Wind energy	Solar energy	Manufacturing hub	Tourism	Grazing	Cropping	Protected horticulture
<ul style="list-style-type: none"> • Volunteers (e.g. Landcare groups, community groups, schools etc) • University students/ researchers • State government departments • Regulators • Biodiversity offsets market • Carbon market 	<ul style="list-style-type: none"> • Research organisations • Enabling infrastructure owners 	<ul style="list-style-type: none"> • Research organisations • Enabling infrastructure owners 		<ul style="list-style-type: none"> • Marketing specialists 			<ul style="list-style-type: none"> • Manufacturing sector • Renewable energy industry • Agricultural associations

5.5 Bowen Basin

Six PMLU options were identified for the Bowen Basin based on the suitability assessment. The collaborative potential of these options was explored through a workshop with regional stakeholders. The assessment and workshop findings are summarised in Table 7.

Workshop participants commented that the suitability of PMLU was primarily influenced by infrastructure and access to water rather than the condition of the mined land. They said that PMLUs needed to be driven by the market and that strategies needed to be in place to mitigate market fluctuations to ensure stability of supply of water, infrastructure and other services for residents. Concerns were voiced about the ability to retain young people and former mine workers in the region post-mining, and participants noted that strategic thinking was required to identify practical solutions.

In considering collaborative potential in the Bowen Basin, workshop participants indicated that stakeholders tended to operate independently, although there was some collaboration at a regional-to-local scale. The collaborative potential of solar energy and regenerative cropping was considered 'high' by workshop participants, protected horticulture/ intensive livestock and tourism was ranked 'moderate'-to-high' and native ecosystem corridors and grazing 'moderate'. The viability of a solar energy R&D hub was questioned by participants.

Participants encouraged mining companies to work on pilot projects now to help focus attention on the importance of PMLU planning and to achieve short-term 'wins'. They recommended that discussions between QRC and the Queensland Government on exit strategies continue and that more detailed work, building on the results from this project, be undertaken to elicit deeper insights on post-mining transitions.

Table 7: PMLU opportunities and collaborative potential – Bowen Basin

	Protected horticulture/ intensive livestock	Solar energy/ R&D hub	Native ecosystem corridors	Grazing	Cropping	Tourism
Suitability ranking – socio-economic	• Very suitable	• Suitable	• Suitable	• Suitable	• Possible	• Presents challenges
Suitability ranking – technical/ environmental	• Very suitable	• Very suitable	• Very suitable	• Suitable	• Suitable, with amelioration required in some parts	• Possible
Strengths	<ul style="list-style-type: none"> • Export potential • Abundance of water storage facilities & buildings • Access to infrastructure (e.g. CQ Inland Port) 	<ul style="list-style-type: none"> • Excellent connection to HV grid, mines close to network (9,000 ha within 1km, more than 50,000 ha within 2km) • Pipeline connections to 	<ul style="list-style-type: none"> • Existing PMLU in EAs • Ecosystem services e.g. recreation (requires management) • High ratio of mine lease to protected 	<ul style="list-style-type: none"> • Existing PMLU in EAs • Established grazing region • Regional aspiration to grow agricultural industries 	<ul style="list-style-type: none"> • Established cropping region, agricultural identity in many parts of region • ~50% soils suitable for cropping without amendment, ~45% 	<ul style="list-style-type: none"> • Regional aspiration for tourism • Heritage potential (limited) • Existing attractions e.g. Gemfields • Close to coast, islands

	Protected horticulture/ intensive livestock	Solar energy/ R&D hub	Native ecosystem corridors	Grazing	Cropping	Tourism
	<ul style="list-style-type: none"> Aligns with existing industries Co-location potential 	<ul style="list-style-type: none"> SEQ potential for hydrogen generation/ export Established manufacturing sector Established training, education facilities including universities Climate Community aspirations (green energy, economic diversification) Co-location opportunities 	<ul style="list-style-type: none"> areas (~50%) demonstrating potential to add ecosystem value 		<ul style="list-style-type: none"> suitable with amelioration Export potential Abundance of water storage facilities & buildings Access to infrastructure (e.g. CQ Inland Port) Regional aspiration to continue to grow agriculture sector Co-location potential Supported by participants Can be implemented now on mine buffer land Labour intensive, possibly more jobs than traditional agriculture 	
Constraints	<ul style="list-style-type: none"> Community sentiment (feedlots, poultry conditions) Environmental impacts (methane production, water discharge quality) 	<ul style="list-style-type: none"> Low employment potential Regional economic benefits Market fluctuations (demand/ potential oversupply) Lack of support from workshop participants 	<ul style="list-style-type: none"> Ratio mine lease to ecosystem corridors is much lower (15%) Low employment potential 	<ul style="list-style-type: none"> Rehabilitation to a standard that supports grazing Size of blocks available to graziers (may be too small to be suitable) Lack of appeal to younger people 	<ul style="list-style-type: none"> Lack of appeal to younger people (future labour force) New approach may not be embraced by traditionalists Cost & time to transition from 	<ul style="list-style-type: none"> Visitors to inland parts of region are mostly business and relatives not tourists Apart from mining heritage, limited PMLU (tourism potential off mined land)

	Protected horticulture/ intensive livestock	Solar energy/ R&D hub	Native ecosystem corridors	Grazing	Cropping	Tourism
				(future labour force) • Attraction & retention of workers • Increasing skill level required (technology) • Isolation of work • Significant marketing would be required to attract students. Younger population does not find grazing/ farming attractive. • Exposure to climate change as grazing success relies on reliable rainfall • Buffel grass die-back is threatening the viability of grazing	traditional to regenerative methods	• Low availability of accommodation in boom cycle
Related opportunities	<ul style="list-style-type: none"> • Synthetic biology as a driver of future agriculture • Locating meat processing facilities closer to the farm to reduce costs and reduce footprint. 	<ul style="list-style-type: none"> • Integration with other PMLUs to produce cheap energy; local communities as end-users 	<ul style="list-style-type: none"> • Integration with tourism • Commercialised plant products 	<ul style="list-style-type: none"> • Opportunities to work with Resources Centre of Excellence, TAFE, universities to attract younger generations through e.g. promoting the high-tech nature of 	<ul style="list-style-type: none"> • Mined land as a support facility (hub) to store water, house production facilities with co-located enterprises on buffer land and/or adjacent landholdings – 	<ul style="list-style-type: none"> • Opportunities in multi-day trips for tourists from Brisbane (a combination of attractions, including coast and inland)

Protected horticulture/ intensive livestock	Solar energy/ R&D hub	Native ecosystem corridors	Grazing	Cropping	Tourism
			modern farming and incorporating regular fieldwork in the curriculum	<p>adopting an integrated approach to land use</p> <ul style="list-style-type: none"> • Work with Resources Centre of Excellence, TAFE, universities to provide training in regenerative agriculture locally • Mines could support regenerative cropping on their buffer land right now and use the products in the camp kitchens. The regenerative cropping enterprise could include greenhouses and hydro/micro farms. The mining and the agriculture industries could work side-by-side then fully transition to agriculture post- mining. There are existing examples of this type of co- located industries. 	

