

An experimental variance to the approximate original contour requirements of the federal surface mine law shows promise from both the policy and environmental viewpoints



Approximate original contour reclamation: An alternative in steep slope terrains

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WHEN the Surface Mining Control and Reclamation Act of 1977 (SMCRA) was signed into law in August of 1977, the event was hailed as a victory for environmental interests. The legislation put severe restrictions on spoil handling procedures used by coal surface mining operations and has produced substantial improvements in overall reclamation practices.

Fundamental to SMCRA are its "approximate original contour" provisions, which specifically require surface mining operators to "... grade in order to restore the approximate original contour of the land with all highwalls, spoil piles, and depressions eliminated..." [Sec. 515(b)3]. The original con-

tour requirement is applied separately to steep-slope mining situations (where pre-mining slopes exceed 20 degrees) by Section 515(d)2, which states that the mining operation will "return the site to the appropriate original contour, which material will maintain stability following mining and reclamation."

Reclamation by approximate original contour (AOC) is a practice of recent origin in the central Appalachian region of southwestern Virginia, eastern Kentucky, and southern West Virginia where pre-SMCRA state laws did not require complete backfilling of highwalls (3). Since the late 1970s, a majority of central Appalachian mined land has been reclaimed to AOC.

Herein, we examine an experimental variance from the steep-slope reclamation requirements defined by Section 515(d) of SMCRA. The purpose for seeking the variance was to investigate the environmental

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and economic feasibility of using an alternative to conventional AOC reclamation practices in steep-slope terrain to produce a carefully constructed surface-mined area of higher land use potential. The major elements of the experimental reclamation practice could be applied to steep-slope mining on a nonexperimental basis if a variance from SMCRA's AOC provisions were obtained. To obtain a variance, a mining firm must comply with the requirements of SMCRA Section 515(e), which governs steep-slope variances, or if the operation were judged to constitute a modified mountaintop removal with the requirements of Section 515(c), which applies to situations "where the mining operation will remove an entire coal seam or seams running through an upper fraction of a mountain, ridge, or hill" [515(c)(2)].

Implementation of the variance on an experimental basis in southwestern Virginia indicates that its environmental and economic effects are superior to those of standard AOC reclamation practices in steeply sloping Appalachian terrain. After reviewing those effects, we believe that changes in laws and regulations could be made that will lower barriers to more widespread implementation of the demonstrated procedure.

AOC in central Appalachia

SMCRA defines approximate original contour as follows: "That surface configuration achieved by backfilling and grading

The primary equipment used to move spoil at Amos Ridge is similar to equipment used at contour surface mines throughout central Appalachia: dozers, wheel-loaders, and off-road haul trucks.



tion achieved by backfilling and grading of the mined area so that the reclaimed area closely resembles the general surface configuration of the land prior to mining and blends into and complements the drainage pattern of the surrounding terrain, with all highwalls and spoil piles eliminated..." [Sec. 701(2)].

The act requires mining operators to reclaim all mined acreage to AOC unless a variance is obtained. Two major requirements for a variance are these: First, the planned reclamation practices must improve the watershed and produce land suitable for an equal or better economic or public use, such as a residential, commercial, industrial, or public use, including recreational facilities [Sec. 515(e)(2) and (3)]. Second, if mountaintop removal mining is used, agricultural land use is also eligible for variance consideration [Sec. 515(c)(3)]. Federal regulations require that there be a "reasonable likelihood" that the planned post-mining use will be achieved [30CFR 816.133(c)(1)]. The current interpretation of this regulation is to require that the reclamation plan included in the mining permit application provide for implementation of the land use for which the land is being made suitable.

Appalachian terrain is comprised of flat-bedded sedimentary rock strata interbedded with coal seams. Long-term geologic erosion has created a landscape of relatively flat ridgetops, steep sideslopes with thin colluvial soils, and alluvial bottoms. This high degree of dissection causes sideslopes to be the dominant landforms; these form an intricate landscape pattern of points and hollows. Slope gradients in excess of 20 degrees are common. Most residential and commercial development has taken place in alluvial

areas, flat lands with deep soils and access to water and transportation.

