DIGITAL EARTH AUSTRALIA AND
THE MINING AND METS INDUSTRIES

# EXTRACTING THE BENEFITS OF EARTH OBSERVATION

MAY 2021

Australian Government
Geoscience Australia

FRONTIER SI

Digital Earth
AUSTRALIA

# FOREWORD

Digital Earth Australia was established by the Australian Government to take advantage of the rapidly increasing availability and accuracy of satellite image data. We exist to place intelligence from Earth observation (EO) satellites in the hands of more Australians, and to equip decision-makers with its powerful insights.

The opportunities for satellite data to drive growth and improvement within Australia's mining sector are expansive. Its potential to boost efficiency, automation, safety, environmental management and ultimately profitability is significant – but so is the knowledge and familiarity gap between technology providers and potential mining users.

This report is one step in bridging this gap, and in encouraging both mining and EO professionals to consider exploring new opportunities. Digital Earth Australia welcomes businesses, educators, innovators and individuals into this conversation, and we look forward to hearing from you.

*Trent Kershaw,*
*Director, Program Delivery*
*Digital Earth Australia*

## ABOUT DIGITAL EARTH AUSTRALIA AND FrontierSI

Digital Earth Australia (DEA) is a program of Geoscience Australia. DEA makes analysis-ready satellite imagery data and data infrastructure accessible to industry, government, and researchers.

Geoscience Australia has engaged FrontierSI to conduct exploratory research into the potential application of EO data across key sectors, including agriculture, mining, finance and insurance, and construction and infrastructure.

This report reflects insights sourced from industry research, interviews, focus groups, conferences, and workshops conducted over 2020. It was funded by DEA and published in 2021.

# EXECUTIVE SUMMARY

Australia's mining and Mining Equipment, Technology and Services sector (the 'mining and METS sector') is progressing towards its Industry 4.0[1] objectives of digital transformation and automation. Earth observation (EO) technology and insights will play an essential role in this evolution, and increased adoption of EO data and services within the sector raises both opportunities and challenges. This report aims to identify the mining and METS sector's critical business problems, its operational lifecycle, and its diverse user groups — informing both technology and mining companies of how EO can drive innovation in the sector.

## OPPORTUNITIES

Notable opportunities for the growth of EO in the sector include:

- Expansion of adoption of existing EO technologies and services across the mining lifecycle.
- Increased use of EO in the sector's move towards greater digitisation and automation.
- The potential for EO to deliver mining process efficiencies and reduce risk.

## CHALLENGES

Three significant challenges that will accompany any increase in the uptake of EO products and services within the mining and METS sector have been identified:

- Insufficient user maturity and confidence in the usability and accuracy of EO data.
- A lack of understanding about the limitations of EO and its impact on downstream processes.
- A lack of clear value propositions, communicating how EO can reduce risk and increase productivity.

## RECOMMENDATIONS

In response to these opportunities and challenges, recommended actions for EO providers are:

- To increase EO awareness in general.
- To present EO as one part of a solution.
- To prioritise interoperability, documentation, standards, and ease of access to EO products.
- To speak in plain language about solving business and risk problems.

## DEA COMMITMENTS

Digital Earth Australia is committed to working with the mining industry to ensure EO is a key part of their digital transformation by:

- Increasing awareness of how EO can support decision making, operational efficiency, and risk management.
- Building confidence in the use of EO in the sector to support compliance activities.
- Promoting data standards and interoperability to make it easier to share and collaborate with EO data.
- Supporting the commercialisation of EO products and services for the sector.
- Embedding EO in the toolkits of the next generation of mining professionals.

*1 https://www.industry.gov.au/funding-and-incentives/industry-40*

# CONTENTS

# PART 1: INTRODUCTION

## BACKGROUND AND PURPOSE

Earth observation (EO) data informs critical insights across many industries. In the Asia-Pacific Region, the value of the EO industry is projected to grow from $300 billion USD in 2019, to a potential $1.35 trillion USD by 2030.[2]

While Australian mining and Mining Equipment, Technology and Services ('mining and METS') companies contribute approximately 15% of the nation's GDP and support more than a million Australian jobs, this sector currently accounts for only 10% of the EO market.[3]

All stages of the mining lifecycle – from exploration, planning, construction and production, to final closure and reclamation – could benefit from increased use of EO data, but this is not yet well understood within the sector.

Equally, with over 300 active mining sites and almost 10,000 companies across Australia, the mining and METS industry can be challenging to understand and access for technology providers and companies.

To improve uptake of EO technology within the mining and METS sector, service providers must first understand the needs of these users. Equally, mining and METS companies need to understand how EO can benefit the industry.

## ABOUT THE MINING AND METS MARKET

Australia's mining industry contributed an estimated $150 billion to Australia's Gross Value Add in 2018-19[4] and METS activity contributed an additional $90 billion. Mining exports accounted for 58% of exported commodities and 46% of exported goods and services, for a total export value of $174 billion. Investment in mining exploration is growing significantly, while mining operations continue to focus on process efficiencies to drive profit growth.

With ongoing challenges that include Australia's variable climate, remotely located mineral deposits, social licence requirements, and increasing global trade pressures, innovation in the mining and METS sector is critical to its future growth and success.

2 *Current and future value of earth and marine observing to the Asia-Pacific region, Australian Government | Asia-Pacific Economic Cooperation.*
3 *METS sector competitiveness plan 2020 update (https://metsignited.org/wp-content/uploads/2020/06/METS-Ignited-Sector-Competitiveness-Plan-2020-Update-Web.pdf)*
4 *ABS Australian System of National Accounts 2018-19 (https://www.abs.gov.au/ausstats/abs@.nsf/7d12b0f6763c78caca257061001cc588/bfef5c43f53f8d2bca257213001d23c9!OpenDocument)*

# Mining and METS in Australia

## by the numbers

**The mining industries represent around 15% of Australia's GDP, and supported up to 10% of employment in 2018-19.**

**$290 b**

Value of the mining exports in 2019-20, up significantly from the previous year. 2020-21 could see a 20% drop, mostly driven by COVID-19 uncertainty.

Mining in Australia encompasses mine operations, exploration and extraction, resource processing, and site closure and remediation. This is underpinned by the equipment, technology and services providers, known as the METS sector.

**541,000**

people were employed directly in the mining/METS industry in 2018-19, supporting over 1,100,000 jobs in the wider community.