	Protected horticulture/ intensive livestock	Solar energy/ R&D hub	Native ecosystem corridors	Grazing	Cropping	Tourism
Collaborative potential¹²	<ul style="list-style-type: none"> Moderate to high 	<ul style="list-style-type: none"> High 	<ul style="list-style-type: none"> Moderate 	<ul style="list-style-type: none"> Moderate 	<ul style="list-style-type: none"> High 	<ul style="list-style-type: none"> Moderate to high
Potential collaborators	<ul style="list-style-type: none"> Regulators Local governments Infrastructure owners Economic & development organisations Beef industry Farming industry Commercial markets Neighbouring landholders Mines (e.g. Ensham) that have mining, solar, grazing Manufacturing sector Renewable energy industry Agricultural associations 	<ul style="list-style-type: none"> CRC TIME and CHDC are working with GW3 and IRC to develop BB regional hub Energy providers Major energy users (manufacturing, hydrogen fuel etc) Regulators Federal government agencies State government departments Local governments Economic & development organisations Research organisations Enabling infrastructure owners 	<ul style="list-style-type: none"> Landholders could become "rangers" for native habitat to complement their agricultural practices Regional vision rather than site-by-site to provide larger corridor / ecosystem planning Adjoining mines Volunteers (e.g. Landcare groups, community groups, schools etc) University students/ researchers State government departments Regulators Biodiversity offsets market Carbon market 	<ul style="list-style-type: none"> Local graziers Grazing associations/ producer organisations Regulators State government departments Local governments Research organisations 	<ul style="list-style-type: none"> Local farmers and graziers Agriculture associations Regulators State government departments Local governments Economic & development organisations Education providers Co-location industries (e.g. biofutures feedstock, carbon) 	<ul style="list-style-type: none"> State government departments Local governments Economic & development organisations Tourism organisations Local tourist operators and affiliates (travel, accommodation, services) Chambers of Commerce Marketing specialists

¹² This ranking was captured via the online survey using a 5-point Likert scale of very low to very high. Participants did not complete the option to provide a rationale for their evaluation.

5.6 Clarence Moreton/ Surat

Five PMLU opportunities were identified for the Clarence Moreton/ Surat, based on the suitability assessment. Their collaborative potential and opportunities were assessed and explored through the workshop with regional stakeholders. The details relating to five suitable PMLUs are summarised in Table 8.

The workshop indicated that regional stakeholders tended to operate independently at local and state levels. Participants agreed that a post-mining employment transition strategy has not been clearly articulated for the region. This lack of direction has had an adverse impact on the region and residents (uncertainty around the future of New Acland mine (stage 3), for example). According to the participants, long-term planning, integration and associated education around planning for post-mining futures are critical but there has been little evidence of this so far. A comment was made that the PMLU options presented would need considerable long-term investment and that this investment would need to come from, or be seed-funded by, the federal and state governments.

As shown in the Table 8, while protected horticulture, wind energy, grazing and tourism were identified as suitable PMLUs, workshop participants considered cropping and grazing to have the highest collaborative potential while protected horticulture was rated as having moderate-high collaborative potential. Additional collaborative opportunities were indicated in relation to each PMLU, most of which relate to tourism.

Natural habitats and an environmental park were also considered suitable PMLU options by workshop participants.

Table 8: PMLU opportunities and collaborative potential – Clarence Moreton/ Surat

	Protected horticulture	Wind energy	Grazing	Tourism	Cropping (west)
Suitability ranking – socio-economic	• Suitable	• Suitable	• Suitable	• Suitable	• Possible
Suitability ranking – technical/ environmental	• Very suitable	• Very suitable	• Suitable	• Suitable	• Possible, with amelioration
Strengths	<ul style="list-style-type: none"> • High abundance of water storage facilities and buildings • Close to Brisbane • Local food source • Diverse supply chain • Potential to create significant employment, including new local SMEs • Large benefits for smaller communities and towns in the region 	<ul style="list-style-type: none"> • Suitable wind speeds (> 6 m/s) in south • Excellent connection to HV grid • Potential for more than 20,000 ha of wind farms within 5km of mine leases • Low price of electricity in the region which could help in growing other industries (community members as end-users) 	<ul style="list-style-type: none"> • Agriculture and farming as traditional economic drivers. Elements of regional identity associated with grazing • Existing rehabilitation is suitable Darling Downs, but legacy issues around Ipswich • Majority of soil types would support pasture species • Local good practice example of New Acland Coal Mine. 	<ul style="list-style-type: none"> • Close to Brisbane • Housing availability • One of government's priority sectors in the region • Potential to link to existing infrastructure (trails, hospitality) • Potential to create significant employment, including new local SMEs 	<ul style="list-style-type: none"> • Sufficient rainfall • Agriculture as a traditional economic driver

	Protected horticulture	Wind energy	Grazing	Tourism	Cropping (west)
Constraints	<ul style="list-style-type: none"> • Challenging keeping workers • Access to water is critical • Requirement of small areas of land (favourable in combination with other land uses) • Demands on skills • Import and export demand • High cost of the establishment 	<ul style="list-style-type: none"> • Low employment potential • Noise • Visual amenity • Risk around instability of markets and oversupply 	<ul style="list-style-type: none"> • Low employment potential, attraction and retention • Low economic contribution to the region • Increased skill level required • Isolation of work 	<ul style="list-style-type: none"> • High demands and costs on infrastructure repurposing and its maintenance 	<ul style="list-style-type: none"> • Increased skill level required • Isolation of work • Low economic contribution to the region • Soil on mine leases are only suitable for cropping in the western parts of the region • Landform design challenges
Related opportunities	<ul style="list-style-type: none"> • Circularity opportunity (e.g. horticulture waste feeds livestock; livestock waste fertilises crops) 	<ul style="list-style-type: none"> • Integration with protected horticulture, given the industry's large requirement for energy and water. Protected horticulture has the added benefit of providing local fresh produce for the region. 	<ul style="list-style-type: none"> • Opportunity to retrain miners to become farmers (a current shortage of workers in the grazing industry in the region) under a government's subsidy for new farmers (e.g. a young farmer scheme - examples in the UK). Benefits raised included building regional farming and community spirit, re-building, re-engaging, upskilling and re-education towards farming. 	<ul style="list-style-type: none"> • Training opportunities in hospitality sectors • Opportunity for 'package of attractions' such as combination of farm stays, recreational hiking, gourmet food and markets • Opportunity for glamping 	<ul style="list-style-type: none"> • Protected cropping for high-value products • Potential to treat coal seam gas wastewater for irrigation supply
Collaborative potential¹³	<ul style="list-style-type: none"> • Moderate to high 	<ul style="list-style-type: none"> • Low to moderate 	<ul style="list-style-type: none"> • High 	<ul style="list-style-type: none"> • Low 	<ul style="list-style-type: none"> • High

¹³ This ranking was captured via the online survey using a 5-point Likert scale of very low to very high. Participants did not complete the option to provide a rationale for their evaluation.

	Protected horticulture	Wind energy	Grazing	Tourism	Cropping (west)
Potential collaborators	<ul style="list-style-type: none"> Regulators State government departments Local governments Toowoomba Regional Council Western Down Regional Council Aboriginal groups with Native Title claims or land holdings Research organisations and universities Landholders and neighbouring landholders Mines Local graziers and farming organisations Community members Economic & development organisations Commercial businesses groups Enabling infrastructure owners TSBE Chamber of Commerce AgForce QFF 	<ul style="list-style-type: none"> Regulators State government departments Local governments Toowoomba Regional Council Western Down Regional Council Aboriginal groups with Native Title claims or land holdings Research organisations and universities Neighbouring landholders Mines Energy providers Major energy users Economic & development organisations Research organisations and universities Enabling infrastructure owners Community members 	<ul style="list-style-type: none"> Regulators State government departments Local governments Toowoomba Regional Council Western Down Regional Council Aboriginal groups with Native Title claims or land holdings Research organisations and universities Landholders and neighbouring landholders Mines AgForce Local graziers and farming organisations Community members 	<ul style="list-style-type: none"> Regulators State government departments Local governments Toowoomba Regional Council Western Down Regional Council Aboriginal groups with Native Title claims or land holdings Research organisations and universities Landholders and neighbouring landholders Mines Tourism Queensland Commercial Tourism operators Commercial businesses groups Enabling infrastructure owners Local SMEs 	<ul style="list-style-type: none"> Regulators State government departments Local governments Toowoomba Regional Council Western Down Regional Council Aboriginal groups with Native Title claims or land holdings Research organisations and universities Landholders and neighbouring landholders Mines Agriculture associations (AgForce) Landcare/ NMR organisations (e.g. Southern Qld Landscapes) Local farmers State and federal cropping agencies Commercial businesses groups Enabling infrastructure owners

5.7 Collaboration framework

To encourage a collaborative approach to PMLU decision-making within post-closure transition planning, we have developed a collaboration framework comprising principles, strategic questions for assessing the collaborative potential of PMLU projects and a collaboration process.

