

Business Case, Gap Analysis and Roadmap for implementation

Natural Capital Accounting in the Australian Mining Sector

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Executive Summary

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Executive Summary

Increasingly, organisations are being asked to account for their impacts and dependencies on nature and their stewardship of the natural capital under their ownership and or management.

Growing concern about risks to economic stability associated with changing climates and declining biodiversity have generated calls for greater action from the private sector. The prominence of Natural Capital Accounting (NCA) and natural capital assessment in responding to these calls for improved disclosure has accelerated considerably over the last decade, which has seen the emergence of numerous initiatives, frameworks, metrics and targets, all aimed at improving the consistency and comparability of reporting in relation to natural capital.

ABOUT THIS PROJECT

The mining sector environmental and economic accounting project was initiated by the Australian Government's Department of Climate Change, Energy, the Environment and Water with the aim of increasing the preparedness of the resources sector for the changing reporting and disclosure regimes associated with rising expectations for disclosure of nature and climate-related risks.

The project was jointly led by CSIRO and CRC TiME and aimed to test the applicability of NCA in the mining sector, build capability, better understand the readiness of the industry for adoption and to provide guidance to promote consistent application and reporting of natural capital information. Key activities in the project included a series of mining-specific natural capital case studies.

The case studies were led by university research teams and partners (Curtin University, Murdoch University, Syrinx Environmental PL, The University of South Australia) working with industry partners (Alcoa, BHP, Hanson) to test the applicability of the processes on industry data. Insights and lessons learnt from these case studies were used to inform an analysis of the business case and indicative roadmap for implementation and to produce guidance materials to assist with building capability and promoting broader adoption across the sector.

ABOUT THIS REPORT

The Australian mining sector is the largest contributor to the Australian economy across major metrics, such as the monetary value of national exports, percentage of total export revenue, proportion of taxes paid to the Commonwealth and contributions to annual Australian GDP. It is also the critical sector to Australia's renewable energy transition aspirations.

However, continued mining operations require ongoing support from key stakeholders, including communities

affected by mining operations who are concerned with environmental degradation. To maintain its Social License to Operate (SLO), the sector needs to adopt tools like NCA; an accounting system that develops a more comprehensive understanding of the interactions between the environment and economy, driving improvements in existing disclosure and sustainability reporting practices.

This document builds the business case for implementing NCA in the Australian mining sector through an analysis of the opportunities that can be realised from NCA adoption, and the challenges to its implementation. It is suggested that the business case for NCA in the Australian mining sector has two drivers. The first is along the disclosure path, where NCA not only aligns with the current environmental and sustainability demands of different stakeholder groups, but also positions the sector for future challenges and opportunities.

NCA is identified as a pivotal tool for understanding the interplay between the environment and the economy, and can drive improvements in disclosure and sustainability reporting, enabling the mining sector to better demonstrate environmental accountability. The second focus is strategic, where NCA is portrayed as a strategic tool for the creation of future value and competitive advantage.

This report details how NCA information can be used for purposes beyond the disclosure of past performance, and suggests opportunities such as scenario modelling, forecasting and variance analyses that can inform sustainable resource management, risk assessment, and long-term planning.

This report argues that, despite significant potential benefits, challenges in the areas of data availability, valuation methodologies, and capacity and capability hinder full realisation of the benefits. The document provides an in-depth analysis of the current gaps based on challenges that were identified through literature review and adopting insights from case studies undertaken at four mining sites.

This analysis leads to a proposed roadmap of recommendations that are geared towards overcoming the identified challenges and realising the significant benefits that NCA can bring to the Australian mining sector. This roadmap includes recommendations for data management, valuation standardisation, and building industry capacity, with a summarised Gantt chart of the recommendations provided below.

The roadmap is designed to facilitate the adoption of NCA, aligning with stakeholders' expectations and contributing to sustainable mining practices.

ROADMAP FOR NCA IMPLEMENTATION IN THE AUSTRALIAN MINING SECTOR

Recommendations	YEAR				
	1	2	3	4	5
1.1 Develop a strategy for data collection that establishes datasets for defining environmental assets, liabilities, and ecosystem services.					
1.2 Establish data standards to ensure consistency and reliability in data collection, reporting and sharing across relevant stakeholders.					
1.3 Invest in data management systems and related tools that centralise and provide accessible data required for the compilation of NCA accounts.					
1.4 Identify data requirements to facilitate disclosures through an assessment of data needs for stakeholders across the mining sector.					
1.5 Enable broader use of data across the mining sector.					
1.6 Continuously enhance data through monitoring for changing data needs/priorities in the NCA landscape.					
2.1 Standardise approaches for both the identification of Ecosystem Assets and Services and the assessment of their importance for inclusion in an NCA assessment.					
2.2 Develop a standardised format of maintaining and disclosing physical accounts alongside monetary accounts as a basis for natural capital Environmental Profit & Loss Statements, Balance Sheets, and Ecosystem Change Statements.					
2.3 Develop record management practices and accounting processes that facilitate the preparation of an Ecosystem Change Statement for disclosure of changes in Ecosystem Extent accounts.					
2.4 Develop a framework to quantify the value of ecosystem services as a public good that encompasses different stakeholder perspectives through a multi-criteria value proposition approach.					
2.5 Assess the importance of intangible factors to the value of ecosystem services and develop an approach that appropriately incorporates these factors through non-market-based methods.					
2.6 Test developed approaches with end users to ensure that the prepared accounts meet the accounting definitions of useful information.					
3.1 Engage with selected stakeholders outside the mining company to impress upon them the importance of incorporating natural capital into economic decision-making and the potential consequences of undervaluing natural assets.					
3.2 Engage with Indigenous Australians to gain a more complete understanding of the importance and value of natural capital so that a rigorous and well-structured NCA reporting system can be created.					
3.3 Build capacity and capability throughout the data ecosystem, including collection, storage, assessment and interpretation functions.					
3.4 Continuously upskill existing expertise through professional development opportunities and training programs that fill knowledge gaps and enhance capacity and expertise.					
3.5 Develop mining specific expertise, e.g., using expert speakers, hands-on training in areas such as cost and lifecycle analyses, case studies, coaching and mentoring.					
3.6 Prepare guidelines on the recording and disclosure of upstream and downstream components of the value chain to comply with broader suitability frameworks.					
3.7 Develop formal educational courses.					
3.8 Affect auditing standard-setting as part of an overall framework of capacity and capability-building to ensure that NCA accounts can be competently and independently audited, verified and reported upon.					

INTRODUCTION TO NATURAL CAPITAL ACCOUNTING

The Australian mining sector is the largest contributor to the Australian economy. The Minerals Council of Australia reported on 11 May 2023 that, during 2021/22, Australia's export of minerals, metals and energy commodities was worth \$413 billion and accounted for 69% of total export revenue.

On an aggregate basis, Australian minerals have contributed 21% of Australia's gross domestic product (GDP) growth in the last 10 years, and 32% of company taxes paid in 2022. Although having a land footprint of less than 2% in Australia¹, the mining industry, like all other sectors, needs to be accountable for ensuring the conservation of nature and the minimisation of its impacts on natural assets and related ecosystem services.

Natural capital refers to the stock of renewable and non-renewable resources that provide benefits to society. Natural capital frameworks recognise that the environment provides goods and services that are essential for both human well-being and economic development.

More than half of the world's GDP is either highly or moderately dependent on natural capital and its related ecosystem services (World Economic Forum, 2020). NCA, or Environmental Economic Accounting (EEA), has been receiving attention from researchers and academics for more than a decade, and in recent years, this interest has surged.

The key reason for this is the growing awareness globally among governments, investors and society, of the risks associated with environmental degradation.

As an accounting system, NCA can help develop a more comprehensive understanding of the interactions between the environment and economy, foster greater sustainable development, more responsible resource management, and drive improvements in existing disclosure and sustainability reporting practices.

By quantifying the value obtained from natural resources and the services provided by its ecosystems, the adoption of NCA can help society recognise the significant contributions that nature makes to human well-being and economic development. This can lead to improved decision-making and ultimately the potential for net positive environmental impact.

Significant drivers for establishing and expanding the practice of NCA include the following:

- 1) Global biodiversity is at risk with rates of extinction leading to suggestions that the Earth is in the sixth mass extinction event, posing a significant threat to the global economy (World Economic Forum, 2020; World Wildlife Foundation, 2023). Despite this, there is no globally accepted metric to measure this biodiversity loss (Deloitte Touche Tohmatsu Limited, 2022a, 2022b).
- 2) A study by the Paulson Institute² estimates that global investments leading to environmental damage exceed conservation efforts by an estimated \$600-\$824 billion per year (Deutz et al., 2020).
- 3) Rockstrom et al. (2009) identified nine "planetary boundaries" that provide a safe operating space for humanity to survive and thrive, including climate change, biodiversity and land system change. In 2009, four of these nine boundaries had been crossed due to human activity (Rockstrom et al., 2009; Sustainability Development Goals Action, 2021) and by 2022, at least two more had been compromised, including environmental pollutants such as plastics and freshwater use³.
- 4) Approximately half of global GDP is highly or moderately dependent on nature (World Economic Forum, 2020). Biodiversity loss and ecosystem collapse are among the highest risks that humanity will face in the next 10 years (World Economic Forum, 2022a), which will likely lead to irreversible adverse consequences for the environment and, by association, economic activity that compromises natural capital (New South Wales Department of Planning and Environment, 2022).

