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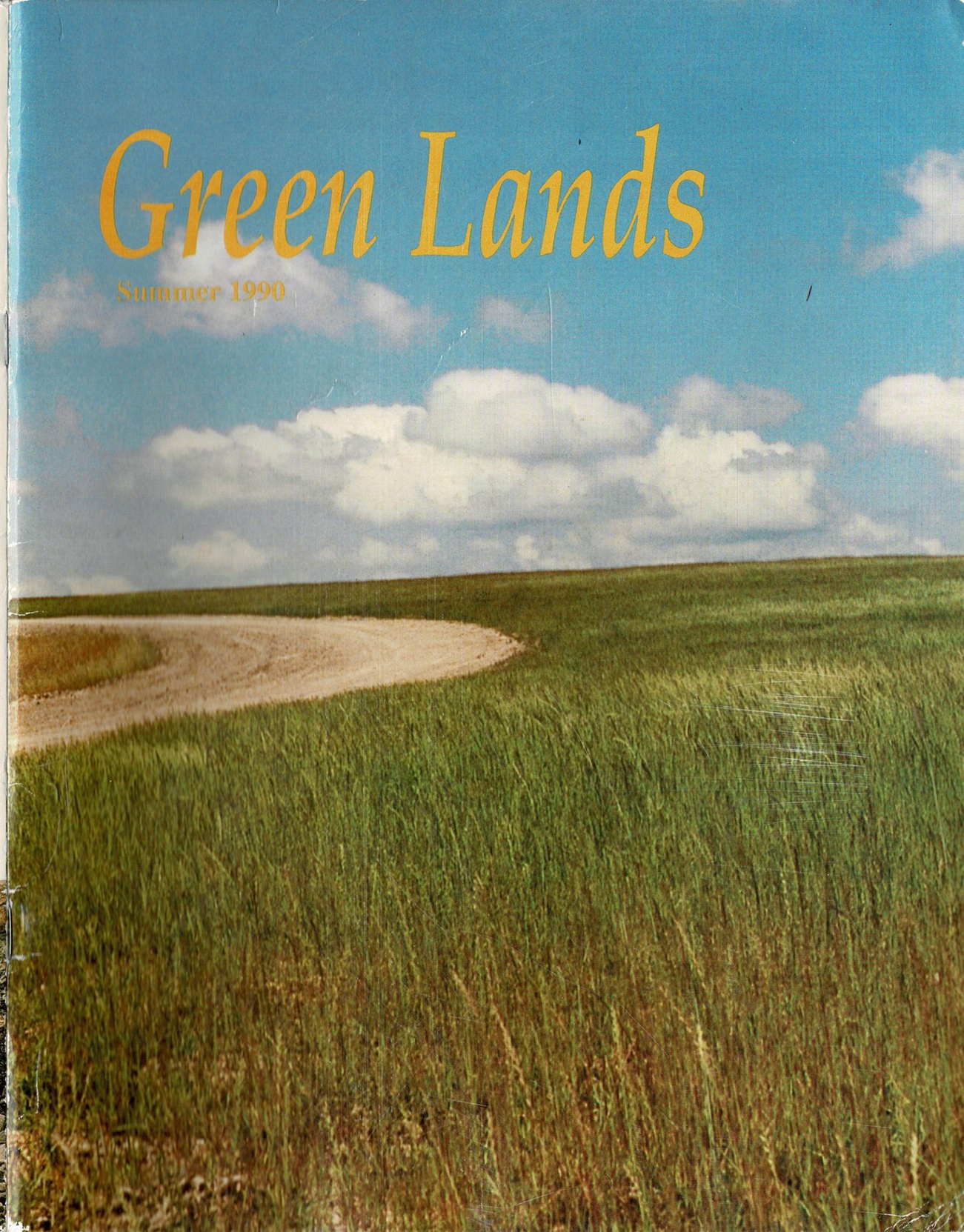

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Green Lands

Volume 20 Number 3

Green Lands
is a quarterly publication of the West Virginia Mining & Reclamation Association, with offices at 1624 Kanawha Boulevard East Charleston, West Virginia 25311 (304) 346-5318

Our Cover
It has taken a long time and a lot of cooperation for Logan County to get an airport. Now it looks as though the project will come to fruition.
Our cover story is on page 6.

Coal Calendar

August

9-12 **Annual Meeting - West Virginia Mining & Reclamation Association**, The Greenbrier, White Sulphur Springs, contact Patty Bruce, WVMRA, 1624 Kanawha Blvd. E., Charleston 25311, (304) 346-5318.

13-15 **Short Course, "Longwall Mining,"** COMER Building, WVU Evansdale Campus, Morgantown, contact Alice Kerns, WVU Department of Mining Engineering, P. O. Box 6070, Morgantown 206506, (304) 293-5695.

15-17 **Short Course, "Surface Subsidence Engineering & CISPM Subsidence Model,"** COMER Building, WVU Evansdale Campus, Morgantown, contact Alice Kerns, WVU Department of Mining Engineering, P. O. Box 6070, Morgantown 26506, (304) 293-5695.

22-24 **Short Course, "Human Resources Management for Safety & Productivity,"** University Park, PA, contact R. L. Franz, Penn State University, 126 Mineral Sciences Building, University Park, PA 16802, (814) 865-7472.

September

10-14 **Review Course for the Professional Engineering Examination of Mining/Mineral Engineers,** University Park, PA, contact R. L. Franz, Penn State University, 126 Mineral Sciences Building, University Park, PA 16802, (814) 865-7472.

23-26 **American Mining Congress - Mining Convention '90,** The Fairmont Hotel, New Orleans, LA, contact AMC, 1920 N St. NW, Washington, D.C. 20036, (202) 861-2800.

23-26 **Interstate Mining Compact Commission - Annual Meeting/18th Annual Conference of the National Association of State Land Reclamationists,** Holiday Inn, Gatlinburg, TN, contact IMCC, 459B Carlisle Dr., Herndon, VA 22070, (703) 709-8654.

24-27 **Finance and Accounting Executives Conference,** Kings Mill Resort & Conference Center, Williamsburg, VA, contact National Coal Association, 1130 17th St. NW, Washington, D.C. 20036, (202) 463-2625.

October

1-5 **Professional Engineer Exam Review in Mining/Mineral Engineering,** COMER Building, WVU Evansdale Campus, Morgantown, contact Alice Kerns, WVU Department of Mining Engineering, P. O. Box 6070, Morgantown 26506, (304) 293-5695.

November

2-4 **West Virginia Mining & Reclamation Association - Board of Directors' Fall Meeting,** Lakeview Resort & Conference Center, Morgantown, contact Patty Bruce, WVMRA, 1624 Kanawha Blvd. E., Charleston 25311, (304) 346-5318.

The mountaintop removal mining method created the flat land necessary for construction of the Logan County Airport.

Logan Gets Its Airport

Some day soon, there will be a Logan County Airport. After 17 years of false starts and nearly abandoned hopes, the facility should become a reality by sometime in 1991.

In the fall of 1973, Dingess Rum Coal Co. deeded 302 acres to Logan County, which in turn created an Airport Authority, a quasi-public body charged with seeing that the airport got built.

In 1975, on behalf of the Authority, the Federal Aviation Agency accepted construction bids. But all bids were considered too high, and the project was dead in the water.

In 1977, Concord Coal came up with a plan to mine the property and use the coal profits to fund construction. In 1980, Concord ran into financial difficulties, and the project stalled again.

Geupel Construction Co. picked up the ball in 1981, also planning to convert mining profits into construction funds. That arrangement worked well until 1984, when Geupel's sales contract with AEP expired, and it began to look like Logan County would never get is airport.

Then, in 1987, determination began to win out. Through a series of financial concessions by Dingess Rum, Geupel Construction, the United Mine Workers, the West Virginia Tax Department, and several of Concord Coal's creditors, mining was resumed with profits again diverted to the construction fund.

Geupel, operating under the new agreement as Logan County Airport Contractors, is now completing the mining and reclamation phases of the operation. Reclamation plans were altered to accommodate FAA standards for the airport facility.

In all, an estimated 25.1 million cubic yards of overburden material have been moved on the operation, more than 17 million by Geupel.