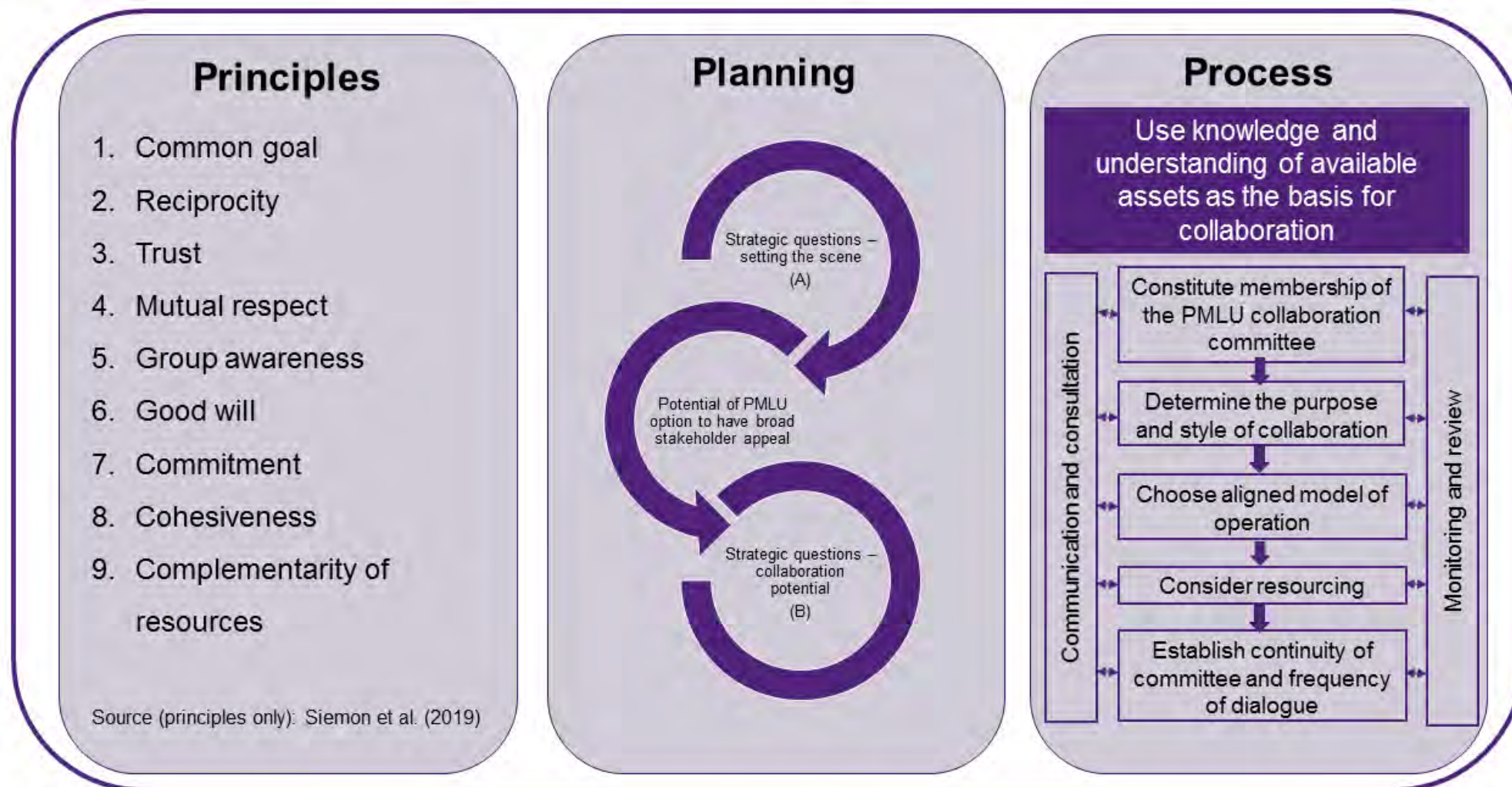


Figure 17: Collaboration framework

5.7.1 Principles of collaboration

Collaboration is the joint effort of working towards a common goal or goals. It can occur in any context where people seek to create value together that they would be unable to create on their own (Randrup et al., 2016). Collaboration is not the same as cooperation; for example, common goals are not a feature of cooperation. The partners simply agree on their contribution and outcomes of the cooperation. Tasks are carried out separately then each contribution is integrated into the final outcome (Siemon, 2019).

Our collaboration framework has 9 principles which are briefly described below.

<p>Common goal</p> <p>Having a common goal underpins any collaboration effort and motivates all collaborators to work together.</p> <p>Reciprocity</p> <p>Reciprocity is a process of exchanging skills or tangible items (such as financial resources, technology, venue hire) between collaborators in order to gain a mutual benefit. Each collaborator is expected to contribute something of perceived equal value. Community members, who may not have significant financial resources, may contribute local and/or Indigenous knowledge, while mining companies may contribute financial resources or mine rehabilitation skills, and local governments the venue for meetings and town planning expertise.</p> <p>Trust</p> <p>Information sharing, cooperation among collaborators and a willingness to navigate issues as they arise requires trust. Trust is based on individual collaborators' confidence that the actions of fellow collaborators will be beneficial to the group (PMLU collaboration committee) and not detrimental to their own needs and private goals.</p> <p>Mutual respect</p> <p>Mutual respect occurs when the perspectives and requirements of every collaborator have been given the same weight or value.</p> <p>Group awareness</p> <p>Group awareness is the understanding of who collaborators are working with on the committee, what is being worked on and how their actions affect each other.</p>	<p>Good will</p> <p>The disposition or consent to act for the good of all collaborators is known as good will. Collaborators should not intentionally work against the attainment of the common goals and they should negotiate in good faith to accommodate each person's motivations for collaborating.</p> <p>Commitment</p> <p>Commitment refers to the obligation of each collaborator to strive to reach the common goals.</p> <p>Cohesiveness</p> <p>Cohesiveness is about the unity of the PMLU collaboration committee. It is often indicated by the strength of the bonds that link each collaborator to the committee as a whole, the sense of collegiality and the degree to which collaborators coordinate their efforts to achieve the common goals.</p> <p>Complementarity of resources</p> <p>Potential collaborators should have the resources/ institutional capacity to participate in the collaboration process with equal standing. If there is not complementarity of resources, collaborators should assess whether there is scope for capacity building and resourcing to fill any gaps. Is there a willingness for well-resourced organisations to support the participation of less resourced entities (e.g. neighbouring landholders, Indigenous groups)?</p>
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5.7.2 Strategic questions for assessing the (high-level) collaboration potential of PMLU projects

These questions are based on the premise that potential for effective collaboration is linked to a specific PMLU option and that options are driven by a region's socio-economic, environmental and regulatory context, which is determined by qualitative and quantitative data analysis.

Focus questions	Level of alignment				
	Very strong	Strong	Moderate	Weak	Very weak
A. Setting the scene (suitability assessment)					
1. (a) Does the region's environmental context support the potential PMLU project (is it environmentally suitable)?					
(b) Could the region's environmental context support the potential PMLU project with minor adaptations that are technically and financially feasible (e.g. short-term establishment watering of native woodland)?					
2. Does the region's socio-economic context (strengths and constraints) support the potential PMLU project?					
3. Does the potential PMLU project meet the aspirations, views and knowledge of regional communities?					
4. Is there regional familiarity with the PMLU?					
5. (a) Does the potential PMLU meet regulatory requirements (including environmental approvals)?					
(b) If not, is government likely to support amendment to enable the PMLU project to proceed?					
(c) Are there limited regulatory barriers to developing the potential PMLU project?					
6. Is the potential PMLU project aligned with local/ state/ federal policies?					
7. Is the potential PMLU project aligned with relevant global trends?					
8. At a high-level, does the potential PMLU project make business and financial sense (and warrant undertaking due diligence in the future)?					
9. Is there demand for the PMLU in the region, across the state, nationally?					
10. Based on responses to questions 1-9, is the potential PMLU likely to have broad appeal at local, regional and state levels?					

