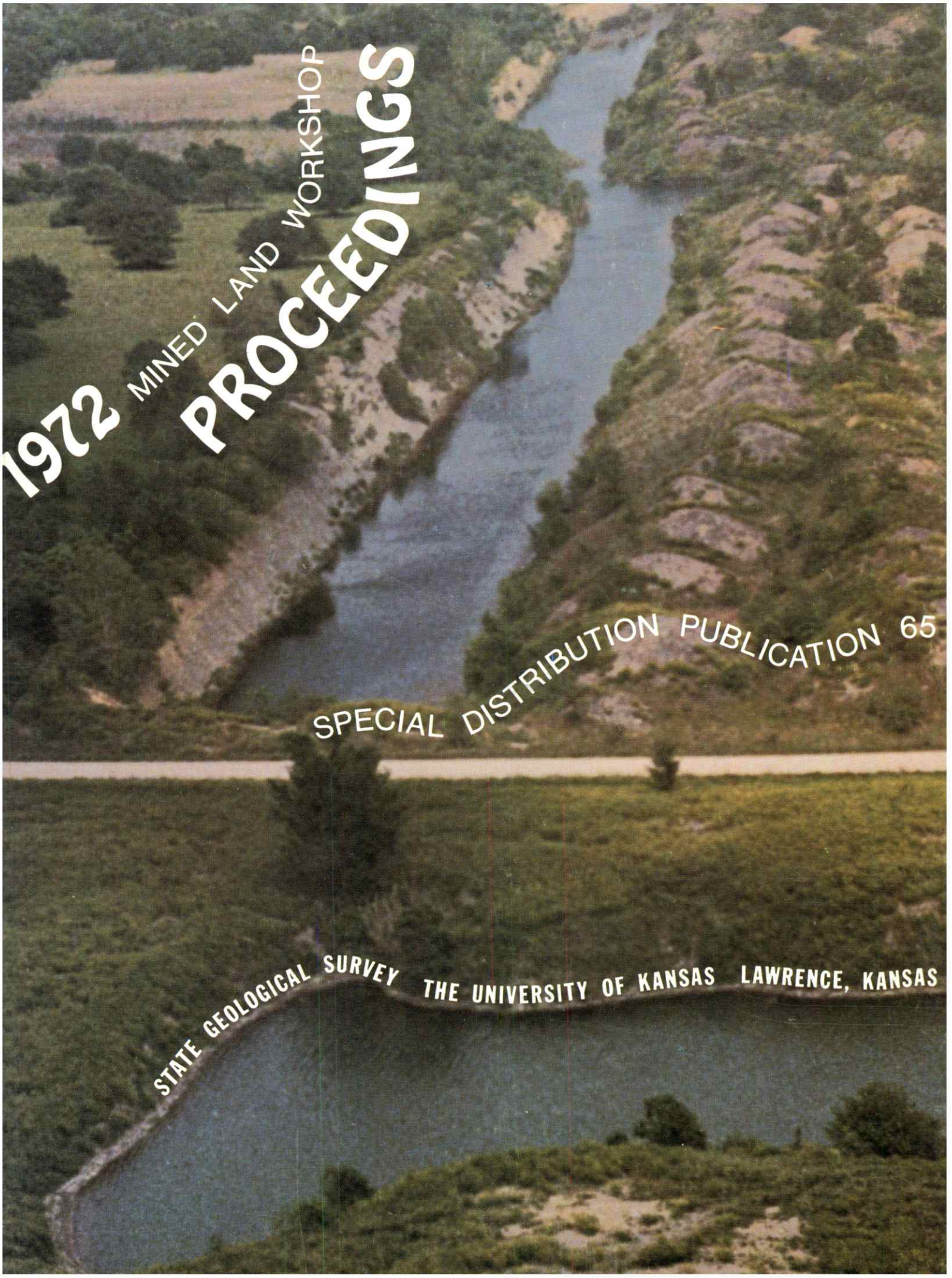
1972 MINED LAND WORKSHOP
PROCEEDINGS
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STATE GEOLOGICAL SURVEY THE UNIVERSITY OF KANSAS LAWRENCE, KANSAS