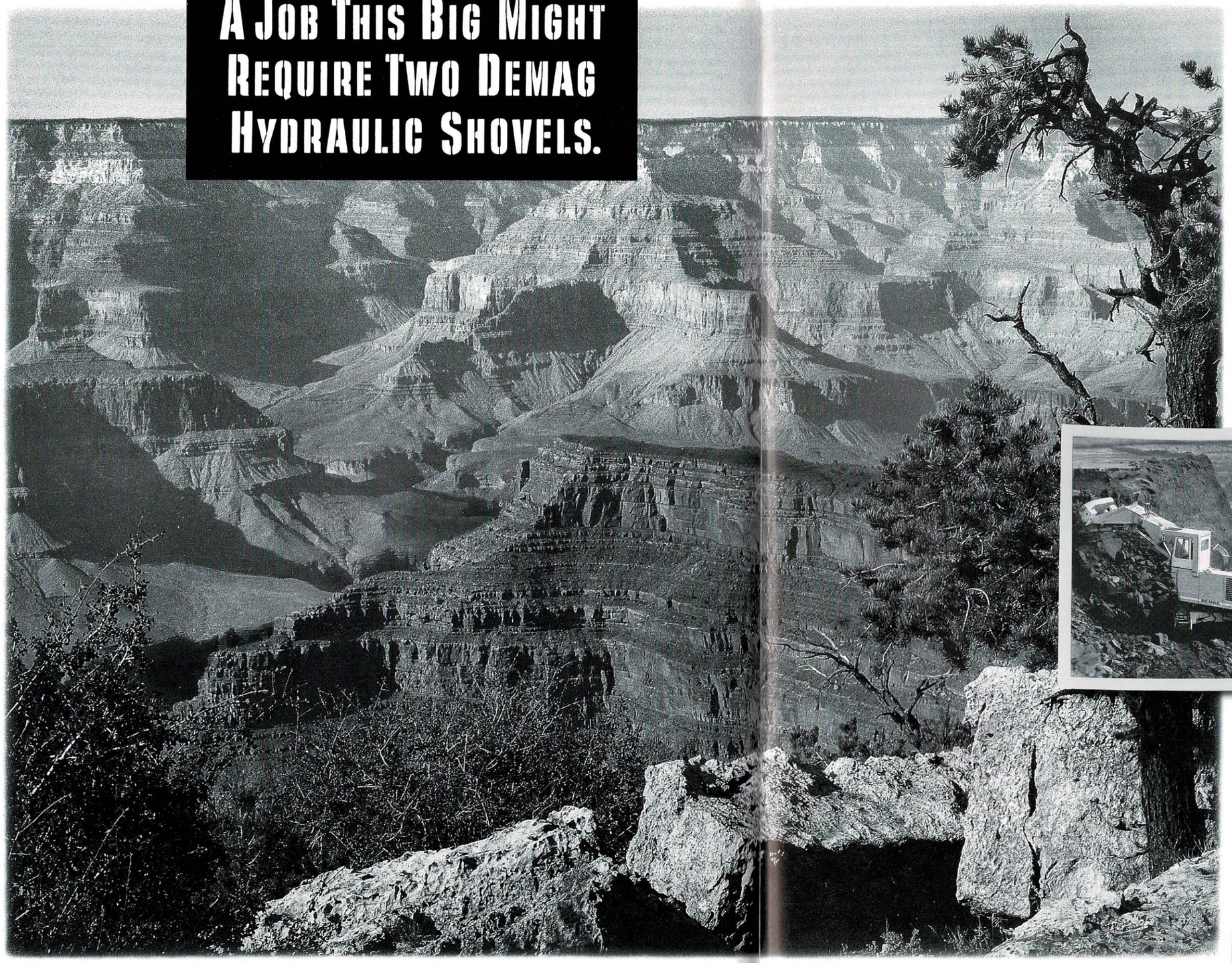
Key to the whole project is the construction of an access road to shorten the seven mile run from Ethel on Rt. 119. When the new road is completed, visitors will make a relatively short two mile trip up Melville Hollow. The road will be built to Department of Highways specifications, and will become part of the State highway system.

Geupel will bring the access road and the runway up to "dirt grade" by this fall, and the Airport Authority will seek federal funds to complete the project.

The completed air facility will feature a runway 60 feet wide and 3,600 feet long, with an "overrun" of an additional 1,400 feet.

Though not in the initial plans, there is room enough on the mountaintop to expand the runway to accommodate commercial air traffic. In the meantime, Logan will have an airport facility, and the coal laden county will have its primary industry to thank for it.

A Job This Big Might Require Two Demag Hydraulic Shovels.



That's not as much of an exaggeration as you might think.

For one thing, Demag makes the largest hydraulic mining shovel in existence. Anywhere. The Demag H485, with an operating weight of 1,200,000 pounds and an incredible 46 cubic yard capacity, can fill a 150-ton truck in just three passes.

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In addition, durability is engineered into all Demag components. For instance, high-strength steel is used on all of a Demag's massive structures. Which allows for a longer equipment life even under the severe demands of mining and quarry applications.

Another feature that makes a Demag an obvious choice is its single-engine drive. Not only does the single-engine system lower operating costs, but it's also easier to service and maintain. All of which make Demag shovels more productive and cost-efficient on any job, large or small.

And now you can count on the most reliable service and parts backup in the industry. Because Demag Hydraulic Shovels are now available from Carter Machinery.

With locations throughout Virginia, there's sure to be one near you. Just call 1-800-868-4228 or your sales representative for information on the Demag Hydraulic Shovel that best suits your needs. Whether you plan to do a job on a relatively small scale — or a grand one.

Carter CAT

MANNESMANN DEMAG

Construction will begin by the end of this year on the 926 bed maximum and medium security prison on this Kanawha-Gauley Coal & Coke Co. mine site in Fayette County.

Mine Site Brings Boom to Fayette

State and Fayette County officials broke ground this spring for West Virginia's new 926 bed maximum and medium security prison, to be constructed at Mt. Olive, on a reclaimed mountaintop surface mine.

West Virginia Governor Gaston Caperton announced selection of the Fayette County site in January. Final approval for the project was given by the Regional Jail and Correctional Facility Authority Board.

The prison will replace the 123 year old facility at Moundsville, hopefully by 1992. It is expected to be a major economic boost to the Upper Kanawha Valley, creating an estimated 300-700 direct jobs, with as many as 2000 service related positions to follow.

The actual construction site, covering 120 acres, is a reclaimed surface mine along Cannelton Hollow Road, operated by Kanawha-Gauley Coal & Coke Co. The area is on Marting Mountain, about seven miles from Montgomery, and adjacent to the site where coal operator Tracy Hylton, contracting for Cannelton Industries, ran the state's largest mountaintop removal operation.

Cannelton donated land for the project, as did Kanawha-Gauley and West Virginia Tech. Other coal companies have also contributed. Pen Mining provided equipment and supervision during the site preparation process, as did Cannelton and Addington Brothers.

The new prison will feature modern penal facilities and concepts. Inmates will be housed in small groups in "pods," each with its own recreation yard and dining facility. The entire complex will be guarded by state-of-the-art security systems.

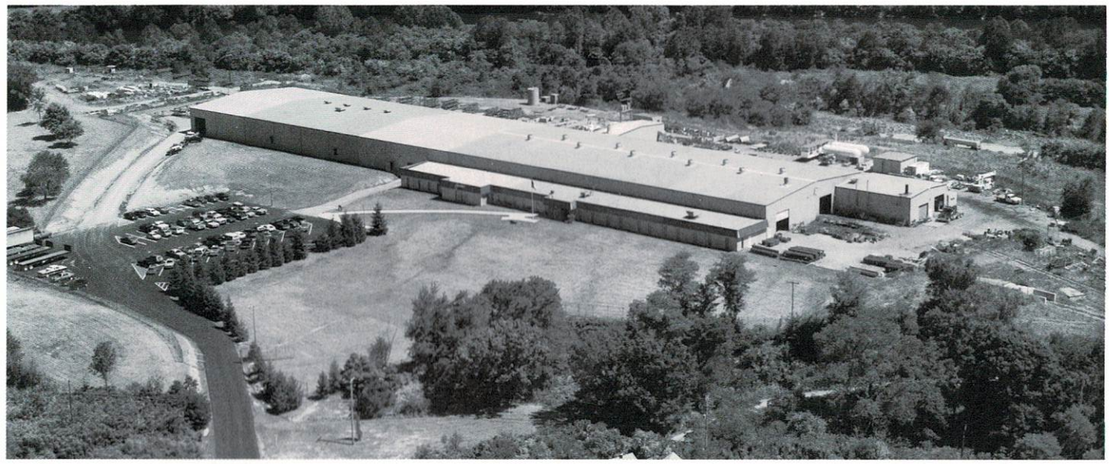
Construction at Mt. Olive is the first step in a long -range plan to modernize correctional facilities statewide. A new facility will be constructed in Marshall County to help ease the loss of the old prison at Moundsville. Major renovations are also on the boards for the present facilities at Huttonsville and Pruntytown.

