

INNOVATIVE DESIGN FOR IMPROVED MINING ECONOMICS AND LAND USE¹

by

Timothy A. Keeney and George A. Hall²

Abstract. There are two primary purposes for good engineering design: (1) public safety and welfare; and (2) economy of construction. This paper describes a specific application of an innovative design to achieve these purposes in the surface mining of coal. Fundamental mine design considerations include site specific topography, as it affects excess spoil disposal and drainage control, and the physical and chemical characteristics of the overburden as they pertain to earth moving, spoil disposal, and postmining land use. A unique application of the design purposes to these design considerations is described for a surface mining operation in central West Virginia where site conditions did not fit conventional surface mining methods.

Additional Key Words: Engineering, Regulations, Surface Mine Reclamation

Introduction

There are conspicuous variations in geologic conditions from one geographic area to another, and these variations are very important to mining operations. For example, eastern Kentucky, southern West Virginia, and western Virginia are generally characterized by sandstone dominant strata forming narrow valleys and very steep hillsides. On the other hand, eastern Ohio, southwestern Pennsylvania, and northern West Virginia are frequently characterized by shale dominant strata, often easily weathered to clay, which have formed moderate slopes and wider valleys. These examples are broad generalizations, and there are diverse local variations. Central West Virginia is replete with such variations.

The topography, the chemical and engineering properties of the overburden, and other site specific conditions, along with the intended postmining land use, actually delimit the mine design. Of course, inherent in all design must be consideration of public safety and welfare. Any feasible design which fits these requisite conditions should be evaluated, and the most suitable (usually from an economic viewpoint) should be selected. Unfortunately, this is seldom the approach used in the design of surface mining, especially with respect to spoil disposal and reclamation.

For the most part, spoil disposal, drainage and sediment control, and reclamation are dictated by governmental regulations, not by site specific conditions and sound engineering design. The broad spectrum of geologic conditions must be met with a few approved "proven" designs--anything else is, by definition, "experimental."

This paper describes an instance where the geologic conditions and the intended postmining land use did not lend themselves to application of conventional spoil disposal and reclamation methods. Fortunately, the West Virginia Department of Energy accepted an alternative design under a "variance" provision in their regulations. The alternative engineering design which resulted in more fav-

¹Paper presented at the 1990 Mining and Reclamation Conference, Charleston, West Virginia, April 23-26, 1990. Publication here does not preclude publishing this manuscript, in whole or in part, elsewhere.

²Timothy A. Keeney is President of Level Land Construction Company, Inc., 1217 Virginia Street East, Charleston, WV 25301; George A. Hall is President of Terra Engineers, Inc., 1624-1/2 Kanawha Boulevard East, Charleston, WV 25311.

orable mining economics and improved postmining land use potential is described.

Site Description

Fundamental Mine Design

The design of a surface mining operation must utilize earthmoving procedures which will avoid degradation of surface and ground water by either acid drainage or suspended sediment. This begins with an assessment of the physical and chemical properties of the overburden to be disturbed, followed by development of a suitable approach to disposal of excess spoil which recognizes constraints of site specific topography. Finally, cost-effective measures to provide drainage and sediment control for all disturbed areas must be provided.

Site Topography and Geology

Description of the Problems

The problems associated with mining of coal reserves in this area were varied. First, the surface land owners were insistent that the postmining landscape be capable of greater utility than before mining, since premining slopes precluded uses more intensive than forestland. Second, as can be seen from the geologic description above, quality durable rock was scarce to nonexistent during the initial mining cuts. Third, the expensive hauldown and special handling required with conventional excess disposal in valley fills would have to be avoided to maintain mining feasibility. Additionally, surface landowners were adverse to the construction of open rock cores across the resulting fill areas.

The operation in question is located in Nicholas County, West Virginia, approximately 10 miles north of the city of Summersville. A series of surface mining operations had previously been conducted along the hillsides of an elongated valley in the headwaters of Little Beaver Creek of Gauley River. The hillsides were traversed by periodic natural drainage channels. The drainage channels were nearly perpendicular to the stream in the valley, although some channels had branches in their upper extremities. Slopes were moderate, but somewhat steeper in the higher elevations. As shown in Figure 1, natural drainage channels were quite narrow, with side slopes averaging 50%.

The overburden to be disturbed included predominantly fine-textured strata overlying four coal seams. In descending order, the seams included the Cedar Grove Rider, Cedar Grove, Alma, and Peerless. Shale and mudstone overlie the Cedar Grove Rider, and the Cedar Grove Rider and Cedar Grove are separated by an interval of 45 ft of shale and mudstone. The Cedar Grove to Alma interval was made up of 20 ft of mudstone, while the Alma to Peerless interval was comprised of a 10 to 12 ft interval of fine-textured sandstone underlain by 18 ft of mudstone.