1972 Mined Land Workshop Proceedings

Mined Land Redevelopment Workshop

Holiday Inn
May 23-24, 1972
Pittsburg, Kansas

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State Geological Survey of Kansas
The University of Kansas
Lawrence, Kansas
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Contents

1972 Mined Land Workshop Proceedings

INTRODUCTION

On May 23 and 24, 1972, the Kansas Geological Survey, the Mineral Resources Task Group, and the Ozarks Regional Commission hosted a second workshop on mined land redevelopment.

In 1969, Governor Robert Docking appointed an Action Task Group and charged them with encouraging redevelopment of approximately 50,000 acres strip-mined for coal prior to enactment of the Mined Land Reclamation and Conservation Act of 1968, which provides for reclamation of land disturbed after January 1, 1969.

Aided by grants from the Ozarks Regional Commission to the Kansas Geological Survey, Kansas State University Cooperative Extension Service, and See-Kan RC&D, the Action Task Group has brought about cost-share leveling of 1,160 acres of disturbed land at 66 sites in 4 counties to demonstrate that reclamation is physically and economically feasible. Almost all of the sites are grassland demonstrations. The Agricultural Stabilization and Conservation Service's REAP Program is providing special funds to cost-share liming, fertilizing, and seeding of these areas.

The 1972 workshop featured a bus tour of redevelopment projects in Crawford and Cherokee counties. In addition to the tour, nine papers were presented touching on various aspects of redevelopment. Topics included agricultural, forestry, and recreational land use; hydrological properties of mined-land spoils; utilization of fly ash as a soil amendment; and methods of soil compaction.

Participants of the workshop viewed several demonstration plots prepared over the past year from which reclamation data was extracted. This data was also presented at the workshop.

The object of the workshop was to present as much factual data as possible, and at the same time allow for ample discussion and questions and answers. In order that the most benefit may be derived from this exchange, these proceedings have been prepared for workshop participants and other interested individuals.

RESULTS OF SOIL STABILIZATION TESTS WITH FLY ASH AND CALCIUM SULFATE SLUDGE

By Leon Boyce

A preliminary investigation of possible uses for sludge from sulfur dioxide removal systems indicates that soil stabilization could be a means of recycling this solid waste. A need to improve poor on-site soils due to the increased cost of removing it or replacing it with more suitable material, the possible favorable economic advantage of using boiler wastes compared to cement or lime, availability of fly ash with approximately 12 percent calcium oxide and sludge with about 25 percent unreacted limestone, and a greater awareness on the part of designers in regard to swelling and other undesirable soil properties has led to soil stabilization tests using fly ash and sludge. Calcium oxide in the fly ash and unreacted limestone in sludge, it was reasoned, would react with soil similarly to lime to improve soil properties.

Calcium sulfate sludge is formed when limestone is added to coal-fired boilers to control emissions of sulfur dioxide (SO_2). Tests reported in this paper were made with sludge resulting from the limestone slurry system for SO_2 removal, in which limestone slurry is injected into the flue gas and scrubbers as shown in Figure 1. It is expected that a new boiler being constructed jointly by Kansas City Power & Light Co. and Kansas Gas & Electric Co. at La Cygne, Kansas, will produce about 800,000 tons of sludge annually by this process, starting in late 1972. Fly ash utilized in tests reported in this paper was produced in a pulverized coal-burning boiler and collected in an electrostatic precipitator.

Other SO_2 removal systems utilize a process in which powdered limestone is injected into a high-temperature zone of the boiler; fly ash, calcium sulfate, and excess limestone are removed in a scrubber as a sludge after the gases leave the boiler. Sulfur dioxide removal systems with limestone addition generate sludge comprising approximately 50 percent calcium sulfate, 25 percent excess limestone.