Failures to account for the economic value of natural capital and its related ecosystem services in decision-making results in the underestimation of the environmental inputs associated with economic activities. This is often the case now, as economic activities rely on the extraction and consumption of natural resources without adequately acknowledging their finite nature.

As a result, this omission promotes non-sustainable resource management practices. Addressing these problems requires the development and implementation of a framework that values nature and integrates its contributions alongside economic outcomes, thus enabling better decision-making that promotes environmental sustainability, responsible resource management, and the preservation of vital ecosystems and services for the benefit of society and its future generations.

From a corporate perspective, NCA can serve as a tool to meet two key corporate outcomes: 1) reporting, disclosure and transparent communication of natural capital performance to various stakeholders (i.e., disclosure focus); and 2) strategic decision-making, creating future value through actions such as forecasting, scenario modelling and capital budgeting (i.e., strategic focus).

The first outcome focuses on external stakeholders such as regulators, investors, community and society, whereas the second is principally internally focused on generating future value and creating a competitive advantage for businesses. NCA can therefore be a powerful tool to achieve both short-term (i.e., disclosure reporting) and long-term (i.e., value creation) goals.

¹ CEO, Minerals Council of Australia (Constable, 2022).

² A research institute founded by the former U.S. Secretary of the Treasury, Henry Paulson.

³ Discussion of the planetary boundaries concept by the Stockholm Resilience Centre: <https://www.stockholmresilience.org/research/planetary-boundaries.html#:~:text=In%20January%202022%2C%2014%20scientists,%E2%80%9Cnovel%20entities%E2%80%9D%20including%20plastics.>

It can do this by collecting, processing and reporting nature-related data that can be used for both analysing and reporting past performance (i.e., a typical financial accounting system), and future strategic decision-making, (i.e., a typical managerial accounting system, as illustrated in Figure 1).

Financial accounting is externally focussed and is related to the process of recording, summarising and reporting past transactions from business operations over a defined period of time. As such, reports and disclosures can be generated to communicate historical financial performance to demonstrate accountability and create credibility for continued operations. In this way, financial accounting can help with various reporting outcomes such as the United Nations Sustainable Development Goals (SDGs).

Managerial accounting is internally focussed. It is the practice of identifying, measuring, analysing, interpreting and communicating financial data to managers in pursuit of the organisation’s strategic goals.

As such, it facilitates important internal processes such as capital budgeting, the analyses of variances from budgets, and forecasting, by reviewing historical information to identify trends and opportunities to create long-term value for businesses.

For example, using data from past performance to undertake scenario modelling enhances the future value of a business by providing information that facilitates better strategic decision-making.

Both financial and managerial accounting are key components of an Accounting Information System, which collects, stores and processes accounting data for multiple purposes. By incorporating both financial and managerial accounting principles, NCA can be a powerful mechanism to achieve multiple goals, including corporate objectives, both in the short and long term.

This document articulates the business case for the implementation of NCA at an organisational level within the mining sector by:

- 1) highlighting both the disclosures/reporting-focused and strategic/value creation-focused opportunities for mining.
- 2) identifying gaps and challenges inhibiting the realisation of these opportunities.
- 3) formulating recommendations to facilitate the overcoming of identified gaps and challenges.

As the mining sector is well placed to implement recommendations for overcoming challenges, the sector has the potential to unlock significant value by adopting NCA.

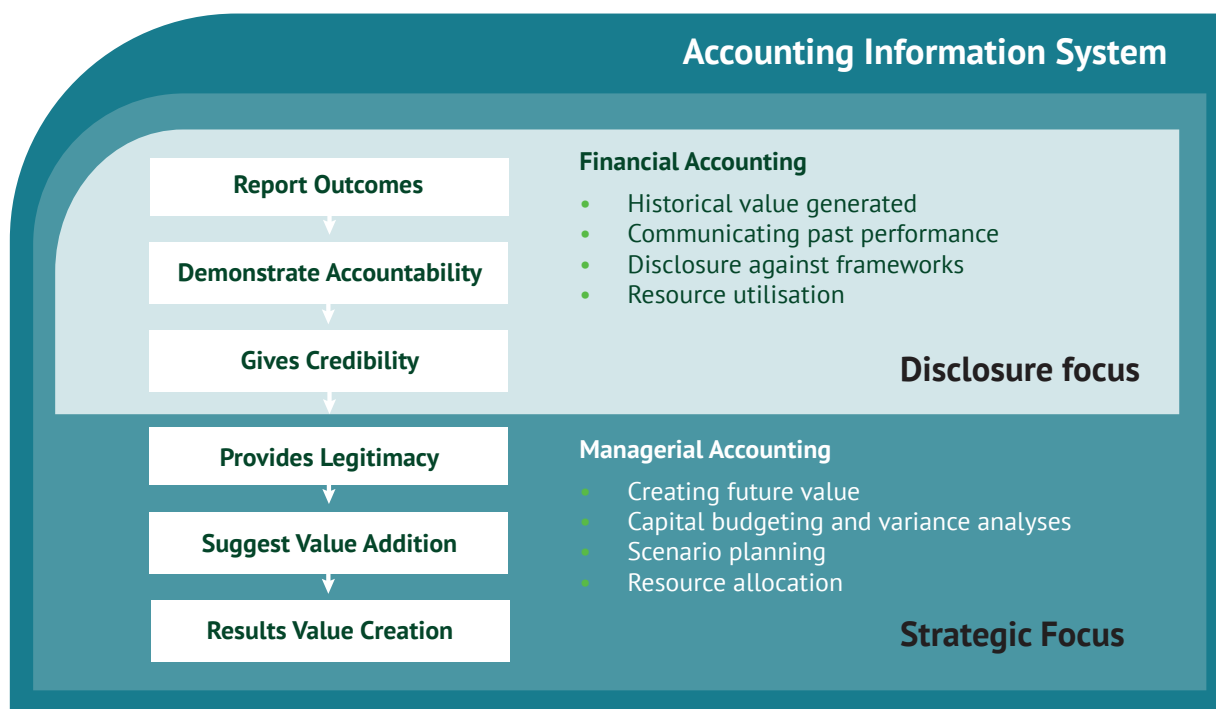


Figure 1: Components of an Accounting Information System



Business Case for Implementation of NCA

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Business Case for Implementation of NCA

NCA AND THE MINING SECTOR

While NCA implementation has traditionally been applied at a national scale (Smith et al., 2023; United Nations, 2021), it is recognised that to gain mainstream applicability, a bottom-up approach to implementation is required. Companies need to implement NCA systems within their operations, producing the information needed for regional or national scale accounts to be prepared (Union Bank of Switzerland Sustainability and Impact Institute, 2023).

Although the implementation of NCA can provide several benefits to organisations, the primary focus has been on its use as a disclosure mechanism in line with the System of Environmental-Economic Accounting (SEEA) and the System of National Accounts (SNA) frameworks. Current NCA methods are limited in that they tend to look back to what has happened, concerned more with impact minimisation and rehabilitation rather than positioning for potential future natural capital industries.

For example, the existing NCA approach includes current and direct impacts and dependencies on nature

when assessing risks (e.g., access to land and water; environmental, health and safety regulatory compliance; and on the work needed to obtain environmental approvals and support operational efficiencies). However, NCA can deliver a great deal more, beyond the existing disclosures focus.

There is enormous opportunity for companies to not only better demonstrate accountability towards nature, but also create long-term value and gain competitive advantage, both within mining and across industries. As such, implementing NCA within mining not only helps in terms of maintaining its SLO but also strategically and sustainably creates value from competitive positioning.

Global corporations are under increasing pressure from regulators, investors, consumers and society to be more transparent about their impact and dependencies on natural capital and ecosystem services (World Economic Forum, 2022b) as reflected in the comment below:

“ Investors are increasingly assessing companies on environmental, social and governance criteria. Today, 90% of investors’ engagement with companies is about transparency, which hinders investors’ ability to talk about other issues, such as performance.

Helena Viñes Fiestas

Head of Sustainability Research at BNP Paribas Asset Management
(Ernst & Young, 2018)

The growing recognition of risks to organisations, linked to the ongoing loss of natural capital and its importance to society more broadly, has led to calls for greater disclosure and the emergence of initiatives like the Taskforce on Climate-related Financial Disclosures (TCFD)⁴ and the Taskforce on Nature-related Financial Disclosures (TNFD)⁵.

These market-led initiatives seek to develop risk management and disclosure frameworks for organisations that facilitate reporting and action on evolving climate/nature-related risks and opportunities. For the TNFD, the ultimate aim is to shift global financial flows away from nature-negative outcomes and toward nature-positive outcomes, by creating a corporate culture that supports the identification, assessment, management and disclosure of nature-related dependencies, impacts, risks and opportunities.

For sectors where there is a clear link between their revenue stream and dependence on the services that nature provides, the business case for implementing NCA is often straightforward, in that the sector requires natural inputs to maintain operations leading to

economic prosperity. For example, companies in the fisheries sector depend on healthy oceans to replenish the stocks of fish they harvest and sell. In the case of mining however, this dependence is not as clear.

Yet, as shown in Figure 2, it is the mining sector's impacts that are most visible, resulting in a need to maintain an SLO. Consequently, the business case for the mining sector needs to be developed along two fronts; (1) the need to report on its historical actions (i.e., the disclosure focus); and (2) the desire to gain a competitive advantage that allows for future value creation (i.e., the strategic focus).