Focus questions	Level of alignment				
	Very strong	Strong	Moderate	Weak	Very weak
B. Collaboration potential					
11. Using the broad stakeholder groups in Appendix 2 as a starting point, identify potential collaborators for the selected PMLU project. Is there depth and diversity of stakeholders?					
12. (a) Do each of the potential collaborators have the resources/ institutional capacity to contribute to the collaboration process and project roll-out?					
(b) If not, is there scope for capacity building and resourcing to fill any gaps?					
13. Is there a willingness for well-resourced organisations to support the participation of less resourced entities (e.g. neighbouring landholders, Indigenous groups)?					
14. Is there a natural project lead (organisation) among potential collaborators?					
15. Are there existing collaborations among stakeholders at a regional level, including between mines?					
16. Is there strong collaboration between local governments within regions?					
17. Do the local governments in the region undertake long-term strategic planning, including strategies for transitioning to post-mining futures?					
18. Is there an appetite for collaborative decision-making (i.e. shared power and a willingness to take collective action to implement decisions)?					
19. Can potential collaborators to meet face-to-face at a central location without hardship (distance, cost etc)?					
20. Is communication connectivity stable enough to support online collaboration?					

5.7.3 Collaboration process

In setting up a collaboration process for a PMLU project or collection of projects, regional stakeholders should use the knowledge and understanding of available assets (regional strengths) as the basis for the collaboration. Assets include the skills, expertise, local and/or Indigenous knowledge, financial and human resources available. The process to set up collaboration is described below, and a series of focus questions is provided for context.

Constitute membership of the PMLU collaboration committee (or group or team)

- Establish membership criteria (who can participate?)
- Determine the size of the committee
- Will there be any limitations on the number of committee members from the same organisation/ stakeholder group?
- How will members be recruited (see Appendix 2 for a list of stakeholder groups that could be considered as a starting point)?

Determine the purpose and style of collaboration

- What is the purpose of the PMLU collaboration committee?
- What outcomes are expected from the collaboration?
- Will the committee be based on collaborative or cooperative approaches?
- Will the collaboration be informal or formal (i.e. requiring legal agreement/s)?
- Will each collaborator be required to sign a confidentiality agreement?

Choose aligned model of operation (the way the committee works)

- How will the committee operate?
- How will decisions be made?
- What governance/ accountability processes will be required?
- What is the most appropriate committee structure?
- What roles are required (e.g. chair, secretary, IT specialist, legal officer)?
- Will the chair be a revolving role so that each collaborator has the opportunity to chair the committee?
- How will roles filled (e.g. nomination and vote)?
- What term is appropriate for committee roles?
- What time commitment is expected from committee members?

Consider resourcing

- Will the committee need operating funds and, if so, how will the funding be sourced?
- How will committee members be paid for their work (e.g. in-kind, external funding)?
- Will committee members be reimbursed for expenses (e.g. travel, phone, stationery)?

Establish continuity of committee and frequency of dialogue

- What is the life of the committee?
- Will the committee be dissolved once the PMLU has a formal project team or is under development, or will the committee transition to a community consultative committee for the operational life of the PMLU?
- What is the process for dissolving the committee?
- How frequently will the committee meet?
- Will the meetings be face-to-face or online or use a hybrid approach?
- How will matters be dealt with in-between meetings?

6. Research priorities and interventions

6.1 Environmental aspects

The review of the scientific literature relevant to the development of PRCPs included consideration of international and national trends in land use planning, land use frameworks, selection of PMLUs and how common they were, social, environmental, and economic impacts and benefits of PMLUs, and future trends in PMLU selection. There have been several reviews conducted at the global scale to identify the major factors considered in the selection of a PMLU and they show that the choice of PMLU is primarily driven by government legislation. Largely, most of the international research has focused on investigating the performance of rehabilitation activities that will deliver success with meeting pre-determined completion criteria, without questioning the selection of the PMLU. The review findings align with current practice in Queensland: the PMLU is listed in EAs (government legislation), and rehabilitation practices are supported by a range of research findings from projects undertaken over the last 20 years. This means that if proponents wish to list an innovative PMLU in their PRCP, there is little national or international research they can rely on to guide their decision. In addition, there is no information about how alternative land uses can be incorporated in the required documents and schedules. Hence, most operations are preparing their PRCPs based on the committed PMLU, with no well-defined avenue for amending it.

To support selection of innovative PMLUs and embed the process of PMLU selection in regional and collaborative frameworks, there needs to be stronger research focus on this discipline, ideally at regional, national and international scale. This project showed that Australia was at the forefront of land use planning research but that land use policy and planning lacked coordination and leadership. There is a great opportunity to influence and improve land use planning processes by establishing a strong research discipline related to PMLU selection.

In March 2020, the Federal government announced a \$29.5 million investment in a new Cooperative Research Centre for Transformations in Mining Economies (CRC TIME). The CRC TIME commenced in 2021 and funded a foundation project to review and outline current practice with mapping out PMLU options. This demonstrates initial interest in the topic, which is likely to be extended over the 10-year time frame of the CRC. The QRC should consider continuous engagement with the CRC, ideally as a partner, to influence and strengthen the discipline of regional and national land use planning.

This project showed that the PMLUs with the greatest potential contributions are renewable energy (solar and wind), native ecosystems, grazing, cropping, protected horticulture, intensive livestock, tourism and in some locations, phytomining. These can contribute to physical, financial, natural and social capitals. The PMLUs that are supported by existing research findings are native ecosystems, grazing and some cropping options. However, while there has been extensive research undertaken to support the re-establishment of native ecosystems, this project has identified that in the Bowen Basin, the highly modified landscapes would benefit from connection of the small 'endangered' and 'of concern' ecosystems that remain. This is the region that is most in need of reinstating ecosystem connectivity and should, therefore, constitute a research priority to identify how rehabilitation practices could be modified to deliver maximum benefits.

For the other PMLUs that are not supported by existing research findings, there are requirements to define the rehabilitation methods that will successfully deliver them, along with associated completion criteria. Examples of targeted research needs include:

- **Renewable energy:** there are barriers that can prevent development of renewable energy schemes on mined land, but most are related to co-existence with mining activities (e.g. site access, safety considerations, compliance with mining lease conditions). To establish renewable

energy as PMLU, after mining activities have ceased, research is mostly required for the development of smart grid and storage systems that will capitalise on intermittent energy production and of cost-benefit analysis tools to guide the design and capacity of such projects.

- **Protected horticulture:** there is a large interest in the horticulture industry to repurpose mine buildings for protected cropping. This would protect food production from climate variations and provide controlled indoor environments, potentially on a large scale. In recognition of this potential, the University of Queensland has established a multidisciplinary research network¹⁴ to promote a collaborative approach to addressing the research questions, which include selection of high-value crops, design of water efficient systems and supply chain considerations. The initial research challenge is to demonstrate that repurposing a mine building for protected cropping can work. This can be achieved through a case study, in which crops would be grown in a repurposed mine building or workshop. The research network only requires access to a building connected to water and power supply. It is strongly recommended that QRC canvas his members for their interest in participating in such a case study and establish a connection with the Protected Cropping Network.
- **Phytomining:** the benefits will be the greatest in regions or areas where specific metals are present (in mine residue or water) and species of hyper-accumulator plants that target these metals can be identified. The research priority is to compile data providing concentrations of metals in mine water, as this will also indicate their potential presence in mine residue. A request can be submitted to the team managing the WaTERS database¹⁵.