Abundant coal outcrops on sideslopes create ideal conditions for mining. Contour mining operations move laterally along the outcrops, removing overburden to expose coal. Such operations have been profoundly affected by SMCRA. The current conventional practice is to rebuild the topography by trucking a majority of the overburden upward from the mining pit to the "backfill" so as to cover the "highwall" left by the mining cut. However, volumetric expansion of the blasted rock generates "excess spoil," that is, spoil that cannot be backfilled. Thus, the original contours cannot be duplicated exactly. Companies often dispose of excess spoil in hollows below the mining benches. Construction of a "hollow fill" [515(b)(22)] includes removal of vegetation and/or topsoil, placement of spoil in the hollow to insure stability and drainage and to prevent damage to natural water courses, and capping the fill with a surface medium that will support vegetation. Landslides resulting from uncontrolled spoil placement and subsequent saturation by surface waters were a major pre-law environmental problem (7). Thus, hollow fill construction is closely regulated at the federal [30CFR 816.71-74] and state levels (8).

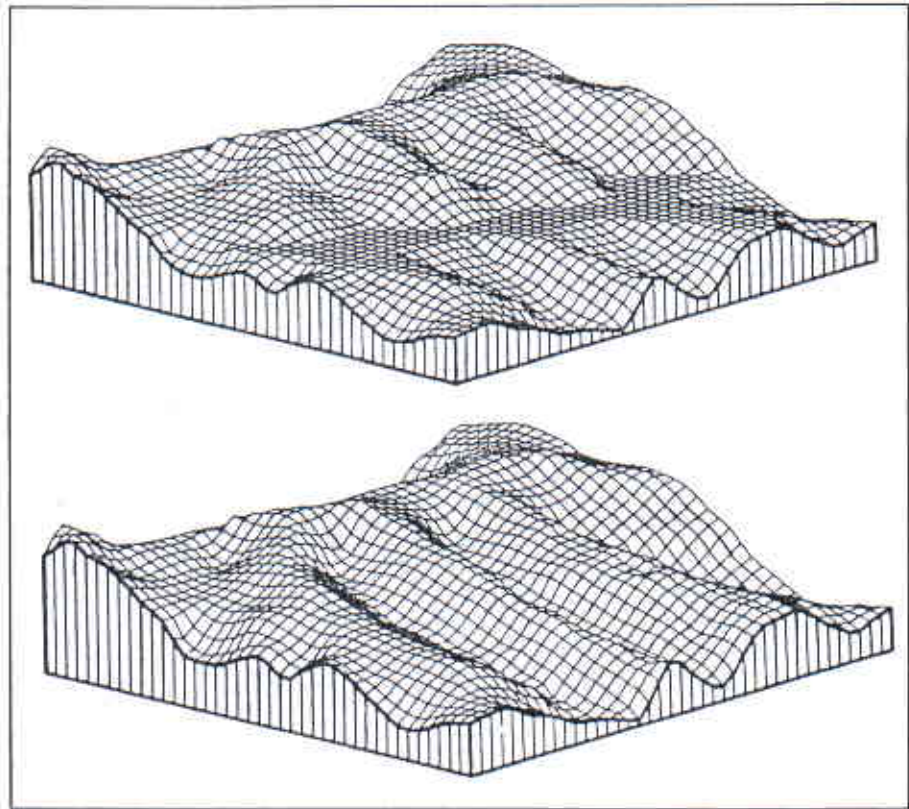
Recent research on 22 deliberately chosen backfills on 12 separate mining sites indicates that highwall backfills constructed in steeply sloping terrain are, in some cases, potentially unstable and erodible (1, 2). These potentially unstable backfills are an unintended, undesirable result of SMCRA's AOC provisions. Moreover, our investigations of the alternative experimental practice demonstrate the availability of a variance reclamation method that allows contour mining firms to rebuild steeply sloping point-and-hollow terrain to create more stable configurations.

The variance on steep slopes

An experimental variance to AOC practices has been investigated in Wise County, Virginia (16). At the Amos Ridge site, the premining topography consisted of a series of finger ridges protruding from a central "spine," Amos Ridge. Excepting the tops of the fingers, slopes on nearly all the land being mined exceeded 20 degrees.

The Amos Ridge Coal Company has mined with an experimental practice variance [under Sections 711 and 515(e) of SMCRA] obtained with the cooperation of the U. S. Office of Surface Mining Reclamation and Enforcement (OSMRE) and the Virginia Division of Mined Land Reclamation. Contour mining was conducted across

Isometric representations of the premining and postmining topographies at Amos Ridge. The area represented covers about 100 acres; the southeastern corner is located at the bottom of each image. The postmining topography (right, top) produced by the experimental "landscape alteration" mining and reclamation method. The outslopes of the three hollow fills are represented by the triangular-shaped surfaces between the undisturbed ends of the finger ridges along the eastern edge. The premining topography (right, bottom), showing finger ridges protruding from the central "spine" of Amos Ridge at the western edge. Below is a photograph of the outslope of the first (southern-most) hollow fill at Amos Ridge, as viewed from the east.