The following section outlines how NCA can facilitate disclosures from the mining sector to its key stakeholders (i.e., disclosure focus), an important aspect of maintaining an SLO. The document then discusses the opportunities for mining firms to create long-term value and competitive advantage by adopting NCA (i.e., strategic focus).

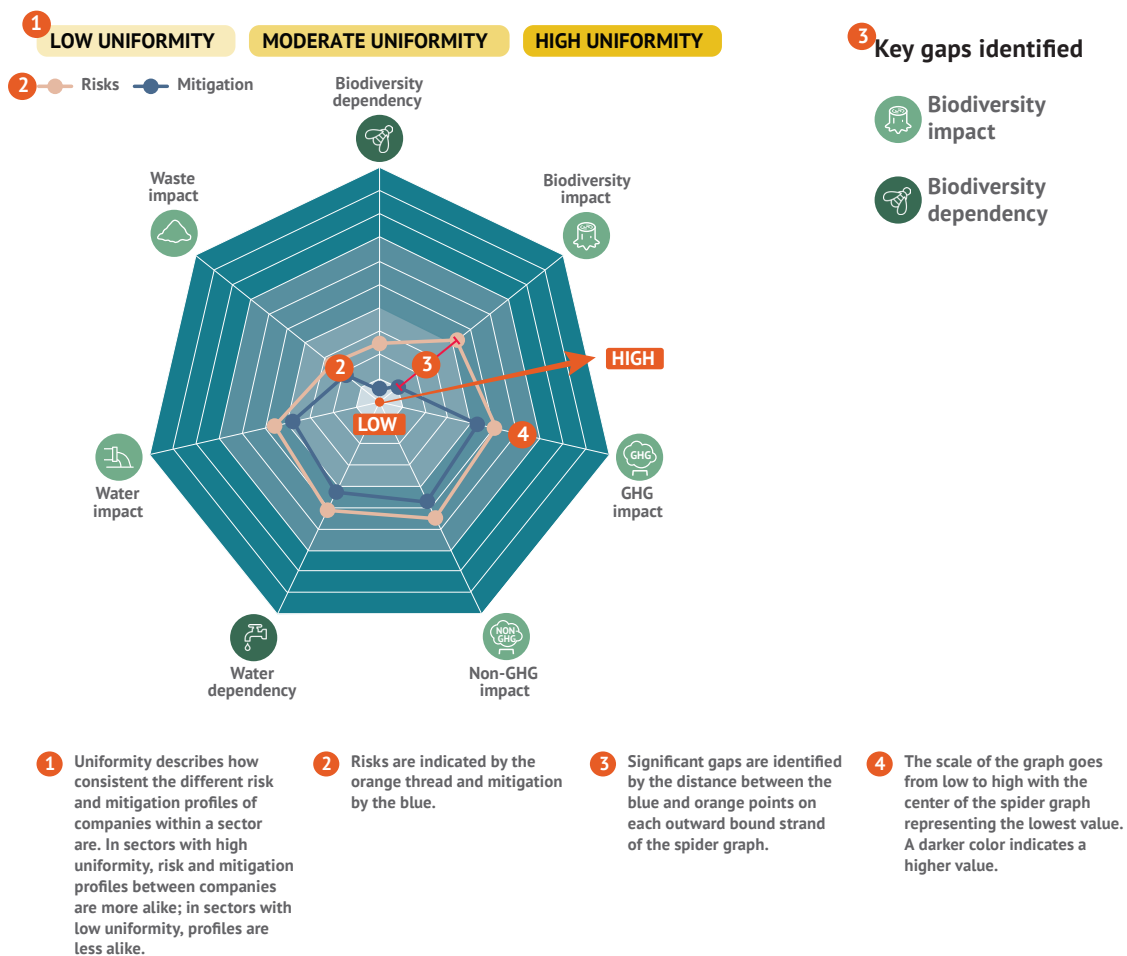


Figure 2: Mining Sector Natural Capital Risk Assessment (Allianz Global Corporate and Specialty, 2018)

⁴The Taskforce on Climate-related Financial Disclosures: <https://www.fsb-tcfd.org>

⁵The Taskforce on Nature-related Financial Disclosures: <https://tnfd.global>

DISCLOSURE FOCUS

The mining sector is under continuous pressure to comply with multiple requirements (e.g., TCFD, TNFD, International Sustainability Standards Board (ISSB)). The resources sector is an important steward of a large pool of natural capital and, as a result, typically has a diverse group of stakeholders. These stakeholders can be categorised into four key groups: (1) Companies, (2) Investors and Financial Institutions, (3) Governments and Regulators, and (4) Communities and Society.

The use of NCA to collect, manage and analyse data associated with mining’s impacts on the environment, and the contribution nature makes to its economic activity, can offer benefits for these stakeholders and, importantly, highlight the substantial benefits made by the mining sector in meeting its obligations to key stakeholders. More specifically, accounting for and disclosure of natural capital performance can help businesses achieve:

- 1) timely and transparent communication to stakeholders regarding the valuation of natural capital and associated ecosystem services, as well as risks associated with an organisation’s impacts and dependencies on nature.

- 2) disclosures in line with frameworks that are commonly used by stakeholders to understand the relationship between the economic performance and environmental impacts of companies, e.g., SEEA, the SNA, etc.
- 3) enhanced disclosures and better reporting, which aligns with sustainability reporting frameworks including the TCFD, TNFD, ISSB and Global Reporting Initiative (GRI), as well as potentially emerging requirements like the Australian Federal Government’s proposed climate-related financial disclosures, anticipated to be effective 2024/25.

There are several important opportunities that mining can realise by meeting the informational requirements of each key stakeholder group through the adoption of NCA (as illustrated in Figure 3). Providing high quality and transparent disclosures will not only lead to better asset assessments by miners, but will also inform improved decision-making by stakeholders, including governments, society and investors (Global Reporting Initiative, 2022).

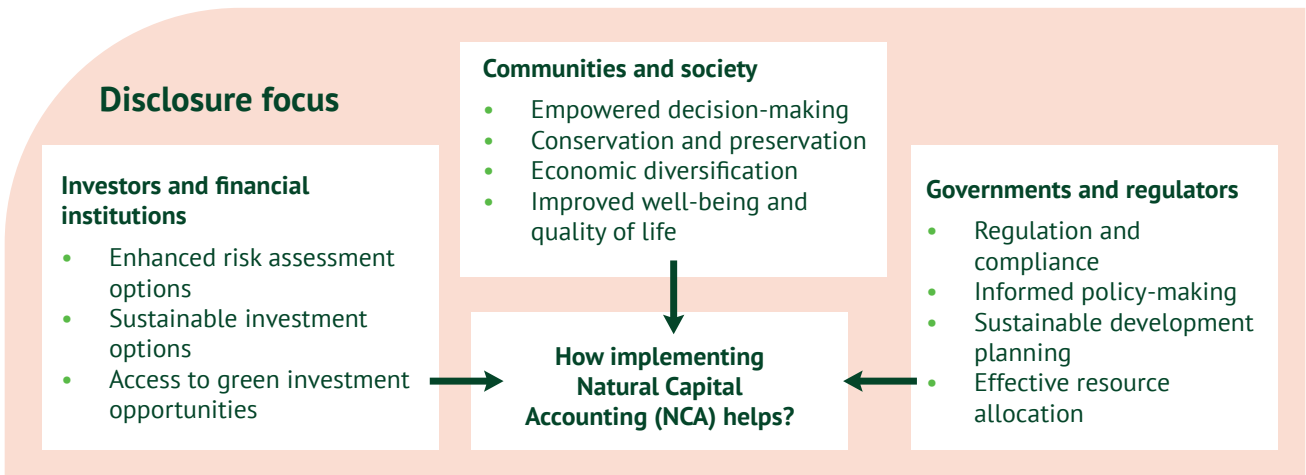


Figure 3: Opportunities associated with informational requirements of external stakeholders

Investors and Financial Institutions

Investors (including institutional investors) and financial institutions are increasingly recognising the importance of the availability of NCA information in meeting their own informational needs and disclosures. The disclosure of operational impacts and dependencies on nature by mining companies can result in a reduced risk profile, making them more attractive to capital investment for those who seek long-term value creation.

Consequently, the timely and transparent communication of NCA information, prepared in line with reporting frameworks such as SEEA and other sustainability frameworks, would meet the information needs of investors and financial institutions. Lenders are

prioritising “green finance” and environmental, social and governance (ESG) factors into their investment decisions (Inderst & Stewart, 2018). Adopting NCA equips mining companies with an accountability mechanism to mark themselves as a viable investment/lending option⁶.

In addition, by incorporating natural capital values into their asset valuations, mining companies can provide timely and transparent communication of their financial health, leading to both improved investor confidence and access to capital at cheaper rates.

By disclosing information relating to their stewardship of ecosystems in the supply chain, mining companies can assist investors and lenders by providing such information that is in line with the latter’s own reporting

⁶This is achieved by providing repeatable and comparable information that can be used to assess current natural capital performance or assess the natural capital performance of a range of companies.

requirements. Reporting that is aligned with the SEEA framework and other sustainability standards and requirements (e.g., the TCFD, TNFD, GRI, Australian climate-related financial disclosures, etc.) can play a critical role in providing scalable information in a standardised, repeatable and comparable way, thus meeting information needs and enabling comparisons between and within industries, and enabling systematic transformation in the supply chain.