The project also identified that there were knowledge gaps concerning the assessment of the technical feasibility of two PMLUs:

- **Pumped-storage hydroelectricity** ('pumped hydro') allows energy from intermittent sources, such as solar and wind, to be saved for periods of higher demand. The potential for pumped hydro cannot be assessed with current data sets. Such schemes would strongly support development of renewable energy. A research priority is to gather the data describing future plans for underground mines, particularly in the Bowen and Surat basins, so that the potential for using underground workings as water storage can be assessed. There are also options to assess the potential at underground coal mines that are currently closed.
- **Regenerative agriculture** is not well defined but has support in many of the regions. There should be an initiative to better define what adopting the general principles of regenerative agriculture would mean at the scale of each region.

A key finding from this project is that while progressive rehabilitation, closure planning and the selection of PMLU options are important considerations for each mining operation, decisions made at a mine site need to consider the regional context. This context includes the technical, environmental, socio-economic and governance conditions as well as the preferences and needs of stakeholders. This chapter, therefore, extends the research agenda beyond the environmental domain into regional post-mining transitions and highlights strategic responsibilities for key stakeholder groups.

¹⁴ <https://gci.uq.edu.au/protected-cropping>

¹⁵ <https://science.des.qld.gov.au/government/science-division/waters>

6.2 Post-mining transitions: strategic responsibilities, interventions and associated research

This section presents interventions and associated research required to initiate dialogue and take preliminary action on post-mining transition within the four Queensland study regions. The interventions and research have been categorised according to the entity responsible and its strategic responsibilities. The information is presented in Table 9, with responsible entities organised from national scale (federal government) to local scale (local government, mines and local stakeholders).

Table 9: Strategic responsibilities, interventions and research priorities

Entity	Strategic responsibilities	Interventions/ associated research
Federal government	Telecommunications	<ul style="list-style-type: none"> Improve internet/ mobile phone connectivity in the state, particularly in remote Queensland
State government	Gather international examples of processes used to develop and establish post-mining visions (how have other governments done it?)	<ul style="list-style-type: none"> Literature review (R)
	Develop a vision for Queensland's post-mining future and the transition pathways	<ul style="list-style-type: none"> Conduct facilitated visioning workshop/s – take into account the complexity of transitions, importance of regional context Engage with regional governance networks, LGAs Drive establishment of regional post-mining transition forums to kick-start transition planning and development of stakeholder networks; link in with CRC TiME's Bowen Basin regional hub Consider funding poorly resourced stakeholder groups to enable participation in post-mining transition forums Foster cross-regional collaboration to encourage sharing of key learnings
	Adopt a systems approach to supporting PMLU development	<ul style="list-style-type: none"> Investigate industrial systems – how to integrate various PMLU options into an integrated system, key parameters, critical mass, barriers, commercial issues etc (R)
	Develop incentives for trialling suitable PMLUs that at first glance do not seem to have significant job opportunities or regional benefits (which are key regional aspirations)	<ul style="list-style-type: none"> Literature review of examples of incentive mechanisms (e.g. UK subsidy for new farmers to train and stay post-mining) (R) Development of incentive policy and program. Could include payments for ecosystems services, premium prices on products from regenerative agriculture etc

Entity	Strategic responsibilities	Interventions/ associated research
		<ul style="list-style-type: none"> Conduct pilot program using suitable PMLU in a region (R) Develop case study materials using plain English to assist regions assess potential of pilot and other PMLU options
	Education framework Develop vision / framework for innovative tertiary education pathways that deliver the new skill sets required to optimise PMLU developments	<ul style="list-style-type: none"> Develop policy around 'local curricula for local needs' to deliver skills needed for resourcing PMLU options Curriculum development to support modern agricultural techniques and roll-out to regional centres Marketing campaign to attract young people into agricultural sector
	Foster development of new technologies that will create jobs from PMLUs	<ul style="list-style-type: none"> Further investigation of microgrid, smart grid and energy storage solution, to support development of renewable energy (R) Develop IT curricula to enable regional training/ tertiary education for smart grid development, manufacture, maintenance
	Define mining region and regional boundaries	<ul style="list-style-type: none"> Define what constitutes a mining region in Queensland using geolocatable parameters, suggestions for harmonisation across all levels of government. (R)
State & regional governance network ¹⁶ & local government (joint)	Regional tourism	<ul style="list-style-type: none"> Growing regional tourism including system/ supply chain requirements, leadership/ governance (R) Support and promote professional development training for all aspects of tourism development, including computer literacy, small business skills, governance, marketing etc particularly for remote regional areas
	Renewable energy / mining co-existence	<ul style="list-style-type: none"> Pilot study. Requires extensive engagement with state government departments and consideration of regulatory barriers (access to mine site & Safety Act, conditions of mining lease etc) (R) Assess the potential for Green Bonds to contribute to the financing of renewable energy projects
	Regenerative agriculture	<ul style="list-style-type: none"> Research existing regenerative agriculture farms in Queensland (local conditions) and assess potential for PMLU on mined land and buffer land (R)

¹⁶ Regional governance networks refer to entities in which decision-making is made at regional scale e.g. Central Queensland Regional Organisation of Councils and Mount Isa to Townsville Economic Development Zone.

Entity	Strategic responsibilities	Interventions/ associated research
		<ul style="list-style-type: none"> • Develop a knowledge base and education framework to progress regenerative agriculture towards an evidence-based practice • Identify farmers in the study regions, including mine neighbours, who are interested in transitioning to regenerative agriculture and support transition
Regional governance network/ local government	Develop regional vision for transition to a post-mining future, with specificities aligned with local strengths and weaknesses, opportunities and constraints	<ul style="list-style-type: none"> • Establish/ actively participate in regional post-mining transition forum • Assess potential for Green Bonds to support upgrades to water supply infrastructure that will lead to greater drought resilience, for instance by relying on mine water for additional supply • Map local knowledge, local needs – extend the baseline works from this study to conduct a deeper dive for a region (pilot) or each region (R)
	Encourage regional champions, PMLU trailblazers (from industry and broader community with strong interest and project ideas)	<ul style="list-style-type: none"> • Get some early wins with PMLU demonstration projects led by (ideally) industry and local community. Protected horticulture offers good potential – established network of researchers, growers and industry; ‘ease’ with which a case study can be set up: requires a mine building to re-purpose with access to water. Develops transferrable skills. Suggest Moranbah region, as produce can be supplied to mining camps (circular economy) (R). • Tailings re-processing / re-purposing: <ul style="list-style-type: none"> – Assessment of environmental outcomes over life-of-mine of the two scenarios – re-purposing versus completing rehabilitation (suitable for PhD research) (R) – Economic benefits: making money out of re-purposed tailings versus reducing financial liability (R) – Identifying synergy opportunities, particularly in Mount Isa and the North Queensland triangle formed by Cairns, Townsville and Cloncurry • Agriculture / mining co-existence: identify case studies that demonstrate the potential for co-existence and synergies between mining and agriculture. Sojitz in the south Bowen Basin have a strong interest in this type of project. Glencore Coal South Africa, B4D and ICM project at Umsimbithi Colliery (Wonderfontein) are comparing wheat yield on smallholding-sized plot using groundwater versus mine water (R)