four finger ridges and three intervening hollows while removing three seams of coal (the low splint seam, and its upper and lower markers) running through the upper fraction of these ridges. Rather than completely rebuilding the finger ridges to AOC, the firm used spoil generated from the finger ridges to construct three hollow fills. The result is a relatively large, near-level "bench," a terrace-like landform extending over the stripped fingers and filled hollows that covers about 12 of the 72 acres under permit. The objective of producing a usable, stable landform was pursued by constructing the hollow fill outslopes at 3:1 grades, rather than the maximum-allowable 2:1 grade (30CFR 816.71) and by building plant growth media with selected, uncompacted soil and spoil materials. All highwalls were backfilled. With the exception of the AOC and hollow fill construction provisions (two hollow fills were constructed using experimental techniques), all SMCRA performance standards and Virginia regulatory standards were met. We term this form of mining and reclamation as "landscape alteration" mining.

Comparing the techniques

Our analyses indicated that there are a number of reasons why the landscape alteration mining strategy is superior to mining by AOC on this site.

Environmental benefits. The landscape alteration landform at Amos Ridge will be more stable and less prone to erosion than the steeply sloping AOC backfills that would have been generated by conventional backfill, grade, and compaction reclamation methods. The chances of slope failure are less because the total area of reconstructed steep slopes is less. If future backfill failures were to occur at the landscape alteration mining site, the existence of the broad bench

at the base of the backfills would limit off-site effects.

Potential erosion of surface soil from the reclaimed landscape also is reduced by implementing the landscape alteration strategy. Long, uninterrupted steep slopes and surface silt contents favor erosion (1, 2, 10). The landscape alteration strategy reduces the incidence of steep slopes as a proportion of total area. Those slopes that do occur are interrupted by the bench at the highwall backfill base. The operator's ability to selectively place backfill surface materials to limit silt content is increased by the spoil handling flexibility inherent in the landscape alteration plan (14).

An associated hydrologic benefit of the alternative technique will be a reduction in

rainfall runoff. Infiltration of incident rainfall is favored by the near-level bench area covered with a porous, uncompacted mine soil. SMCRA sections regulating AOC variance are very specific regarding watershed effects: steep-slope variances must improve watershed control [515(e)(3)] and mountain-top removal variances must improve drainage control while not damaging natural water courses [515(c)(4)(C) and (D)].

This situation occurs in contrast to the common results of conventional steep-slope mining, where operators are required to compact AOC backfill surfaces to ensure stability [30CFR 816.102(c)]. This compaction limits infiltration into the backfill. The only interruption of AOC slopes often is an abandoned haul road, which tends to con-

concentrate runoff, thereby increasing its erosive power. The net effect of a conscientiously performed landscape alteration strategy is that watershed control is improved by decreasing stream peak flows, a definite benefit in the headwaters of flood-prone watersheds (9).

If events in future years cause sharp increases in coal prices, economic pressures will dictate that many current Appalachian contour mines be considered for re-mining. The use of the landscape alteration technique now will enhance re-mining operators' abilities to limit potential off-site environmental effects. Smaller quantities of previously handled spoil will need to be moved to get at unmined coals because the finger points have not been reconstructed totally. The bench areas below the highwall backfills will tend to isolate larger portions of the environmental impacts of re-mining from undisturbed areas.

There is one major advantage to the AOC strategy relative to the landscape alteration strategy: Less area is disturbed because fewer hollow fills are used for spoil disposal. However, this holds only if AOC backfill failures and erosion do not adversely affect unmined area downslope. At the Amos Ridge site, the landscape alteration mining plan disturbs about 10 percent more land than the AOC alternative.

Land use benefits. The landscape alteration method enhances the reclaimed land use potential in two ways: by producing a landform with a near-level surface and by enabling operators who choose to use blasted overburden as a topsoil substitute [515(b)(5)] to isolate materials to construct a mine soil medium appropriate for that use (5) at minimal expense. This ability to isolate topsoil substitute materials is a consequence of the availability of multiple spoil disposal areas during landscape alteration mining, in contrast with steep-slope AOC mining (14).