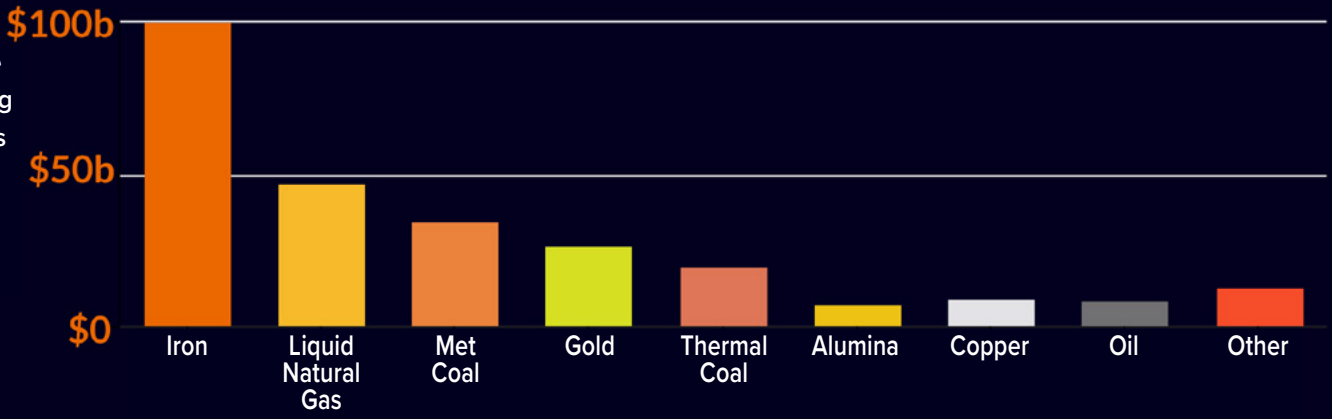
**58%**

of all Australian goods and services exports in 2018-19 were from the mining industry.

**3.7%**

of Australian water extractions are used for mineral processing and transportation, dust suppression, and mine employee needs.

Export value of key mining commodities to the Australian economy.




**17%**

is the proportion of the work-force who are female. The average age of workers is 40, with a typical week representing 48 hours of work.

**$5.9b**

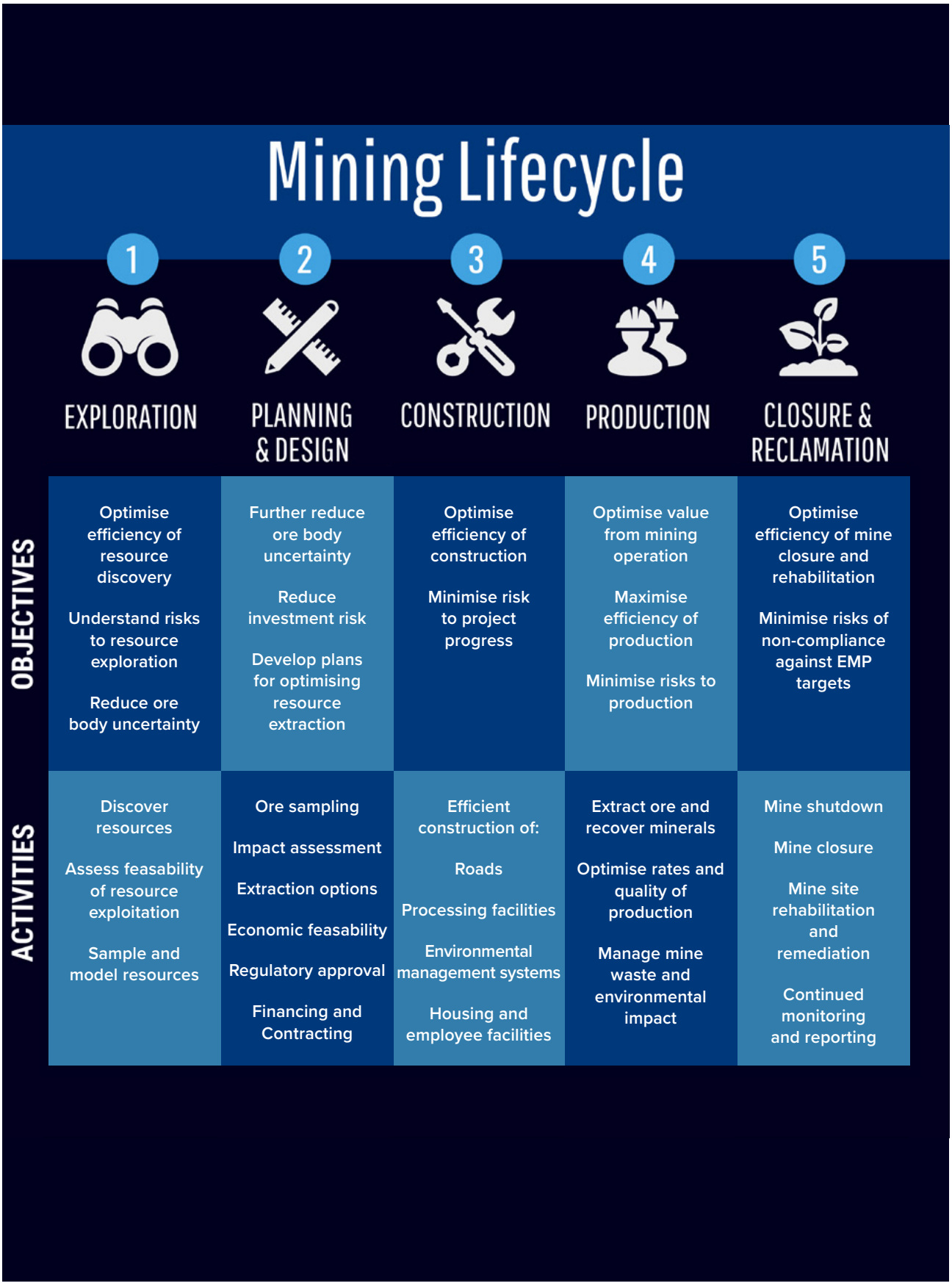
is the combined spend on R&D and exploration across mining and METS in 2018-19.

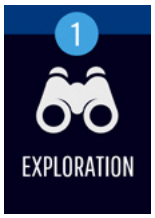
Sources: ABS, GA, LMIP, WGEA, Minerals Council, METS Ignited

# PART 2: THE MINING LIFECYCLE

EO has the potential to add value at every stage of the mining lifecycle. These stage are:

1. **Exploration:** finding new mineral deposits
2. **Planning and design:** how the mine site will fit into the landscape
3. **Construction:** monitoring construction to fit with plans
4. **Production:** monitoring mine site impacts and changes
5. **Closure and reclamation:** monitoring change over time and compliance.


Mining Lifecycle
1
2
3
4
5
EXPLORATION
PLANNING & DESIGN
CONSTRUCTION
PRODUCTION
CLOSURE & RECLAMATION
OBJECTIVES
Optimise efficiency of resource discovery
Understand risks to resource exploration
Reduce ore body uncertainty
Further reduce ore body uncertainty
Reduce investment risk
Develop plans for optimising resource extraction
Optimise efficiency of construction
Minimise risk to project progress
Optimise value from mining operation
Maximise efficiency of production
Minimise risks to production
Optimise efficiency of mine closure and rehabilitation
Minimise risks of non-compliance against EMP targets
ACTIVITIES
Discover resources
Assess feasability of resource exploitation
Sample and model resources
Ore sampling
Impact assessment
Extraction options
Economic feasability
Regulatory approval
Financing and Contracting
Efficient construction of:
Roads
Processing facilities
Environmental management systems
Housing and employee facilities
Extract ore and recover minerals
Optimise rates and quality of production
Manage mine waste and environmental impact
Mine shutdown
Mine closure
Mine site rehabilitation and remediation
Continued monitoring and reporting




# LIFECYCLE STAGE 1: EXPLORATION

**Discovery of mineral deposits and determination of the extent of mineralisation is critical for establishment of new mine sites.**

Exploration companies are increasingly using EO data to discover potential mine sites, due to improved data accessibility and the development of analytics platforms that can process the information efficiently and at scale using cloud-based infrastructure.