Increased volume of solid waste generated by coal-fired boilers results from increased burning of coal and production of ash due to lack of natural gas and oil; increased use of electricity and production of ash due to increased population, changing life styles, etc.; and increased ash due to high-efficiency collectors required to meet pollution standards.

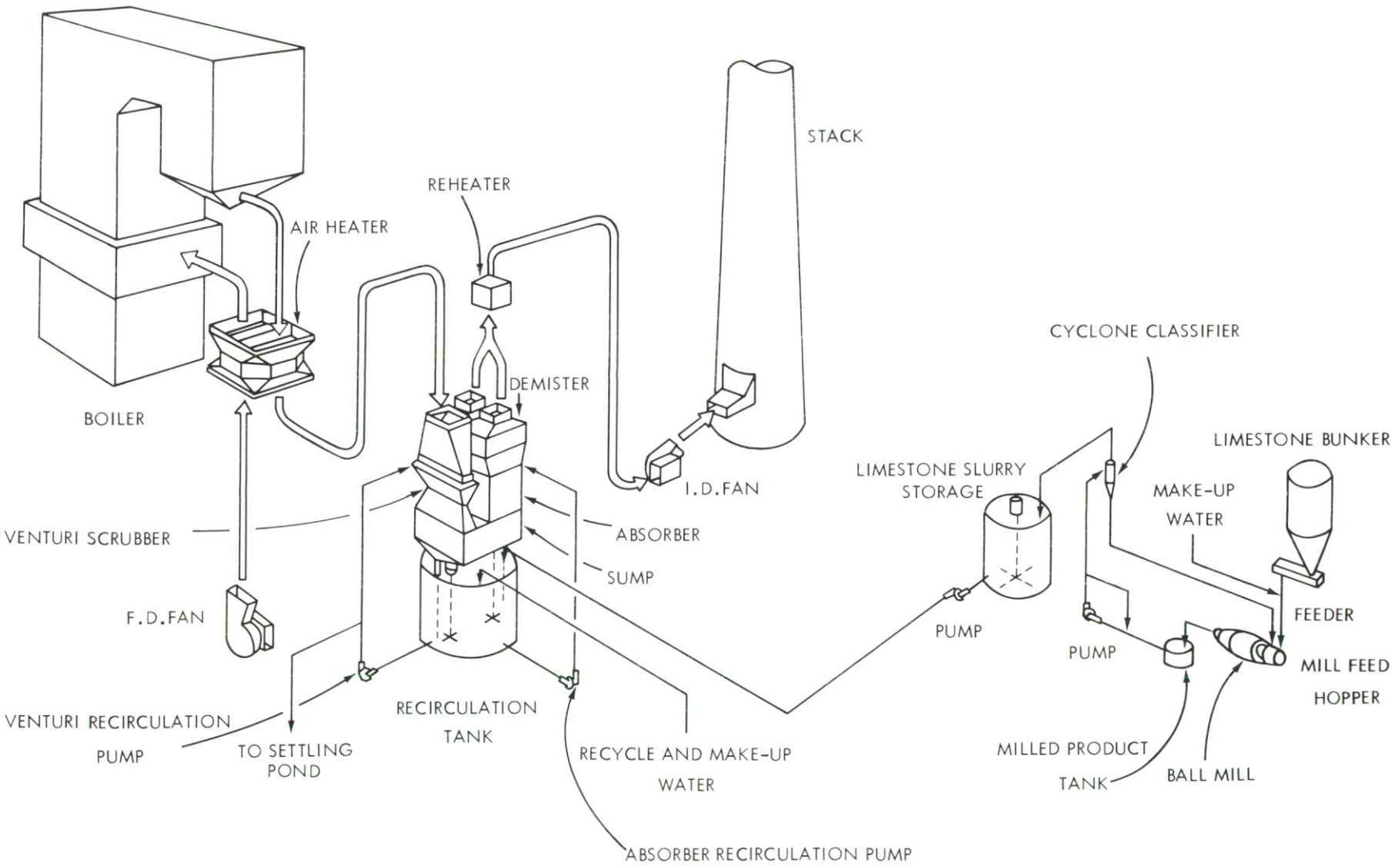


FIGURE 1.—Limestone slurry system for SO_2 removal.

