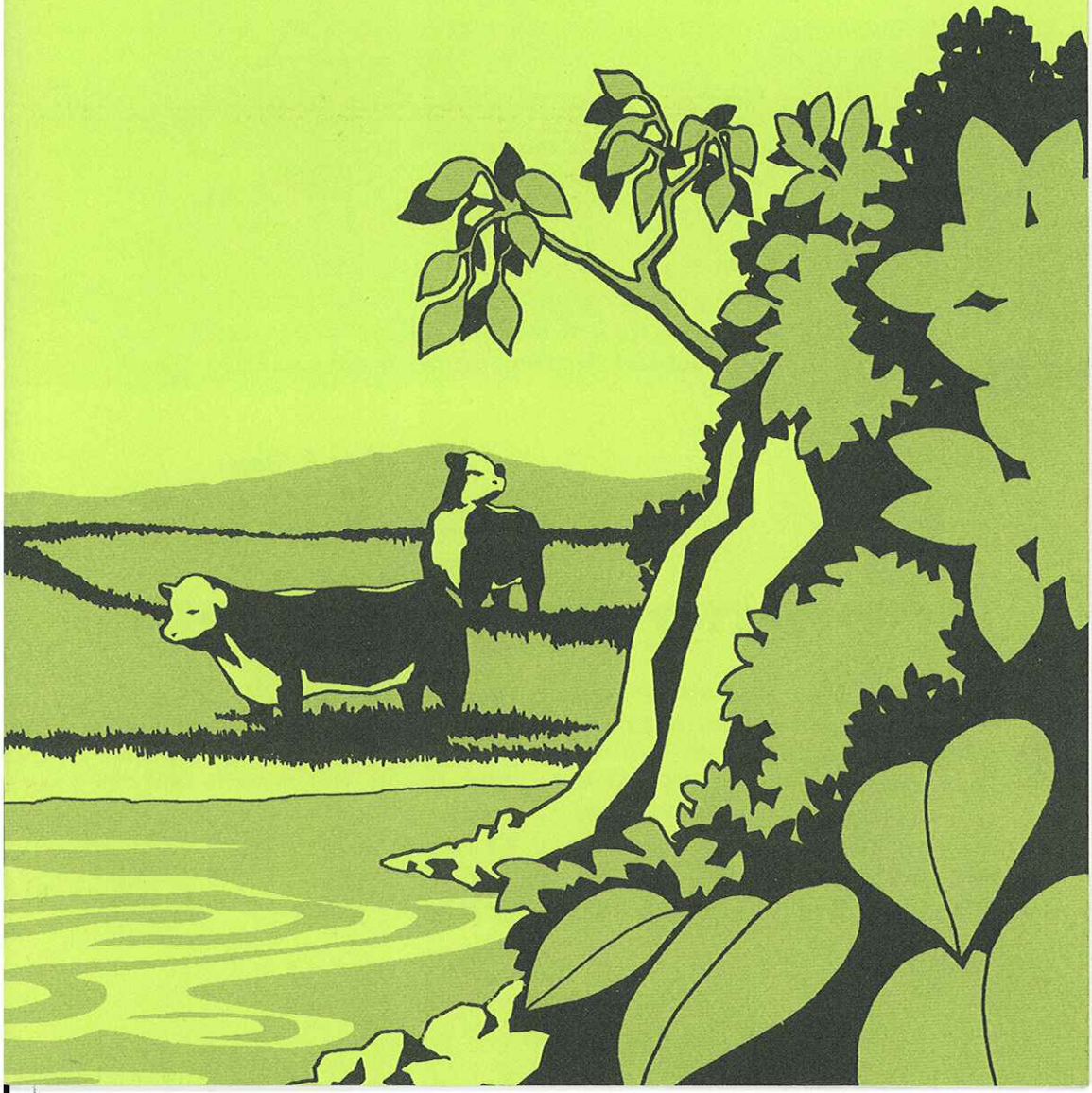
COAL

and the Environment



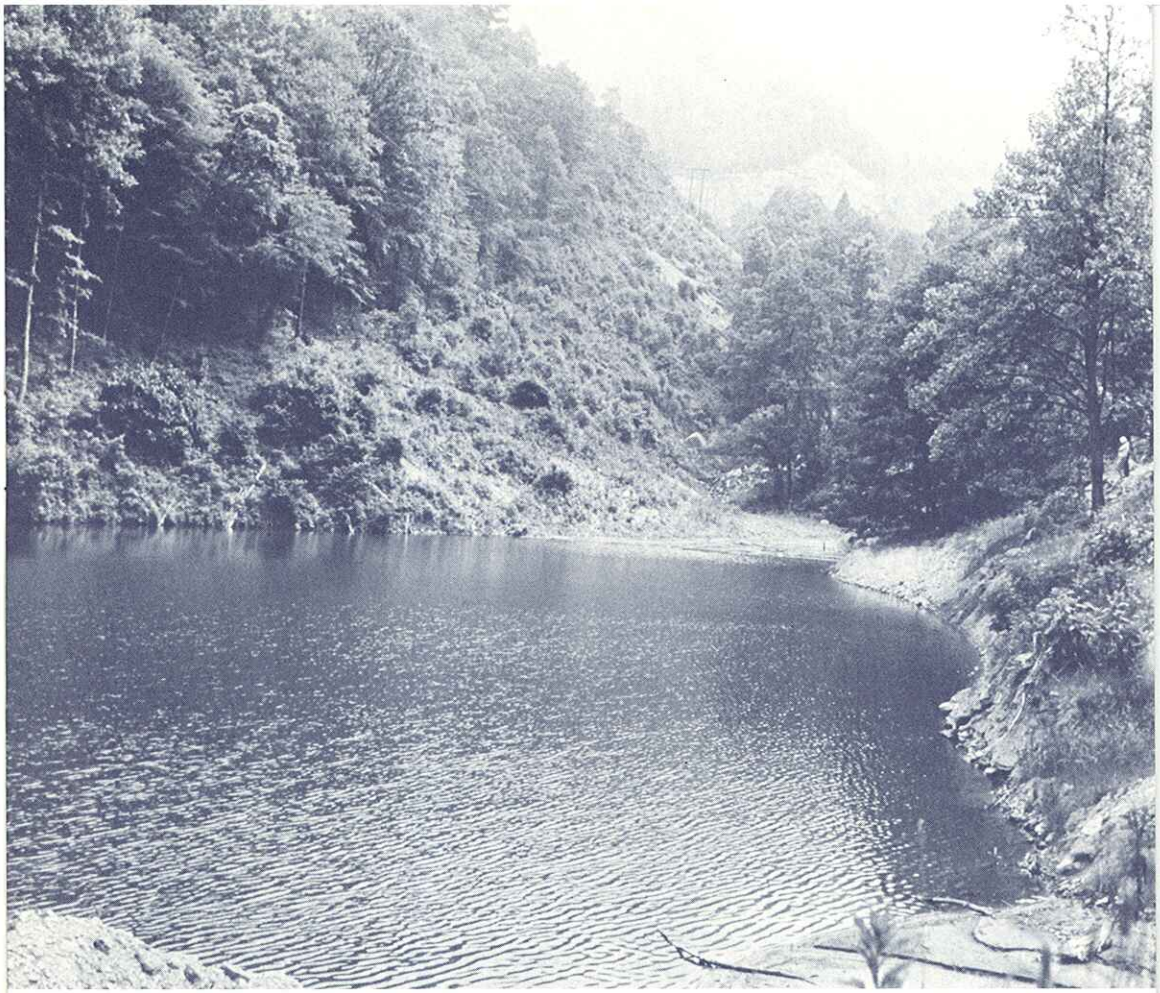
The coal industry is ever moving forward to adapt its product to meet the newly emerged environmental ethic which has rightfully become a high-priority item in our national energy scheme.

Air and water pollution, along with the reclamation of surface-mined land, have been major concerns in our industry and our commitment to solving these problems is total.

Massive amounts of time and money have already been invested in developing environmental technology and we will continue to search as long as necessary.

Outlined in this booklet are the accomplishments and goals of the dedicated researchers who are working daily to forge a cooperative link between the production and utilizaton of coal and the preservation of our environmental balance.