**EO can help maximise efficiency at this stage by:**

- Providing consistent global data layers that contain information on surface material properties including vegetation, mineralogy, geometry/shape and moisture content critical for targeting as inputs for machine learning analysis.
- Allowing for the establishment of objective environmental baselines to assist in remediation following exploration activities.
- Monitoring weather and fire to protect the safety of field crew in remote locations.

## QUESTIONS ASKED AT THIS STAGE:

**"What are the important characteristics of the land that I need to understand?"**

**"What are the possible environmental and socioeconomic effects on the local area?"**

**"Where are the possible targets?"**

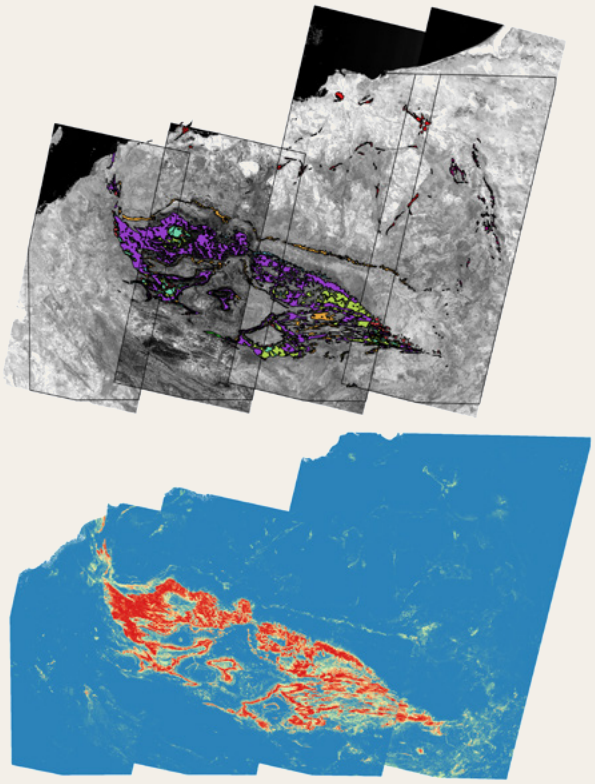
**"What is the optimal drilling program to get more detailed information?"**

**"What is the potential size of the deposit?"**

## USE CASE: SOLVE GEOSOLUTIONS

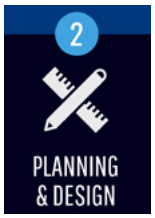
Solve Geosolutions is a Melbourne-based mining technology company. Its services include machine learning, prospectivity mapping, and exploration targeting for mining and exploration companies.

Data-driven targeting approaches involve searching for the signatures of a mineral deposit across diverse datasets. Satellite data represents one of the most essential targeting layers in regions with outcropping geology. Multispectral satellites such as Sentinel-2, Landsat, ASTER, and WorldView-3 are commonly used in mineral exploration.
*solvegeosolutions.com*



*Sentinel-2 imagery over the Pilbara region, overlain by regional geological mapping of the Hamersley Group (top).*

*Machine learning prospectivity model of the economically significant Brockman Formation (bottom).*




# LIFECYCLE STAGE 2: PLANNING & DESIGN

**Conducting an Environmental Impact Assessment (EIA) and gaining the necessary environmental approvals are critical outcomes of the planning and design stage.**

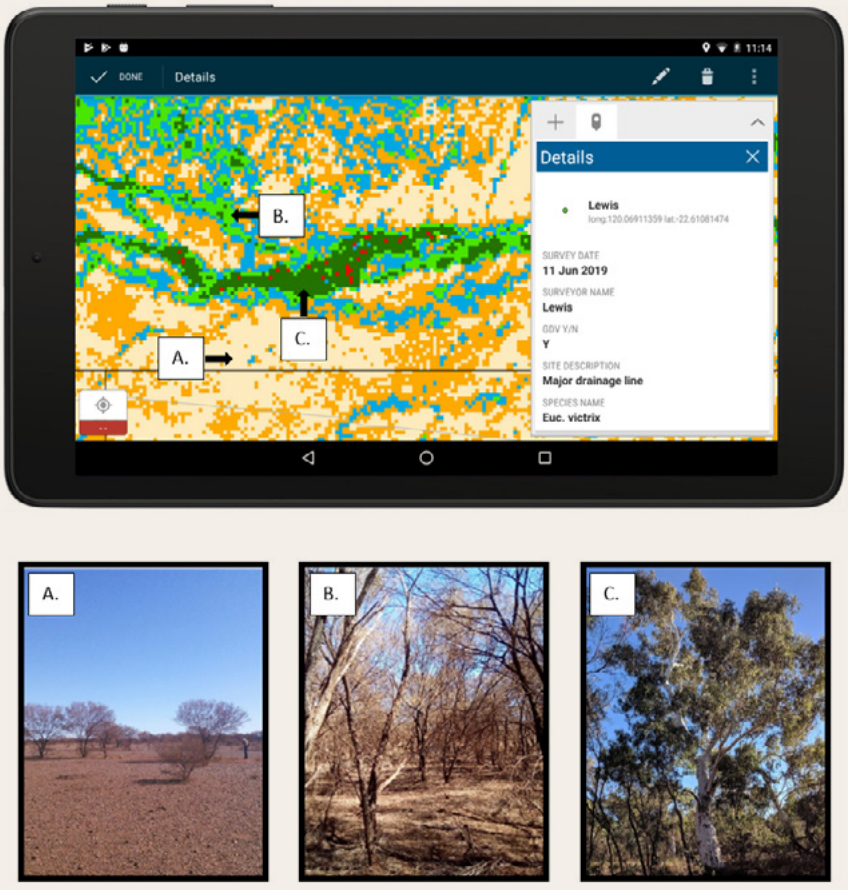
**EO can help maximise efficiency at this stage by:**

- Mapping vegetation community types across the project site, with particular focus on communities vulnerable to disturbance, such as Groundwater Dependent Vegetation (GDV) and protected and endangered vegetation communities.
- Enabling appropriate baselines for vegetation communities, based on accurate characterisations of natural variability.
- Developing a common language and site view between proponents and regulators that helps minimise risks of non-compliance.

## USE CASE: CURTIN UNIVERSITY

Curtin University has been pioneering new approaches to the identification and management of GDV in the Pilbara region of Western Australia using multispectral satellite imagery from both Sentinel-2 and the long-term Landsat archive. Their work helps build the confidence of mining and regulatory users in the use of EO data through working to develop tools for vegetation management that assist both proponents and regulators in monitoring environmental impacts and demonstrating compliance.

