Mining Environmental Services Capability

“Turning Risk into Value”
Turning Risk into Value

Verterra is a leader in the field of ecological engineering of sustainable ecosystems that integrate human society with the natural environment for the benefit of both.

We provide specialist technical environmental services supporting mine development, operation, rehabilitation and closure.

With an extensive scientific and practical knowledge of vegetation, soil, water and landscape function Verterra provides cost-effective solutions to meeting a wide range of technical, operational management and regulatory requirements in the mining industry.

Our mixture of highly skilled and nationally certified environmental soil scientists, ecologists, hydro-geologists and environmental engineers and experienced land, water, vegetation, wildlife and management practitioners enable Verterra to provide an unparalleled level of innovation and capability in developing and implementing tailored, end-to-end solutions for mine site rehabilitation and closure. We also support routine operational

Tailored approach

Verterra delivers solutions tailored to each client’s specific site conditions, expectations, operating constraints and compliance requirements.

Our integrated scientific, ecological, technical expertise, research skills as well as our practical experience and systems thinking enable Verterra to use a multi-lens approach to any problem, opportunity or challenge. We deliver value by conceptualising, designing and delivering solutions that reduce cost, and improve economic, environmental and social outcomes. We consider:

- **Site conditions**: The physical and biological attributes of the site that create the envelope of possible rehabilitation approaches.
- **Operational considerations**: Considerations in the mine site workflow, access, soil removal and replacement process.
- **Compliance**: Licensed approval conditions that must be observed in any rehabilitation option.
- **Sustainability**: Threshold requirement for all options.
- **Reliability**: Robustness of the proposed approach to deliver the expected outcome.
- **Cost**: Minimum cost or maximum return within the constraints of other attributes.
- **CSR outcomes**: Corporate aspirations for demonstration of corporate social responsibility.

Capabilities

- **Specialist technical** environmental services
- **Rehabilitation** operational services
- **Integrated mine closure** planning
- **Mine personnel outsourcing** and support services
- **UAV services** and remote sensing.

Qualified Team

- Soil Scientists
- Ecologists (Flora, Fauna, Aquatic/Marine)
- Hydrogeologists
- Hydrologists
- Environmental engineers
- Air and Noise Specialists
- Carbon and Climate Change specialists
- Senior Foresters.
- Irrigation specialists

Tailored Approach

A multi-lens approach with customised solutions.
Verterra Advantage

Over 50 specialists representing a range of scientific and environmental disciplines: *Hydrologists, Hydrogeologists, Forestry specialists, Ecologists (Flora, Fauna, Aquatic/Marine), Soil Scientists, Agronomists, Vegetation Management, Irrigation, Air, Noise and GIS Specialists, Carbon and Climate Change Experts.*

*End-to-end* service delivery.

*Innovative management solutions* that meet compliance and add value.

*Highly developed systems* for large-scale soil mapping and land capability characterisation.

Developing *cost-effective best management practices* for problematic and dispersive mine spoil—a multi-billion dollar liability.

Ground breaking expertise in *beneficial use of coal seam gas water*. Our full spectrum of capabilities include: *concept, design, compliance approval, implementation and monitoring and management.*

Specialist technical environmental services for mining

Verterra brings substantial depth of *technical expertise* across the full range of soil, water, vegetation air and landscape technical services related to mine planning, operation and closure including:

- Soil surveys and land capability assessment
- Dispersive spoil management
- Strategic cropping land evaluation
- Soil, water and vegetation research services
- Hydrology and hydrogeology
- Mine water management
- Fauna and flora surveys
- Conservation genetics
- Air and noise monitoring
- GoldSim Optimisation Modelling.

We couple detailed scientific knowledge with unique intellectual property and practical experience to deliver *innovative management solutions* that *meet compliance* and *add value*. Our projects contribute to reducing cost and liability while improving social licence to operate.