Carl E. Bagge
President
National Coal Association



COAL
and the Environment

THE TERM SPACESHIP EARTH was coined to dramatize the fact that man lives in a self contained environment, a thin shell of usable land, air and water. Those essential resources, which seemed boundless through most of history, are starting to show their limits under the demands of increasing population and advancing technology. And people are beginning to worry about the capacity of the crust of earth to provide more and more vitally needed resources and to absorb growing volumes of waste.

Americans must be concerned about preserving the environment—they have lived off it better than most, producing

and consuming their natural resources at a rate adding up to the highest standard of living in the world.

But the key to this good life is energy, and America's problem now is to keep energy in full flow without permanently upsetting the natural balance of the environment. Environmental concern has caught up with us just as the nation is running short of its naturally clean and most accessible fuels.

The coal industry, with the nation's biggest fuel reserves, is involved in the energy-environment drama but refuses to be cast as the villain in the piece. The problems of air pollution, mine drainage and strip-mined land have been weighed against coal production and use without nearly enough allowance for solutions that can keep the environment in good repair and the nation in strength.

Coal's air pollution problems were built into the solid fuel when Nature laid it down as a molecular mix of desirable carbon and undesirable ash, sulfur and other distracting elements. Those problems have been dogged but in the light of increasing knowledge about fuel and combustion technology they are clearly not insuperable. In fact, the odds on solving them are long enough to have spurred development of a coal-oriented sector of the booming pollution control industry.

The control effort is building on past success. Before the public began to worry about the invisible threat of sulfur dioxide to pure air, it was concerned about the highly visible nuisances that arose from coal burning—and oil burning, as well. People understandably complained about the soot and fly ash that spotted curtains, coated cars and kept sandblasters busy. But new technology is on top of that problem. With devices readily available that can remove more than 99 per cent of the solid offenders from plant stack emissions, no city need put up with a rain of grit and grime.

Now the focus of the clean air campaign is elimination of sulfur dioxide gas discharges, and that is a top-drawer challenge to the control experts. Picking solid particles out of a gas stream is like spearing fish in a rain barrel compared with sulfur dioxide removal. That is more like taking a needle out of a haystack, with the needle made of straw. The desulfurization effort calls not only for handling an enormous quantity of flue gases but also for a chemically acute process of selection to take out sulfur dioxide, which is less than one-half of one per cent by volume of the total gas stream.

That kind of complicated problem is rarely solved quickly, which explains why years of difficult and costly research on flue gas desulfurization is only now producing hardware results. Currently, at least a score of electric utility plants have sulfur dioxide removal systems in operation from the pilot to the big demonstration stage. Some control equipment manufacturers are offering their systems on a commercial contract basis, but as yet no system has been installed on a big enough power plant and operated long enough to finally prove its long-term effectiveness and commercial availability.

However, only the precise date of that breakthrough remains unclear; that it will come—and soon—is a matter of simple necessity, because the electric utility industry must continue to burn available coal to keep up with national power demands, and it must burn its backbone fuel in compliance with increasingly tighter air quality standards.

Several sulfur dioxide removal proc-

esses are presently being studied, including scrubbing the stack gases with low-cost chemicals that absorb sulfur dioxide and are then discarded; and scrubbing with high-cost chemicals which absorb sulfur oxide and are then regenerated to recover sulfur in salable form.

The Environmental Protection Agency has sponsored a research program on adding dry limestone or dolomite to the boiler feed at the Tennessee Valley Authority's big Shawnee electric generating station near Paducah, Ky.

Meanwhile, EPA and TVA have added another sulfur dioxide removal approach to their test program, installing a large chemical pilot plant at Shawnee to scrub flue gases with a limestone slurry. The project, scheduled to run for 30 months after a start in 1972 and estimated to cost $8 million to $10 million, will cover maximum removal of both sulfur dioxide and particulate matter, as well as disposal of solid wastes from the process.