The need for an inexpensive method of stabilizing soil and the increased production of fly ash and calcium sulfate sludge prompted research on the use of solid waste from coal-fired boilers to improve soil properties. Much work and research on soil stabilization, which has been defined as treatment of soil to improve strength and other properties,[1] has been carried out using lime, cement, and fly ash in various combinations on various soils. Results presented in this paper involve tests conducted on a highly plastic clay stabilized with fly ash and calcium sulfate sludge. Results of tests conducted with lime are included as a basis for comparison.

Figures 2 through 5 show soil properties of a typical highly plastic clay before and after modification with lime, fly ash, and sludge.[2] The improved soil properties indicated by this test data are reduced plasticity and increased compressive strength. Immediate improvement of soil properties by fly ash and sludge addition is attributed to improved gradation of the fine clay by the addition of coarser material. The improvement of soil properties with time as evidenced by increased compressive strength is believed to be due to pozzolanic reaction between the soil and fly ash or sludge.

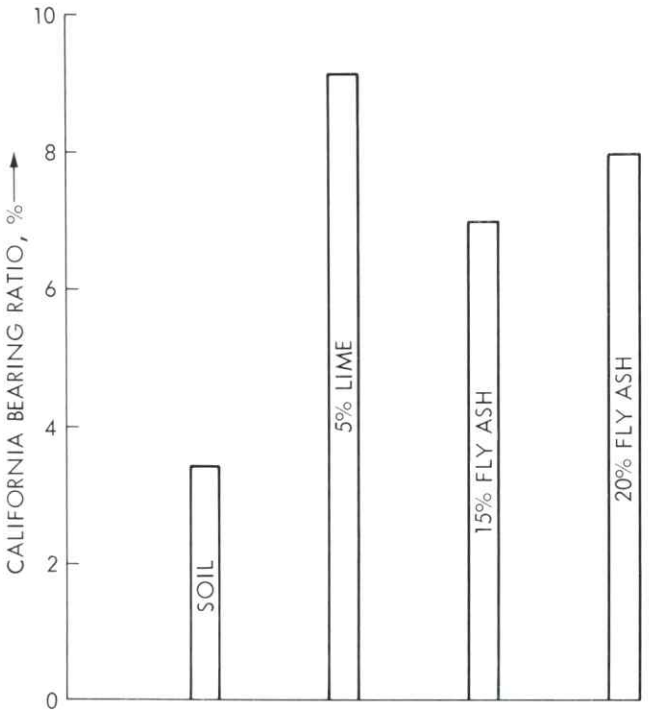


FIGURE 2.—Influence of fly ash and lime additives on soaked CBR values, Martin City, Missouri, soil. Note: All samples compacted to 95% of optimum dry density at optimum moisture content determined by ASTM D-698.

[1] *Central Electric Generating Board Pulverized Fuel Ash Data Book.*
[2] Test data reported by Woodward-McMasters, Inc., Kansas City, Missouri.