Governments and Regulators

Australian regulators are placing greater emphasis on the preservation of natural assets rather than income flows and economic performance alone (Department of Climate Change Energy the Environment and Water, 2022). In the global move towards decarbonisation and an increased awareness of the benefits that natural capital provides, Australia is implementing policies with greater environmental reporting requirements⁷.

The Critical Minerals Strategy 2023-2030 calls for “targeted, proportionate support from the Australian Government to de-risk strategically important critical minerals projects” that demonstrate strong ESG practices, support the sector’s SLO, and fairly share the benefits of critical minerals development with communities, including First Nations Australians (Commonwealth of Australia, 2023).

Such policy changes clearly recognise the importance of nature, and with the increased reporting burden being placed on the mining sector, the implementation of NCA can help communicate the sector’s management of natural capital resources in a transparent manner. When prepared in line with reporting frameworks such as the SEEA and other sustainability standards, the mining sector will be able to integrate nature into decision-making processes, thus facilitating positively informed policy-related decisions. Indeed, the adoption of NCA introduces a recording system that can collect, sort and manage data to provide timely reporting that supports the aspirations of governments and regulators to:

- 1) set appropriate regulations, monitor compliance, and enforce environmental safeguards to minimise negative environmental impacts and maximise the sustainable use of natural capital.
- 2) incorporate the value of nature into policy-making processes to facilitate better decisions regarding land use planning, resource management and economic development.
- 3) allocate resources towards projects and initiatives that protect and enhance natural capital (Department of Climate Change, Energy, the Environment and Water, 2022).

Communities and Society

Due to its invasive nature, the mining industry is often the focus of attention from communities, including remote Indigenous communities and other stakeholder

groups, thus placing continual pressure on the sector’s SLO. Maintaining an SLO is critical to the continued viability of the mining sector, as communities expect mining operations to disclose their environmental performance in terms of both degradation and enhancement to the natural environment they impact.

By implementing NCA and complying with both reporting and sustainability frameworks, the mining sector can generate timely and transparent communication to interested communities, demonstrating their commitment to responsible resource exploitation within a framework of engaging with local communities, Indigenous groups, and associated stakeholders. Timely and transparent NCA reporting can help build trust with communities by strengthening the accountability of the company’s environmental performance. More specifically, NCA adoption and communication can:

- 1) provide a framework to help communities understand and assess the value of natural capital and ecosystem services in their local area, allowing them to actively participate in decision-making related to land use, resource management, and development projects.
- 2) encourage economic diversification, job creation (e.g., ecotourism, agroforestry, and nature-based enterprises) and increase income generation for the community, while promoting the sustainable use and stewardship of natural resources (Cust & Ballesteros, 2021; The World Bank, 2012; Turpie et al., 2022).
- 3) facilitate improved quality of life by improving access to services in greatest demand within the local region, such as public health, recreational opportunities, cultural well-being and contributing to overall community resilience and well-being (Bodegraven, 2018; Department of the Environment, Water, Heritage and the Arts, 2009; Natural Resource Management Ministerial Council, 2009).

STRATEGIC FOCUS

In addition to the benefits that come from natural capital reporting and related disclosures, adoption of NCA by businesses in the mining sector also presents the opportunity to utilise the information collected for this disclosure function to improve strategic decision-making practices that:

- 1) generate value creation into the future.
- 2) create competitive advantage.

This is depicted in Figure 4, which shows that the information collected through the disclosure focus can facilitate strategic decision-making that unlocks additional value for the organisation through activities such as sustainable resource management, recognition of natural capital risks, and better planning practices.

⁷These include the Environment Protection and Biodiversity Conservation Act 1999 and as part of their Nature Positive Plan, 30% of Australia’s land and seas by 2030 will be protected including the creation of a nature repair market (Department of Climate Change, Energy, the Environment and Water, 2022).

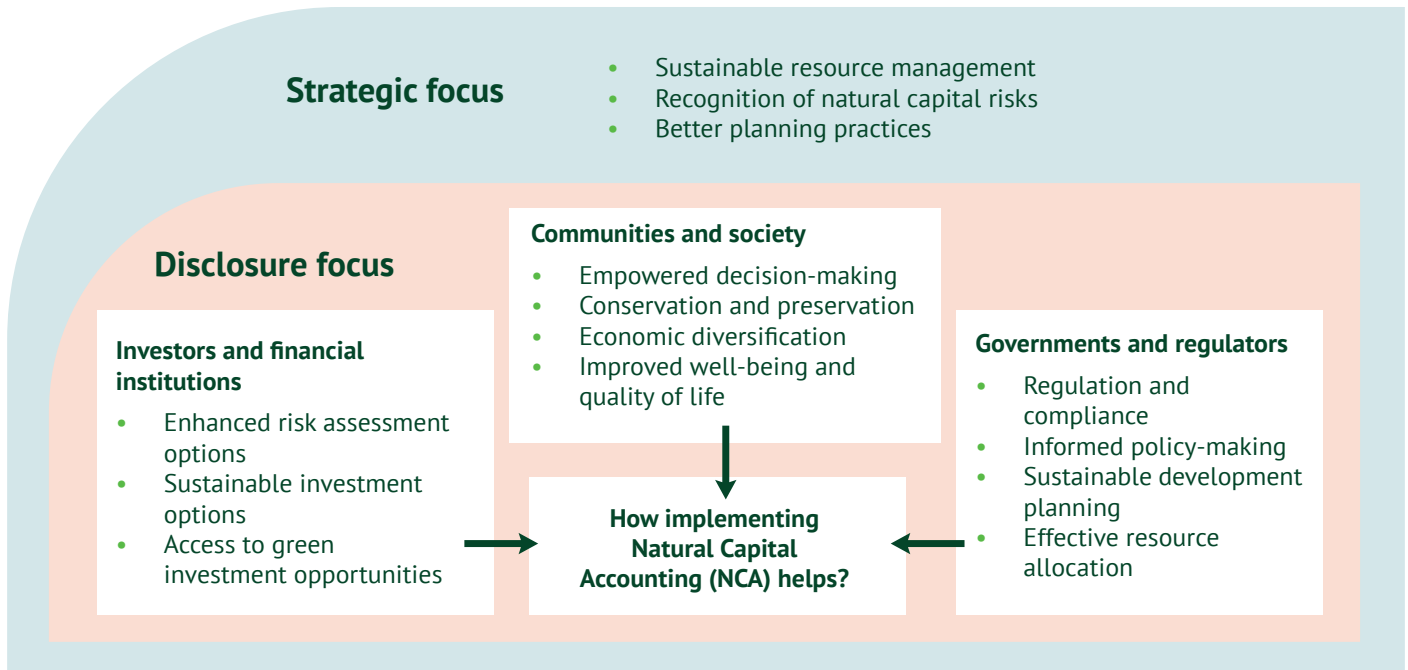


Figure 4: Strategic opportunities that can create value and provide competitive advantage

As illustrated in Figure 1 (p7), there is a continuum along which NCA value creation and competitive advantage can be achieved through activities including forecasting, resource allocation and scenario modelling, which contribute to more sustainable resource management, recognition of natural capital risks, and improved planning practices at the strategic level.

These opportunities can provide a competitive advantage for companies whose dependence on land access poses a risk to future economic activity, especially as competition for access to land increases from both within the mining sector, and with alternative users outside the sector.

Furthermore, as negative impacts on biodiversity become less acceptable, there is a risk to continuing and/or starting new projects. The disclosure of historical practices and outcomes provides a platform to:

- avoid, obviate and/or mitigate against potentially detrimental outcomes for the organisation.
- facilitate communication and transparency associated with the companies' interactions with the natural environment.

The data collected and information created, through the analysis of that data, can also unlock future strategic value through:

- improved planning and decision-making that generates and/or sustains value.
- a competitive advantage for the organisation.

Globally, businesses have started to realise that nature loss is business loss (Deloitte Touche Tohmatsu Limited, 2022b). Under the Corporation's Act, directors of a company are required to act in the best interests of the organisation's shareholders. Historically, this has been viewed narrowly through the lens of financial performance and shareholder economic value.

However, this duty also requires that the organisation understands and mitigates its risks including those associated with natural capital. Further, acting in the best interests of shareholders means ensuring that the organisation is sustainable and that its sustainability assessment incorporates environmental and social perspectives (Philip, 2023). This is especially true for local communities and may require long-term rehabilitation and restoration planning.

NCA provides measurement systems for the quantification of natural capital that can assist businesses in understanding the relative importance and value of the natural capital stock under their stewardship. It does this by measuring the stock of natural capital and assessing its condition and ability to deliver ecosystem services.

These services form the basis for valuation, providing insights on where natural capital investments are needed. Linking this type of information with financial performance can assist in the evaluation of potential returns from investment in the maintenance of natural capital and help to achieve business, environmental and social goals (Integrated Futures Pty Ltd, 2022), thereby facilitating a more comprehensive assessment of business performance via a more complete acknowledgement of its inputs.

Disruption of the natural capital on which companies depend for production can result in operational interruptions, shortfalls in revenue, and an adverse impact on financial performance (Natural Capital Finance Alliance, 2019).