In the future, the plan calls for the construction of 13 regional jails to replace or augment overcrowded county lockups.

The entire correctional facility construction project will be financed through bond sales. The cost for the main prison will be $43 million, part of the overall $80 million package. Construction at Mt. Olive is expected to begin by the end of the year.

West Virginia Governor Gaston Caperton prepares for the ceremonial groundbreaking for Fayette County's new penitentiary.

Formerly the state's largest mountaintop removal operation and now a haven for wildlife, this Perry & Hylton site is adjacent to the new prison construction.



Fairchild International's modern manufacturing plant at Glen Lyn, VA.

Fairchild International has a Silver Celebration

Jack Fairchild started his own company in 1965. But he'll only take half the credit. For the last 25 years and more, everything Jack Fairchild has owned and accomplished is tied directly to his wife Myrleen.

A native of eastern Kentucky, Jack met Myrleen while serving in the Navy in California. When he left Morehead State College in 1959, he went to work for Elmac Corp.

By 1965, he was ready to strike out on his own. With a borrowed $4000, he started Fairchild Equipment & Supply Co.

Myrleen ran the office from the kitchen table of her Beckley, WV home, and first employee Latell Morris worked the shop, while Jack took to the field to acquire used mining equipment and to hustle up rebuild customers.

By 1971, the company was beginning to grow. Fairchild was named the exclusive sales agent for Elkhorn Industrial Corp., a manufacturer of battery powered equipment. power scoops. The following year, Jack achieved the same status with Wilcox Manufacturing Co.

That venture was so successful that, in 1974, the company purchased Wilcox Manufacuting. The corporate name was changed to Fairchild, Inc., and the future direction of the Fairchild empire was charted.

More acquisitions followed, first Machine Design Corp., a Virginia manufacturer of mine power equipment, then Vortex Air Corp., which manufactures air pollution control equipment.

By 1975, after a little more than a decade in business, Jack and Myrleen stood at the helm of the world's largest independently owned used mining equipment company.

They celebrated the 20th anniversary of the company in 1985 with the purchase of Elmac Corp., the very company which first employed Jack in the late 1950's.

As more acquisitions developed, such as Babcock International's Battery Equipment Division, Mine Machine Parts, Inc. (MMP), and the Hanaline Corp., Fairchild, Inc. became Fairchild International.

During the 1980's, the company operated six divisions, with more than 560 employees spread among its Beckley headquarters, and branches throughout West Virginia, southwest Virginia, eastern Kentucky, and western Pennsylvania.

Through it all, things have stayed in the family. Despite the phenomenal growth of Fairchild Equipment & Supply, Fairchild, Inc., and Fairchild International, 100% of the stock has remained in the hands of Jack Fairchild.

Now there's a second generation coming on. While serving as chairman and secretary-treasurer, respectively, Jack and Myrleen raised three sons, and all are involved with family enterprises.

Jack and Myrleen of Fairchild Equipment & Supply Co. in 1965.

Jaydee is vice president of Exports for the corporation, which does business in Asia, Europe, Africa, and throughout North America. It is, in fact, the largest U.S. supplier of mining equipment to the People's Republic of China.

Younger sons Jack, Jr. and Gary are district managers, Jack Jr. for southern West Virginia and Gary for northern West Virginia.

In the late 1980's, two major changes occurred. First, headquarters were moved to Glen Lyn, VA, though the family, and much of the business, remains in the Beckley area. Then in early 1989, a serious business reversal forced the company into reorganization.

Now Fairchild International is bouncing back. Like the powerhouse football coach, Jack Fairchild didn't have to rebuild. He just reloaded.

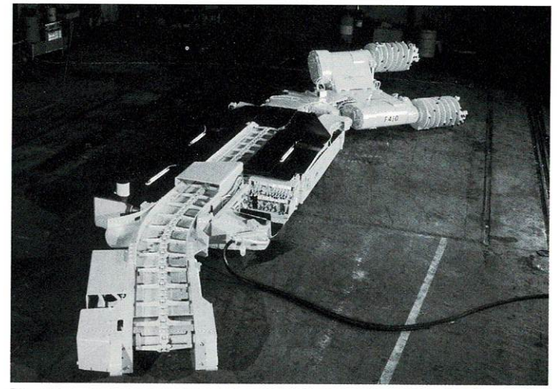
The same enthusiasm for people and business that built a shoestring operation into a mining equipment giant is evident today as Jack Fairchild talks about his company's second quarter century.

"I'm really excited. Our business in the last four months has been pretty good. We're very definitely turning it around, and now every month seems to be better than the last one."

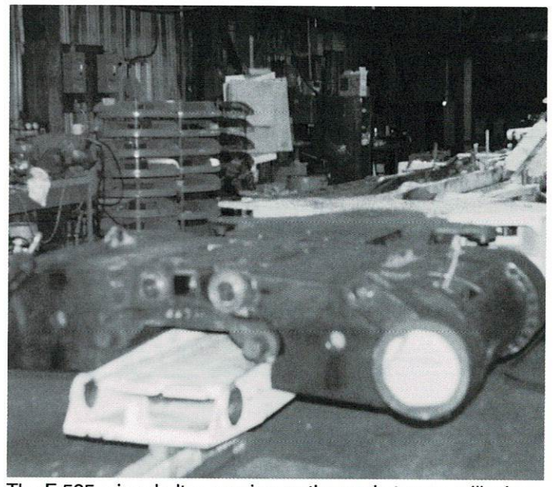
Product development has long been a strong suit for Fairchild International. Now two new pieces of equipment are helping the Fairchild comeback.

The F-410 continuous miner is already on the market and doing very well. "It's a tremendously versatile machine," explains Jack, "with the ability to mine seams as thin as 32 inches or as high as six feet."

"And," he continues, "we're about 85-90% ready with our F-525 miner-bolter, which will mine and bolt 200 feet before place changing. I expect these products will quadruple our business in the months and years ahead."



The F-410 continuous miner, which is fueling Fairchild's comeback, can mine seams from 32 inches to six feet.

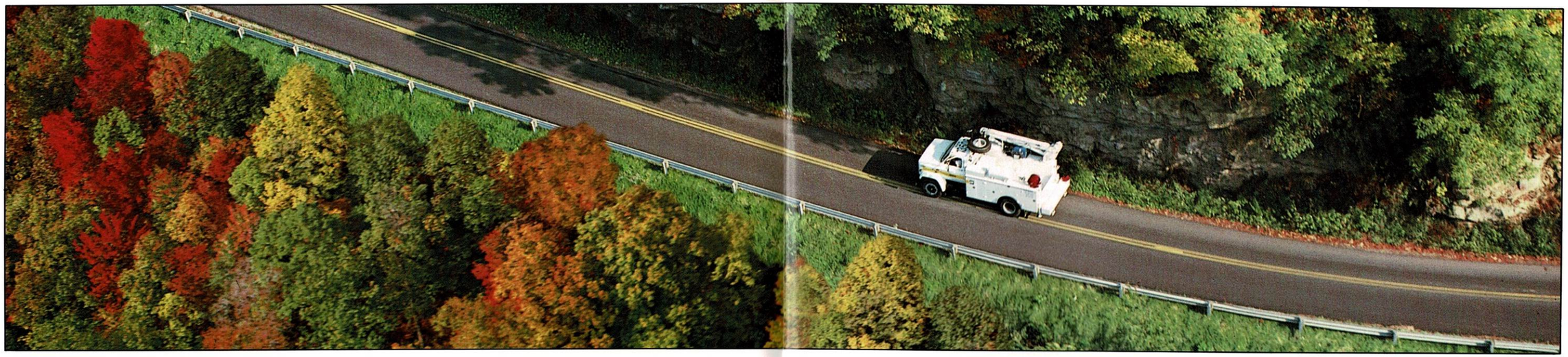


The F-525 miner-bolter, coming on the market soon, will mine and bolt 200 feet before place changing.

