MINIMIZING ACID MINE DRAINAGE BY SURFACE AND SUBSURFACE WATER HANDLING PROCEDURES

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One of the most serious potential environmental problems resulting from coal mining operations is the formation of acid mine drainage. Acid mine drainage is an extremely important environmental consideration for a number of reasons:

- Harmful to aquatic life (toxic; sludge smothers bottom life)
- Corrosive to in-stream structures (bridges, culverts)
- Aesthetically displeasing (iron yellow-boy sludge)
- Costly to treat (present regulations require perpetual treatment)
- Long-term (may continue to produce acid for hundreds of years)
- May interfere with vegetative cover

In order to effectively control acid mine drainage, it is important that we have at least a basic understanding of its formation, past practices, and why these past practices have been unsuccessful in many cases. As Dr. Lovell explained earlier this morning, there are three basic ingredients required to produce acid mine drainage - water, oxygen, and a source of reactive pyrite. Coal and adjacent rocks contain various sulfur compounds, including the mineral pyrite. When exposed by mining activities, the reactive portion of the pyrite oxidizes in the presence of air and water to form sulfuric acid and iron sulfate. These water soluble compounds eventually are flushed from the mine into the surface or ground water system. The iron will further oxidize to a red or yellow sludge, sometimes referred to as "yellow-boy." Factors that determine the extent of pollution formation include: availability of air, water, and reactive pyritic material; length of time those reactants have been in contact; physical and hydrologic conditions of mined area; type of mining employed (underground versus surface); and the control practices employed to minimize the formation of acid mine drainage. We will briefly discuss those factors relating to surface mining this morning, and, time permitting, we can discuss underground mining problems during the question and answer period if there is any further interest in that area.

Historically, most research effort has been devoted to the control and abatement of drainage from abandoned underground coal mining operations since over seventy-five percent of all acid mine drainage originates in underground minesites. Consequently, it was not until the early 70's that any real effort was devoted to controlling acid mine drainage from surface mining operations. These early efforts almost invariably concentrated on eliminating the oxidation process by burying potentially toxic materials on the mine pit floor. At the time, this seemed like the most logical approach since it was believed that a better air seal could be assured by this deeper burial and, therefore, pyrite oxidation would be less likely. In fact, everyone was so firmly convinced that oxidation could be controlled in this manner that many people, operators and regulatory personnel as well, started to use the pit floor for disposal of highly toxic refuse from coal preparation facilities.

Over the years, this theory has been shown to be totally ineffective, and, in fact, has proven to be one of the major sources of acid mine drainage from reclaimed surface mines. Hind-sight being 20120, it is easy to see the, flaws in the theory now. First, any surface water infiltrating the backfill will be directed to, and concentrated at, the pit floor; Secondly, most ground water will also be concentrated at the pit floor since the coal seam is generally underlain by an impermeable underclay; Thirdly, infiltrating surface water will generally contain enough dissolved oxygen to generate acid mine drainage when it reacts with pyritic materials; Fourth, considerable oxidation occurs on the surface of pyritic materials while they are exposed (before burial) and subsequently reacts with waters draining across the pit floor; and, Fifth, it is extremely difficult to eliminate all oxygen from the course spoil materials commonly associated with surface mining systems. As a result of these factors, many of the reclaimed surface mines at which operators made the unfortunate mistake of burying toxic materials on the pit floor acid seeps have appeared which may continue for literally hundreds of years unless some other abatement action is taken.

Recognizing the problems associated with past practices, what can we do to minimize the potential formation of acid mine drainage? Acid mine drainage control technology in surface mining has advanced dramatically over the last several years as a result of past experience. Consequently, there are a number of specific control options available to the operator which, if carefully implemented, will successfully curb the generation of acid mine drainage. West Virginia's Surface Mine Drainage Task Force recently developed a manual entitled "Suggested Guidelines for Method of Operation in Surface Mining of Areas with Potentially Acid-Producing Materials," which provides an excellent outline of control consideration procedures. I would strongly recommend that each of you become thoroughly familiar with this publication and consider its recommendations in conducting your future mining operations.