**Soil and Spoil**

Verterra’s expertise in large-scale soil mapping and land capability characterisation, and *specific expertise in management of problematic and dispersive spoils*, is supported by systems specifically developed by us for this capability. We are currently working with Anglo American, Rio Tinto, Peabody, Glencore and New Hope Group to develop *cost-effective best management practices* to address this problem which represents a multi-billion dollar liability to the mining industry.

**Mine Water**

Verterra developed a *novel, integrated approach to the beneficial use of coal seam gas water* via irrigated forest and fodder plantations. Our detailed feasibility study for a key mining client underpinned the *first beneficial use licence to be approved* by DERM (now EHP) for large scale irrigated use of coal seam gas water in Queensland; and subsequently informed the development of over 1,200 ha of irrigated forest plantation and over 500 ha of irrigated fodder crops using coal seam gas water.
**Flora and Fauna**
Verterra has established systems combined with substantial expertise in practical ecological assessment, design and management. Our understanding of fundamental ecological principles informs flora and fauna assessments and rehabilitation methodologies. Verterra successfully developed a novel approach to revegetation of semi-evergreen vine thicket, a difficult to manage, threatened vegetation community, under hostile site conditions on re-contoured mine spoil.

**Hydrology and Hydrogeology**
Our hydrology and hydrogeological experts have undertaken and delivered numerous investigations to understand mine impacts on surface and groundwater. Verterra links this understanding through our cross-disciplinary expertise to design and develop management approaches that reduce risk and create value for our clients.

**Conservation Genetics**
Verterra has unique expertise in conservation genetics encompassing both molecular and quantitative genetics techniques and analyses. We have the capacity and the understanding to design and manage recovery strategies for rare species impacted by mining, and to maximise either biodiversity or production outcomes to meet varying post-mining objectives.

**Optimisation modelling**
Mining requires simultaneous management of numerous complex, interacting material operations and processes. Verterra offers our capacity to model interactions between factors that influence the volume, reliability, variability and cost of operations to optimise production, reduce risk and minimise cost.
Rehabilitation services

Verterra’s rehabilitation operational services are backed by scientific and technical expertise and reinforced by substantial practical experience. This ensures innovative and practical approaches to our clients’ requirements. Services include:

- Site and tailings dam rehabilitation
- Weed control
- Seed supply
- Rehab monitoring
- Soil surveys
- Vegetation offsets
- Spoil analysis and characterisation
- Beneficial mine water reuse.

Verterra’s cross disciplinary expertise and shared knowledge from other industries adds value as well as enabling an integrated, holistic approach to problem solving.

We use a “whole-of-site” property management planning approach to projects to identify land uses best suited to soil type and landform and land capability. This can include: biodiversity along riparian corridors and steep slope spoils, to commercial land uses on buffer lands and suitable spoil slopes. It is also carried through to the detail of seed supply, rehabilitation monitoring feedback and weed management.

Verterra has designed and delivered beneficial mine water reuse projects for pasture, fodder crops, commercial forestry and SEVT; resulting in reduced environmental liabilities and cost while improving environmental and rehabilitation outcomes.

Our projects involving integrated rehabilitation of spoil and buffer lands for a range of final land uses (in line with site and landform capability), have contributed to improved rehabilitation outcomes, reduced costs and long-term liabilities and supported social licence to operate. These projects include:

- Fodder
- Commercial forestry
- Agroforestry
- Mixed native forest for commercial timber and biodiversity
- Regionally endangered SEVT communities
- Establishment of vegetation and koala habitat offsets
- Seed analysis
- Quality control and rehabilitation monitoring to inform species selection,
Integrated closure planning

Effective mine rehabilitation is critical to achieving a number of key objectives.

Verterra’s integrated approach to mine rehabilitation ensures compliance, minimises liability and maintains a social licence to operate.