Jack Fairchild's expectations are always optimistic. But that's understandable. He's made high hopes and hard work pay off for a quarter of a century, and there's no indication that anything will change in the next 25 years.

Many happy returns, Jack and Myrleen.

Going the extra mile.



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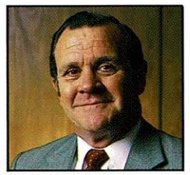
47 field service mechanics. We have the largest group of specialized field service mechanics in the region. Every day they log in hundreds of miles, making on-site visits to keep your equipment up and running. Joe Dailey, Vice President, Parts and Service, puts it best... "The best equipment supported by the best field service mechanics. That's the Walker Difference."



Joe Dailey
Vice President
Parts and Service

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The **Walker** Difference

Income Opportunities on Reclaimed Surface Mine Lands In Central Appalachia

Carl E. Zipper
Associate Director, Powell River Project
Virginia Polytechnic Institute
and State University,
Blacksburg, VA

Jeff G. Skousen
Assistant Professor and
Land Reclamation Specialist
West Virginia University,
Morgantown, WV

Introduction

In the central Appalachian coal region of southern West Virginia, eastern Kentucky, southwestern Virginia, and northeastern Tennessee, the unique terrain and economic conditions create unique land use problems. The steeply sloping terrain creates a shortage of land suitable for residential, commercial, or industrial development. Hence, commercial enterprises, industrial activities, and other income opportunities are limited for the residents of these areas.

However, high-quality bituminous coal is abundant in numerous mineable seams in the region and, for nearly a century, have provided the resource for employing the majority of the population through mining and reclamation activities. Surface coal mining operations are constantly producing "new lands" through land reclamation. In some cases, these reclaimed lands have characteristics which will enable them to support non-mining, income-producing activities to a far greater extent than the pro-mining landforms.

The purpose of this paper is to provide a brief overview of income opportunities available to those who own, or have access to, reclaimed surface mined lands with favorable surface characteristics in central Appalachia.

Land Characteristics in Appalachia

Unmined lands in Central Appalachia are generally steeply sloped with thin, acidic soils unsuited for agricultural uses. Coal mining and timbering are the region's major industries. The region's timber is primarily slow growing upland hardwoods. The steeply sloping terrain has discouraged other industries from locating within the region.

Surface coal mining operators have opportunities to produce lands with the capacity to support other income-producing activities. Two major characteristics of the land which can be altered through mining and reclamation are:

Slope: Steeply sloping, pre-mining landforms can be altered through mining and reclamation to include large areas of gently sloping land; and

Soils: Appalachian mountain soils are generally thin, acidic, and infertile. Through the use of controlled overburden placement techniques, overburden materials with superior characteristics are selected, crushed, and placed on the land surface in sufficient thickness to act as a deep rooting medium (Skousen et al. 1987). These carefully selected overburden materials have demonstrated greater potential as a plant-growth medium than the original topsoil (Daniels and Amos 1984, Thurmond and Sencindiver 1986). When gently sloping lands with favorable soil characteristics are produced during surface mining operations, a variety of income-producing activities become available to local residents who have access to those lands.

Beef Cattle and Other Livestock

Reclaimed surface mined land in Appalachia is often revegetated with forage species that have potential value as livestock feed. Greater utilization of the renewable forage resource is an approach to adding economic diversity to the region. Cattle are generally chosen by Appalachian producers due to their proven weight gains on forage grown on reclaimed areas, their lack of vulnerability to predators, and accessibility of many Appalachian areas to established cattle markets.

Since 1980, an experimental cattle herd has been maintained on lands owned by Penn Virginia Resources Corp. in Wise County, VA, as a joint venture of Penn Virginia and the Powell River Project. The herd is maintained on reclaimed mine lands on a year round basis. Approximately six acres per cow supply all the forage needed by the herd for the entire year except for small amounts of hay and grain which are provided during the winter months.

Over the past eight years, calf gains have typically been above two pounds per head per day from birth to weaning, and been sold for approximately $325 per head. An overall 92.6% calf crop has been produced, which is well above the Virginia state average of 85% (Gerken 1988). An economic analysis of the cattle operation has shown that cattle production is profitable.

The ease and cost of fencing, and vehicular access will be major considerations to anyone considering the establishment of a cattle grazing operation on a reclaimed mine site. Small operations (i.e. 20 to 50 head) managed by individuals and their families on acreages near their homes offer the best alternative. The majority of current producers maintain the herd on a part-time basis to supplement income from other employment. Opportunities for establishing large herds (i.e. hundreds of head) on reclaimed lands are generally limited by the unavailability of contiguous land areas of sufficient size to maintain such herds.

Christmas Trees

Christmas tree production can be a profitable land use on reclaimed mine land. Most Christmas tree species grow well on reclaimed minesoils with favorable chemical characteristics that are not excessively compacted. Whereas timber crops take at least 30 years to mature, Christmas trees can be harvested in seven to ten years.

The key to successful Christmas tree production on reclaimed mine sites is selecting suitable minesoils. Growers should look for soils with a pH between five and six. Minesoils with dark gray or black colors should be evaluated carefully, because these colors are often associated with very high or very low pH and/or high levels of soluble salts. The soil must be deep and uncompacted, so that a healthy root system can develop. Sites with standing water after a rain are probably too compacted or poorly drained to be suitable for Christmas trees. Soil surfaces should be level to gently sloping, and free of large rocks and boulders to allow use of machinery, such as mechanical mowers.

Compared to many agricultural enterprises, Christmas tree production does not require large capital expenditures. Individual growers can easily maintain about five acres of trees in their spare time. The major equipment required to produce Christmas trees can be purchased for as little as $1500. Seedling costs vary from as little as $75 per acre for white pine seedlings (approximately 8-10¢ per seedling) to as much as $850 per acre for Fraser Fir seedlings. The cost to fertilize and to control weeds and pests generally ranges from $50 to $100 per acre.

Revenue from the sale of trees will depend upon market conditions, quality of trees, and method of selling. If trees are planted at a rate of 1,050 per acre (6' by 7' spacing), management is sufficient to obtain a 60% survival rate, and the grower is able to obtain a wholesale price of $10 per tree, the grower will earn about $6,000 per acre over a 7-10 year period. If superior management yields an 80% survival rate of a more valuable species such as spruce or fir, a $15 per tree wholesale price will enable the grower to earn approximately $12,000 per acre over a 10 year period.

Christmas trees are being produced and sold at several sites in West Virginia and Virginia, and results indicate that reclaimed mine sites can produce high-quality Christmas trees (Miller 1987). Guidelines for producing Christmas trees on reclaimed mine lands are available (Torbert et al. 1989).

Pine Timber Production

Forestry is a logical postmining land use for much of the reclaimed land in the Appalachian mountains. Properly reclaimed mine land can produce as good or better tree growth than most natural Appalachian soils. However, the forest production potential of a reclaimed mine site will be strongly influenced by site conditions, as produced by reclamation practices (Davidson et al. 1984). Although nearly all reclaimed mine sites will grow trees, many sites will not be sufficiently productive to make pine timber production a profitable enterprise. In terms of species selection, a landowner should look first at various species of pines. Although many hardwood species (which bring high prices as mature timber) are native to the Appalachian

area, the rates at which these species will grow to maturity for harvesting is far too slow, even on the best of sites (Pass 1985).

In the Appalachians, eastern white pine is generally considered to be the species with the best potential for producing a marketable timber crop (Davidson 1986, Skousen 1989). The more site-tolerant pine species suffer from other problems as a timber investment, such as low market values at harvest (i.e. Virginia pine) or lack of winter hardiness (loblolly pine).