Many organizations have developed chemical processing systems for desulfurizing flue gases. Combustion Engineering, Inc., has combined limestone injection with chemical scrubbing on two large boilers at Kansas Power and Light Co.'s generating station at Lawrence and will soon be operating two additional units at the Hawthorne station of the Kansas City Power and Light Co. in Missouri. Combustion Engineering has also developed a system based on gas scrubbing without additive injection, and installations are planned on boilers ranging from 70 to 700 megawatts at generating stations of Louisville Gas and Electric Co. in Kentucky and Northern States Power Co. in Minnesota. Another throwaway system using limestone slurry scrubbing has been developed by Research-Cottrell, Inc., and a demonstration plant on a 115-mw boiler at Arizona Public Service Co.'s Cholla station is scheduled for startup in late 1973. Also, Babcock and Wilcox Co. has supplied a limestone slurry scrubbing system for a 163-mw boiler at the Will County station of Commonwealth Edison Co., Chicago, and is supplying a similar system for a new 820-mw boiler at the La Cygne station of Kansas City Power and Light Co. for operation in mid-1973. Detroit Edison Co. has installed a limestone slurry scrubbing system on a 280-mw boiler at its River Rouge station.

To offset the cost of sulfur dioxide removal systems, many companies have investigated chemical processes to recover sulfur in a marketable form. Chemical Construction Corp. (Chemico) has come up with a new wrinkle—scrubbing the flue gases with a magnesium oxide slurry, then carting the magnesium sulfite that is formed to a central processing plant where the original reactant is split out and regenerated for reuse and the sulfur dioxide is recovered in salable form. The idea is that the processing plant will serve several utility and industrial plants in one geographic area.

Chemico has formed a joint company with Basic Chemicals to promote magnesium-based scrubbing, and a demonstration plant has been installed on an oil-fired boiler at Boston Edison Co.'s Mystic station, with an installation on a coal-fired boiler at Potomac Electric & Power Co.'s station at Dickerson, Md., scheduled for startup in early 1974. Chemico reports that it has installed a full-scale system on a 156-mw coal-fired generating unit in Japan that has been in continuous

Towed by a helper, bulldozer with experimental 40 ft. blade reclaims mined land.

reliable service since March, 1972. It removes 90 per cent of sulfur dioxide from combustion of high-sulfur coal and all but a trace of solid particles.

Monsanto Co. developed a catalytic approach to sulfur dioxide removal, oxidizing the SO_2 to sulfur trioxide, followed by recovery of sulfuric acid. The Cat-Ox process was installed at Metropolitan Edison Co.'s Portland station in Pennsylvania in 1967, and another installation has been made on a 100-mw boiler at the Wood River plant of Illinois Power Co. Monsanto and Enviro-Chem Systems in a joint venture have developed a process (Calsox) to convert SO_2 and fly ash to a mixture of calcium sulfate, calcium sulfite and fly ash that can be used as landfill. That process is to be pilot tested at a generating station of Indianapolis Power & Light Co.

Consolidation Coal Co. is working on a process that uses potassium formate in scrubbing sulfur dioxide from flue gases.

The formate is regenerated for recycling to the scrubber after the recovery of elemental sulfur. The process is being tested in a pilot plant at the Cromby station of Philadelphia Electric Co.

The roster of companies working at various stages of development in the technology of sulfur dioxide control—using a wide range of chemical scrubbers and solid adsorbents—reads like an industrial Who's Who. The technical ingenuity, diversity and sheer weight of the effort going into the current research and development push to eliminate sulfur dioxide emission justifies optimism that a practical solution will be found.

While the air pollution experts have been working on the problems of fly ash and sulfur dioxide, the water experts have been steadily advancing the even older cause of curbing stream pollution caused by drainage from coal mines.

The key to eliminating the mine drainage problem is to prevent the formation of acid waters in the first place, but the stumper for scientists and technicians in industry, government agencies and universities has been getting an exact fix on the mechanism of drainage formation. The fact that the occurrence and composition of mine drainage follow nature's variety all over the coal map has not made their

Charolais cattle graze on reclaimed mined land in the Midwest.