Natural resources and ecosystem services will become increasingly stretched as the global population grows, which will contribute to increased risk for business. A report by Ernst & Young (2013) indicates that the consumption of natural capital annually is 50% more



than the Earth can restock, and businesses will face the stark choice of adapting or failing.

Aside from the physical risks associated with natural capital impacts and dependencies, there are also transitional risks associated with changing market expectations and disruptions due to loss of reputation or changing regulations and litigation risks (Organisation for Economic Co-operation and Development (OECD), 2019).

Due to the emergence of aggressive decarbonisation and nature targets, as a response to climate change challenges and biodiversity losses, risks to mining operations are increasing, notwithstanding the mining sector's importance in meeting increased future critical minerals requirements. As noted by PricewaterhouseCoopers International Limited (2021):

“ Many of the impacts we have on Natural Capital currently bear no cost. Our emissions to air, discharges to water and use of land and other natural resources frequently impose impacts on others for which they are not properly compensated. New regulation, legal action, consumer boycotts and brand damage can all lead to externalities being ‘internalised’, resulting in costs to the business. As a result, they need to be treated like any other serious ‘off balance sheet liability’, carefully understood, measured, and managed.

PricewaterhouseCoopers International Limited (2021)

Ignoring the current situation can lead to significant unmanaged risks in the supply chain that can threaten the stability of a business and future cash flows, facilitate accumulation of material off-balance sheet liabilities, and lead to faster erosion of the underlying natural capital despite growing profits. For the mining industry, these risks can be:

- **systemic:** Increases in extreme weather events globally causing supply disruptions and a collapse of operations.
- **physical:** Localised flooding that causes disruptions to a particular operation or region, as described by Gorringer and Nicholas (2022) from the Institute for Energy Economics and Financial Analysis who note that, in the first half of 2022, flooding contributed to a 22% increase in unit costs for major Australian thermal coal miners.
- **transitional:** Changes in legislation relating to the extraction of non-renewable resources and the ever-increasing need for mining companies to demonstrate an SLO. For example, in 2012, the Canadian gold mining company, Infinito Gold, was refused a permit by the Costa Rican government to develop a mine because of its potentially significant impacts on agriculture, forests and endangered species, leading to a drop in share value by 50% (International Institute for Sustainable Development (IISD), 2021).

NCA provides a better approach to mine lifecycle assessment by considering the full suite of inputs to businesses. If ecosystems are valued upfront, an understanding of the residual liabilities and risks that will be left post-mining can be determined. This understanding will then influence the mine closure plan

(MCP) via better recognition of what is possible post-mining, not only from an environmental restoration and biodiversity point of view, but also that of a business's ESG commitments. This can then be integrated into decision-making processes and compared with the costs and benefits of alternative post-mining land uses. The changed operational environment and interest demonstrated by stakeholders in understanding operations and their impact on the environment has changed the dynamics of how mine planning is done.

A report by KPMG (2014) suggested that Australian businesses should not disregard the risks relating to the ongoing depletion of natural capital assets. This capital is significant in maintaining the economic and social quality of life, and the sector should recognise that natural capital is not recurrently available at lower cost without incurring various related risks (i.e., systemic, physical, transitional). Thus, there is now greater need to include natural capital in planning processes.

Increased scrutiny of operations and the legacy left following closure of mining operations has meant that planning must be done in a manner that recognises and manages the environmental impact across the entire mine lifecycle, including commitments by the mining industry to nature-positive outcomes (International Council on Mining and Metals (ICCM), 2023).

As such, lifecycle assessment and the creation of an implementable MCP have become requirements for a mining operation to receive approval. The context of the plan is also changing; it is no longer acceptable to plan for closure based on the site in isolation. For example, in South Australia, mine plans (operational and MCP) now consider the broader region in terms of the impact that the single operation has, as well as the cumulative impacts that will emerge based on the suite of projects

in the region (Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act), 1999).

In addition, during the approvals process, having information about the current site that is contained within an NCA system, as well as information pertaining to the effectiveness of closure plans and activities at other related sites, facilitates a far more accurate forecasting of environmental outcomes, providing more evidence to regulators that the MCP will be implemented, and the intended results realised. This can lead to a more streamlined and simpler approval system to navigate, with those approvals being granted in a timelier manner.

NCA can provide a better understanding of cumulative impacts on a regional scale⁸ using standardised data collection and formatting, given NCA systems are designed to present information at the ecosystem scale, which extends beyond the traditional boundaries of a single organisation. This occurs because localised ecosystem assets generate data that is aggregated up to ecosystem scales. If correct information is gathered by skilled teams with appropriate technical capabilities and technological support, structured NCA systems can be amalgamated to help generate monetary values of vast ecosystems, with a level of comfort that has not traditionally been possible.

The implementation of NCA in the mining sector presents opportunities to improve performance throughout the mining lifecycle. During the operational phase, the implementation of NCA can assist mining companies with adopting innovative approaches to minimise their environmental footprint. In this respect, NCA can be utilised to develop and monitor key performance indicators within mining companies to reduce their environmental impacts; an important accountability mechanism.

There is even greater opportunity to use NCA during the planning and exploration phases when decisions can be made with respect to the design of operational processes that can truly help with the minimisation of impacts, or even impact avoidance throughout the life of a mine. By valuing natural capital and ecosystem services, companies can, from the onset, identify opportunities for resource efficiency, waste reduction and the adoption of cleaner technologies. This can lead to operational cost savings, improved efficiency and a competitive advantage in an evolving market that prioritises sustainable practices and innovation as critical components of a nature-positive transition.

NCA implementation across the Australian mining sector can help measure and value the significant ecological sites under the sector's stewardship, and facilitate the industry transition to this nature-positive future, represented by the aspirational goals of the Kunming Montreal Global Biodiversity Framework and the International Council on Mining and Metals (ICMM). NCA can provide enhanced information that incorporates nature-related risks and opportunities into strategic planning, risk management, governance, resource

allocation and capital budgeting decisions. For example, NCA has the potential to showcase the impact that high-quality land restoration can have on building quality ecosystem assets that support valuable ecosystem services into the future, e.g., carbon sequestration, water quality improvement, and habitat provision for threatened species.

Within an accounting information system, nature-related time-series data can help inform numerous long-term strategic decisions that can secure competitive advantage. NCA can assist by providing better information on nature-related risks and opportunities, for incorporation into an organisation's strategic planning, risk management and capital allocation decisions. At this corporate level, NCA enables managers to evaluate their investments and policies, making it easier to identify trends via forecasting and scenario modelling that can facilitate development of enhanced plans. The generation of natural capital accounts over time can establish time-series data from which important trends and patterns can be identified. These accounts provide the information required to demonstrate linkages between natural resources and productivity (Medrilzam & Adinia, 2017; Schenau, 2017).

Over the longer term, NCA implementation can demonstrate the impact that high quality land restoration can have on building valuable ecosystem assets that support ecosystem services, including carbon sequestration, water quality improvement, and habitat provision for threatened species. This can deliver a more holistic understanding of the benefits and risks associated with the exploitation of an orebody and, therefore, result in better valuation and utilisation of mineral resources. Such information can include boundaries of mining sites, the types of ecosystems that are either fully or partially within the boundary, changes in the extent and condition of the ecosystem assets over time, and changes in natural capital stocks and the flow of services.

Accurate methodologies for measuring and valuing changes in natural capital stocks and flows will facilitate the integration of nature-related impacts and dependencies into strategic decision-making across businesses, thus responding to the evolving nature of societal and stakeholder needs. Consequently, by voluntarily adopting NCA, mining companies can evidence their accountability towards nature, which, in turn, will result in competitive advantage over peers within the mining sector and across other industries such as forestry, agriculture etc., which are in competition for increasingly scarce resources such as land.

By adopting NCA, the sector can invest in greater long-term value creation and develop a competitive advantage while strengthening its SLO with its multiple stakeholders – particularly communities such as the First Nations Peoples, upon which future mine approvals may depend.

⁸For example, the water component of an NCA assessment requires consideration of catchment and sub-catchment boundaries that are (almost always) greater than any individual project boundary.



Gap Analysis - Opportunities and Challenges

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Gap Analysis - Opportunities and Challenges

As discussed earlier, the business case for implementing an NCA framework in the Australian mining sector provides a basis for this gap analysis. It highlights the significant benefits and opportunities for the mining sector in meeting both the informational requirements from different stakeholder groups, as well as opportunities to create strategic value into the future.

During the development of the business case and detailing of disclosure and strategic opportunities, several challenges surrounding data, valuation and capacity-building hindering these disclosure-focused and strategic-focused opportunities were identified, by reviewing the literature and adopting insights from case studies undertaken at four mining sites as follows:

- 1) BHP in Western Australia – a restoration case study focussing on the Beenup site.
- 2) Alcoa in Western Australia – a transition⁹ case study focussing on the rehabilitation of Jarrah Forest after bauxite mining at the Jarrahdale, Huntly and Willowdale sites.
- 3) Hanson in Western Australia – a transition⁹ case study focussing on the Gaskell Road operation.
- 4) BHP in South Australia – an operating mining case study focussing on the Olympic Dam operation.

The challenges identified are not unique to these sites, but instead are common to many mining operations. The individually identified challenges are shown in Appendix 1, where they have been grouped into three categories – data, valuation, and capacity and capability – following consultation with the case study teams (including industry participants) and additional mining sector partners associated with CRC TiME.