The primary drawback has to do with the length of time required to achieve a return on investment. Even on the best of sites, a time span on the order of 30 years will be required to obtain a marketable crop of pine timber. Given present price and market trends, an acre of eastern white pine timber planted today on a reclaimed mine site with a site index of 100 will likely be worth in excess of $3,500 (1988 dollars) in 30 years at maturity (Zipper et al. 1987). Once the stand is established, little is required in the way of management until harvest. Guidelines for reclaiming sites to produce pine timber are available (Plass 1976, Torbert et al. 1984,1986).

Horticultural Crops

The characteristics of appropriately reclaimed mine lands are also suitable for growing horticultural crops such as apples, grapes, and blueberries. The suitability of reclaimed areas for such crops has been demonstrated by research in Virginia and growers in West Virginia and Virginia. Production and profitability are, as noted before, greatly influenced by mining and reclamation practices, and the resulting characteristics of the site (slope, and physical and chemical properties of the minesoil).

Residential, Commercial, and Industrial Land Uses

Land suited for commercial, residential or industrial development is in short supply in many Appalachian communities. Surface mining operations can be conducted so as to yield reclaimed land suited for development. Non-flood prone, flat lands suitable for development bring premium prices in many Appalachian communities, due to scarcities engendered by the natural terrain. As with all land, a primary characteristic of reclaimed land that will influence development potential is location. Land value is influenced to a large extent by proximity to other uses of land that might complement a particular use.

Gaining physical access from the public road can be quite costly, especially if flat land has been produced on a ridge top and the road runs in a valley at the base of the ridge. Access to public utilities is an obvious necessity to develop reclaimed sites, and the cost to install utilities will be strongly influenced by location. Access to public sewers, or an adjacent undisturbed area suitable for septic drainfield waste disposal is a necessity, as there are no known technologies for environmentally sound on-site disposal Appalachian terrain (Krebs and Zipper 1989). The limitations of the natural terrain have made reclaimed mine sites indispensable assets to the economic and social expansion of many communities. In numerous cities in central Appalachia, major new commercial and service related facilities have been constructed on reclaimed mine lands in recent years. Previous to construction of the "new lands" with favorable contours for large scale commercial use, these land uses were simply not feasible due to shortages of appropriately located flat land. Throughout Appalachia, many homes have been successfully constructed on reclaimed mine sites (Miller 1978b), as well as schools, hospitals, and recreational facilities (Miller 1976, 1978a, 1983a, 1983b). Where lands can be developed to improve land use, there are income opportunities available to the landowner.

Summary

The steeply sloping terrain of the Central Appalachian Region greatly limits the potential for commercial and industrial development, and restricts the amount and levels of other income producing activities by residents. Coal mining and reclamation, the major income producer and employer in the region, has the capability to create large areas of flat or gently sloping terrain, and can make income-producing opportunities for residents and developers. Postmining land uses which have successfully provided additional income for landowners on more gently sloping reclaimed areas in the region are beef cattle production, Christmas tree plantations, timber production, horticultural crops, and residential, commercial, and light industrial land uses.

References

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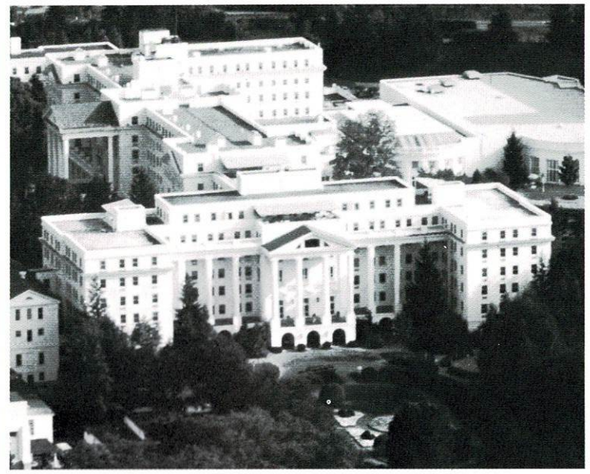

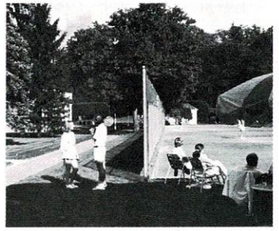

The Anatomy of a Durable Rock Fill:
Why they work (and when they won't)

by George A. Hall, Ph.D., P.E.
Terra Engineers, Inc.
Charleston, WV

Introduction

The first earth fill was generated when man first developed the capability of excavating the earth. Man's ability to excavate the earth has been growing at an increasing rate, and his need to create earth fills has increased accordingly. In recent decades, the surface mining industry has become the leader in earth moving and therefore in the creation of earth fills.

The hard lessons of nature have taught man that earthwork does not always accomplish the desired results. In fact, occasional efforts have been disastrous. Consequently, man has studied earth materials and earth structures in an effort to ascertain how earthwork should and should not be performed. A considerable body of knowledge has developed from this study; however, a curious condition also appears to have developed. It would seem that those with the least understanding of our knowledge regarding earth fills have become the most outspoken critics of fill construction.

The origin of the term "durable rock fill" is somewhat vague. The reasons for the recent criticism of durable rock fills are even more vague. Hundreds of mine spoil fills, including scores of durable rock fills, have been constructed in West Virginia over the last 15 plus years, and, quite remarkably, no significant failures are known to have developed. This should be considered in light of the following quotation (1)*: "Landslides are extremely prevalent in parts of the Appalachian Plateau, West Virginia probably being the most difficult area from this standpoint on the Continent." Now, despite the remarkable success record in an area where failures abound, the critics are predicting dire consequences for durable rock fills. Because of these unfounded predictions, they want to redefine durable rock.

False criticism of durable rock fills needs to be corrected. However, the coal industry must not become complacent with the success of these fills.

If success is to continue, it is important that all parties involved with durable rock fills understand the why's and how's of the materials and their most advantageous placement.

Durable Rock

There has been considerable controversy over what is and is not durable rock and how durable rock should be defined both verbally and in the field. When the solution to an important problem is very simple, people will find a way to make it complicated; they simply cannot believe that an important problem has a solution which is simple. Such is the problem of defining durable rock.

The original definition of durable rock as applied to mine spoil is apparently due to D. R. Casagrande (2). Casagrande referred to "hard rock spoil" which he defined as "rockfill consisting of at least 80% sandstone, limestone, siltstone, cemented shale and other rocks that do not slake in water; and not more than 20% of materials that slake, such as clay shales, clays and other fine grained soils."

In addition, Casagrande specified an internal drainage system of granular material which was "free of clay and shall consist of durable particles such as natural sands and gravels, sandstone, limestone or other durable rock which will not slake in water." These descriptions apparently became the original OSM definition for durable rock, and, based on geotechnical engineering properties, it is a rather

** Numbers in parentheses refer to specific references listed at the end of the article.*

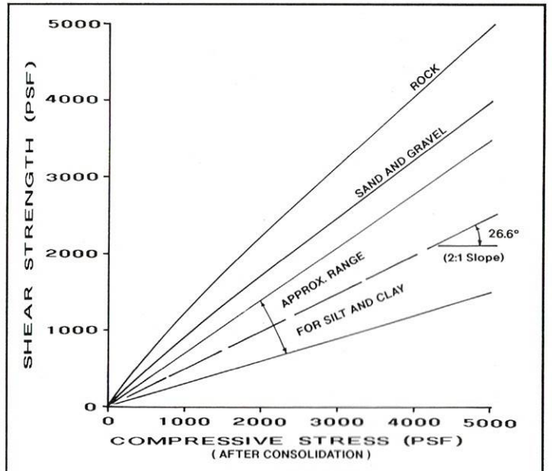

Figure 1 Approximate Shear Strength of Different Sized Material

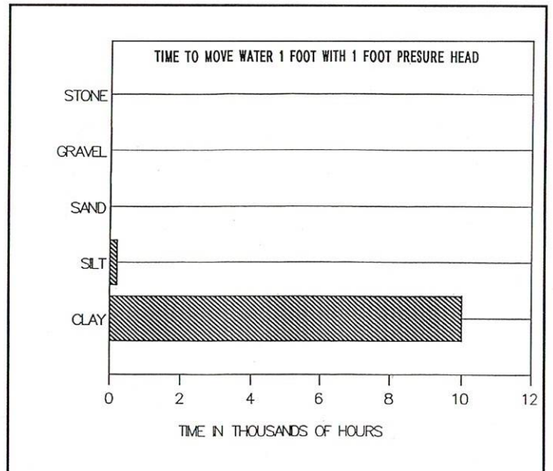

Figure 2 Effect of Particle Size on Water Flow

good definition. Please note that Casagrande considered granular material, including sand and gravel, to be durable rock but excluded clay, clay shale (which readily breaks down to clay), and other fine grained soil. Fine grained soil in geotechnical engineering vernacular is silt and clay (minus No. 200 mesh or minus 0.074 mm).