Our expertise includes delivery of final landform designs for mine disturbed areas with associated completion costs, and GIS mapped disturbance area categorisation linked to rehabilitation liability cost modelling. Mapping and rehabilitation liability cost modelling can be tailored to fit the client’s scope and budget. We use 3D software to simulate the movement of material in-office before construction begins in the field. Verterra has the unique capability to integrate bulk spoil movement with ultimate land use and vegetation requirements in addition to assisting with final closure compliance documentation.

Verterra staff have knowledge of and proven experience with closure criteria, planning review, planning design and liability estimation for global mining companies. Our projects include:

- Evaluation of prior rehabilitation and assessment against final land use objective, and development of appropriate closure criteria.
- Modelling the volume and sequencing of overburden removal to progressively create the final landform and estimate progressive costs over the life of mine.
- Various reclamation design, redesign, coal stockpiling and productivity improvement projects.

Benefits

Optimised landform design, together with equipment utilisation and productivity rates

Data that can then be used to identify the most cost and time effective means of constructing each part of the landform

Bulk push can be minimised and can provide significant cost savings of over 50%

End to end service delivery—bulk spoil movement + ultimate land use + vegetation requirements + assist with meeting compliance obligations + assist with EA Surrender Authority.

Closure Planning Services

Closure planning review
Mine closure planning
Landform design, GIS mapped disturbance area categorisation, and cost optimisation (liability cost modelling)

3D Modelling
Surface water drainage designs for the final landform design or operational site water management
Rehabilitation liability modelling and cost estimation
Assist with meeting compliance obligations
EA Surrender Authority process and documentation.

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Mine personnel outsourcing and support services

Verterra can provide personnel on a secondment or consulting basis for long or short-term engagements. We employ qualified and experienced environmental and community engagement professionals with mine site, risk management and environmental compliance experience.

Our personnel deliver projects ranging from report preparation through workshop facilitation to supervision of on-ground works. We assist clients in meeting compliance obligations, fulfil legal requirements and provide third party support services.

Personnel Support

Verterra personnel support services include:

- Regulatory authority and legislative review.
- Community, neighbouring landholder and other stakeholder engagement.
- Internal compliance audits with either site Environmental Authority or internal environmental standards and procedures.
- Internal Environmental Management System (EMS) effectiveness audits.
- Internal risk assessments and procedural development/review.
- Wildlife handling training and awareness and permitting programs.
- Hazardous substances storage and transfer audits and procedural review.
- Environmental training and awareness programs.

Verterra can also provide a package of environmental compliance and management services for sites under care and maintenance arrangements.

Benefits and services

Meet compliance obligations
Fulfil legal requirements
Third party support services
Stakeholder and community engagement
Environmental management support
Environmental monitoring and inspections
Water management
On-ground supervision of works
Care and maintenance for mines
Management system maintenance
Report preparation
Weed and site security management

Stakeholder engagement

The third pillar integral to successful “Triple bottom line” project delivery is Community Engagement.

Verterra have personnel with specialist skills and demonstrated experience in facilitation and stakeholder engagement. We focus on linking the social aspect of project development with environmental outcomes and the economic bottom line.
In 2017, Verterra introduced in-house UAV capability for delivery of environmental services. We hold a Civil Aviation Safety Authority (CASA) Remote Operator’s Licence (ReOC) Licence 6202 and have an appropriately trained licenced operators with Remote Pilot Licence (RePL). Routine job hazard assessment procedures, pre-flight planning and flight operating procedures as required by CASA regulators are implemented in connection with all flight operations. Verterra operates a Matrice M600 drone (15 kg maximum take-off weight) during flight operations. The M600 is equipped with:

- High-resolution colour camera; and
- Multi-spectral camera.

and provides the capability for the following key services:

**Normalised Difference Vegetation Index Mapping (NDVI)**

Verterra’s equipment enables calculation of a number of indexes including NDVI. NDVI measures the amount and health of live vegetation in an area via the difference between the reflected intensity of near infra-red and visible light. Rehabilitation areas can be comprehensively surveyed safely, and revegetation success quickly quantified via cover percentage, health and structure.