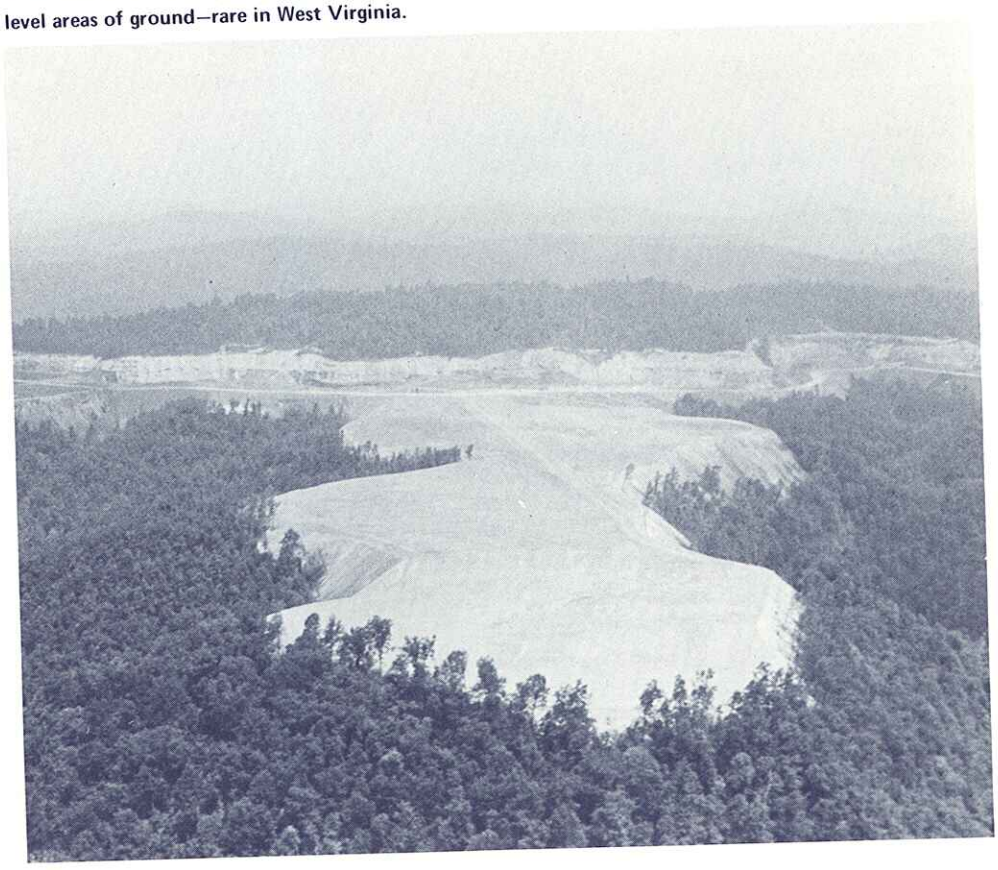
job any easier.

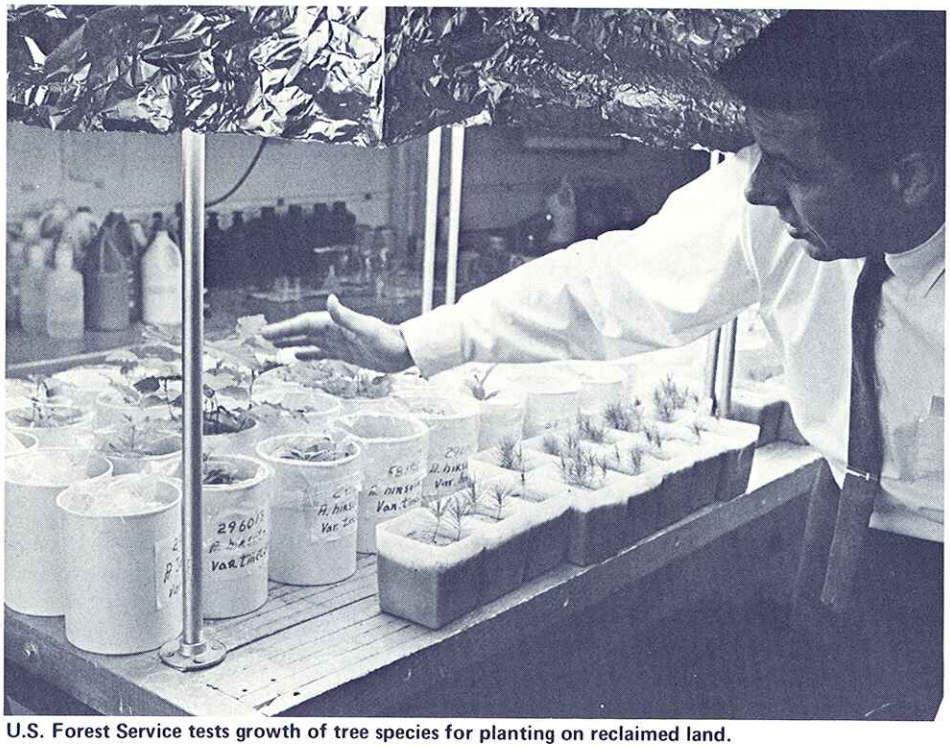
Drainage in underground mines forms from the reaction of subsurface and seeping surface waters with exposed coal and associated minerals, raising knotty problems of geology and hydrology in addition to chemistry. Researchers at Ohio State University are working to develop a mathematical model for predicting mine drainage, and others at Penn State University are investigating the use of natural hydrogeological systems to control its formation by diverting water flows and ways to neutralize acid drainage by use of alkaline ground water. Contrary to popular exploitation of the problem, all mine drainage is not acid—and even when it is it does not become a real pollutant until it changes the quality of the receiving water enough to make it unsuitable for defined uses.