The key objective of this gap analysis is to assist the Australian mining sector with developing and implementing NCA, by identifying and discussing the associated challenges, ongoing performance, technologies employed, data required, and the technical capabilities required. By aligning these challenges with the identified opportunities, this section:

- 1) highlights the existing gaps for NCA implementation.
- 2) identifies effective and workable recommendations to address these gaps, to realise the full benefits that NCA implementation can generate.

DATA

Data is at the heart of successful NCA systems, providing a basis for the measurement, valuation and disclosure aspects of NCA, and enabling future-focused strategic decision-making. Currently, there are no data requirements for NCA in the areas of:

- 1) assessing and valuing impacts and dependencies.
- 2) establishing boundaries and materiality assessments.
- 3) recording and disclosure of ecosystem assets, liabilities, equity and service flows.
- 4) undertaking spatial mapping to determine the physical extent and condition of the ecosystems under stewardship.

Consequently, critical accounting records such as the Asset Register, which evidences and substantiates the physical condition and financial accounts during annual reporting, are either incomplete or not maintained. This leads to a deficiency in the datasets that underpin an appropriate governance and accountability structure for mining companies that want to adopt NCA.

More specifically, the following examples outline areas where data issues pose challenges to the successful implementation of NCA in the mining sector:

- High quality ecosystem extent and condition mapping is the foundational data for any ecosystem accounting exercise, but data availability and reliability are highly variable across jurisdictions and across Australia's mineral assets.
- Materiality assessments generally encompass legal, regulatory, operational, reputational, social and financial considerations, therefore increasing the likelihood of subjectivity in these assessments. As a result, assessing the relevance and materiality of ecosystem services is complex, and datasets need to be developed to support materiality assessments.
- Ecosystem accounting areas (EAA) are difficult to define due to partial data availability related to lease and sublease agreements, as well as changes to land tenure associated with expansion and contraction of the mining lease area, sublease of pastoral lands for later potential mining, and transfers of lands to third parties.
- Additional datasets are required to capture the real conditional change of natural assets (rather than monetary values only) so that, where appropriate, other important quantitative metrics (e.g., hectares of land being affected, number of trees, soil quality in terms of water retention, etc.) can be considered and included.

⁹A transition case study refers to a study with both active mining operations and restoration works.



- Data around some of the common impacts, dependencies and risks associated with a mine, as well as associated costs of mine development and production, particularly during its pre-mining and production stages, is not easily accessible or readily available, and is therefore unable to support a detailed Environmental Balance Sheet and related Notes to the Accounts.
- Greenhouse gas emissions and climate change-related impacts and dependencies are difficult to include in further assessment and development of accounts due to incomplete data. For example, emissions to water and air are difficult to include in assessments as the data is generally collected for purposes other than the preparation of NCA accounts. Furthermore, the assessment of impacts and dependencies upstream and/or downstream in the value chain have insufficient available data.
- The lack of comprehensive data information systems results in an inability to capture other key ecological data that complements other critical data resources (e.g., financial, geological, operational, etc.). Often, the data is not stored centrally or its whereabouts is unknown to intended users. As a result, the health of the natural capital under stewardship, which informs ecological monitoring programs enabling an assessment of the efficacy of environmental management actions, is difficult to assess.

VALUATION

Businesses make decisions about how they use natural resources, but often do not fully consider nature, which can lead to decisions being made against the best interest of stakeholders. This can happen due to the full costs and benefits of these natural resources not being incorporated into the valuation metrics that underpin many decisions, especially economic decisions. Often partial risk assessments and incomplete valuation metrics are used in decision-making as a result of an incomplete understanding of the impacts and dependencies on nature that are material not only to the business, but also society.

The value of ecosystems and the services they provide are difficult to identify, as various methodologies with differing available data can be used. This leads to potential inconsistencies in calculations and suboptimal decisions being made, based on this information. The difficulty in valuation of these difficult-to-value assets is often a result of the way we currently measure the value of natural resources in the mining industry, which does not consider all contributing factors.

The intangibility of some components of the benefits and costs associated with natural ecosystems and their services, often make them difficult to quantify using traditional valuation techniques. Also, the sector does not typically have insight into the complete chain of how natural resources affect businesses (i.e., impacts and dependencies), so a complete picture of how valuable they are is not portrayed.

To address these issues, an appropriate process for measuring the value of natural resources is required so that a full recognition of the benefits and risks faced by

mining businesses can be incorporated into decision-making practices. This process should include an assessment of the asset's materiality (i.e., will its value influence decision-making?), which can be leveraged from the materiality assessment undertaken as part of the identification of impacts and dependencies faced by the business.

For those assets that are deemed material, a consistent methodological approach that identifies the appropriate data for assessing value, and a way of incorporating the intangible, difficult-to-quantify contributions, is required. This will facilitate a deeper understanding of the ecosystem's health and whether there are available resources to keep it functioning properly into the future.

As a result of the 'long being viewed as free and limitless' behaviours, there is an underestimation/ignorance of costs resulting from the over-exploitation of natural resources. Such zero-depreciation treatment of natural capital undervalues prices from mining. Since the inputs for the secondary and tertiary sectors are outputs from the primary sector, such underestimates ultimately flow into incomplete prices of goods and services produced in an economy.

Furthermore, accurate valuation information does not flow along the supply chain, as downstream customers/suppliers who require information for their own valuation and reporting needs are either not receiving any information, or the information they receive is inaccurate. NCA therefore needs much better information for analysis of the linkages between environmental and financial systems. More specifically, the following examples outline areas where valuation issues pose challenges to the successful implementation of NCA in the mining sector:

- Compilation of comprehensive and consistent ecosystem services accounts is more complicated and challenging than the valuation of other natural resources, due to the intangible nature of some benefits. Natural capital accounts do not include the full positive and negative impacts and dependencies, but instead, focus on valuing the costs and benefits (i.e., positive impacts only) associated with managing an area of land using an ecosystem services framework.
- There are valuation difficulties associated with recognising public goods (social value) versus marketable values, which also calls for consideration of what other types of accounts could be incorporated into a mining NCA Chart of Accounts best suited to disclosure and reporting.
- There is an incomplete understanding of the purpose behind the valuation of natural capital assets and, in some instances, monetisation can result in undesirable decisions where the commercial activities have a higher monetary value than the monetised environmental value. This can be due to use of incomplete information and/or inappropriate value concepts.
- Condition assessment of natural resources is conceptually and technically challenging. SEEA-EA recommends approaches to aggregation of condition metrics but does not prescribe an approach.

- The current NCA approach does not consider whether the asset base is sufficient to ensure healthy continued functioning ecosystems, as other key metrics are not included, such as replenishment rates, extent of degradation, etc.
- There are significant challenges in adding biodiversity to the natural capital Balance Sheet and to the Environmental Profit & Loss Statement. For example, there needs to be an agreed approach for valuing biodiversity, which does not allow for double counting, as biodiversity is included in ecosystem condition accounts as a key characteristic in identifying its ability to provide various services.
- There are currently diverse methods being used to develop natural capital accounts across Australia and globally. As a result, the reporting outcomes are not easily transferable or consolidated across mining and other sectors. There is considerable uncertainty with all monetary valuation methods for natural capital assessments due to the absence of a standardised approach. Valuation methods must ensure that ecosystem services are not already captured elsewhere to avoid double counting in instances where they overlap multiple ecosystem assets.

CAPACITY AND CAPABILITY

The implementation of NCA in the mining sector requires collaboration and diverse skills. Without improved and stronger collaboration between the mining industry, consultants, government bodies and research academics, it will be difficult to realise the full benefits from the adoption of NCA.

Currently, the capability required to address the deeper conceptual challenges with the development and implementation of an NCA framework is lacking (e.g., valuation and changes in the valuation). Furthermore, the lack of capacity and capability also hinders improvement to corporate management in areas such as risk management and governance.

Valuing nature is a complex task given its quantification and measurement issues. The diversity of skills and capabilities required reduces the overall operational effectiveness (Patricio & Franco, 2022) and will continue to perpetuate declining talent in the mining sector (Van Putten et al., 2021).

As also borne out of the Beenup case study (Meney et al., 2023), if the right mix of skills and competencies are absent, many important advantages for mining companies will not eventuate, such as the ability to demonstrate greater business sustainability, develop stronger supply chains, garner a better market reputation, obtain greater support from investors and financial

institutions, and receive greater acceptance and support from consumers.

More specifically, the following examples outline areas where capacity and capability issues pose challenges to the successful implementation of NCA in the mining sector:

- An overwhelming challenge for the implementation of NCA in mining is how to treat the mineral resource, which is a non-renewable natural capital asset. Key issues to address include ownership, measurement, valuation of the assets considering resource depletion, and the associated impacts to be apportioned over the life of the resource. As a result, the interplay between these issues within a company's financial accounts needs to be addressed, and an appropriate mix of capabilities needs to be in place to provide a solution.
- Condition remains a difficult conceptual challenge in ecosystem accounting. Condition should be framed within the context of the supporting ecosystem services. However, mechanistic linkages to ecosystem services are difficult to establish, and both environmental science and accounting expertise needs to be in place.
- Capturing physical assets and flows, where these should sit on a balance sheet, who the beneficiaries should be, and how ecosystem services or their benefits should be valued, requires ecologists, economists and accountants to work collaboratively.



