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Technical specification for monitoring and evaluation of land reclamation and ecological restoration in mines

矿山土地复垦与生态修复监测评价技术规范

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3 Terms and definitions

Mine land reclamation and ecological restoration is defined as the activity that, for the geological environment damage, land destruction and ecosystem damage or degradation caused by the extraction of mineral resources, relies on human support and guidance together with natural restorative capacity and takes preventive and restorative measures so that the mine geological environment becomes safe and stable, the destroyed land is reclaimed for use and the ecosystem function is restored or improved; a note abbreviates it to reclamation and restoration.

A monitoring site is a fixed or temporary point set up for observation, testing or sampling. The monitoring area is the region formed together by the extraction area, the area affected by mining and the sample plots of the reference ecosystem. A reference ecosystem is an ecosystem that can serve as the target or benchmark of ecological restoration; a note states that in this document it means in particular the ecosystem before extraction, the undisturbed local ecosystem around the mine, or an ecosystem that can be predicted to be reached on the basis of the target values.

The four kinds of value used throughout the document are defined as follows. The reference value is the figure obtained by surveying and monitoring the reference ecosystem, or the figure explicitly laid down by an existing standard. The base value is the figure of the monitored object at the base period, obtained by survey before extraction begins; a note adds that it is also called the initial value or the present value. The monitoring value is the measured figure obtained at different points in time, as monitoring requires, over the whole process of extraction, reclamation and restoration. The target value is the binding or guiding figure fixed by the reclamation and restoration plan and by the planning and design.

Adaptive management is the method and process of gaining experience by monitoring and assessing the reclamation works, management measures and practical measures taken in the past and of correcting and improving them as the ecosystem changes.

4 Purpose and general requirements of monitoring and evaluation

4.1 During the extraction of mineral resources, monitoring and evaluation are carried out on geological environment damage and its treatment, on land destruction and reclamation, and on ecosystem damage or degradation and its restoration, so as to give a sound basis for the process supervision, the adaptive management and the acceptance of mine land reclamation and ecological restoration.

4.2.1 Problem oriented, focused on the essentials. Centred on geological environment damage and treatment, land destruction and reclamation, and ecosystem damage or degradation and restoration within the monitoring area, and having regard to the mineral extracted, the scale of construction, the mining method, the process and the timing, the key

monitoring content, indicators, point positions and periods are to be set on a sound basis, so that each mine has its own plan.

4.2.2 Scientific and regular, throughout and complete. The acquisition of indicators is to meet the relevant national technical standards and specifications and the rules of the departments concerned. The layout of monitoring points is to take account together of the needs before, during and after extraction. Before extraction the geological environment background, the current state of the land resource and the ecosystem baseline are surveyed; during extraction the protective and preventive control measures, the current and intended destruction and the effect of reclamation are monitored; after extraction the management and maintenance are monitored.

4.2.3 Accurate and efficient, practical and workable. While meeting the required monitoring accuracy, economical and practical monitoring methods and means are to be chosen, advanced and reliable techniques being used where economic and technical conditions allow, so that accuracy and efficiency are raised. The indicators are to be sufficiently sensitive and measurable; indicators that change easily are to be monitored over a short period and stable indicators over a long period.

4.2.4 Qualitative and quantitative, authoritative and comparable. Monitoring and evaluation are to combine qualitative and quantitative methods, the evaluation method being sound and reasonable. The data are to be continuous and reliable, and full use is to be made of the long-term monitoring data and research results of the natural resource, forestry and grassland, water, agriculture and rural affairs and ecology and environment departments and of research institutes and universities.

6 Objects and content of monitoring

6.1 Monitoring before extraction chiefly obtains the base values and reference values of the mine geological environment background, of the current state of the land resource and of the ecosystem baseline. It monitors the groundwater and soil environmental background of the mine and the surrounding area before extraction; establishes the current land use, the situation of basic farmland and the quality and productivity of each land use type within the monitoring area; establishes the area of the surface water environment and the condition of terrestrial vegetation within the area; and, following the main functional zoning and the natural features of the mining area and working from the land use parcels, sets sample plots and quadrats of forest, grassland and wetland ecosystems on grounds of typicality and representativeness so as to build the reference ecosystem and obtain the reference values. The monitoring content and indicators before extraction are given in Table A.1.

6.2 Monitoring during extraction chiefly covers protective and preventive control measures, the current and intended destruction, and the effect of reclamation. It monitors how the protective and preventive control measures of the mine are carried out, including the measures themselves and their effect; the goaf subsidence, unstable slopes, groundwater

environmental damage and soil environmental damage caused by extraction; the type, area and degree of land destroyed by excavation, subsidence, occupation and pollution and the destruction of basic farmland; the destruction of ecological land, the surface water environment and the water resource environment of coal mining subsidence areas; the recovery and treatment of geological environment already damaged, the reclamation and use of land already destroyed and the restoration of ecosystems already damaged or degraded; and the change of the geological environment, land resources and ecosystems that are to be destroyed. The monitoring content and indicators during extraction are given in Table A.2.

6.3 Monitoring after extraction chiefly covers the management and maintenance of the areas already reclaimed: the maintenance of infrastructure, the tending of land quality and vegetation and the maintenance of ecosystem function. For the reclaimed open pit, spoil dump, gangue hill, tailings reservoir, heap leaching site and subsidence area, the stability of the geological environment, the effect of the control of potential pollution, the effect of ecosystem restoration and the latent risks are monitored in particular; and the water bodies, water sources, permanent basic farmland, protected areas and basic grassland affected by extraction are likewise monitored in particular. The monitoring period after extraction is recommended to be five to ten years. The monitoring content and indicators after extraction are given in Table A.3.

7 Layout of monitoring points and monitoring methods

7.1 The monitoring area and the layout of points are to cover the extraction area, the affected area and the area of the reference ecosystem. Points are preferably laid out by combining points, lines and areas, and full use is to be made of the existing monitoring networks of the several departments and research institutes so that a monitoring network for mine reclamation is formed. Automatic and manual monitoring are to be combined, and remote sensing monitoring, fixed sample plots, quadrats and belt transects, fixed automatic monitoring of the soil and water environment, test analysis and public interview may all be used for dynamic follow-up monitoring of the reclamation work and its effect throughout. The monitoring period and frequency of each indicator are to be settled having regard to the natural geographic conditions, the mineral extracted, the mining method, the destruction, the reclamation measures and targets, the monitored object and the management needs. Points are to be concentrated on the open pit, spoil dump, gangue hill, tailings reservoir, heap leaching site, subsided land, in-situ leaching site and the discharge outlets of ore washing and dressing water, and points are to be set on the water bodies, water sources, permanent basic farmland, protected areas and basic grassland that extraction may affect. The layout, period and frequency are to be adjusted from the results so that data collection stays accurate, timely and complete; where natural conditions are poor, reclamation difficult or potential pollution risk high, the period is to be lengthened and the frequency raised. Monitoring of the protective measures and their effect uses field