Materials and Methods

Characterization of Overburden Materials

The geologic materials to be disturbed were analyzed by Acid-Base Accounting in accordance with EPA Manual No. 600/2-78-054. The strata were shown to contain an overwhelming dominance of alkaline materials, ranging from 10 to 40 tons/1000 tons CaCO₃ Equivalent. In addition, the materials were analyzed for available plant nutrients and found to contain high to very high levels of plant available Ca, Mg, and K. Phosphorous levels were low, but were superior to native soil levels. Using these data and supported by successful applications on surrounding operations, a topsoiling variance was obtained. This eliminated costly rehandle, lowering earthmoving costs.

Results and Discussion

Excess Spoil Disposal-Design to Fit Conditions

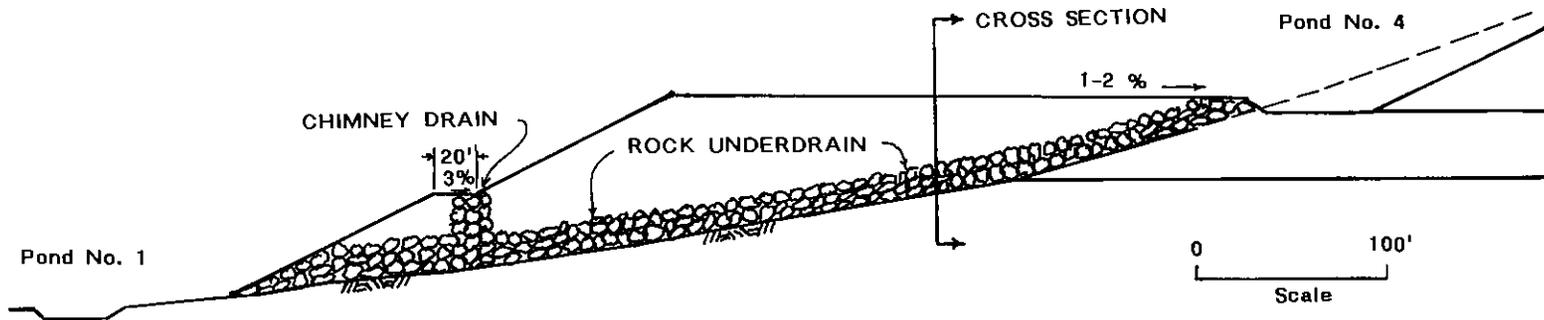
Excess spoil disposal is generally accomplished in one of three ways: 1) Downslope placement, when slopes are less than 20 degrees (36 percent); 2) Valley Fills, in which a rock core extends along the axis of the valley all the way from the valley floor to the surface of the fill; or 3) Durable Rock Fills, in which at least 80% of the spoil must be durable rock.

As previously described, the overburden materials at the site in question were dominated by fine-textured materials. Excess spoil disposal was further complicated by the fact that initial cuts resulted in the generation of spoil materials dominated by soil and weathered rock. Durable rock core materials would not be released until mining of the 2nd and 3rd cuts. Additionally, the surface owners requested that the rock core not be left open across the top of the fills so as not to interfere with the utility of the reclaimed land.

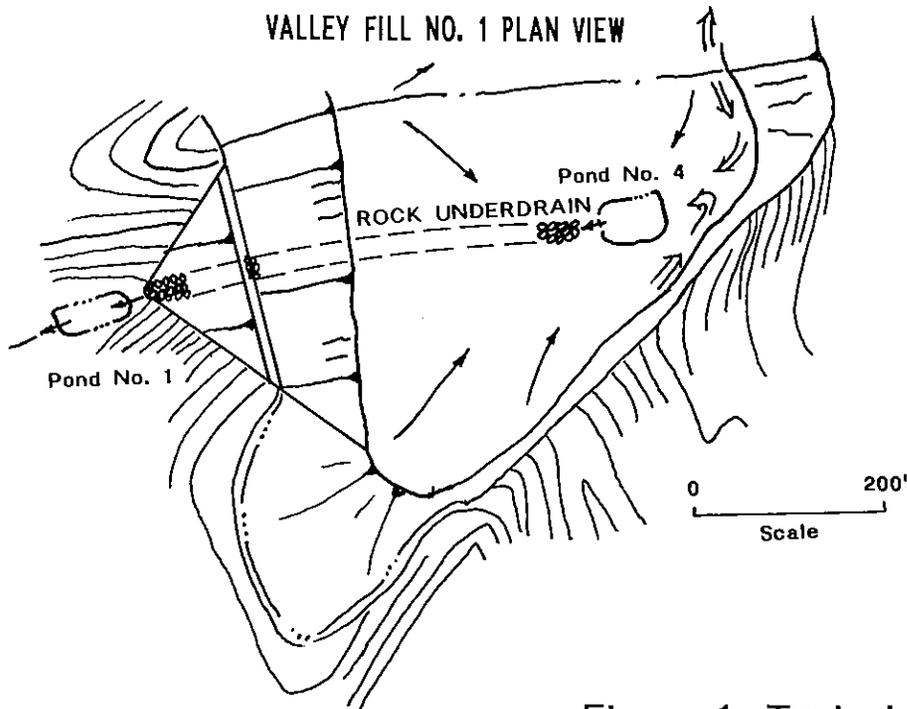
Under these constraints, the approach was developed to design the valley fills with rock underdrains which would pass the peak discharge from a 100 year, 24 hour storm event. This would accomplish the necessary drainage and fill stability, as well as compensate for the scarcity of durable rock in the development phase of the operation by decreasing the minimum required rock volume.