Roadmap for Implementing NCA within the Australian Mining Sector

ROADMAP OF RECOMMENDATIONS 25

Roadmap for Implementing NCA within the Australian Mining Sector

This section acts as an extension to the gap analysis described earlier, providing a recommended roadmap to address the challenges that impede the successful implementation of NCA in the mining sector. In preparing the business case, opportunities that can be realised from the implementation of NCA were identified by: (1) reviewing both academic and industry literature, and (2) insights from case studies undertaken at four mining sites:

- BHP in Western Australia – a restoration case study focussing on the Beenup site.
- Alcoa in Western Australia – a transition⁹ case study focussing on the rehabilitation of Jarrah Forest after bauxite mining at the Jarrahdale, Huntly and Willowdale sites.
- Hanson in Western Australia – a transition⁹ case study focussing on the Gaskell Road operation.
- BHP in South Australia – an operating case study focussing on the Olympic Dam operation.

These opportunities were initially grouped into the following seven sets to show the key benefits that a mining company could enjoy through the adoption of NCA:

- 1) Comprehensive Reporting and Disclosure.
- 2) Better Alignment with Sustainability Frameworks.
- 3) Improved Measurement of the Benefits Provided by Natural Assets.
- 4) Comprehensive Data Systems.
- 5) Better Planning.
- 6) Strengthening Capacity and Capability.
- 7) Better Valuation and Utilisation of Mineral Resources.

When the opportunities were identified, the challenges inhibiting the implementation of NCA in the mining sector were also recognised, as shown in Appendix 1.

These challenges are not unique to these case study sites. Instead, they are common to many mining operations, and were initially categorised into the following nine groups:

- 1) Inherent Limitations related to NCA.
- 2) Methodology.
- 3) Ecosystem Accounting Systems: Measurement, Valuation and Reporting.
- 4) Accounting and Sustainability Standards and Framework, including Systems and Processes.
- 5) Accounting Systems and Processes.
- 6) Data.
- 7) Land Management.

- 8) Spatial Boundaries and Natural Capital Ownership.
- 9) Capacity Building.

During analysis of the opportunities and challenges, it was recognised that some challenges related to multiple opportunities, showing that the seven opportunity sets are not mutually exclusive. In some cases, the realisation of one is also dependent upon the realisation of one or more other opportunity set/s.

For example, having Better Ecological Data Systems supports Comprehensive Reporting and Disclosure and Better Planning. Given the purpose of this Gap Analysis is to identify the impediments to the implementation of NCA, identification of the opportunities that are dependent upon the realisation of other opportunities is needed.

This then allows for the challenges to be prioritised, thus providing a sequence for facilitating a pathway to implementation. Towards this goal, an initial analysis was undertaken to align the opportunities with their related implementation challenges, to highlight the primary implementation issues.

Following discussions with the case study teams and industry partners, the business case was developed along two focus points – disclosure and strategic – as outlined in the previous section. As such, further consultation with industry partners resulted in an aggregation of the challenges, and a re-grouping into the three functional areas as follows:

- 1) Data.
- 2) Valuation.
- 3) Capacity and Capability.

These three areas are discussed in the gap analysis, and the twenty individual challenges shown in Appendix 1 are grouped in these areas as such. They were then assessed for whether they were inhibiting the disclosure or strategic opportunities that NCA can provide, resulting in the recommendations outlined in Table 1 as a pathway to adoption of NCA in the mining sector.

This table – the Roadmap – outlines the recommendations with identification of the responsible entities (including direct and indirect stakeholders), the level of importance (priority), and an indicative time horizon for action.

⁹ A transition case study refers to a study with both active mining operations and restoration works.

TABLE 1: ROADMAP OF RECOMMENDATIONS

DATA				
<p>Good data underpins successful NCA systems and provides a sound basis for the measurement, valuation and disclosure aspects of NCA that enable future-focussed strategic decision-making. This requires framing and developing an NCA data strategy, so that required data is available for compilation of accounts comparable across the mining sector and other sectors. The following steps will address the challenges identified in the gap analysis.</p>				
Recommendations	Responsible Entities	Priority	Time Horizon	
1.1	Develop a strategy for data collection that establishes datasets for defining environmental assets, liabilities, and ecosystem services/flows, and changes therein. An initial step would be to understand the data already being collected for compliance reporting purposes. The datasets should also support appropriate costing and valuation methods for the environmental assets and services, including those for provisioning, regulation and maintenance, and cultural services.	Mining companies, Mining Equipment and Technology Services companies (METS)	High	0-1 years
1.2	Establish data standards to ensure consistency and reliability in data collection, reporting and sharing across relevant stakeholders. For example, robust data practices relating to the collection, security, privacy, storage, usage, etc. of data.	Regulators, Mining companies	High	0-2 years
1.3	Invest in data management systems and related tools that centralise and provide accessible data required for the compilation of NCA accounts. Ensure the data is well documented, and its whereabouts is known and available when required.	Mining companies	High	0-3 years
1.4	Identify data requirements to facilitate disclosures through an assessment of data needs for stakeholders across the mining sector (mining companies, regulators, lenders, national statistical agencies, international organisations, research institutes and communities). Identify those needs that can be met by an NCA system.	Mining companies, Key stakeholders	Medium	0-3 years
1.5	Enable broader use of data across the mining sector by developing: <ul style="list-style-type: none"> • best practices around spatial data processes (including land use change over time, ecosystem asset changes, improving remote sensing, etc.) • protocols for sharing data among relevant stakeholders • federated databases and directories as a resource for smaller mining companies that do not have the resources available to collect the required data. 	Regulators, METS sector	Medium	2-5 years
1.6	Continuously enhance data through monitoring for changing data needs/priorities in the NCA landscape (e.g., assessing greenhouse gas emissions, energy demands, climate change-related impacts and dependencies) and adoption of new technologies/software, automated systems, AI/big data, and digitalisation, to make the processing of information and compilation of natural capital accounts more efficient.	Regulators, Mining companies, Community groups	Medium	Ongoing
VALUATION				
<p>The adoption of ecosystem accounting requires improved methods of valuing natural capital and ecosystem services for inclusion into the accounts of mining companies. Such adoption will require attention across several operational and non-operational levels to ensure that information collection processes that affect valuation exist and operate effectively. The suggested methodologies will need to include appropriate materiality and risk assessment techniques. They also must recognise the unique characteristics of natural assets that are not easily quantified due to different meaning and significance for different stakeholder groups. The following steps will address the challenges identified in the gap analysis.</p>				
Recommendations	Responsible Entities	Priority	Time Horizon	
2.1	Standardise approaches for both the identification of Ecosystem Assets and Services and the assessment of their importance for inclusion in an NCA assessment, to enable comparisons across companies within the mining sector and across different sectors. This includes the establishment of: <ul style="list-style-type: none"> • parameters within which the Ecosystem Accounting Area to be included in an NCA assessment is defined, e.g., all areas under stewardship by the company, etc. • a standard Chart of Accounts for identifying and classifying Ecosystem Assets (EA) • baseline parameters against which EA Condition is assessed • an approach to performing materiality assessments for inclusion of Ecosystem Services based on objective criteria, where possible. 	Regulators, Mining companies	High	0-1 years
2.2	Develop a standardised format of maintaining and disclosing physical accounts alongside monetary accounts as a basis for natural capital Environmental Profit & Loss Statements, Balance Sheets, and Ecosystem Change Statements.	Regulators, Mining companies	High	0-1 years

2.3	Develop record management practices and accounting processes that facilitate the preparation of an Ecosystem Change Statement for disclosure of changes in Ecosystem Extent accounts. This arises from the dynamic nature of land tenure and the impacts that changes in ownership/stewardship can have on the natural capital position of a company in its natural capital Balance Sheet. Such an outcome requires the identification of data/documents supporting operational processes within the landscape context, such as land ownership and changes therein; leasing contracts and changes to such contracts; transfer of land to conservation estates; retention of high value land, e.g., near a national park; and land areas disturbed/rehabilitated.	Regulators, Mining companies	Medium	0-2 years
2.4	Develop a framework to quantify the value of ecosystem services as a public good that encompasses different stakeholder perspectives through a multi-criteria value proposition approach. This will require investigation and adaptation of evaluation methodologies that recognise different quantifications of value and are consistent across sectors for the various services.	Researchers, Regulators, Key stakeholders	High	0-3 years
2.5	Assess the importance of intangible factors to the value of ecosystem services and develop an approach that appropriately incorporates these factors through non-market-based methods.	Researchers, Key stakeholders	High	2-4 years
2.6	Test developed approaches with end users to ensure that the prepared accounts meet the accounting definitions of useful information; namely, relevance, reliability, accuracy, comparability, timeliness and understandability. This will assist in developing a uniform framework for disclosure that facilitates the alignment of natural capital accounts with existing financial reporting practices, and evolves with emerging reporting requirements.	Regulators, Mining companies, Investors	Medium	3-5 years

CAPACITY AND CAPABILITY

Multidisciplinary expertise and teams are required to develop a mining-specific framework that generates both financial and non-financial information satisfying financial statement assertions of accuracy, valuation, completeness, existence and rights and obligations. Such expertise will include accounting, environmental and ecological science, and legal skillsets that enhance skills in developing environment accounts, forecasting, auditing and related assurance services. Additional capacity and capability will also be required to influence the accounting standard-setting processes so that NCA, and the mining sector, is actively considered in revisions given its unique characteristics and operations. Such work specifically applies to accounting issues, for example, intangible assets, restoration liabilities, valuation of assets, monitoring changes in flows/values, determining social value, and valuations recognising the asset base of natural capital utilised. Continuing to build capacity across the mining sector that aligns with changing NCA expectations and needs will be a key success factor in ensuring both its uptake and longevity. The following steps will address the challenges identified in the gap analysis.