In order to successfully control acid mine drainage, there are two basic objectives that must be considered in the mining scheme: 1) to minimize the formation of acid mine drainage; and, 2) to safely contain any contaminated drainage within the minesite so that it can be treated before entering a receiving stream. The best method of minimizing acid mine drainage is to be totally aware of the physical character of your minesite, particularly overburden composition water quality and quantity. Overburden composition is a critical area of concern. Recent research has shown that the proper placement of alkaline materials can be as important as the placement of toxic strata, a fact largely overlooked in past practices. Since several speakers will address overburden analyses and interpretation this afternoon, I will not devote any more time this morning to that subject other than to advise that you pay particular attention to these discussions.

Water handling practices are largely dictated by the composition of overburden materials, and any discussion pertaining to the prevention of acid mine drainage must consider both spoil placement and water control. The philosophy of avoiding acid mine drainage formation is quite simple keep surface and ground water out of contact with potentially toxic materials! The philosophy is simple - however, accomplishing this task requires careful planning and, even more importantly, assurance that the control plan is followed religiously. Regardless of the degree of planning involved, only you, the operator, can make the day to day decisions and provide the control necessary to make the system work - and that i's why it is so critically important that you understand the relationship of water and overburden. There are only a few key points to remember, so let's review those principles:

- Infiltrating surface water and ground water will concentrate on the pit floor. Therefore, toxic or potentially toxic materials should be kept off the pit floor.
- The longer potentially toxic materials are exposed, the greater the oxidation that will occur (which can later generate acid mine drainage in the backfilled material). To minimize this potential, all potentially toxic material should be buried as soon as possible in an area where contact with infiltrating waters will be minimized (preferably at least 6 feet off the pit floor).
- Alkaline water will retard the acid mine drainage reaction process and acid water will accelerate the process, much the same as hot water will dissolve salt or sugar quickly while cold water will not. By keeping waters alkaline, the amount of acid mine drainage generated will be significantly reduced, even if these waters come into contact with potentially toxic materials. This can be accomplished by placing overburden materials so that any infiltrating water passes through alkaline material before contacting toxic materials. Where alkaline materials are not present in the overburden, admixing of lime should be considered to assure that infiltrating waters remain in an alkaline condition.
- Potentially toxic materials are often present and concentrated on the pit floor. If this condition exists, the pit floor should be cleaned as much as practical and then limed to maintain alkaline drainage. Where the pavement is potentially toxic, it may be advantageous to construct a trench at natural drainage points to minimize contact time by rapidly draining the fill area. These natural drainage points can generally be identified by studying the dip of the strata to locate low points. Springs are also a good indicator. As an added precaution, the trench could be limed with alkaline material.
- Because the backfill is composed of very porous materials, most surface water infiltrating the backfill material from above the operation will enter near the highwall. Therefore, it is important to minimize fracturing of the highwall during the final cut and also to place the best materials (least toxic, most alkaline) in this portion of the backfill. Toxic materials should not be buried within 20 feet of the highwall.
- Where overburden analyses indicate that the pit floor is alkaline, it may be beneficial to break this material up to provide greater contact with water draining across this area.
- Surface water diversion ditches should be used wherever practical to reduce the amount of surface water draining across the unconsolidated backfill material. Controlled drainways (lined channels, pipes, rip-rapped ditches) can also be used to aid in reducing surface water infiltration when transferring upslope drainage across the backfill.
- Obviously, toxic materials should be kept off the surface of the final backfill. There should be a minimum of six feet of cover over any toxic or potentially toxic materials.
- Naturally, any water control practice ordinarily used in non-sensitive areas should also be incorporated into the final grading scheme. This would include practices such as terracing or cross-ditching, shaping the backfill for positive drainage control, tracking-in slopes, mulching, and revegetation.

In light of what we now know about the formation and control of acid mine drainage, these principles seem quite logical, and, in fact, elementary.

I believe that we now have the necessary understanding to prevent or control acid mine drainage -- however, it is up to you, the operator, to put these principles to practice. As I previously noted, the manual "Suggested Guidelines for Method of Operation in Surface Mining of Areas with Potentially Acid-Producing Materials" provides an excellent source of information to aid in your future mining plans. In addition, I am certain that members of the Mine Drainage Task Force, the Department of Natural Resources, or the West Virginia Surface Mining and Reclamation Association would be happy to work with you in developing a mining and reclamation plan best suited to your particular operation.