As a further means of eliminating unnecessary mining costs as well as to compensate for the dominant volume of nondurable material, a waiver was obtained to allow placement of fill material in 50 ft lifts rather than the required 4 ft lifts. This procedure eliminated the costly proposition of hauling material down to the lower lifts by dumping them from a higher elevation, which also allowed for the required durable core rock to segregate by gravity at the base of the dumped slope.

VALLEY FILL NO. 1 PROFILE



VALLEY FILL NO. 1 PLAN VIEW



VALLEY FILL NO. 1 CROSS SECTION

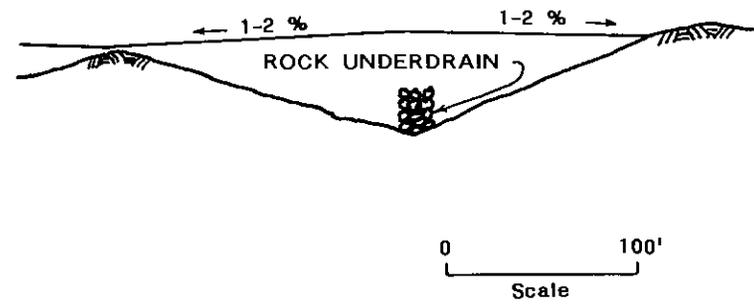


Figure 1. Typical Valley Fill Details

Some further details of the drainage design and construction and their effect on slope stability require delineation. It is these details which allow the design to satisfy the design purposes. Firstly, the rock drain cross section sized for a 100 year, 24 hour flood was the minimum allowable cross section. The fills were constructed by dumping predominantly nondurable material along the sides of the hollows, leaving a channel in the middle for the underdrain. Boulders of durable rock tended to roll to the bottom. Many of these were intentionally separated from the fill and pushed over the edge of the fill to roll into the underdrain area; a dozer with a rake attachment was used for that purpose. Of course, the sandstone stratum was the major source of rock for the underdrain. Some of the shale encountered was relatively durable, and boulders of this material were used to cover the drain. The net effect of this careful construction was underdrains which were larger than the required minimum at virtually all locations.

Secondly, specifications required an enlargement of the drain cross section under the downstream face of the embankment for two reasons: bench drainage was passed to the rock drain by means of chimney drains (see Figure 1); an enlarged drain in the toe area prevents the possibility of pressure flow during an extreme flood, thereby preventing an adverse effect on slope stability.

Postmining Land Use

The requests of the surface owners to construct a postmining landscape that was conducive to a higher level of land management was a major consideration with the design of the operation. The concept of the rock underdrains and valley fills, coupled with the documentation of the presence of highly favorable chemical and physical properties of the overburden materials, allowed for the construction of a wide terrace-like bench area along the contour. Slopes were graded to drain to the back of the fills into sediment ponds. The ponds are situated behind the surface opening of the rock underdrains so that when filled with storm drainage, the ponds will discharge into the underdrains. This procedure would appear to offer an added benefit of water

conservation by augmenting both normal and storm drainage volumes.

The mixed overburden material was used as the topsoiling medium for plant growth on the entire operation due to the alkaline nature and fine-textured characteristics of the material. This procedure has been used on adjacent areas since 1982 with highly favorable results. Approximately 30 acres of alfalfa and timothy hay crops are currently in production.

The terrace or "Level Land" design approach has been to construct landscape capable of supporting a variety of uses. As reported above, the main use to date has been hayland. The manageable topography can be conceived to be also favorable for livestock enterprises. However, one residence has now been constructed by a surface owner on land mined and reclaimed in this manner. It is apparent that uses such as forestland would be enhanced due to the ability to use more intensive management techniques as well as mechanical harvesting on the gentle slopes.

Conclusions

The project described in this paper illustrates one instance where site specific conditions and postmining land use required some innovative design. The innovative design accomplished the intended goals of both public safety and economy of design. Careful construction practices improved on the design to increase the safety of the fills.

It is of paramount importance that government regulations be sufficiently flexible to allow alternative design practices. Many designs are possible which rely on sound principles, are not "experimental," and are equal or superior to "accepted" practice. If the coal industry is to survive, these designs must be encouraged.

It is of equal importance that the industry use care in constructing innovative projects. The construction described herein required a little extra time and effort, but the results will benefit posterity.