Entity	Strategic responsibilities	Interventions/ associated research
		<ul style="list-style-type: none"> • Pumped hydro pilot including feasibility of using underground workings as water storage (R) • Promote establishment of Indigenous businesses in post-mining environment (e.g. tourism, nurseries to provide seeds and seedlings for rehabilitation activities and medicinal purposes, rehabilitation, post-closure monitoring etc) <ul style="list-style-type: none"> – International examples: can we learn from what has been done in other locations – literature review (R) – Engagement → interest → feasibility → capacity building → seed funding (action learning research) (R)
Mines and mining companies	<ul style="list-style-type: none"> • Actively support development of proposals that will address the technical research priorities, some of which can be addressed through projects funded by the Australian Coal Association Research Program (ACARP). • Actively support development of proposals that will address the socio-economic aspects of post-mining transition. 	<ul style="list-style-type: none"> • Secure ACARP funding to identify priority areas for phyto-mining in the Bowen Basin (R) • Identify options for a case study to demonstrate the potential for repurposing mine buildings for protected cropping (R) • Support/ fund research into regional implications for post-mining transition, initiating economic diversification (process and options), establishment of Indigenous/ local businesses etc (R) • Extend mine social investment programs to include post-mining transition capacity building e.g. establishment of Indigenous/ local businesses (business planning, small business skills), reskilling mine employees.
Industry bodies and community groups (see Appendix 1 for potential stakeholder list)	<ul style="list-style-type: none"> • Actively participate in regional post-mining transition forums • Provide expertise in relevant PMLU options • Fund/ co-fund R&D projects where appropriate • Foster collaboration opportunities, including between unconventional partners 	

(R): Research

7. Conclusions and recommendations

7.1 Conclusions

Regional capacity to transition to a post-mining future is dynamic and multidimensional. It depends on the capacity to harness, adapt or re-configure regional assets and an ability to cultivate new competencies that enable the region to survive and prosper after mining activities cease (Boschma et al., 2017). While characteristics of mining will guide this transition, understanding the regulatory and regional contexts in which mines operate are equally important to delivering positive and enduring outcomes.

Mine rehabilitation and the selection of PMLUs have an important role to play in regional transitions to post-mining futures. This project has delivered a technical, environmental and socio-economic baseline for four Queensland regions: NWMP, North Queensland, Bowen Basin and Clarence Moreton/ Surat. This research has found that PMLU planning should be integrated into the regional planning processes. Considering PMLUs in isolation may overlook regional aspirations, for example, in relation to economic development and employment. An overarching strategy is needed to establish a shared vision across the spectrum of stakeholders, harness regional expertise, optimise collaboration opportunities and articulate a coherent action.

Although the current regulatory arrangements (including those for PRCPs) do not preclude collaboration, they are not conducive to promoting PMLU initiatives beyond existing rehabilitation commitments of individual sites or stimulating changes to PMLUs where there is a greater environmental or socio-economic benefit. With any shift to regional PMLU planning, there may be opportunities to streamline or facilitate existing processes and requirements.

This research also shows that stakeholders' local knowledge can inform expert-driven assessments of PMLU suitability and provide valuable insights into collaborative potential and opportunities. However, an important observation relates to the challenge in getting stakeholders to think about and engage with the concepts of mine closure and PMLU in advance of imminent closure. At this stage of most mine lifecycles, closure is intangible for many stakeholders. A lack of transparency, communication and engagement around mine closure and PMLU planning generally has contributed to this situation.

The project identifies several PMLU options assessed as suitable for the study regions – grazing, re-establishing native ecosystem corridors, renewable energy, cropping and regenerative agriculture, protected horticulture and intensive livestock production, phytomining, manufacturing hub and tourism. Not all PMLU options are applicable for each region. Through our scoping work, research participants indicated their preference for PMLU options that incorporated multiple, inter-related activities that operated as an integrated system rather than single land uses (e.g. grazing alone). An integrated system could include, for example, a combination of industrial and agricultural enterprise designed around sustainable water use, renewable energy production, onsite processing and secondary activities, and education training, fieldwork.

The outcomes from this project establish suitable PMLU options, based on an assessment undertaken at regional scale. These options could be pursued where there is broad support and following further assessment of feasibility. A collaboration framework with principles, strategic questions and process has been developed to assist that endeavour. However, there will be a requirement to include existing site-level rehabilitation and mine closure obligations to ensure that selection of regional PMLU options does not preclude mines from meeting their existing requirements and, where possible, to capitalise on opportunities for site-level conditions to align or contribute to one or more innovative PMLUs identified as suitable at regional level.

Finally, it is worth highlighting that the overall finding is that collaboration is required between the mining industry, the state and local governments, regional governance networks and the community to guide and create pathways for change.

7.2 Recommendations

Roundtable and workshop participants provided suggestions on how the findings from this project could be progressed. These included that QRC continues discussions with the Queensland Government about mine closure planning (exit strategies), that the findings are considered for inclusion into the Queensland Resources Industry Development Plan (via QRC) and that the Queensland Government takes the lead in transition planning. Participants said that although this project was a good start, QRC needed to undertake further, more detailed work to elicit deeper insights and that it should encourage mining companies to initiate on pilot PMLU projects.

Drawing on this stakeholder feedback and the information presented in Section 6.2, we present 9 recommendations. They are that:

1. QRC presents project findings to the Queensland Government.
2. In collaboration with the mining industry and regional stakeholders, the Queensland Government develops a vision for the state's post-mining futures and transition pathways, including policies, programs and incentives/ funding.
3. The Queensland Government drives the establishment of regional post-mining transition forums, with ownership of the forums to remain with the regions. Regions would select forum participants and develop their own governance mechanisms and operational structures.
4. The Queensland Government collaborates with regional governance networks (e.g. Central Queensland Regional Organisation of Councils and Mount Isa to Townsville Economic Development Zone) and local governments on post-mining transition initiatives, ensuring regular, transparent engagement with other stakeholders, including community groups, and fostering their participation in regional decision-making.
5. QRC joins Cooperative Research Centre for Transformations in Mining Economies (CRC TiME) to leverage advances being made and avoid duplication of effort around PMLU and post-mining transition. CRC TiME brings together more than 70 leading mining and mining service companies, regional development organisations, state and federal governments and research partners to drive transformational change in mine closure.
6. The Queensland Government and relevant local governments utilise the Bowen Basin regional hub being established by CRC TiME. The CRC is establishing seven regional hubs across Australia to bring together stakeholders who share the same geography to collaborate on transformation initiatives. Although in the early stages of development, the Bowen Basin hub offers a framework for the development of one of Queensland's regional forums and provides an opportunity to pilot the forum concept.
7. QRC member companies, community groups and enabling stakeholders collaborate to undertake simple PMLU pilot projects to get 'runs on the board' and build momentum.
8. Regional governance networks, local governments and mining companies encourage regional champions to instigate pilot projects and facilitate collaboration.
9. The Queensland Government and the mining industry develop and fund a PMLU and post-mining transition research program that addresses the research priorities suggested in Section 6.

8. References

Regional plans and strategy documents

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Appendix 1: Research participants

The SMI project team wishes to thank the 32 people who volunteered their time to participate in the roundtables and workshops conducted for this project. As part of the invitation to participate (consent form), we asked participants if they would like to be publicly acknowledged. This is the list of those participants:

Participant	Affiliation
Christine Evans	Previously with Aurizon Network (now Multicom Resources)
Craig Davenport	Fitzroy Basin Association
Kate Bennick	Department of Environment and Science
Cr Megan Daniels	Central Highlands Regional Council
Neil Lethlean	Capricorn Enterprise
Peter Dowling	Central Highlands Development Corporation
Terry Short	Highlands Environmental
Drew Penny	Port of Townsville
Jean Robins	Charters Towers Chamber of Commerce
Adrian Eshman	Aurizon Operations Limited
Chris Wake	Department of Environment and Science
Cr Danielle Slade (Mayor)	Mount Isa City Council
David Keenan	Mount Isa City Council
Megan Crowther	Department of State Development, Infrastructure, Local Government and Planning
Andrew Sinnamon	AgForce
Brett Davey	Ipswich City Council
Graham Cooke	Landcare, landholder
Warwick Squire	Gasfields Commission Queensland
Frank Edwards	Capricorn Enterprise
Todd Rohl	Toowoomba Chamber of Commerce
Florence Drummond	Indigenous Women in Mining and Resources Australia

Appendix 2: Regional stakeholders

The following tables present a list of regional stakeholders categorised by region and according to stakeholder group.