To detect and map acid mine water flows, scientists are using such sophisticated methods as infrared photography from airplanes and chemical tracers infused in underground waters.

Since most mine drainage bleeds from abandoned underground mines, many years

New "head of the hollow" method of strip mining recovers all coal in hilltop seam, produces large, level areas of ground—rare in West Virginia.





U.S. Forest Service tests growth of tree species for planting on reclaimed land.

of effort have gone into development of effective methods of mine sealing. That is not as simple as boarding up a deserted building, and the idea is to keep something in—a chemical solution—and at the same time keep out an even more fluid intruder, the air that triggers and supports the troublesome chemical reactions. Deep in the earth as they are, mines still breathe, inhaling air through cracks and chinks and the smallest pores in the overburden in response to differences in atmospheric pressure.

Results of mine sealing techniques devised over the past half-century—including bulkheading, grouting air entries, injecting gel and slurry sealants and enlisting heavier-than-air vapors—have been mixed, depending on local conditions that frequently won't stay put, let alone mirror the conditions at other sites. Thus, a consulting engineer recently reported that construction of 92 mine seals at abandoned workings in Butler County, Pa., decreased mine water discharges enough to protect a receiving lake from pollution; at the same time, the Environmental Protection Agency reported that its big mine-sealing demonstration project at Elkins, W. Va., did not reduce oxygen concentrations in the mines or decrease the pollution load, although the acidity and sulfate levels were cut somewhat.

Where prevention is impossible, which is often the case in underground mines, the practical alternative has been control

and treatment of the flow to protect receiving streams from contamination. At active coal mines, drainage control is part of the operation and whatever water that cannot be excluded from the mine is regularly pumped out for treatment at chemical plants or lagoons. Coal companies are concerned about the natural phenomenon of mine drainage both as a pollution problem and as a burden on coal production, and they have put their money where their mines are.

Preventing drainage formation in underground coal mines is still the target of many research projects; however, in surface mining preventive procedures can be adapted to local conditions and have proved almost 100 per cent successful. Newer methods of surface mining and land reclamation are being designed to eliminate the problem—by forming disturbed overburden into a stable earth mass and rapidly establishing vegetative cover to control rainfall runoff to streams.

The complexity of mine drainage calls for multiple solutions to suit circumstances, and the processes for treating unproductive drainage discharges must be im-

Baling alfalfa on reclaimed strip-mined land near Lumberport, W. Va.

proved in the economic as well as the technical scale to make the cost-benefit ratio reasonable. Research organizations, including Bituminous Coal Research, Inc., are moving beyond the conventional lime treatment of acid waters to less expensive but effective neutralization with limestone. Iron in drainage waters is a related problem, and researchers are developing such new techniques as foam separation of metals, ion exchange and bacterial attack.

Hard-won but significant progress in mine drainage control indicates that the problem will eventually yield to the ingenuity of science and an enlightened public recognition that the national stake is not only clean streams but an urgently needed surge of coal power.

