



# Guidelines for rehabilitation of extractive sites in environmentally protected areas

## Deliverable D2.2



The purpose of this Deliverable is to compile comprehensive guidelines and best practices for carrying out rehabilitation activities on mine sites in environmentally protected or sensitive natural areas. This can be done either on an ongoing, progressive basis during operations, or at the end of the mining lifecycle.



The guidelines emphasise the importance of engaging local communities throughout the mine lifecycle and, particularly, in the rehabilitation process. This involves ensuring that rehabilitation efforts align with local needs and expectations to foster and sustain the long-term sense of belonging and active participation.



### Key technical findings:

Integration into the mining lifecycle: Rehabilitation must be planned from the exploration phase and integrated throughout the mine's operational, closure, and post-closure stages.

### Rehabilitation methods:

- Landform recontouring to stabilise terrain and manage water flow;
- Topsoil remediation through replacement and soil quality enhancement;
- Revegetation using native species, hydroseeding, and successional planting;
- Water management, including treatment systems and constructed wetlands;
- Waste management aligned with the Extractive Waste Directive (2006/21/EC) to ensure the secure containment and potential reuse of materials.

### Innovative technologies:

- Remote sensing and GIS for mapping and monitoring;
- Drones and IoT sensors are used for real-time data collection and aerial seeding;
- AI and ML tools are used for predictive modelling and automated analysis;
- Bioengineering and phytotechnology are used for soil stabilisation and contaminant removal.

### Community involvement:

Active participation of local stakeholders throughout the mine lifecycle is essential to ensure the social acceptance and long-term sustainability of rehabilitation efforts.

### Climate adaptation:

Strategies must account for the impacts of climate change, including extreme weather conditions, water scarcity, and soil degradation, by incorporating resilient and adaptive circular solutions.



Mining is vital for the supply of essential raw materials for industry and infrastructure development in Europe, as per the EU Green Deal and the Critical Raw Materials Act. However, the ecological damage often caused by mining operations highlights the urgent need to adopt effective rehabilitation measures throughout the mining lifecycle, not just at its end.

### Methodology:

The guidelines developed are based on fifteen case studies presented in CIRAN D2.1. They emphasise the importance of environmental rehabilitation from social and economic perspectives. A lifecycle management approach is necessary in the rehabilitation process, starting at the mine planning stage.

The guidelines provide a comprehensive framework for the rehabilitation of mine sites in protected areas. They cover principles of rehabilitation, rehabilitation methods, technological approaches, societal and economic considerations, challenges and barriers, and the impact of climate change on rehabilitation processes.

Proposed future directions for mine site rehabilitation include:

- Integrated land use planning
- Advanced monitoring and maintenance
- Enhancement of ecosystem services
- Community-centric approaches
- Innovative and coordinated policy and regulatory frameworks
- Interdisciplinary research and collaboration
- Economic incentives for sustainable practices
- Advances in bioengineering and phytoremediation

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