Durable rockfill had been defined in terms of slaking. Unfortunately, Casagrande did not define slaking, although it was obvious from his presentation that he was referring to the breakdown of materials to soil fines (especially clay). A simple jar slaking test would be adequate to evaluate a given zone of material. If any slaking occurs, the slaked material needs to be examined to determine if any portion has broken down to silt and clay size particles. Materials which break down to form fine grained soils are normally readily discernible. If the material slakes to form a readily discernible fine fraction which feels "slimey and slippery," then the material is suspect. If the material is shale, it is no doubt breaking down to soil fines, and is nondurable. If the material is an argillaceous sandstone, it should be further assessed to determine the percentage which is nondurable. Any shale which shows a tendency upon wetting to break down to clay material should be considered nondurable. On the other hand, many cemented shales will break down to form plate shaped particles which form a granular mass (3). These shales are durable rock.

The worst materials are readily and quickly identified by the jar slake test. The really bad materials will start to break down immediately, while materials of lesser difficulty will take longer to break down to the elemental fine grained particles. A maximum of 24 hours is sufficient to disclose slaking tendencies.

In 1983, OSM decided to "improve" their definition of durable rock. The new definition includes rock "that will not slake in water or degrade to soil materials." The new definition is an unfortunate and injudicious choice of words. The addition of the words "or degrade to soil materials" would have some merit if it were modified to "or degrade to fine grained soils," or even better, "or degrade to silt and clay sized particles." Most people consider sand and gravel to be soil sized material. These materials are important to the functioning of a durable rock fill.

Durable Rock, Geology, and Topography

The geology of a hilly or mountainous area is reflected by its topography. The character of the sedimentary rocks in the Appalachian area is reflected by the steepness of the topography. The natural hillside slopes in the shale dominant northern West Virginia coal fields are much more moderate than the slopes in the sandstone dominant southern West Virginia coal fields. The native soils derived from the rock strata also reflect the character of the rock. Clay shales and clay soils are quite rare in the southern West Virginia coal fields. Consequently, the higher, steeper, more rugged southern mountains lend themselves to the durable rock fill while the less rugged northern areas are

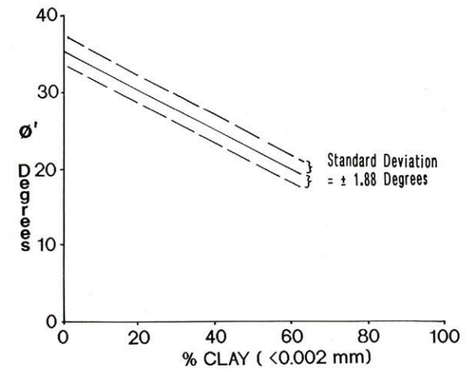

Figure 3 Normally Consolidated Angle of Friction Versus Percent Clay for Appalachian Soils

less supportive of this type of construction. In the majority of southern West Virginia surface mining areas, all of the rock and soil meet the criteria for durable rockfill. Hence, the geology and topography of an area is a major factor in determining the degree of applicability of the materials for durable rock fills. There are, of course, variations within even the most favorable areas, and site specific conditions must be considered.

Properties of Durable Rockfill

Durable rockfill is not a material but a broad spectrum of materials. The primary requirements for durable rock are:

1. They are granular materials.
2. They should form a reasonably well graded mass ranging from boulders down to fine sand with no significant clay content.
3. The materials must not slake to form soil fines; that is, the granular materials must remain granular materials (except where subjected to long term rigorous surface weathering).

Durable rockfill, then, is durable rock with up to 20% nondurable material. The importance of minimizing the quantity of soil fines is illustrated in Figures 1, 2, and 3. Figure 1 illustrates that, in general, the strength of fill materials increases with particle size. Figure 2 illustrates that permeability, or the rate at which water will flow through a material, also tends to increase with particle size. There are, of course, other factors which affect strength and permeability, so the illustrations are general and should not be applied to specific cases. See references (4,5,6,7) for more detailed treatment of rock fill properties.

Figure 3 is the result of the writer's research (8) and illustrates the effect of clay content on the normally consolidated friction angle of cohesive (clayey) soils. It is apparent that clay added to a durable rock fill will reduce strength and permeability, and, depending on the location within the fill, a clayey zone could cause failure. Figure 3 is also valuable in evaluating foundation soils since such soils will usually behave as normally consolidated under the weight of the fill.

Fill Behavior Resulting From Materials Properties

We consider a valley fill to be well-behaved when it does absolutely nothing. It must sit quietly and endure the ravages of man and nature without moving or complaining. We consider any significant amount of fill movement to be poor behavior. The movement might be loss of material by erosion, settlement, or a landslide in the fill face. Whether a given movement is considered as "naughty" or "bad" depends usually on the magnitude of the movement and its effect on the environment or the works of man.

Post construction settlement in a durable rock fill will result primarily from breakage of particles at highly stressed contact points. Rock fills will usually settle a couple of percent of the fill height, and the settlement will be essentially complete within a couple of years. There are deviations from these numbers, but settlement is usually not a major problem unless there are other contributing factors.

The element most responsible for poor behavior of fills - whether they are durable rock or other earthen embankment - is water. Surface water runoff can cause erosion while subsurface water can cause internal erosion and slope failure. We will now consider each of these problems.

Surface Water Drainage

Surface water runoff is normally handled by two methods: ditches and benches. It is unfortunate that early proponents of durable rock fills specified that diversion ditches should be constructed in original ground around the fill perimeter. The apparent reasoning for this drainage pattern is to limit the amount of infiltration into the fill by

getting the water off quickly. On the other hand, the ditches in original ground promote landslides and siltation which can block or impede water flow, thereby diverting water on to the fill. For this and other reasons, many mining companies prefer to direct drainage to the center of the fill. There are other drainage patterns which might be advantageous on a site specific basis, so a modification to current regulations is definitely in order.

Regardless of drainage pattern, ditches must be designed for both flow capacity and erosion resistance. Erosion resistance is a major problem on steep slopes, and this means the fill face or the contiguous valley sides. Unless the ditch is excavated into bedrock, steep slope erosion protection is nearly always plain riprap, sometimes using very large diameter rock. It is very important to have good bedding for riprapped channels. The large boulders must have a sufficient quantity of smaller boulders and cobblesin the bedding to provide interlocking and also to be able to resist the water flow in and under the riprap. Durable rockfill usually provides such bedding so long as the operator is reasonably selective. Unless the fill toe and/or the receiving stream are on bedrock, a stilling basin is also necessary at the channel outlet.

Internal Drainage-Stability

The most important and complex problem in earthwork embankment design is the balance between internal drainage and stability. The ideal solution to this problem is to provide good internal drainage; however, we sometimes lose sight of the fact that this is not the only solution. We will look at the most common internal drainage - stability problems and some common geotechnical engineering solutions. We will then look at regulatory requirements.

Figure 4 represents the profile of a valley fill (not necessarily durable rock) and the valley bottom foundation materials. The bedrock is assumed to be stable (a normal but not absolute assumption), so we are concerned only with fill materials, foundation materials, and water. The foundation materials, being in the valley bottom, will normally be saturated with water. What happens to the foundation material when the fill material is placed on it? Naturally, it is squeezed by the weight of the fill, and the water in the voids of the material tends to be squeezed out as the material is compressed - just like squeezing a sponge. This foundation material becomes stronger as it is squeezed into a more compact condition, as indicated graphically in Figure 1.

