Topic UGM-1

White Paper Topic: Contaminant Loading - Predict Hydrologic Budget of Underground Mines

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Prediction of Recharge and Discharge to Underground Mines with Respect to Differing Geologic
Settings and Mining Conditions – Development of Hydrologic Budgets

Problem Definition

Prediction of recharge and discharge characteristics of underground mines prior to mining and/or prior to mine abandonment is critical to determining the long term impacts of these operations and the potential treatment liabilities. While some of these hydrologic budget data are available on a case by case basis, more comprehensive studies are needed. There have been no comprehensive studies regarding these characteristics on a regional scale. A compilation of available case studies and other sources show that the infiltration rates for underground mines can vary by more than 2 orders of magnitude (0.01 to nearly 3 gpm / acre). The vertical infiltration rate variability is related to several factors not the least of which is the depth of the mine below the surface.

The parameters that influence mine recharge and discharge need to be the focus of any study of this type. A priori, parameters that may impact vertical infiltration include depth of cover (i.e. overburden thickness), overburden lithology, topography, type and style of mining, and possibly other regional and geologic variations. Additionally, it is known that depending on head differences, underground mines can and do yield water to and receive significant inflow from adjacent mines. Some of the parameters that will need to be documented to define lateral ground water movement include: location adjacent mines, thickness and integrity of the coal barriers, potentiometric head differences, and permeability of the coal and immediate overlying strata.

The importance of being able to predict recharge, infiltration and discharge rates from underground mines cannot be overestimated. They dictate the rate at which the mines will flood and ultimately discharge. The degree of interaction between mines is equally important in framing the entire mine pool/mine complex scenario. In conjunction with the water quality, mine discharge rate is a determinant of pollution loading. This in turn will dictate the need for treatment prior to discharging. If treatment is needed, the size and type of treatment facilities will be driven by the anticipated loading rates. Estimations of long-term cost of treatment will result.

Potential Course of Action:

A study of this nature should begin by compiling the available published information. Pre-existing studies will serve as a foundation of where to start and the ultimate course of the broader study.

The next step is to collect and compile relevant data from as many existing mines throughout the Appalachian Plateau as possible. A substantial amount of data on mine inflow rates are available from pumping records in permit files and/or NPDES reports located at the applicable State Regulatory agencies. Additionally, many mining companies may be amenable to providing this information to promote a better understanding of these processes. In order to create a viable infiltration and discharge prediction method, a significant amount of accurate pumping and discharge data is desirable. Mapping and company records will yield insight as to coal barrier integrity and thickness as well as mine water levels.

The types of required information include, but may not be limited to:

- Mine pumping rates. The pumping volumes will be correlated to the mined area at various times during the operation.
- Discharge rates for mines that have flooded or drain freely and have reached the point of equilibrium (e.g., mine inflow equals outflow).
- Overburden thickness – These data will likely vary within mines, thus a prorated approach may need to be employed. It is anticipated that mine infiltration decreases with increasing mine depth. The rates of change in pumping volumes for mines as they mine into deeper cover will yield insight into the relationship of overburden thickness to infiltration rates.
- Overburden lithology (percentage and thicknesses of sandstones, shales, claystones, limestones, etc.).
- Overburden faulting and fracturing.
- Overlying topography (e.g., mountainous vs. low land areas).
- Precipitation/climatic data corresponding to the discharge measurements.
- Coal barrier thicknesses and integrity.
- Where available hydraulic properties of the coals and overlying strata.
- Historical and present water levels in flooded mines.

The data collected will be entered into a data base and a variety of bivariate and multivariate statistical analyses will be used to determine if there is some degree of predictability that can be developed. Some of the likely analytical methods to be employed include: simple regression, multiple regression, correlation analysis, and factor analysis. Based on experience, these data may be subdivided into classifications prior to analysis. For example, the mines in the mountainous areas may be separated from those low land areas and high extraction (e.g., longwall) mines need to separated from room-and-pillar operations.

Cost of Project:

TBD

Time Required:

Collection of data could be achieved in 6 to 12 months depending on the number of people that can be enlisted to help with the project. If state agency personnel could be called upon to gather these data and submit it to a central data base or person, this would expedite the process. A consistency key is that the data are reviewed and collected in a similar manner. Data entry should be occurring as the data are collected.

Data analysis could be completed in 3 to 6 months. Report write up and completion would take approximately 6 months including internal peer review and modification.