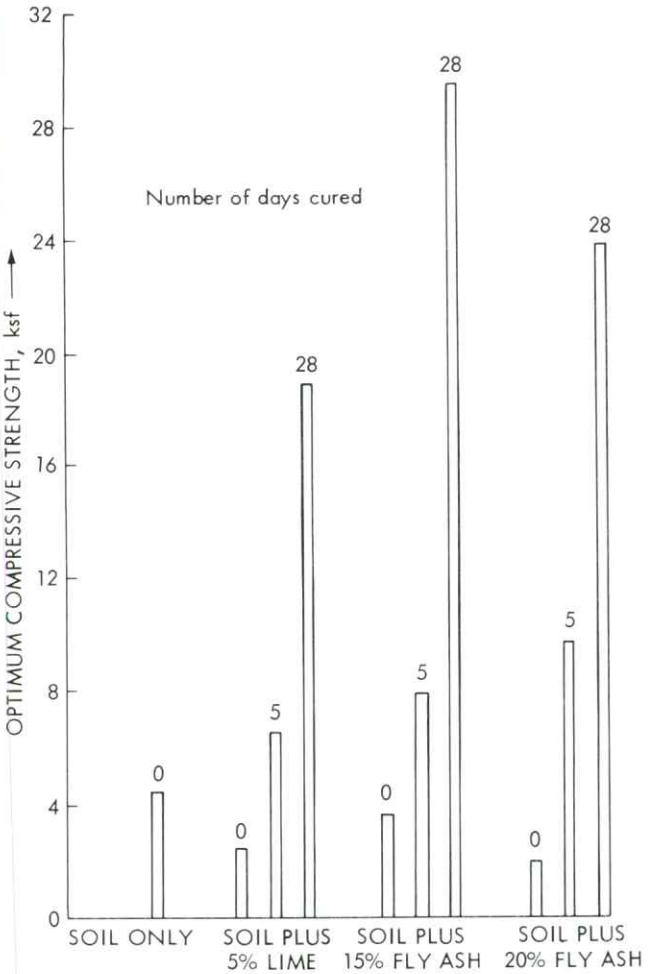


FIGURE 3.—Influence of curing soil-lime-fly ash mixture.

The application of this soil stabilization technique to mine spoils is suggested by the similarity of materials involved. Shales, dominant in certain mine spoils, rapidly disaggregate into clay-sized material which it is believed can be improved by the addition of fly ash or sludge.

Foundation design in mine spoils, like any design, should be based on a knowledge of soil involved. Although most design allows for judgment and experience, a soil investigation is recommended for mine spoils. Some of the problems which could occur if conventional designs were arbitrarily used are excessive settling of all or part of a structure from consolidation of the mine spoil due to the increased load; excessive settling due to punching or rotational shear failure of the soil; settling or heaving due to moisture change of the soil; earth slides or movement due to unstable soil.

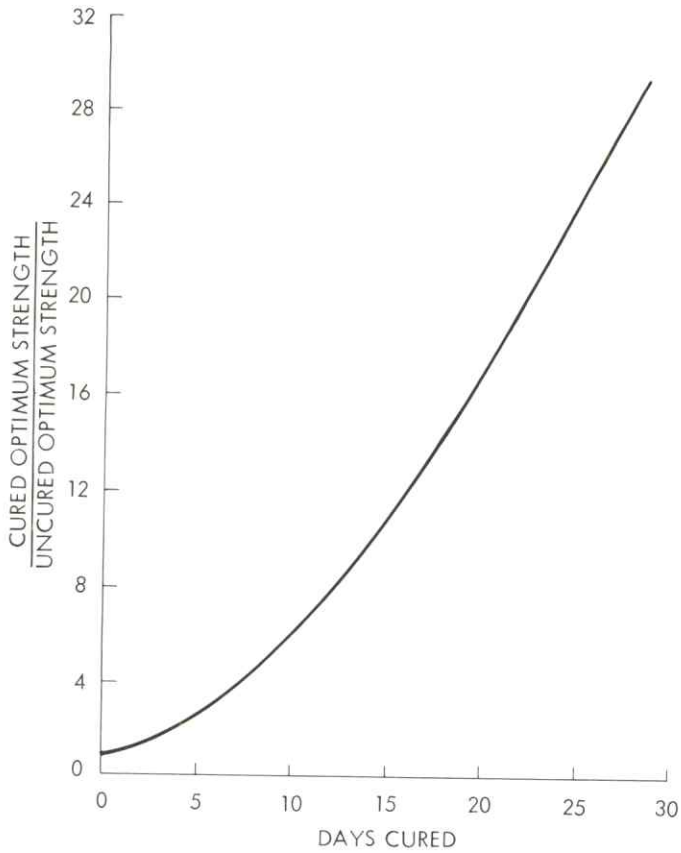


FIGURE 4.—Strength gain of sludge (15%) and Martin City, Missouri, clay.