If the foundation material is granular, it has a rather high

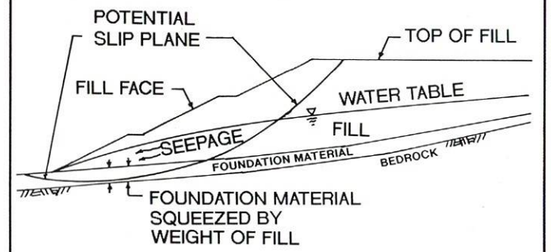

Figure 4 Illustration of Internal Drainage-Stability Conditions

permeability, as indicated graphically in Figure 2, and the water will be squeezed out very quickly. If the foundation material is fine grained with a conspicuous clay content, it may take days, weeks, months, or even years for the material to be consolidated. The time increases with the square of the thickness of the material and with decreasing permeability.

The highest water pressures from squeezing develop during or at the very end of fill construction. This is the "end of construction" analysis condition where partially consolidated foundation soils have their lowest shear strength. Clay foundations are frequently the cause of fill failures, but granular foundation soils seldom cause problems. Nevertheless, foundation difficulties can be overcome so long as they are anticipated (see discussion on seepage below).

Another troublesome internal drainage - stability problem results when water can get into a fill faster than it can get out. The sources of water are springs, seeps, and infiltration. So long as the water can drain out as quickly as it gets in (good internal drainage), there will be no build-up of a water table within the fill. If, however, water gets in faster than it gets out, a water table will develop as indicated on Figure 4. The outward and downward seepage of the water tends to drag the fill material with it (seepage forces), and this action reduces stability of the fill face.

Seepage at a fill face is a problem only if it is not antici-

pated in the design and construction of the fill. Prevention by good internal drainage is best, but a buttress or flatter downstream slope (among other things) can also be used to provide the required stability.

Such measures can also be used for weak foundations. Often a little extra effort to flatten the fill below the bottom bench or bottom two benches (perhaps using some extra rock from ditch riprap construction) will eliminate potential stability problems.

Other Behavioral Considerations

The greatest asset of the durable rock fill is gravity separation which results in large material at the bottom with finer material at the top. This process tends to construct a graded filter between the finer and coarser material. Many West Virginia operators attempt to dump a rock core in the middle of the fill profile (from valley bottom to surface). This procedure has several advantages, the most notable being sediment control during construction and the formation of a good central drainage system. The procedure is used in side channels as well as the main valley, so virtually all springs and seeps are drained.

As dumping of the core proceeds to the surface, there is not sufficient vertical drop to produce gravity segregation of rock sizes, and the upper portion of the core contains a significant quantity of finer rock. This is a blessing, since the finer materials reduce infiltration and inhibit development of a water table in the fill. CAUTION: Except where detailed analyses show that the core will carry the design storm and the downstream face will remain stable (1.5 factor of safety), surface water should not be directed into the core for permanent drainage. Instead, use finer rock at the top of the core to reduce infiltration. If the water can get out through the underdrain faster than it can get into the fill, there will be no stability problems. Note that the sand portion of the durable rock is very important in limiting infiltration.

The most important part of any valley fill is the fill face area. In a durable rock fill, this is the part normally constructed by "pushing down" to develop a flatter slope required to achieve long term stability. The degree to which this goal (long term stability) is satisfied depends on many factors including:

1. the method of dumping, especially single lift or multiple lift;
2. the type of material in the dumped face area with respect to size and resistance to handling;
3. the dumped face configuration; and
4. the procedure for pushing down the fill.

These and possibly other factors determine whether the rock underdrain system will function adequately at the critical downstream end.

Ideally, the underdrain should have the highest flow capacity at the downstream end. This precludes a damming effect which would build up a water table in the fill and reduce stability. On the other hand, pushing down finer material from the top of the fill is not conducive to good underdrain construction. Hence, there are two alternatives: use the factors listed above (and possibly others) to enhance underdrain construction at the downstream end; or assume an impaired underdrain condition and design and construct a compatible stable slope. The design must consider both piping potential and slope stability for the highest anticipated water table in the fill.

It is unfortunate that OSM regulations recognize no alternative designs. If we exclude the conventional West Virginia or "head-of-hollow" fill, OSM recognizes only two types of fills, only one surface drainage pattern, and they always require an underdrain. Any deviation in design is considered "experimental" even though it may have been established engineering practice before OSM existed. The regulations need more design flexibility.

Conclusions

Geologic conditions in Southern West Virginia are very supportive of durable rock fill construction. Nearly all of the soils and rock strata meet the 80-20 durability criteria with little, if any, selective treatment by the operator. This condition combined with generally good operation has led to an excellent performance record.

No continuing large scale construction operation has ever been carried out without an eventual failure. Sooner or later a massive durable rock fill failure will develop. If history is an indicator, such a failure will cause more stringent regulations, and this is not the solution to failure prevention.

Failures will be prevented by the application of sound engineering principles. It is the responsibility of regulators and operators alike to acquire an understanding of these principles and to work together to further the development of pertinent engineering knowledge. It is hoped that this article will contribute to that end.

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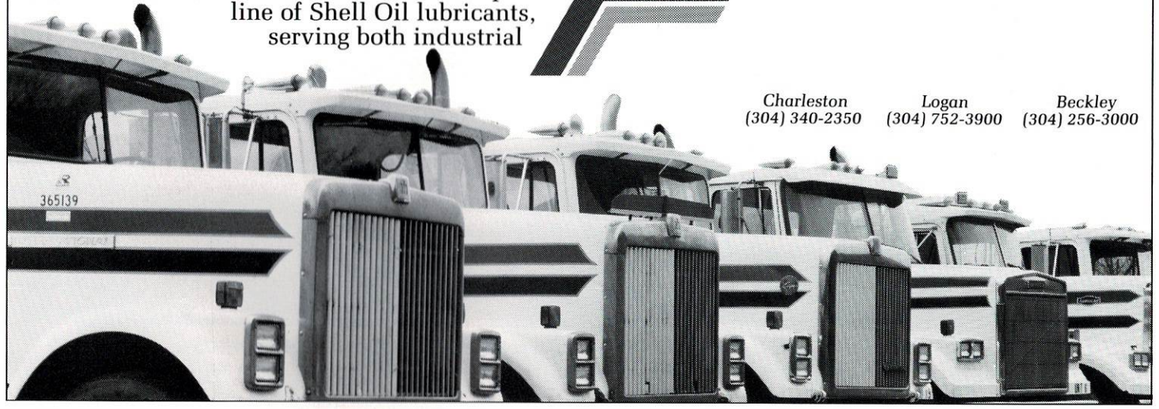

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Students from Union Elementary School in Mt. Storm celebrated Earth Day by planting 1,000 trees on a reclaimed mine site of Allegheny Mining.

Earth Day - 1990

Earth Day 1990 was celebrated across West Virginia from many groups with diverse interests — none more directly than WVMRA members. Declaring that "Every day is Earth Day for West Virginia miners," the Association announced plans over a year ago to participate directly in the observance of the 20th anniversary of the original Earth Day.

Numerous member companies opened their operations to the public on or about April 22. Many others participated in special projects with civic, educational, and other interested organizations.

As WVMRA President Ben Greene put it, "What our people were doing was showing off what they do every day of every year. Coal miners deal with old Mother Earth on an every day basis.

"We certainly applaud those groups and individuals who planted trees and cleaned up eyesores on Earth Day, but at the same time, we would like the public to realize that miners are out doing these things all of the time."

Nevertheless, West Virginia companies figured prominently in Earth Day observances. For example:

• Arch of West Virginia opened its operation to the public, then in a separate observance, brought its employees and their families for a picnic and planting of shrubs.

• Marrowbone Development Co. worked with local boy scout troops to plant trees on its reclaimed area.

• Allegheny Mining Corp. provided land, trees, and expertise to students of Union Elementary School to plant 1,000 trees.

• Hobet Mining Inc. hosted students from Weberwood Elementary School in South Charleston and supervised the planting of sunflowers.

