

## SUMMARY OF THE DOCTORAL DISSERTATION

M.Sc. Eng. Katarzyna Niedbalska

### **„Forecasting of the hydrodynamic consequences of an open-pit closure on the example of CTL Maczki-Bór”**

The adopted directions for the liquidation of the open-pit, and in particular materials used for these purposes and their properties, directly affect the hydrodynamic conditions in the mine area. The possibility of further economic use of the area will depend on the forecasted hydrogeological consequences of these activities, manifesting within the rock mass and on the surface after the completion of the liquidation and reclamation process. In the doctoral dissertation, the author made an attempt to solve the problem of the assessment of the effects of the open-pit liquidation for groundwater and surface waters in terms of rational management of post-mining areas and minimizing the negative impact of the reclamation process on their quantitative and qualitative condition. The set goal was achieved through the implementation of mutually complementary field, laboratory and model research based on the adopted methodology of activities.

This is empirical-theoretical dissertation. Based on the literature review (chapter 2), a synthesis and characterization of the main directions of open-pits reclamation, types of materials used to fill excavations and their impact on the soil and water environment were made. The possibilities of using model studies for forecasting the impact of open-pits abandonment on the condition of groundwater and surface waters for various adopted methods of reclamation (flooding of open-pit workings, complete filling of the post-mining voids, mixed methods, etc.) were indicated. The analysis of the state of knowledge in the subject of the doctoral thesis has become the basis for formulating assumptions and defining the scientific goals of the dissertation (chapter 3).

The individual stages of the developed research methodology were verified on the research polygon, which was the open-pit mine of backfilling sand CTL Maczki-Bór S.A. It is an excavation in which, apart from the residual exploitation of the deposit, technical reclamation is carried out, consisting in leveling the area to the original elevation using postmining waste from hard coal mines. The current and historical characteristics of the mine in relation to the scope and impact of mining and remediation activities were the subject of work under chapter 4.

In order to obtain the most complete view of changes in the properties of rock debris in the excavation, a wide range of field and laboratory work was carried out (chapter 5). Their aim was to assess the influence of the origin of the waste, its storage time and the nature of the impact of water and vertical pressure on the physical, mechanical and hydrogeological properties of the deposited material. The laboratory surveys were carried out by the author on 5 samples of rock debris, which remained on the top of waste dump from half a year to over 35 years. The research was conducted on the basis of the proposed methodology, including both commonly known methods of testing, as well as those modified by the author. The new approach in laboratory work has been indicated in the field of research on the filtration properties of rock material subjected to variable vertical pressure, as well as in the assessment and prediction of changes in waste density as a function of depth.

The reconstruction of the current hydrodynamic conditions in the area of the open-pit on the numerical model (chapter 6) was the basis for the forecasting calculations of the hydrodynamic effects of mine closure on the rock mass and land surface. In order to reduce the risk of surface flooding and inundation after the completion of the open-pit reclamation, the author proposed solutions of an active or active-passive nature in the form of various configurations of wells or wells and drains. The assessment of their effectiveness was the subject of the prognostic studies carried out by the author, the characteristics of which are presented in chapter 7.

The verification of the hydrodynamic model and the forecasts made on it was also carried out on a hydrogeochemical model illustrating the distribution and migration of sulphate ions in the Quaternary aquifer (chapter 8). These ions have been indicated as the main indicator of groundwater and surface water pollution emitted currently and in the future from the Carboniferous waste rocks. Based on the simulation, the probable impact of pollutants on groundwater and the range of the stream of pollutants migrating with the groundwater after finishing the excavation's drainage was indicated. The expected impact of post-mining waste and groundwater from pit drainage on the quality of surface waters were also presented. Moreover, an assessment of the economic use of groundwater drained by the system of drains or wells, due to the expected concentrations of sulphate ions in relation to their content criteria for drinking water, was also made. As a result of the model surveys, the author indicated the scope of groundwater monitoring after the completion of the excavation reclamation (chapter 9).

The entirety of the research conducted by the author is summarized in chapter 10, indicating the implementation of the assumptions and research goals in the work. The broad possibilities of practical application of the proposed research methodology in other similar objects and the use of the results of the doctoral dissertation in the management of liquidation, drainage and management of the groundwater environment in the CTL Maczki-Bór S.A. backfill sand mine were indicated.