When construction on mine spoils is anticipated the following recommendations should be considered: (1) establish contours and surface drainage to promote stable ground water and moisture conditions; (2) allow time for spoils to season, as settlements of 3 to 8 percent[3] should be expected; (3) make a soil exploration with appropriate borings and tests to determine necessary soil properties for design; (4) use special design if required based on expected settling, bearing values, etc., from the soil exploration. Consider matt footings, spread footings, or piers; (5) use judgment in design based on required performance and experience with foundation design in unconsolidated river and glacial material and landfills.

[3] Terzaghi, K., and Peck, R. B., 1968, *Soil Mechanics in Engineering Practice.*

Soil stabilization tests involving the addition of fly ash and calcium sulfate sludge to various soils indicate that the use of such solid waste improves soil properties, due to better gradation and a pozzolanic reaction of the fly ash and sludge with the soil. Further tests and trial installations are necessary to verify this conclusion. Improved methods of mixing fly ash and soil and the establishment of economic guidelines will be necessary to encourage the use of this technique for soil stabilization.

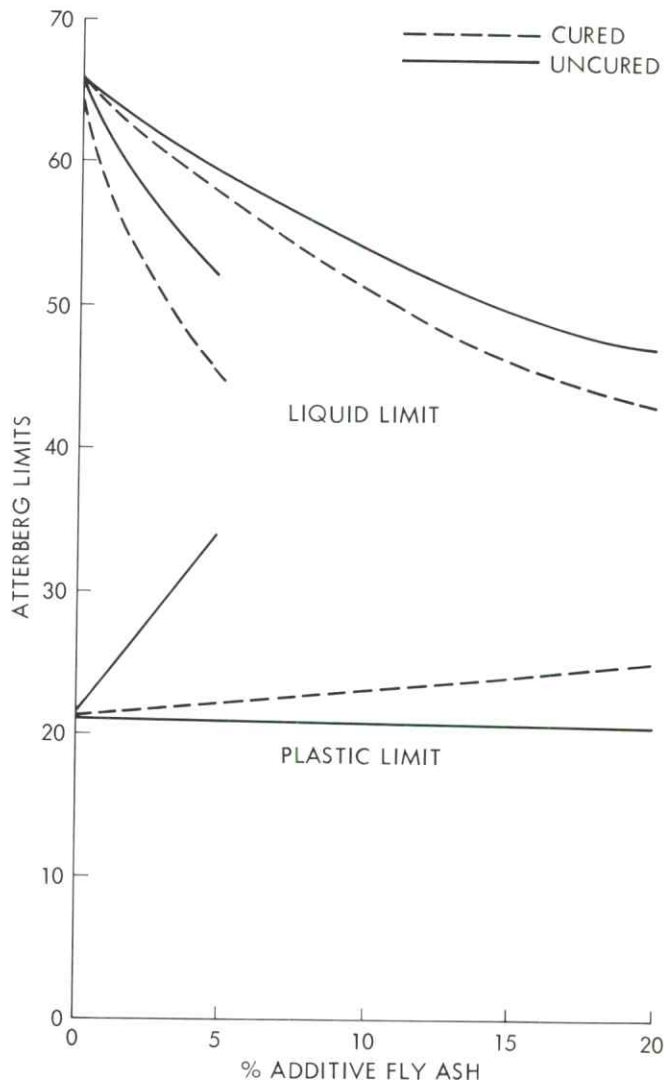


FIGURE 5.—Atterberg limits for Martin City, Missouri, soil.