The figure right shows an example of the output produced by the Groundwater Dependent Vegetation identification and monitoring methodology using Sentinel-2 data developed by Curtin University.
*frontiersi.com.au/project/gdv*




*Example of identification of GDV at a Pilbara site. Red shows a high likelihood of GDV.*

## QUESTIONS ASKED AT THIS STAGE:

**“What is the mineralogy?”**

**“What is the viability of the proposed project?”**

**“What information do contractors need to prepare their bids for work?”**

**“What regulations are relevant, and what information do regulators need to see to give approval?”**

**“What funding and investment is needed?”**

**“What areas and site features need to be monitored once operations commence?”**

**“What are the site baseline conditions?”**


# LIFECYCLE STAGE 3: CONSTRUCTION

**EO data can be used during the mining construction stage to choose the location of mine infrastructure and to optimise the efficiency of construction.**

EO data can be deployed to monitor construction progress or plan the mine and supporting infrastructure like rail lines, pipelines, power lines, and conveyors around environmental features that need to be avoided, such as priority vegetation communities.

**EO can help maximise efficiency at this stage by:**

- Providing highly accurate digital elevation models across mine sites for engineers and surveyors to quickly begin work.
- Providing regular visual updates on construction to track progress remotely.
- Providing fundamental data layers in digital information infrastructures that management teams and contractors can refer back to during construction and throughout the life of the mine.
- Minimising investment in on-ground data collection and measurement by field staff.

## USE CASE: AAM GROUP

Once a proposal for a new project has been approved, the AAM Group delivers EO products which underpin the efficiency of construction and development of mines and their supporting infrastructure, including the design of rail lines, pipelines, power lines and conveyors. Products include high resolution digital terrain models of the site and surrounding areas from satellite, aircraft, and drone.

EO data and products generated during the construction stage also provide a record of the pre-mining landscape. Derived products from the data can be used to generate comprehensive site models and provide a baseline reference to guide rehabilitation of the landscape within the mine closure stage. Such products can also be used to track the placement of materials, monitor the construction of the mine and associated infrastructure, and ensure that the mine footprint and all construction matches with the plans submitted to regulators for approval. *aamgroup.com*

*Example of mine site with supporting infrastructure positioned using high resolution digital terrain models.*

## QUESTIONS ASKED AT THIS STAGE:

**“Can I see the progress of construction?”**

**“Is my site stable before, during, and after construction?”**

**“Have we impacted any environmental or cultural areas?”**

**“Can I avoid sending a person to a risky location?”**

**“How could the geospatial information gathered in previous stages be leveraged?”**

**“How do I keep track of new roads and where they go?”**


# LIFECYCLE STAGE 4: PRODUCTION

**During the production stage of a mine, ore is separated from waste rock, minerals are extracted from the ore, and the product is shipped to market.**

While extraction is the end result of a series of physical and chemical processes, optimised production requires numerous systems and workflows to work together. Opportunities exist within this integration of systems for EO data and spatial data infrastructures to improve workflow and increase production efficiency.

**EO can help maximise efficiency at this stage by:**

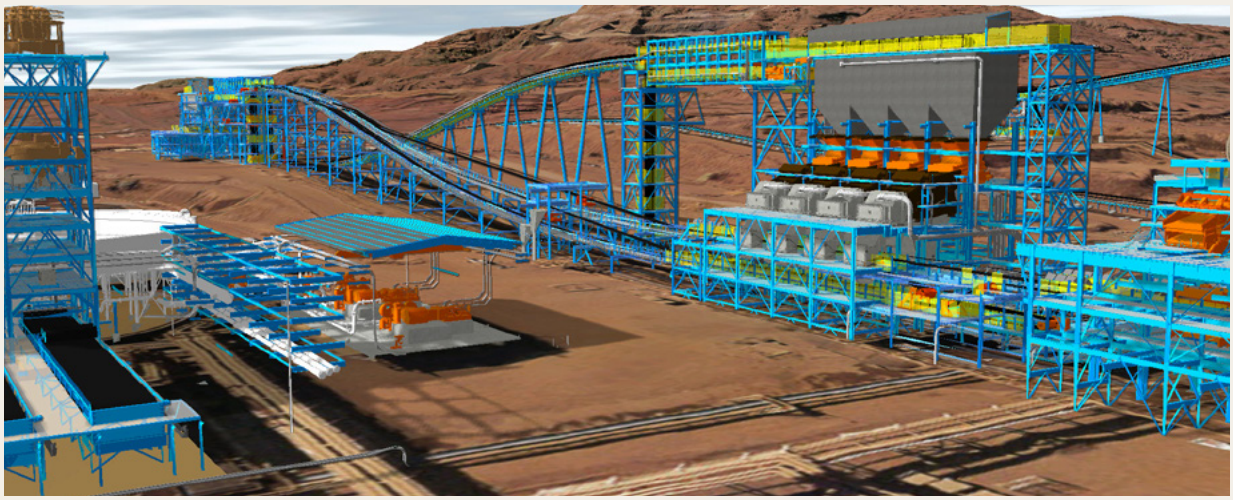
- Building a common operating picture which allows disparate teams to operate with the same view.
- Acting as a standard of data infrastructure, joining different business areas together, including risk management, production, and surveying.
- Providing a high-performance visualisation, communication, and simulation platform.
- Combining a range of business systems from across the mining lifecycle into a holistic operating picture which includes monitoring assets that are out of line of sight, plant design logistics, expansion planning and scheduling, and floodplain analysis.

## USE CASE: NGIS AND Skyline

Perth-based geospatial company NGIS have partnered with leading 3D technology company Skyline to deliver an intelligent digital platform for the Australian mining industry. It allows the user to integrate unmanned aerial vehicle (UAV) data for dynamic terrain modelling with outputs from geological modelling and engineering designs, enabling a self-service approach to monitoring mine site production and compliance that drives operational awareness and efficiencies.

The figure below shows a representation of a mine site. The virtual mine site can be constructed by high resolution LiDAR and complemented by information flows from other EO sources, process equipment, and management systems to provide a real time view of operations.
*ngis.com.au*

*Example of virtual mine site constructed based on high resolution LiDAR data.*



## QUESTIONS ASKED AT THIS STAGE:

“How can I regulate output based on market conditions?”

“How can I ensure that mined units accurately match modelled resources?”

“What do my stockpiles look like?”

“How can I map the next drill blocks?”

“How can I map what was extracted yesterday?”

“How do I know what the ore quality will be tomorrow?”

“How can I make sure mine road conditions for autonomous trucks are safe?”

“How can I monitor operations from pit to port?”

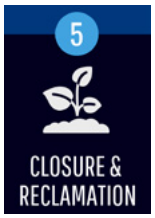
“How can I understand the impacts of groundwater on vegetation?”

“How can I track where materials are placed within the waste rock dump?”

“How can I monitor the structural integrity of tailings dams?”

“How do I control weeds to meet legislation requirements?”

“How do I do annual disturbance monitoring on my tenement that is required annually under state government legislation?”