North West Minerals Province

Stakeholder groups	Stakeholders
Local mines (operating)	<ul style="list-style-type: none"> • Barbara • Cannington • Capricorn - Copper • Crusader • Eloise • Ernest Henry • George Fisher • George Fisher South • Greenwood • Hughenden • Katie • Kings Cross • Kulthor • Lady Loretta • Lorena • Mount Colin • Mount Isa Copper • Mount Isa Silver-Lead • Osborne • Phosphate Hill • Robin • Rocklands • Undilla • Westralia
Local governments	<ul style="list-style-type: none"> • Mt Isa City Council • Cloncurry Shire Council • Richmond Shire Council • McKinlay Shire Council • Flinders Shire Council • Townsville City Council
State authorities	<ul style="list-style-type: none"> • Office of the Coordinator-General • DSDILGO • Department of Resources • Department of Transport and Main Roads • Queensland Health • Department of Energy

	<ul style="list-style-type: none"> • Department of Regional Development, Manufacturing and Water • Department of Agriculture and Fisheries • Department of Environment and Science • Department of Aboriginal and Torres Strait Islander Partnerships • Department of Education and Training • Department of Tourism, Innovation and Sport • Queensland Treasury • Department of Communities, Child Safety and Disability Services
Federal government agencies	<ul style="list-style-type: none"> • North Australia Development group • Regional Development Australia • Department of Infrastructure, Transport, Regional Development and Communications
Utilities/ infrastructure	<ul style="list-style-type: none"> • Powerlink • Ergon • Copperstring • Stanwell • Sunwater • QCNFibre • nbn • Energex • Energy Queensland
Traditional owner organisations	<ul style="list-style-type: none"> • Kalkadoon • Mitakoodi • Indigenous Women in Mining and Resources
Tourism	<ul style="list-style-type: none"> • Mount Isa Tourism Association (MITA) • Overlanders Way • North West Tours • Tourism Queensland • Outback Queensland Tourism Association • Australasian Business Travel Association (ABTA)
Social and community groups	<ul style="list-style-type: none"> • Mt Isa Family Support Service and Neighbourhood Centre in Mount Isa • North West Queensland Regional Organisation of Councils • Southern Gulf NRM • Bush Heritage Australia
Transport	<ul style="list-style-type: none"> • Local transport companies • Aurizon • Pacific National • Queensland Rail

	<ul style="list-style-type: none"> • FCB Logistics • Port of Townsville
Economic development	<ul style="list-style-type: none"> • MITEZ • GSD • Agriculture and Protected Cropping groups • Chamber of Commerce & Industry Queensland (CCIQ)
Industry associations	<ul style="list-style-type: none"> • Queensland Resources Council • MITEC • AgForce • Cotton Australia
Educators, research organisations and universities	<ul style="list-style-type: none"> • High schools • University of Queensland – Sustainable Minerals Institute • TAFE Queensland

North Queensland

Stakeholder groups	Stakeholders
Local operating mines (Source: Queensland's Mineral, Coal and Petroleum Operations and Resources Map, August 2017)	<ul style="list-style-type: none"> • Buckland • Chillagoe • Conjuboy • Coralime • Christmas Creek • Far Fanning • Georgetown • Hey Point • Hillgrove • Hughenden • Inkerman Lime • King Vol • Mount Carbine • Mount Carlton • Mount Molloy • Mount Ruby • Mungana • Nychum • Pajingo • Palmer River • Pauleeson • Phoenix Lime • Porphyry

	<ul style="list-style-type: none"> • River of Gold • Ravenswood/ Mount Wright • Skardon River • Thalanga • Weipa (East Weipa, Andoom & Amrun)
Local governments	<ul style="list-style-type: none"> • Charters Towers Regional Council • Mareeba Shire Council • Townsville City Council • Arukun Shire Council • Narranum Aboriginal Shire Council • Mapoon Aboriginal Shire Council • Weipa Town Authority • North Queensland Regional Organisation of Councils
State authorities	<ul style="list-style-type: none"> • Office of the Coordinator-General • DSDILGO • Department of Resources • Department of Transport and Main Roads • Queensland Health • Department of Energy • Department of Regional Development, Manufacturing and Water • Department of Agriculture and Fisheries • Department of Environment and Science • Department of Aboriginal and Torres Strait Islander Partnerships • Department of Education and Training • Department of Tourism, Innovation and Sport • Queensland Treasury • Department of Communities, Child Safety and Disability Services • Department of Energy and Public Works • Hydrogen Working Group
Federal government agencies	<ul style="list-style-type: none"> • North Australia Development group • Regional Development Australia • Department of Infrastructure, Transport, Regional Development and Communications • ARENA • Small Business Australia
Utilities/ infrastructure	<ul style="list-style-type: none"> • Powerlink • Ergon • Origin Energy • AGL • Sunwater • QCNFibre

	<ul style="list-style-type: none"> • nbn • Energex • Energy Queensland • First Solar • Genex Power
Traditional owner organisations	<ul style="list-style-type: none"> • Cape York Land Council • North Queensland Land Council • Kalkadoon Native Title Aboriginal Corporation • Bawinanga Aboriginal Corporation • Ewamian Aboriginal Corporation • Charters Towers Warringnu Aboriginal and Torres Strait Islander Corporation • Amrun Indigenous land rehabilitation workers (Weipa, Rio Tinto) • Indigenous Land and Sea Rangers – North Queensland • Indigenous Carbon Industry Network • Cape York Partnership • Western Cape Communities Trust
Tourism	<ul style="list-style-type: none"> • Tourism Tropical North Queensland • Tourism Cape York • Charters Towers Visitor Information Centre • Tourism Queensland • Charters Towers Chamber of Commerce and Mines • Western Cape Chamber of Commerce • Townsville Chamber of Commerce
Social and community groups	<ul style="list-style-type: none"> • Landcare • Indigenous Carbon Industry Network • Weipa Community Care Association • Tangaroa Blue Foundation • Prospect Community Services • Charters Towers Women of the Outback Shed
Transport	<ul style="list-style-type: none"> • Aurizon • Pacific National • Queensland Rail • Port of Townsville
Economic development	<ul style="list-style-type: none"> • Charters Towers Chamber of Commerce and Mines • Western Cape Chamber of Commerce • Townsville Chamber of Commerce • Townsville Enterprise • Charters Towers Regional Council • Mareeba Shire Council • Townsville City Council

	<ul style="list-style-type: none"> • Arukun Shire Council • Narranum Aboriginal Shire Council • Mapoon Aboriginal Shire Council • Weipa Town Authority • Western Cape Communities Trust
Industry associations	<ul style="list-style-type: none"> • Small Business Association • Ai Group • Australian Association for Manufacturing Excellence • Cattle Council of Australia • Australian Beef Association • AgForce • Meat and Livestock Australia • Canegrowers • Queensland Farmers Federation • National Farmers Federation • Graincorp • Queensland Resources Council
Educators, research organisations and universities	<ul style="list-style-type: none"> • James Cook University • CQ University • TAFE North • Centre for Mined Land Rehabilitation • Centre for Water in the Minerals Industry • Queensland Alliance for Agriculture and Food Innovation

Bowen Basin

Stakeholder groups	Stakeholders
Local operating mines (Source: Queensland's Mineral, Coal and Petroleum Operations and Resources Map, August 2017)	<ul style="list-style-type: none"> • Baralaba • Blackwater • Blair Athol • Broadmeadow • Burton • Byerwen • Callide • Carborough Downs • Caval Ridge • Clermont • Collinsville • Coppabella • Curragh • Daunia • Dawson