The mining of coal by removing the overburden presents another environmental problem. But land reclamation has proved more and more successful with each passing year. The coal industry has not only proved that reclamation can work, but is busy demonstrating it on a rising scale. Coal strip mining reached a high in 1971 but operators stepped up their reclamation pace by grading and planting a record 81,673 acres. That bounty of restored land included areas sown to grass and legumes, planted with trees, graded for parks, and filled with water to create lakes or ponds.

Regulation of surface mining on the state level is increasing. At least 14 of the 22 major surface coal-producing states strengthened existing statues, and Missouri and New Mexico each enacted their first reclamation laws in 1971 and 1972, bringing the number of state laws to 21. Reclaimers still found that they could do the best job of returning disturbed land to productive use working under local rather than national controls because the climate, geology and terrain of mined areas vary considerably from state to state. NCA has supported federal legislation to help states do a better job of regulation.

Bass caught through ice on Ohio strip-mine lake.

A few years ago, reclaimers were still plagued by the problems surrounding any new technology—not enough trained personnel, limited information and equipment and general resistance to new procedures. Today there is a growing corps of men trained in reclamation whose enthusiasm and expertise have convinced industry that good reclamation is both necessary and possible.

Time was when a stripping dragline with a 140-foot boom and a 7 cubic yard capacity bucket was thought of as big.

Oats grow hip-high on reclaimed mined land in Knox County, Ill.

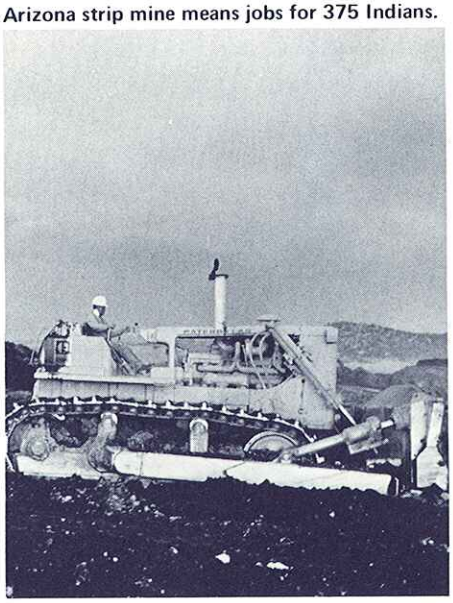
Now Ohio Power Co. is breaking coal ground with a walking dragline that has a 220 cubic yard bucket—which indicates how mining equipment, as well as the country's energy needs, have grown. Back in the days of the small shovel, many operators believed that a little grading, a few hand-planted trees or a scattering of legumes constituted a reclamation job. Today the reclamation is much more sophisticated, with plans for restoring the land often beginning before stripping shovels take their first bite of overburden.

Aerial maps, soil samples, modified mining methods and plant testing are all part of the preliminary planning. Later, the actual reclamation begins. Land is graded to state specifications, soil is analyzed to determine what vegetation it will support, and trees or tree seedlings are planted by one of the modern methods ranging from hydroseeders and heli-

copters to fixed-wing aircraft. (Hand planting is still necessary in some areas, but even this process has been streamlined by the newly developed planting gun.)

And still the research for new and better reclaiming methods continues. On the most sophisticated end of the scale, the environmental division of the Bureau of Mines is exploring the use of remote sensing devices in planning and evaluating reclamation. The project calls for using high-altitude aerial photography, black-and-white, color and infrared. These techniques would help identify areas that have been successfully vegetated, those that have been graded and those that have had no treatment at all. Still in the talk stages, the use of remote sensing could also aid reclaimers in determining water sources, survival of vegetation, locating acid pollution, pinpointing areas of compaction and detecting potential slumps.

Arizona strip mine means jobs for 375 Indians.



As for new mining methods, operators are experimenting with moving mountain overburden parallel to the highwall, keeping it on the operating bench rather than pushing it out over the outslope. Known as the "throw it over your shoulder" method, this innovation reduces erosion and the visual effects of the highwall while minimizing the possibility of slides.

Reclaimers are getting new equipment designed especially for their needs. As the area of mined land has increased, one problem has been keeping up with grading. A Kansas land reclamation contractor has developed a 21-foot-long angle blade that will move 4,060 cubic yards of mined land per hour compared with the 600 graded with a conventional bulldozer blade in comparable areas. In West Virginia a reclaimer with a mechanical bent is designing a slope scarifier that will produce a fine textured seedbed for outslopes. By creating small ridges or terraces on mountain slopes with this machine, reclaimers can insure better seed germination as well as reduce water runoff and erosion about 42 per cent compared with conventional grading practices.