# LIFECYCLE STAGE 5: CLOSURE & RECLAMATION

**Closure and reclamation is carried out at the end of the mining lifecycle and aims to return the mine site to a safe, stable and non-polluting state.**

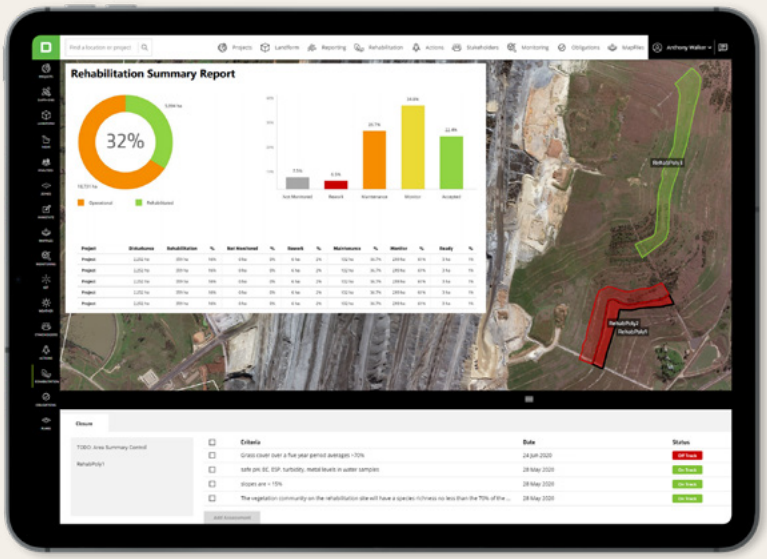
The aim of this stage of work is to return the mine site to as close as possible to the reference state, as set out in the mine closure plan, certified by the regulator. Once the rehabilitated area is certified, the land is handed back to the permanent custodian of the land.

**EO can help maximise efficiency at this stage by:**

- Providing quantitative measurement of the extent and magnitude of movement of landforms due to erosion, helping identify and manage the risk of potential failures, and providing assurance that an area is safe and stable.
- Providing a means of remotely monitoring landform features such as vegetation regrowth, stockpiles, landfill, infrastructure, and tailings facilities where ground-based measurements are unavailable or unsafe.

## USE CASE: K2fly NATURAL RESOURCE GOVERNANCE

K2fly provides enterprise Software-as-a-Service (SaaS) solutions for technical assurance, resource and mineral governance. K2fly's cloud-based platform assists environmental rehabilitation activities. The platform helps community, geotechnical, and management teams improve compliance. It provides the visibility to reduce risks and supports accurate disclosure in the dams and tailings space, as well as improvement in relinquishment, tracking of closure and achievement of the rehabilitation targets associated with rehabilitation and closure.




*Example of tracking subsidence utilising InSAR data through the K2fly platform.*

The K2fly platform allows mining operators to take a map-centric, visual and geospatial approach to their mine rehabilitation and tailings storage facility monitoring. The platform centralises EO data like radar, interferometric Synthetic Aperture Radar (InSAR), Light Detection and Ranging (LiDAR) and drone imagery data together with CCTV and inspections information in one location, making it easier and more efficient to monitor and manage sites and facilities remotely. K2fly's cloud solution based on InSAR detects land surface deformation over time to a precision of 1-2 millimetres. This data has historically been desktop-based in GIS and difficult to action.

*www.k2fly.com*

## QUESTIONS ASKED AT THIS STAGE:

**“What will my closure plan be?”**

**“How will I measure the environmental cost effectively?”**

**“How can the rehabilitation progress be transparent to everyone?”**

**“How can we improve safety by having less people on the ground but still demonstrate compliance?”**

**“How do we give communities confidence in mine rehabilitation work?”**

**“How do we meet our compliance obligations more cost-effectively?”**

**“How can we ensure regulators trust EO data?”**

**“What standards for the use of EO data in compliance need to be developed?”**

# PART 3: USER PROFILES

**Potential users of EO data and services exist in many types of organisations within the mining ecosystem.**

## USER EO MATURITY LEVELS

The outcomes of industry consultation for this report have been summarised as a series of generic user profiles, grouped according to characteristics and levels of EO use maturity.

**EARTH OBSERVATION USER MATURITY LEVELS**

| EO User Maturity Levels | Description of user |
|---|---|
| UML 0<br>Non-user | Has never had any interest in EO. |
| UML 1<br>EO Explorer | Has never made use of EO but is aware of it and may have planned occasional tests to assess its potential benefits. |
| UML 2<br>Ad-hoc user | Has used EO on an ad-hoc basis but without an explicit interest in repeated usage. |
| UML 3<br>Pilot/Experimental tester | Has already used EO in one or more trials and is considering its integration within standard practices. |
| UML 4<br>Confident user | Has confidently used EO and is working to incorporate it as part of operational activities. |
| UML 5<br>Operational user | Has adopted EO operationally and has integrated it within standard operational processes. Related resources such as staff, budget and resources are either allocated or readily deployable. |

*Adapted from the EC/ESA publication "The Ever-Growing Use of Copernicus across Europe's Regions."*

## USER PROFILES

The following profiles have been created to represent individuals who are most likely to use or promote EO within their part of the mining lifecycle.

A number of common requirements emerged across all user profiles. These are that EO data and products needed to:

- deliver the stated outcomes
- be easy to access
- fit with existing workflows
- not require additional software or licenses
- increase automation and digital transformation
- have clear and consistent instructions and documentation
- save time
- deliver cost savings
- lead to increased production
- make the operation safer
- decrease the risk of non-compliance

# THE EXPLORER

EO Maturity Level: 1-4

0 1 2 3 4 5

1 EXPLORATION | 2 PLANNING & DESIGN | 3 CONSTRUCTION | 4 PRODUCTION | 5 CLOSURE & RECLAMATION

## Ecosystem category:

Mining Company

## Role in the sector:

Discovers the resources.

## Key driver:

I am focused on business success and am keen to use whatever technology and data will help the business make viable new discoveries.

## As an explorer

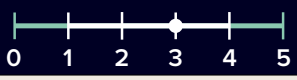
"I want a tool that lets me see where I want to see and software that automates the drudgery, but which makes the most of my expertise. It doesn't ask me to regularly buy data for the same area, and it gives me high quality data without trying to do everything. I want consistently processed time series of raw data so I can create my own products."

## Meet Kim

Kim is a geologist working for a drilling company. She uses hyperspectral imagery to help determine the most likely places to send the exploration team. The satellite imagery is used in conjunction with many other data sources such as geology maps to prioritise exploration areas.

# THE PLANNER

EO Maturity Level: 1-4





## Ecosystem category:

Mining Company

## Role in the sector:

Develops options for resource exploitation.

## Key driver:

I am a professional with skills and experience which can include geosciences, environmental sciences, engineering, finance or business.

## As a planner:

"I want a single system where everyone can put their data. I want data that lets me estimate costs, feasibility and ROI. I want to help investors understand the opportunity and help regulators get a better understanding of how the mine site will function."

## Meet Ed

Ed is a planner in charge of a team of multi-disciplinary specialists. The team is working on developing detailed mine site procedures, infrastructure designs, an operational ore extraction schedule, supply chains, planning workforce size and roles, and environmental compliance. Ed and his team are currently using GIS software to show a recent high resolution satellite image as a background. They will work with the mining company's GIS Analyst to produce updated spatial layers showing the site design and infrastructure. Some of the planning team may complete smaller GIS jobs themselves, and will be able to view new satellite or aerial imagery as it becomes available.