	<ul style="list-style-type: none"> • Eagle Downs • Ensham • Foxleigh • German Creek • Goonyella Riverside • Grosvenor • Hail Creek • Isaac Plains • Jellinbah East • Kestrel • Lake Lindsay • Lake Vermont • Middlemount • Millennium • Minerva • Moorvale • Moranbah North • Newlands • North Goonyella/Eaglefield • Oaky Creek • Peak Downs • Poitrel • Rolleston • Saraji • Sonoma • South Walker Creek • Wollombi/Suttor Creek • Yarrabee
Local governments	<ul style="list-style-type: none"> • Isaac Regional Council • Central Highlands Regional Council • Banana Shire Council • Rockhampton Regional Council • Livingstone Shire Council • Central Queensland Regional Organisation of Councils
State authorities	<ul style="list-style-type: none"> • Office of the Coordinator-General • DSDILGO • Department of Resources • Department of Transport and Main Roads • Queensland Health • Department of Energy • Department of Regional Development, Manufacturing and Water • Department of Agriculture and Fisheries

	<ul style="list-style-type: none"> • Department of Environment and Science • Department of Aboriginal and Torres Strait Islander Partnerships • Department of Education and Training • Department of Tourism, Innovation and Sport • Queensland Treasury • Department of Communities, Child Safety and Disability Services • Department of Energy and Public Works • Hydrogen Working Group • Queensland Government's Land Restoration Fund
Federal government agencies	<ul style="list-style-type: none"> • Regional Development Australia • Department of Infrastructure, Transport, Regional Development and Communications • ARENA • Small Business Australia
Utilities/ infrastructure	<ul style="list-style-type: none"> • Powerlink • Ergon • Origin Energy • AGL • Sunwater • QCNFibre • nbn • Energex • Energy Queensland • First Solar • Genex Power • CQ Inland Port
Traditional owner organisations	<ul style="list-style-type: none"> • Barada Barna • Durumbal • Queensland South Native Title Services Ltd • Central Queensland Indigenous Development
Tourism	<ul style="list-style-type: none"> • Mackay Tourism • Department of Tourism, Innovation, Sport and Recreation • Tourism & Events Queensland • Capricorn Enterprise • Isaac Regional Council • Central Highlands Regional Council • Banana Shire Council • Rockhampton Regional Council • Livingstone Shire Council • Central Highlands Development Corporation

	<ul style="list-style-type: none"> • Chamber of Commerce and Industry Queensland • Capricornia Chamber of Commerce • Emerald Chamber of Commerce • Moranbah Chamber of Commerce • Mackay Region Chamber of Commerce
Social and community groups	<ul style="list-style-type: none"> • Fitzroy Partnership for River Health • Fitzroy Basin Association • Central Queensland Mines Rehabilitation Network • Landcare
Transport	<ul style="list-style-type: none"> • Aurizon • Pacific National • Queensland Rail
Economic development	<ul style="list-style-type: none"> • Greater Whitsunday Alliance (GW3) • Central Highlands Development Corporation • Capricorn Enterprise • Central Queensland Indigenous Development • Regional Development Australia – Mackay, Isaac, Whitsunday • Regional Development Australia – Central and Western Queensland • Resources Centre of Excellence • Chamber of Commerce and Industry Queensland • Capricornia Chamber of Commerce • Emerald Chamber of Commerce • Moranbah Chamber of Commerce • Mackay Region Chamber of Commerce • JB Foods
Industry associations	<ul style="list-style-type: none"> • Queensland Farmers Federation • National Farmers Federation • Graincorp • Small Business Association • Queensland Resources Council • Bowen Gumlu Growers Association • AgForce • Meat and Livestock Australia
Educators, research organisations and universities	<ul style="list-style-type: none"> • RCS Australia • Central Queensland University (E&R) • TAFE • Centre for Mined Land Rehabilitation • Centre for Water in the Minerals Industry • Queensland Alliance for Agriculture and Food Innovation

Clarence Moreton/ Surat

Stakeholder groups	Stakeholders
Local mines (operating)	<ul style="list-style-type: none"> • Beachmere • Boral Darra • Boral Ipswich • Brittain's • Cement Hills • Cement Mills No.1 • Eidsvold Siltstone • Enterprise • Goondicum Crater • Greenwood Village • Gurulmundi • Gurulmundi North • Ironbark • Jeebropilly • Miles • Monier Darra • Monier Ipswich • Mount Biggenden • Mount Rawdon • Mount Sylvia • Ningi • Nubrik No 1 • Oakleigh Lime • O'dea East • O'dea Extended • Queensland Bentonite • Rochedale Brickworks • S&S Mining • Tanamerah Sandstone • Testarosa Clay • Warbrick • Warwick Plant • Warwick Sandstone • Yangan Sandstone
Local governments	<ul style="list-style-type: none"> • Balonne Shire Council • Goondiwindi Regional Council • Maranoa Regional Council • Southern Downs Regional Council • Western Downs Regional Council • Brisbane City Council

	<ul style="list-style-type: none"> • Council of the City of Gold Coast • Ipswich City Council • Lockyer Valley Regional Council • Logan City Council • Moreton Bay Regional Council • Noosa Shire Council • Redland City Council • Scenic Rim Regional Council • Somerset Regional Council • Sunshine Coast Council • Toowoomba Regional Council
State authorities	<ul style="list-style-type: none"> • Office of the Coordinator-General • DSDILGO • Department of Resources • Department of Transport and Main Roads • Queensland Health • Department of Energy • Department of Regional Development, Manufacturing and Water • Department of Agriculture and Fisheries • Department of Environment and Science • Department of Aboriginal and Torres Strait Islander Partnerships • Department of Education and Training • Department of Tourism, Innovation and Sport • Queensland Treasury • Department of Communities, Child Safety and Disability Services • SEQ Regional Planning Committee • Darling Downs Regional Planning Committee • Council of Mayors (SEQ) https://seqmayors.qld.gov.au/
Federal government agencies	<ul style="list-style-type: none"> • Regional Development Australia • Department of Infrastructure, Transport, Regional Development and Communications
Utilities/ infrastructure	<ul style="list-style-type: none"> • Ergon • Sunwater • Powerlink • QCNFibre • nbn • Energex • Energy Queensland • Stanwel • Seqwater

	<ul style="list-style-type: none"> • Unitywater • Queensland Urban Utilities
Traditional owner organisations	<ul style="list-style-type: none"> • Jagera • Giabal • Jarowair • Jinibara • Kabi Kabi • Kombumerri, Ngaraghwai, Mununjali, Wangerriburra • Quandamooka • Yuggera Ugarapul • Malaruch PBC • Indigenous Women in Mining and Resources
Tourism	<ul style="list-style-type: none"> • Southern Queensland Country Tourism • Destination Gold Coast • Brisbane Economic Development Agency • Australasian Business Travel Association (ABTA)
Social and community groups	<ul style="list-style-type: none"> • Friends of Felton • North East Downs Landcare • New Hope Community Reference Group • Landcare/NMR organizations – e.g. Southern QLD Landscapes) • HOPE Australia Protect the Environment
Transport	<ul style="list-style-type: none"> • Local transport companies • Aurizon • Pacific National • Queensland Rail
Economic development	<ul style="list-style-type: none"> • Oakey Chamber of Commerce • Toowoomba Chamber of Commerce • Ipswich Region Chamber of Commerce • Brisbane West Chamber of Commerce • Chamber of Commerce & Industry Queensland (CCIQ)
Industry associations	<ul style="list-style-type: none"> • Queensland Resources Council • Queensland Farmers' Federation • AgForce • Cotton Australia • GasFields Commission Queensland
Educators, research organisations and universities	<ul style="list-style-type: none"> • High schools • TAFE Queensland • University of Queensland – Sustainable Minerals Institute

- Central Queensland University
- Griffith University
- Queensland University of Technology
- University of Southern Queensland

Contact details

A/Prof Claire Côte

T +61 7 3346 4061

M +61 (0) 431 025 888

W uq.edu.au

CRICOS Provider Number 00025B