This data can be used to identify areas requiring supplementary revegetation in order to avoid exposure to erosion. This assessment can also provide a ‘bio-assay’ of variation in soil conditions that may influence revegetation success, and inform targeted sampling to determine required soil amendments.

**UAV Applications**

- **NDVI** mapping of vegetation amount and health.
- **Vegetation** — rehabilitation success monitoring.
- **Landform Digital Terrain Mapping** — quantifying changes in landform over time due to erosion.
- **Direct application of seed and fertiliser** — small difficult to access sites.
- **Digital photogrammetric mapping** — can also be used to measure tree height as part of bio-condition monitoring.
Drone-Based Landform Digital Terrain Mapping

Verterra has the capacity for photogrammetric landform surface mapping to quantify changes in landform over time due to erosion.

Targeted photogrammetric mapping provides:

- Capability for 100% enumeration of soil movement;
- Quantitative assessment of erosion;
- High-level confidence in rehabilitation success; and identifies
- Target areas for remedial works.

Digital photogrammetric mapping can also be used to measure tree height. In combination with NDVI, it provides a powerful basis for digital landform assessment.

Advantages

There are many advantages of using UAVs for imagery, surveying and material applications.

- **Reduced Costs:** Significantly reduced cost relative to full scale aerial tasks and many land-based tasks.
- **Quick mobilisation:** Capacity to mobilise and complete tasks quickly.
- **Reduced safety risks:** by enabling unmanned operations, particularly in difficult to access areas or steep terrain.
- **High quality data:** acquisition of high quality data less affected by cloud, fog and other environmental conditions.
- **Ability to fly at lower altitudes than other aircraft:** which can increase the accuracy and quality of data acquisition; reduce delays due to cloud, fog and other environmental conditions; virtually eliminate potential for spray drift and; minimise interaction with mine operational activities.
Soil and Spoil
Risk-based management principles for dispersive mine spoil behaviour
Stabilisation of Collinsville Ash Dam
Detailed land characterisation for CSG water development

Mine Water
Considerations and challenges in use of CSG water
Santos irrigated forest and fodder plantations
QGC irrigated forest and fodder plantations 1 and 2
Xstrata irrigated tropical pasture cropping

Flora and Fauna
Botanical survey of Semi Evergreen Vine Thicket (SEVT) communities
Wyaralong environmental corridor and vegetation offsets
Survey and assessment of standing timber and biodiversity values
Vegetation management, monitoring and reporting plan

Hydrology and Hydrogeology
Hydrogeological assessment of groundwater flow and solute transfer pathways
In-situ soil permeability assessment

Conservation Genetics
Conservation genetic review of Dawinia masonii and Lepidosperma gibsonii
Validation and quality control of mixed species seed

Optimisation Modelling
Coal seam as field water balance model peer review
Community dam scenario and optimisation modelling
Comparative economic assessment of coal seam gas water uses

Rehabilitation Services
Mine spoil revegetation with Semi-Evergreen Vine Thicket (SEVT)
Commercial Timber Plantations as an alternative final land use
Revegetation management plan

Integrated closure planning
Closure planning for Collinsville Ash Dam
Callide integrated site rehabilitation and revegetation

Mine Personnel outsourcing and support services
Review of draft revised salinity impact and CSG irrigation regulatory guidelines
QGC Beneficial Use Plan review
Opportunities for biodiversity, carbon and other values through easement management

Stakeholder engagement
Midlands water for food community reference group workshop facilitation
Mine disturbed revegetation management plan
Queensland Hardwoods program

UAV Services
Billies Bay Maintenance and Bio-Condition Monitoring
ACARP Rehabilitation of Dispersive Mine Spoil—monitoring of trials
NQ Dry Tropics—Major Integrated Project—Landholders Driving Change
Maleny Irrigated Forest Construction and Wetland Maintenance
Maroochydore environmental buffer treatment
Contact Us

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Other Locations

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<tr>
<th>Location</th>
<th>Address</th>
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<tbody>
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