DELIVERABLE 4.2 RISK MANAGEMENT AND MONITORING STRATEGIES

SUMMARY

Various risks to working and abandoned mines, in a future climate change scenario, were identified in WP2. Modelling work followed in Task 3.1, and this led to several remedial measures being recommended in Task 4.1. Building on these foundations, in Task 4.2, as reported here, various monitoring strategies have been studied to evaluate the continuing effectiveness of the remedial measures developed in Task 4.1 under a future climate change scenario.

A tool that has been used for some categories of risk is the Trigger Action Response Plan (TARP), which defines a range of trigger levels and the associated responses to be initiated in the event that a trigger level is reached. Accordingly, an introductory section of this report provides an introduction to the TARP approach, quoting an example relating to spontaneous combustion in a mine, and providing a short bibliography on the subject. However, TARPs have not been created for all the categories of risk studied here. In some cases the TARP approach is not appropriate, and in others it would be very site-specific so, instead of providing a complete TARP, guidance on possible triggers and actions is given to assist mining professional in developing their own TARP.

Risks in the following categories have been studied and monitoring strategies discussed:

- flooding due to runoff from spoil heaps during heavy rainfall events,
- alteration to water level in mines, potentially resulting in flooding in the mine, and changes in the discharge to surface water courses with the possibility of increased pollution,
- spoil heap reclamation, with particular reference to studies in the Czech Republic and UK,
- gas emissions from closed mines,
- stability of tailings dames,
- surface movement on spoil heaps, with the potential of landslides.

To conclude, an assessment is presented of the technical and scientific challenges that are still to be addressed, in future decades, in order to validate or correct the climate change impact evaluation made in this project, and to identify any further remediation actions that may become necessary.

The concept of Trigger Action Response Plans (TARP) is generally well-understood within parts of the mining community, especially in Australia. The approach appears to be rarely used outside of mining, which suggests that it was probably developed within the mining

industry, but was considered appropriate to provide an overview within the TEXMIN project. This is particularly important because, although the literature contains numerous case studies in which the TARP approach has been used effectively, little in the way of introductory material is widely available. Accordingly, efforts were made to collect as comprehensive a collection as possible of literature associated with TARP.

The use of TARPs is referred to in the technical annexe, but it was decided not to adopt a common standard method of presenting TARPs in TEXMIN, because it is recommended that any TARP developed within T4.2 should be considered by stakeholders as providing top-level guidance only. Indeed, it is commonly stated that TARPs should be tailored to a particular mine or other facility. Any TARPs presented in the project, therefore, would need to be appraised by stakeholders and adapted to meet the needs of the specific mine, including the addition of more detailed site-specific information. Because of the requirement to adapt any of the TARPs which appear in this report, therefore, it would offer no end-user benefit to standardize on a format, because as part of the end-user adaptation, the TARP would be re-drafted to meet the organisation's standard format. Instead, therefore, individual partners have presented their TARPs in a way that is best able to communicate the essential elements of the approach they are recommending, to address a particular threat.

UNEXE followed up their work on mitigating the flood risk due to runoff from spoil heaps in Task 4.1. In particular, for each of the various mitigation measures identified, consideration was given to how these could be compromised due to climate change and of preventative measures, including the observations on which triggers would be based, and recommendations on appropriate responses. However, despite the emphasis on the TARP approach, full TARPS, including quantitative thresholds, were not provided as explained here.

TARPs usually employ various threshold values of relevant measurements to trigger actions associated with increasing severity levels of a particular risk. The measurements are usually derived from instrumentation and are available in real time. In the case of risks associated with floods due to runoff from spoil heaps, in most cases instrumentation would not be available to provide input to triggering an action and, instead, such triggers would have to be based on manual observations. Although unusual, the use of manual observations as trigger points is not unprecedented in the mining industry. Note is made, for example, of a report that presents the updated final design undertaken for the proposed A21 water-retaining dike at the Diavik Diamond Mine (BGC Engineering Inc., 2014), and, in particular, Appendix P which presents a TARP. Although many of the TARP events are described as "instrumental events" and, in that respect, are typical of most TARPs, it is noted that a table of "Force Majeure visual triggers" is presented. These triggers are visually derived and, in some cases, involve a degree of subjectivity.

It must be recognised, however, that a possible disadvantage of using manual observations as triggers is that, unlike data from sensors, the information will not be available in real time.

Indeed, for abandoned spoil heaps that are remote from the offices of the bodies who are responsible for them, it might only be economically viable for observations to be made infrequently, with time periods measured in weeks or months. Fortunately, however, the likely climate-induced changes to spoil heaps and their associated mitigation measures and drainage infrastructure, will not occur quickly. Unlike a TARP associated with the risk due to spontaneous combustion in a mine, to give a common example, therefore, triggering actions based on infrequent observations is not considered to be a drawback in this instance, even though it will result in an unusual looking TARP. It was not considered practical to present a full TARP because this is the domain of experts in various disciplines and would form part of further research. In addition, it is commonly pointed out that TARPs should be site-specific, and this further suggests that the information presented here should be considered as general guidance from which a site-specific TARP can be created. Such guidance has been provided.

UNEXE also gave some consideration to handling the risk to biodiversity on former mine sites, and spoil heaps in particular. It was recognised that there is very limited expertise in biodiversity of animal species among the TEXMIN consortium, that this is a subject that warrants much greater attention from the research community, and that this will be promoted during the phase of TEXMIN post-project dissemination and exploitation activities. Nevertheless, some brief information was provided to give an indication of how a TARP could be developed to address these issues, listing triggers and probable actions. To summarise, therefore, it was considered appropriate to view the output of this part of the task as a catalyst in promoting further study into this subject.