Backing up the reclaimers is a cadre of men whose work in the lab and nursery makes for more predictable success. Reclaimers are constantly experimenting to discover new plants—even from distant lands—that will survive the often adverse conditions found on disturbed land. However, crown vetch, a local product, remains a reclamation favorite in some areas because of its earth-binding root system and its ability to restore nitrogen to exhausted soil.

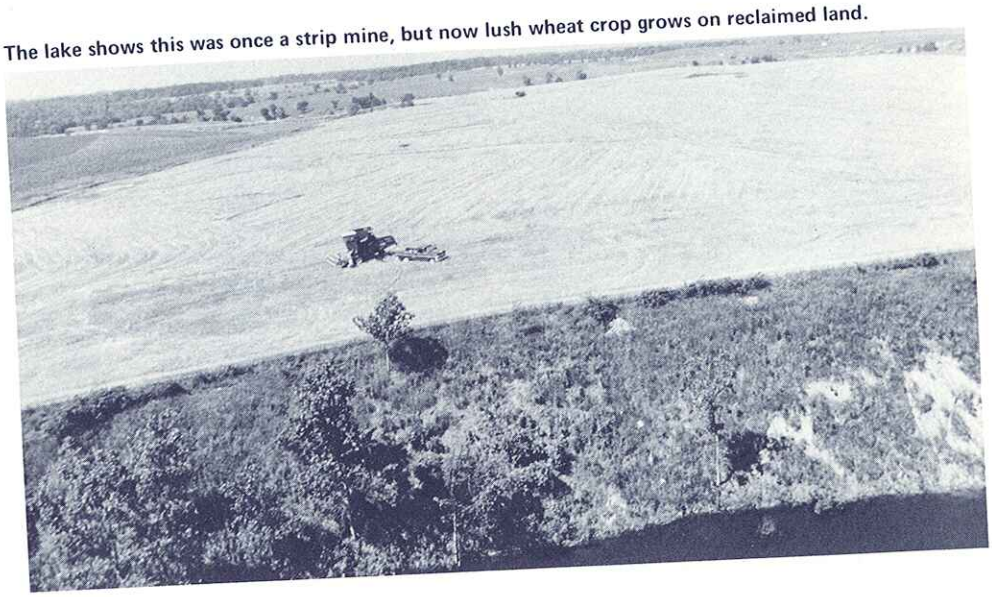
But not all the reclamation attention is focused on planting. Parks and lakes often appear on strip-mined land and, as the expanding mining industry makes more

and more restored land available, plans for such layouts are becoming more ambitious. The coal industry's drive for reclamation and, in many cases coal company land gifts to the public, have opened new vistas for the nation's 45 million dedicated campers. Cataloguing all the campsites available on reclaimed mined land is difficult, but a recent partial survey turned up some 26 well-established campgrounds in just eight states, ranging in appeal from the primitive spread of woods and lakes in Indiana's Greene-Sullivan State Forest to Ohio's Sallie Buffalo Park with four well-stocked lakes and shelter houses and the Windy Hollow Recreation Area in Kentucky, which provides electricity and water with its campsites.

There has been a lot of talk among conservationists about coal being bad for the environment. Its burning can pollute the air and extracting it from the earth can cause acid mine drainage and denuded landscapes. The coal industry, however, is not unaware of the problems. It has been seeking practical solutions to them for years—well before the now-popular push for environmental control came into vogue. While much of the research is paying off now, the industry recognizes there is more work to be done.

Coal is still our most abundant and economical source of energy in the United States. With the early excitement about nuclear power fading, environmentalists and industries alike are turning again to Old Reliable. What they see is a fuel that's taken on a new look, now that scientists have worked it over. The same qualities which have made coal one of the country's principal energy sources for decades still remain. It has drawbacks, just as all fuels do. But these are fading, and the coal industry is seeing to it that they fade just as rapidly as science and technology can come up with answers.

The lake shows this was once a strip mine, but now lush wheat crop grows on reclaimed land.



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