# THE BUILDER

EO Maturity Level: 1-3



## Ecosystem category:

Mining Company

## Role in the sector:

Carries out the construction stage of mining projects.

## Key driver:

Constructing the mine on time, within budget, and according to the detailed mine site plans and designs.

## As a builder:

"I want high-resolution imagery that shows the level of detail that I need. I want data that I can access regularly and show to anyone who needs to see it – it should support good communication with project owners."

## Meet Mick

Mick is a Construction Manager in charge of the construction of some new mine infrastructure. He's currently using maps produced by the mining company's GIS Analyst to help guide the site preparation. These maps have high-resolution satellite imagery displayed as a backdrop and show the vegetation communities. A METS company completed fieldwork and then manually drew the vegetation communities on aerial imagery to produce the dataset.

# THE OPERATOR

EO Maturity Level: 0-1

0 1 2 3 4 5

1 EXPLORATION | 2 PLANNING & DESIGN | 3 CONSTRUCTION | 4 PRODUCTION | 5 CLOSURE & RECLAMATION

## Ecosystem category:

Mining Company

## Role in the sector:

Runs mine site production processes and workflows.

## Key driver:

Meeting production targets in a safe workplace.

## As an operator:

"I want clear instructions about what to do, clear descriptions of work plans and schedules, and detailed hand-overs. I want to know who is doing what, so our process runs smoothly and safely."

## Meet Sally

Sally has worked in the mining sector for many years. She currently manages the site operations and uses derived EO products to ensure the mining operation is within compliance guidelines.

# THE DATA ANALYST

EO Maturity Level: 0-4

0 1 2 3 4 5


## Ecosystem category:

Mining Company

## Role in the sector:

Synthesises and analyses big data to track operational performance.

## Key driver:

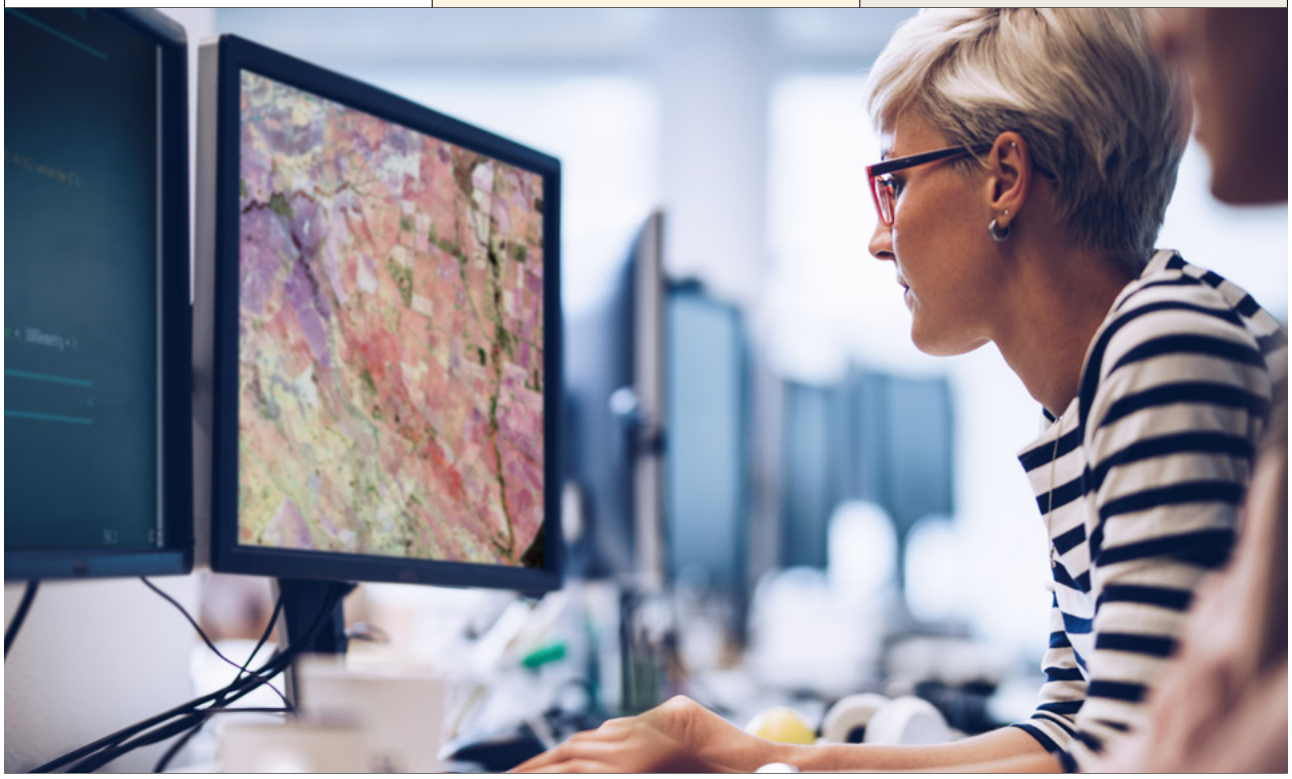
Delivery of benefits to the business, such as risk mitigation, operational efficiencies, cost savings, and production increases.

## As an analyst:

"I want data that integrates easily into my systems so I don't have to change my existing workflows. I want consistent access to reliable data that reduces uncertainty and helps others do their jobs better. I want tools that bring different data sets together, that are clearly already working well for other users."

## Meet Eva

Eva is an experienced GIS analyst and uses ArcGIS Pro to produce maps of current operations. She is familiar with using satellite images as backdrops but doesn't necessarily understand how to create new derived products.



# THE ENVIRONMENTAL ADVISER

EO Maturity Level: 1-4

0 1 2 3 4 5


## Ecosystem category:

Mining Company

## Role in the sector:

Ensures compliance with Environmental Management Plan approval requirements.

## Key driver:

I am a professional who wants to find the right balance between mining and its impacts on the environment.

## As an environmental adviser:

"I want descriptive data that meets clear industry standards and shows me trends in environmental conditions and ecology so I can estimate impacts and get approval from regulators. I want to be given a clear index and threshold standards for that index. I want to contribute to quantitative analysis of risk in high value decisions for the company."

## Meet Ben

Ben is a hydrologist at a mining company. He uses derived EO products and analytics from reports to make environmental management plan decisions and determine field sample locations for his team and consultants. He sometimes displays derived EO products in a GIS system but doesn't know how to use GIS tools to produce analytics. There are no remote sensing scientists on staff at the mining company. If a new analysis of EO products or additional fieldwork is required beyond his team's capacity, Ben will set up a contract with a consulting company.

# THE EXECUTIVE

EO Maturity Level: 0-2

0 1 2 3 4 5


## Ecosystem category:

Mining Company

## Role in the sector:

Manages a mining project to ensure operations are optimised.

## Key driver:

Optimised processes across the whole 'life-of-mine'.

## As an executive:

"I want easy access to information that shows me exactly what's happening across all operations so I can make good decisions. I want to see case studies that demonstrate how a product increases operational efficiency and reduces risk, and I want good news stories for investors and the public."

## Meet Barbara

Barbara is the head of a department in a major mining company. She very rarely looks at satellite imagery. Still, she uses the information in reports summarising analytics from EO data to make business decisions on operations. She presents future plans based on these reports to the executive team.