Flat lands with improved use potentials can provide numerous benefits to the residents of central Appalachia. Because of the mountainous terrain, coal mining is the only major industry in many communities; unemployment and poverty rates are high (6). The majority of land that is sufficiently "flat" to support commercial centers and residential communities is adjacent to streams. The very nature of the central Appalachian terrain—steep slopes with thin soils—makes these areas floodprone. Creation of flat land after mining, permitted with variances from SMCRA's AOC requirements, will benefit Appalachian residents if such areas can be developed to support residential, commercial, and/or industrial land uses (10).

Reclaimed mine sites can also support

livestock and softwood timber production. Establishment of such enterprises can assist Appalachian communities by providing additional income and employment opportunities. In Virginia, appropriately reclaimed mined areas appear to be particularly well-suited to the production of Eastern white pine (12, 15). Construction of relatively flat areas with productive soils is vital to the profitability of such enterprises.

Mining operation benefits. Mining and reclamation operations at the Amos Ridge site have been studied intensively, and the techniques offer potential advantages to the mining industry as well as to local communities.

Machinery operation and overburden movement data from the Amos Ridge site from January 1984 through August 1985 formed the basis of our study of mining costs (18, 20). We collected additional data from other steep-slope contour mining sites where conventional AOC procedures were used and developed data processing and cost modeling software for application to the Amos Ridge data (17, 19). We used this system to model the economics of landform construction, comparing the cost of mining using the landscape alteration techniques to our estimate of what the cost of mining would have been under conventional AOC practices (14). Costs included all on-site operations—blasting, spoil movement and placement, and reclamation.

The cost of mining to produce the landscape alteration landform was less than the likely cost under AOC mining. Depending upon the spoil movement assumptions, the estimated cost difference varied between 14 and 58 cents per ton of coal produced. The primary reason for this cost difference is the change in topography brought about by mining. To reconstruct the terrain using AOC methods, far greater quantities of spoil would have been moved upward from the point of origin. The landscape alteration method, on the other hand, results in large quantities of spoil being moved laterally and downward to construct level benches and hollow fills. Had the mining operation been conducted in more conventional fashion, the economics of spoil handling would have restricted the mining to more favorable cuts; thus, coal recovery was increased by the landscape alteration method.

From an operational standpoint, a number of nonmodelled factors also favor production of the altered landform (14). The landscape alteration strategy offers increased operational flexibility. The near-level areas can be used for equipment storage and maintenance during the course of mining. Because of the opportunity to haul, carry, and push material laterally into the hollow fills,

the operator has a greater opportunity to avoid steep, uphill hauls on bad weather days when slick roads reduce hauler efficiency. Also, the alternative strategy requires less wear and tear on machinery because of the reduction in steep, uphill hauling and steep-slope grading. The above factors will have direct effects upon mining cost. There is also a safety factor—the inherent danger of operating large machines at the top of steeply sloping, nonconsolidated banks of earthen materials (10). This situation occurs less frequently during construction of the landscape alteration landform.

The operator's ability to limit off-site environmental effects without incurring excessive costs is enhanced by the spoil-handling flexibility inherent in the alternative strategy. The availability of multiple spoil disposal areas allows selective handling and placement of overburden materials to construct mine soils cost-effectively with desired revegetation properties. Also, miscalculations of spoil volumes or spoil disposal capacities can be accommodated easily through minor adjustments in the elevation of the bench surface.

In contrast, the spoil disposal capacity of a stable AOC backfill is defined rigidly by a combination of the physical limitations placed upon spoil disposal by steep-slope terrain and the SMCRA requirements that the backfilled spoil "completely cover the highwall" and "maintain stability following mining and reclamation" [Sec. 515(d)(2)]. Thus, miscalculations of spoil volume and swell, backfill capacities, or hollow fill capacities can have costly consequences in an AOC mining regime. Excess spoil disposal difficulties or large cost differentials between excess spoil disposal and highwall backfilling, can give an operator an incentive to overfill AOC backfills, producing the convex forms implicated as sources of instability (1, 2) and establishing sources of excessive erosion due to the steep slopes in the lower portion of the backfill (10).

Aesthetic benefits. The effect of uncontrolled surface mining on natural aesthetics was a major problem prior to development and passage of SMCRA [Sec. 101(c)] (11, 13). The landscape alteration strategy does not create exposed highwalls or barren out-slopes, two major features of prelaw, steep-slope mining that, according to many observers, impaired natural beauty (7).

The terraced landscape produced by the landscape alteration strategy is not meant to give a "natural" appearance by simulating an undisturbed mountainside. Because the practice is not widespread, no data exist to define the impact of the practice upon natural beauty, as perceived by the general public. However, terraced landscapes are