	Recommendations	Responsible Entities	Priority	Time Horizon
3.1	Engage with selected stakeholders outside the mining company to impress upon them the importance of incorporating natural capital into economic decision-making and the potential consequences of undervaluing natural assets.	Mining companies, Community groups	High	0-2 years
3.2	Engage with Indigenous Australians to gain a more complete understanding of the importance and value of natural capital so that a rigorous and well-structured NCA reporting system can be created. Tailored engagement activities will be needed to ensure active participation of Indigenous Australians that provides input to the development of a comprehensive NCA system and communication tools demonstrating transparency and consistency in reporting of results.	Indigenous Australians, Mining sector, Regulators, Researchers	High	0-2 years
3.3	Build capacity and capability throughout the data ecosystem, including collection, storage, assessment and interpretation functions. A specific requirement for spatial data analysis expertise should also be prioritised. Capacity and capability development should extend beyond mining companies to include the METS sector that will undertake much of the data collection and interpretation services, which will also support uptake by resource constrained companies.	Education providers, Mining companies, METS sector	High	0-3 years
3.4	Continuously upskill existing expertise through professional development opportunities and training programs that fill knowledge gaps and enhance capacity and expertise.	Mining companies, Education providers	Medium	0-5 years
3.5	Develop mining specific expertise, e.g., using expert speakers, hands-on training in areas such as cost and lifecycle analyses, case studies, coaching and mentoring.	Mining companies	Medium	0-5 years
3.6	Prepare guidelines on the recording and disclosure of upstream and downstream components of the value chain to comply with broader suitability frameworks around the disclosure of the full value chain in NCA mining assessments, thus providing a complete picture of mining impacts and dependencies. This will require a broad range of operational and accounting expertise in identifying and valuing the full value chain related to NCA.	Regulators, Mining sector, Specialists in Environmental Science and Governance	Medium	2-5 years
3.7	Develop formal educational courses, e.g., micro-credentials, masterclass short courses, vocational and university training, in the areas of environmental accounting, ecological science, forecasting, auditing and related assurance services.	Education providers	Medium	3-5 years
3.8	Affect auditing standard-setting as part of an overall framework of capacity and capability-building to ensure that NCA accounts can be competently and independently audited, verified and reported upon (identical to an audit of financial statements).	Regulators, Education providers	Medium	3-5 years



Conclusion

Conclusion

Evidence of significant environmental pressures, such as rapid climate change, biodiversity loss and greenhouse gas emissions, has resulted in growing awareness and resulting demands for greater accountability from organisations in disclosing their impacts on and dependencies upon nature.

Numerous key stakeholders support this call for action, including the mining sector, and NCA has emerged as a pathway to demonstrate responsible natural resource management and link environmental outcomes with financial information. The current use of NCA is focussed on disclosure in line with current and emerging regulatory requirements.

However, NCA can play a much larger strategic role in the mining sector, helping mining generate greater long-term value and a competitive advantage both within the sector and other sectors who compete for access to land within which an orebody exists. Such an outcome is also critical to securing an SLO from key stakeholders such as investors, regulators, financial institutions and communities, thus ensuring the viability and continued operations from future mine sites.

The fundamental purpose of the recommendations in this report is not to advocate the structure of NCA frameworks, such as the SEEA or SNA, but rather evaluate their suitability to the Australian mining sector, and formulate recommendations that assist with the implementation of an NCA framework in support of the accompanying Guidance Material.

It is envisaged that the roadmap provides the path to NCA implementation for the mining sector in Australia, and achieving the multiple benefits that NCA can provide to the numerous players in and around the industry.



Appendix 1: Challenges

DATA

- 1) **Assessing the relevance and materiality of ecosystem services is complex.** A materiality assessment identifies the causal impact and dependency pathways that link specific business activities with natural capital, and assesses the likelihood and magnitude of changes in these pathways that may lead to negative or positive outcomes for the business. These assessments generally encompass legal, regulatory, operational, reputational, social and financial considerations increasing the likelihood of subjectivity in these assessments.
- 2) There is an **absence of applicable Australian or International Accounting Standards for NCA.** Natural capital accounts are still being guided by the principles of the Australian and International Financial Reporting Standards. For instance, the condition of natural capital is still mostly being measured in terms of monetary value, which might be misleading. To capture the real conditional change of natural assets, other quantitative metrics (e.g., hectares of land being affected, number of trees, soil quality in terms of water retention, etc.) need to be considered.
- 3) High quality ecosystem extent mapping is foundational data for any ecosystem accounting exercise. However, **data availability and reliability are highly variable across jurisdictions (and potentially across Australia's mineral assets).**
- 4) Some of the normal impacts, dependencies and risks associated with a mine are **hard to collect**, particularly during its pre-mining and production stages. Without this information, businesses are unable to support a detailed Environmental Balance Sheet and related Notes to the Accounts.
- 5) **Greenhouse gas emissions and climate change related impacts and dependencies** are difficult to include in further assessment and development of accounts due to incomplete data. Furthermore, the assessment of impacts and dependencies upstream or downstream in the value chain have insufficient available data.
- 6) The **ecosystem accounting areas are hard to define** due to data related to lease and sublease agreements. This is exacerbated by frequent changes to land tenure associated with expansion and contraction of the mining lease area, sublease of pastoral lands for later potential mining, and transfers of other lands to third parties. This is likely to be a wider issue across the mining sector.

VALUATION

- 1) There are currently diverse methods being used to develop natural capital accounts across Australia and globally. As a result, the **reporting outcomes are not easily transferable across mining and other sectors and do not fully present a standardised approach.** There is **considerable uncertainty with all monetary valuation methods for natural capital assessments** due to an absence of a standardised method.
- 2) Natural capital accounts **do not include the full positive and negative impacts and dependencies**, but instead focus on valuing the costs and benefits (i.e., positive impacts only) associated with managing an area of land using an ecosystem services framework.
- 3) **Recognition of ecosystems as 'assets' on the Balance Sheet can be challenging.** Technically, only assets that are generating a flow of benefits to the business would be recognised on the Balance Sheet.
- 4) Condition assessment of natural resources is conceptually and technically challenging. **SEEA-EA recommends approaches to aggregation of condition metrics but does not prescribe an approach.**
- 5) The issue of **how natural capital assets should be presented on the Balance Sheet** is still open to debate with **no clear consensus among multiple stakeholders on a preferred method.**
- 6) Monetisation of natural assets could result in **undesirable decisions where the commercial activities have a higher monetary value** than the monetised environmental value, because the valuation is incomplete, uses inappropriate value concepts or does not realise a broad enough valuation concept.
- 7) There are **valuation difficulties associated with recognising public goods (social value)** versus marketable value, which also calls for consideration of what other types of accounts could be incorporated into a mining NCA Chart of Accounts best suited to disclosure and reporting.
- 8) There are significant **challenges in adding biodiversity to the natural capital Balance Sheet and to the Environmental Profit & Loss Statement.** For example, there needs to be an agreed approach for valuing biodiversity that does not double count it, as biodiversity is already captured by many ecosystem services, including carbon sequestration and habitat provision, which are influenced by the structural and functional attributes of ecosystems (components of biodiversity). Hence, any valuation method must ensure that the ecosystem services associated with biodiversity are not already captured in such services. Compilation of comprehensive and consistent ecosystem services accounts is more complicated and challenging compared to other natural resources and there is no appropriate way of compiling such accounts.
- 9) The Ecosystem Accounting Areas are not defined early in the process. Ideally, these **should include the full area owned or controlled (e.g., leased) by the entity, which will normally appear on the company's financial accounts.** This would exclude lands for which there are lease agreements only for access or specific other purposes, but for which the business has no influence over operational activities. These types of conditions should be considered when entering into land use agreements to protect the extent and condition of natural capital assets held by a mining company.
- 10) **The boundary for the monetary accounts only comprises the lands owned or controlled by mining companies** and excludes private lands within the mine lease area and access agreement leases. Although **the ecosystem services or impacts that flow on from these may be beyond the physical boundary of the assets.**

CAPACITY AND CAPABILITY

- 1) The overwhelming challenge for the implementation of NCA in mining is **how to treat the mineral resource, which is a non-renewable natural capital asset.** Key issues to resolve include those around ownership, measurement, valuation of the assets considering resource depletion and the associated impacts to be apportioned over the life of the resource. As a result, the interplay between these issues within a company's financial accounts needs to be addressed.
- 2) **Condition remains a difficult conceptual challenge** in ecosystem accounting. Condition should be framed within the context of the supporting ecosystem services. But **mechanistic linkages to ecosystem services are difficult to establish.**
- 3) **The type, quantity and quality of ecosystem service flows will vary temporally and among mineral assets,** making them difficult to capture.
- 4) There is **no consensus among ecologists, economists and accountants** on how to best capture the physical assets and flows, where these should sit on a balance sheet, who the beneficiaries should be, and how ecosystem services or their benefits should be valued.

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