# THE REGULATOR

EO Maturity Level: 1-3



## Ecosystem category:

Government

## Role in the sector:

Administers regulatory frameworks and ensures compliance.

## Key driver:

Ensuring regulatory requirements are appropriate and verifying compliance.

## As an analyst:

"I want high-resolution imagery that lets me confidently identify features of interest in any region and verify them against other reports and data. I want a data-driven understanding of the ecosystems in which projects will be developed and how mine sites interact with them."

## Meet Greg

Greg is a compliance officer at a state government agency. He uses derived EO products to confirm the findings presented in mining company reports or independent compliance checks.

# THE METS COMPANY

EO Maturity Level: 1-4

0 1 2 3 4 5


## Ecosystem category:

METS Company

## Role in the sector:

Provides technical services and products as required throughout the mining lifecycle.

## Key driver:

We're passionate about our technology and are totally solution and business focused. We want to provide commercial products and services that are fit for purpose in the mining industry all over the world.

## As a METS company:

"We want all the EO data we need in one place – open access, analysis-ready, time series data – so we can provide data-driven solutions that the mining sector will pay for. We want APIs for automated access, easy-to-navigate documentation, standardised methodologies and quality metadata. We want to see standardised tools and endorsed methodologies within the industry, and for the EO maturity level of junior and mid-tier miners to increase."

## Meet Amanda & Brad

Amanda is a remote sensing analyst at an environmental consulting agency who uses a variety of EO data regularly. She uses programming languages to automate tasks and produce derived products, and summarises these outputs for reports. She creates derived remote sensing products that span local to regional areas for the detection of change between successive years over 20+ years.

Brad is a weed management technician at an environmental consulting company. The remote sensing scientist at his company uses satellite imagery to create datasets identifying areas where weeds may occur. The GIS analyst turns these datasets into maps. The technicians use these maps to determine where they should visit to check and eradicate weed infestations.

# THE SPATIAL COMPANY

EO Maturity Level: 4-5

0 1 2 3 4 5


## Ecosystem category:

METS Company

## Role in the sector:

Provides EO and other geospatial products as required throughout the mining lifecycle.

## Key driver:

We're passionate about the power of location data and maps. We know that our data is unique and has quirks and benefits that few currently appreciate. We want to provide commercial products and services to clients that are based on or derived from EO, delivered on a map.

## As a Spatial Company

"We want APIs to automate access to quality-controlled data via an open framework. We want analysis-ready time series EO data based on standard methodologies, in standard formats, with high quality metadata. We want to work with reliable partners to deliver products and services that customers will pay for, and to see better customer maturity and engagement with EO technology – our business depends on it."

## Meet Josh & Tye

Josh works as a software developer for a start-up company developing a web application to display satellite imagery and derived products and analytics for the mining sector. The web application requires raster tiles to be created for the input products. The app may be able to transition to a serverless architecture using Cloud Optimised Geotiffs, eliminating the need for map tile creation and saving time. However, the company can't afford the development time required to transition the software stack.

Tye has a postgrad degree in data science and has recently joined his company, also a start-up. He's using satellite imagery to train AI models in the cloud. Tye doesn't understand traditional remote sensing methods and requires large amounts of data to run his models. He needs satellite imagery to be in a public cloud bucket that works with cloud providers' tools for his models to work.

# PART 4: OPPORTUNITIES

**EO technology is already employed within mining processes, but there is scope for both a broadening of its application and an increase in user maturity levels to see it more widely used across the mining lifecycle.**

## EO USE CAN BE EXPANDED ACROSS THE MINE LIFECYCLE

EO data used in combination with big data analytics, cloud computing, and artificial intelligence offers new ways to improve profitability of operations and decrease risk across the mining lifecycle. Examples of where EO data is already aiding mining operations and could be expanded include:

- **Moderate resolution EO data** (10m to 30m) from satellites such as Landsat and Sentinel-2. This is increasingly available and free to access, opening up broader landscape assessment applications including mineral exploration, land disturbance and rehabilitation monitoring.

- **Hyperspectral satellite imagery** (using more than 20 spectral bands) is a critical tool in the early stages of mineral exploration.

- **Satellite imagery with a high spatial resolution** (< 3 metres) **and temporal frequency** (daily). This has become more readily available in the past five years and can be used to monitor mine operations, production and environmental impacts, and communicate companies' social and ecological governance to investors and government regulators.

## EO CAN SUPPORT DIGITAL TRANSFORMATION AND AUTOMATION

Increased use of EO data will support the digital transformation and automation of mining operations. Automation in mining involves the replacement of human labour across all operations. Continuous feeds of high-quality data are crucial to process automation to increase productivity and reduce risk. Examples of its use include:

- **Remotely monitoring sites.** Satellite data can identify changes in the landscape, enabling remote monitoring of assets, predictive maintenance, remote operation of vehicles, and automation of production processes. This reduces the need for site visits by staff, reducing safety risk and costs.

- **Simplifying environmental compliance.** Satellite data can identify historical and current vegetation in satellite images, enabling automation of environmental compliance monitoring and reporting.

## EO CAN IMPROVE MINING PROCESS EFFICIENCIES AND REDUCE RISK

EO data can be used to optimise mine operations and reduce financial risk across the mining lifecycle. EO data can provide:

- **Targeted mine exploration.** The length and extent of a drilling campaign may be significantly shortened leading to large exploration cost savings.

- **Optimisation of mine operations.** Monitoring pit wall excavation progress, stockpile volumes, and supply chain logistics.

- **A clear and independent source of observations for compliance and approval.** This can be used to understand the site as well as put it into the context of the surrounding landscape and conditions.

- **More efficient and timely approvals and compliance.** When EO data is combined with data collected on the ground at the site, it facilitates a clear view of activity that is quicker and easier for the regulator to assess.

- **Reduced non-compliance with environmental legislation.** Monitoring with EO data improves the likelihood that potential environmental impacts will be detected before they breach a level where a fine or operation stoppage could occur.

- **Remote monitoring of mine or survey sites.** Staff are able to monitor sites for compliance and rehabilitation without needing to visit in-person.

Surveying of vegetation communities or mineral exploration can be completed by desktop analysis using EO data, with field teams sent on targeted reconnaissance to identified sites. This makes operations more efficient, but also reduces the potential for injuries that may occur in remote, uneven mine sites or tenements.

- **Improved environmental outcomes through remote monitoring of sites.** Tailings dam movement can be detected before breaches occur that potentially impact the environment and population. Similarly, environmental conditions such as tree health and dust levels can be monitored to ensure impacts are kept at low levels.
- **Communication of mine site compliance to the public.** Monitoring of mine site location with regard to cultural and environmental features can be used to demonstrate best practice by mining companies and generate goodwill within the community towards the project and company.
- **Regular, remote monitoring of mine sites for ESG.** Environmental and Social Governance (ESG) relies on regular monitoring of and reporting on the site. ESG is becoming an increasingly important component in investor sentiment towards companies, and demonstration of good governance can encourage shareholders to maintain or increase their investments.