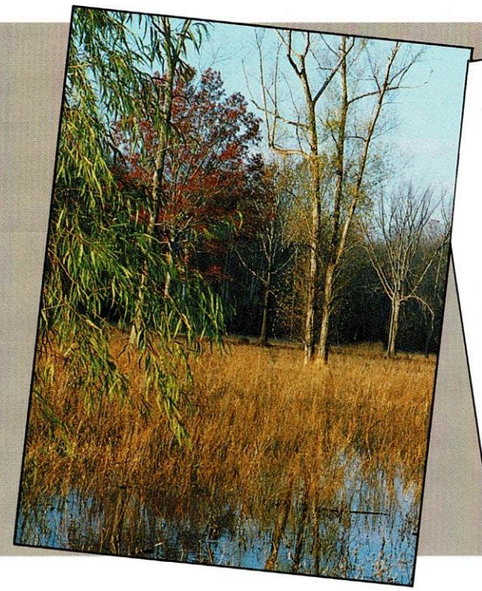
• Coaltrain Corp., Patriot Mining Co. Inc., and Mary Ruth Corp. all conducted open house for the general public.

In addition, the Association itself was involved in providing information and/or speakers for Earth Day observances at Herbert Hoover High School in Clendenin, Sissonville Junior High, Richmond Elementary in South Charleston, various boy scout troops, and Union Carbide. Similar assistance was provided to Earth Day related programs such as the Governor's Conference on the Environment, and the Youth Conservation Program and Expo '90.

Earth Day 1990, in many ways, became a media event, and that probably won't happen again until the 25th observance in 1995. Meanwhile in West Virginia, the coal industry will continue to make every day Earth Day.

Students from Weberwood Elementary in South Charleston visited 'Big John,' Hobet Mining's huge dragline, then planted sunflowers on a reclaimed area.

Reclamation is for the Birds in West Virginia



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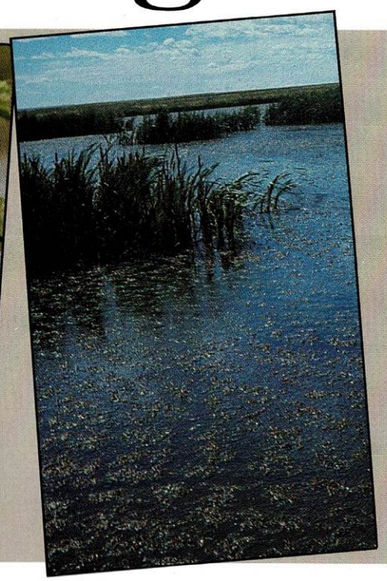

Taking to heart President George Bush's environmental pledge of "no net loss" of wetlands, the West Virginia Mining and Reclamation Association has joined forces with a national conservation organization in a move to help create and preserve new wetlands in the state.

In early January, the Charleston, W.Va.-based mining association signed a memorandum of understanding with the conservation group, Ducks Unlimited Inc. The agreement's aim is to create wetland habitats for waterfowl and other wildlife species through the reclamation of mining lands throughout West Virginia.

Officials from both groups and the federal government are hoping their unusual partnership will stand as a model for future conservation-coal group initiatives to return mined lands to their natural habitat.

"It's a win-win situation," said Benjamin Greene, president of the West Virginia Mining and Reclamation Association. "We have joined with one of the more progressive conservation groups in the country and it is a neat approach."

"We take great pride in having done this," Greene noted. "We see it as another step for us to help out."

***Esme Neely** is a freelance writer based in Annapolis, Md.*

Both Greene and Ducks Unlimited spokesman Rick Van Etten expressed the hope that the partnership will not only prove fruitful to West Virginia, waterfowl and wildlife, but that the agreement becomes a role model for similar scenarios nationwide. Already showing interest in the agreement is Harry Snyder, director of the U.S. Department of the Interior's Office of Surface Mining.

Snyder, who attended the ceremonial agreement signing between the two groups, endorsed the project describing it as "a fine example of what can happen when people get together to identify common goals and ways to meet their needs."

"We hope the agreement will serve as a model of cooperation that others will seek to emulate," he added. "And we hope the Office of Surface Mining will be as successful as these two organizations in our own efforts to bring about similar agreements."

The mining and reclamation association boasts 350 member businesses, 130 of which are coal-mining companies. It is the largest independent state coal association in the country, Greene said.

Ducks Unlimited is the largest private-sector waterfowl conservation group in the world. Incorporated in 1937, the Long Grove, Ill.-based group is an acknowledged leader in wetlands conservation. Throughout the years, working in Canada, the U.S. and Mexico, the group has reserved and managed 5,331,315 acres covering a total of 4,832 wetlands conservation projects.

Total membership stands at approximately 550,000. As of last December, the group had raised more than $515 million since its inception. More than 600 species of waterfowl and wildlife have benefitted from Ducks Unlimited projects, including endangered species such as the bald eagle, whooping crane, peregrine falcon and the piping plover.

The purpose of the signed agreement is to provide a foundation for the cooperative development of wetlands through the reclamation process. Both of the partners, each a non-profit organization, agree the process may also be more economically viable to other reclamation alternatives.

As a part of the terms of the memorandum, the two organizations agree to annually review the development of lands identified for this project, which emphasizes the development and management of wetlands projects specifically for migratory waterfowl.

While Greene said his association's membership unanimously approved the cooperative effort, part of the agreement states the mining group will continue to actively encourage those in the industry to design and construct wetland habitats through the reclamation process.

Reclamation projects are actually accomplished by a two-step process, Greene added. Surface miners, he said, must be meticulously aware of just how they go about their work during the mining process. Then, how a project is finished can also determine the ability of returning the site to wetlands.

The association also will serve as a communications center to provide public information on wetland reclamation projects, as well as disseminate information about Ducks Unlimited throughout West Virginia.

For their part, Ducks Unlimited has agreed to annually review member company proposals and activities to encourage "no net loss" of wetlands within the mining industry.

Both groups will provide technical assistance as needed. The biological expertise the conservation group provides will be reimbursable to the state mining group. Helping to pay for projects, Greene said, is the 35 cents per ton coal tax. Neither group will be financially liable for projects accomplished under the agreement.

Ducks Unlimited is also responsible under the agreement for encouraging and minimizing impediments to the development of wetlands and habitats through the reclamation process in areas of biological importance.

Acting as witnesses to the signing were West Virginia Department of the Energy Commissioner George Dials, and the state's Director for the Department of Natural Resources I. Edward Hamrick III.

The agreement went into effect with the January signing. No termination date was given; however, either group may cancel at any time with 30 days notice.

While the partnership between the West Virginia mining association and Ducks Unlimited may prove to be a model for future wetlands conservation agreements, it is not the first time the waterfowl group has joined forces with the coal industry.

In 1988, the conservation group began work on the Star Fire Project in conjunction with the Cyprus Mountain Coal Co. in southeastern Kentucky. With technical expertise from the University of Kentucky and the state's fish and wildlife resources department, the group reclaimed 1,700 acres once used for coal mining. Included in the project was the creation of a 35-acre lake, 40 acres of upland nesting cover and 20 acres of grass and lagoon pasture.

"From that project we gained the knowledge about the success of various possibilities," Van Etten said. "Now we are exploring the future because we want to do more."

Ducks Unlimited has long been active in West Virginia, a state that is firmly fixed in the middle of the Atlantic Flyaway, the migration route for a large number of waterfowl species. The group currently has more than 1,100 members in West Virginia who, in 1988, raised $202,782.

Greene is equally proud of his members' contribution to the state. He said that some 12,000 to 15,000 acres of mined lands are reclaimed annually in West Virginia. In addition, through the use of the Abandoned Mine Land Fund, approximately 2,000 to 3,000 additional acres are reclaimed annually from lands that were mined and unreclaimed prior to 1977 when the fund was established.

"The West Virginia mining industry has paid approximately $300 million into the fund since it was established in 1977," Greene said. "Making the state's reclamation efforts as among the most extensive in the nation, and it's entirely industry supported."

The conservation group's active projects in the state include the Burnsville-Triplets Run in Braxton County and the Valley Bend Wetlands, phases I and II, in Randolph County. The group has also just acquired seven islands in the Ohio River which are part of a group of 38 islands targeted for the state's first National Wildlife Refuge. The project was initiated by Sen. Robert Byrd of West Virginia. □