# PART 5: CHALLENGES

**The most significant hurdle to increased adoption of EO technology in the mining and METS sector is the integration of new data and ways of working into established mining workflows. Existing operations are tightly controlled, so cases for change must be compelling, with senior management buy-in being critical.**

## LIMITATIONS AND UNCERTAINTY

Mining is an inherently risky industry, from the financial risks of the exploration, design and construction stages, to human risks in the operational steps, and environmental and community risks across the entire lifecycle. This means the industry is particularly sensitive to using data that may introduce uncertainty into existing processes and workflows.

Industry research for this report found that:

- **The limitations of EO are not well articulated.** Many EO products lack clear information about their limitations and observation uncertainty, so the mining and METS sector sees significant risk in relying on them for decision making.

- **The impact of EO on downstream processes is not understood.** The mining lifecycle is a system of systems, so the mining and METS sector must have a thorough understanding of how the integration of EO data will impact downstream processes and workflows.

## USER MATURITY AND CONFIDENCE

While EO technology is recognised in the mining and METS sector as a useful tool, most of the sector does not have the necessary skills or knowledge to understand the problems EO can solve. This leads to a lack of confidence in both the mining and METS sector and its regulators. Government departments and mining companies must have a higher level of familiarity to adopt a technology that will change current practices. By equipping staff with a better understanding of EO within these organisations and companies, capabilities in EO can be uplifted to higher user maturity levels.

EO training is often conducted internally on an informal basis between peers, where the spatial specialist is responsible for uplifting other members of the team whose user maturity levels are lower. Where a company is not able to employ an EO specialist, they can achieve a similar result by working with a third party. Additional training offerings in EO data uses and workflows would also allow increasing user maturity and confidence.

## VALUE PROPOSITION

For EO data to become a trusted source of information for decision making and risk management within the mining and METS sector, its value must be demonstrated by examples. Benefits of integration and adoption must be substantial and well-reasoned. A clear value proposition – communicating how risk will be reduced, or productivity will be increased – needs to be communicated before the use of new data can be considered.

# PART 6: RECOMMENDATIONS

**The following actions are recommended to increase the use of EO within the mining and METS sector:**

## INCREASE EO AWARENESS

The first step to seeing increased use of EO data is to explain its problem-solving potential. The mining and METS sector would benefit from the incorporation of EO-focused content into mining related training and qualifications, as well as additional training that can be accessed on demand in short, focused sessions.

## SPEAK IN PLAIN LANGUAGE

The language used to discuss EO must be fit-for-purpose: technical when required, but plain and simple at other times. EO technology needs clear and practical descriptions of how it can and has been applied to help solve particular challenges, including financial and risk mitigation impacts, so that users can have confidence in its outputs.

## PRESENT EO AS PART OF THE SOLUTION

EO is one source of data used in combination with many others, such as drilling, geochemistry, geophysics, and field-based measurements across the mining lifecycle. EO data must be presented not as an isolated tool or solution, but as part of an integrated suite of high-confidence data products that can solve specific problems across the lifecycle.

## MAKE EO EASY TO INTEGRATE

Users must be able to access and apply EO data in the same way they can access and apply other data. Interoperability is an essential requirement for integrating new technologies into mining operations, which generally involve different organisations at each stage of the mining lifecycle.

Data should conform to published open standards to support interoperability, and two priorities should guide their development:

- EO data should be delivered in standard formats that enable separate systems and software, which may be used for different purposes across different stages of the mining lifecycle, to work together.
- Standards for the use of EO data should be developed so that all users across the mining lifecycle (including regulators) have a common language to describe observations, compare measurements, and set baselines and thresholds.

# PART 7: DIGITAL EARTH AUSTRALIA'S COMMITMENT

**Based on the findings of this report, Digital Earth Australia is committed to working with the mining industry to ensure EO is a key part of their digital transformation. We welcome the opportunity to support the sector in the following areas:**

**Increase awareness of how EO can support decision making, operational efficiency, and risk management**

- Engage with peak bodies to build EO awareness throughout the industry via targeted presentations.
- Promote the benefits of EO at key conferences and networking events.
- Share plain English use cases for EO that clearly illustrate its value in the sector.
- Support events such as data challenges and hackathons in the sector to promote the use of EO.
- Work with peak bodies and partner institutions to deliver targeted short EO training courses.

**Build confidence in the use of EO in the sector to support compliance activities**

- Establish a working group on increasing the trust in EO in the sector.
- Develop demonstrators that show how to integrate EO in mining workflows.
- Work with the sector to determine how EO can support specific legislation and reporting requirements.
- Develop demonstrators for the use of EO in mining compliance.

**Promote data standards and interoperability to make it easier to share and collaborate with EO data**

- Support peak bodies and regulators to develop industry standards for EO.
- Investigate integration of DEA data into existing geology and geophysics data archives used by the sector.

**Support the commercialisation of EO products and services for the sector**

- Work with peak bodies to leverage their start-up and scale-up/accelerator programs for EO use.
- Integrate DEA products and services with emerging regional space data analytics hubs.
- Support the sector to redesign and automate workflows that leverage EO.
- Support the sector to develop common platforms for decision making using EO.

**Embed EO in the toolkits of the next generation of mining professionals**

- Integrate EO-focused content for mining qualifications and short courses.
- Develop teaching capacity, capability and programs.
- Organise joint activities, conferences, seminars, or lectures.

Digital Earth AUSTRALIA

# PART 8: CONCLUSION

**Australia is at a significant acceleration point in the development and provisioning of fundamental, next-generation EO data, products, services and insights.**

Users are demanding precision data and services delivered in near-real-time, customised to their needs at any location. High quality, reliable data products that increase confidence in decision-making and value by maximising efficiency or minimising risk are critical. If integrated properly, EO technology can play a vital role in the mining industry's digital transformation.

This report has outlined recommendations to help accelerate EO product workflows and processes across the mining lifecycle. Still, it will be technology organisations, research providers, government agencies, and notably the companies that comprise the mining and METS sector, who need to develop compelling business cases to drive change.

**If you or your organisation would like to help in driving this transformation, you are encouraged to:**

- Start talking about problems, not solutions.
- Get involved in the adoption of EO products and services.
- Share this report within your organisation and discuss how you could adopt the recommendations.
- Consult supporting documentation for further information and visit the DEA Industry Strategy website: frontiersi.com.au/dea
- Tell us your thoughts: dea@ga.gov.au

## FURTHER READING

The following key bodies offer valuable sources of learning about the mining and METS sector:

- **METS Ignited** metsignited.org
- **AMIRA Global** amira.global
- **Austmine Ltd** austmine.com.au
- **AusIMM** ausimm.com
- **AAMEG – Australia-Africa Minerals and Energy Group** aameg.org
- **Australian Centre for Geomechanics, University of Western Australia** acg.uwa.edu.au
- Mining clubs, such as the **Western Australia Mining Club** waminingclub.asn.au
- **Co-operative Research Centre Transformations in Mining Economies (TiME)** crctime.com.au


## ACKNOWLEDGEMENTS

FrontierSI and DEA would like to thank those who contributed to this report for their constructive ideas and participation.

Australian Government
Geoscience Australia

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