SUITABLE PLANT MATERIALS FOR VARIOUS USES ON RECLAIMED MINED LAND IN SOUTHEAST KANSAS

By Leonard Jurgens

Since about 1960, Soil Conservation Service personnel in cooperation with the Pittsburg and Midway Mining Company and the Cherokee County Soil Conservation District have been conducting plant materials trials—on a sustained basis—on land mined for coal in Cherokee County, Kansas. Over 50 species and varieties of grasses, legumes, shrubs, and trees have been seeded or planted with attention given to plants suitable for grazing, erosion control, beautification, spoil conditioning, recreation area planting, and wildlife habitat improvement. All plantings were made on partially smoothed to smoothed spoil with no soil amendments added. By state law, all land in Kansas mined for coal after January 1, 1969, has to be smoothed to a rolling terrain or a minimum percentage of the land has to be returned to a flat surface. In addition, revegetation must begin within a given time period after the smoothing operations have been completed.

SPOIL MATERIAL

After land smoothing operations in mined areas have been completed, the surface material encountered is a variety of shale materials originating from depths up to 60 feet. In some areas limestone is also encountered. During smoothing operations, larger rocks are buried to facilitate seedbed preparation and seeding.

Shales vary as to their composition and makeup. As weathering occurs, shales that contain an abundance of pyrites release sulfuric acid which lowers soil pH to as low as 2.8. Affected areas are frequently referred to as "hot spots" since vegetation cannot be established on these areas by conventional methods. In a few trial areas the weathered shale showed a 7.0 pH reading. Practically all plant material trials were conducted on shale materials (pH 4.0 to 6.0), with frequent "hot spot" areas. All pH determinations were made by the Hydron-Ion paper test.

As pH changes to a more acid condition, plant nutrients such as nitrogen, phosphorus, potassium, and calcium needed in large quantities by plants are not as readily available.[1] Some of the micronutrients also follow this trend. Just the reverse is true with iron and aluminum. These increase in availability to the plant as pH changes to a more acid condition. With increasing availability levels, iron and aluminum become toxic to plants. This toxicity decreases total growth and forage production and if severe enough, results in death of the plant seedlings germinating under such conditions.

Generally, spoil materials as a group are very well drained and lack water-holding capacity when first exposed. As weathering occurs and shales are broken down into smaller particles, they become quite vulnerable to wind and water erosion. When vegetative cover is established in sufficient quantity, spoil materials gradually improve in physical condition due to the weathering and the favorable action of the plant residue. Vegetative cover also prevents erosion and lowers surface temperatures. Many of the shales are dark gray to black in color and absorb heat readily. South- and west-facing slopes are subject to high summer temperatures on the surface until adequate vegetative cover is established.

Establishing vegetation on spoil materials depends on the tolerance of vegetation to low pH and associated problems and tolerance to the high surface temperature of spoil materials combined with the corresponding lack of rainfall during critical periods, and the lack of water-holding capacity of the spoil materials when first smoothed.

Average annual rainfall exceeds 40 inches in Cherokee County, although periods have occurred when no rainfall has been recorded for a 6- to 8-week period during the summer months. These periods without measurable rainfall during the growing season occur almost annually.

GRASSES

Fifteen grass species have been tried on strip-mined areas in Cherokee County, including varieties of switchgrass and three varieties of indiangrass. The most consistent establishment has been achieved with Blackwell, Caddo, and Kanlow switchgrass. These three varieties of switchgrass have been established on areas with a soil pH as low as 4.0. Initial switchgrass stands frequently were sparse due to surface crusting while seeds were germinating and high surface temperatures of the spoil material during the critical establishment period. Established switchgrass plants have been able to produce viable seedlings to fill in the barren areas except on "hot spots" with a pH of 2.8-3.9. Kanlow switchgrass also establishes and spreads readily on shorelines around pits that retain water.

[1] S.C.S. Kansas Technical Note AGRONOMY KA-14, *How Soil pH Affects Availability of Plant Nutrients.*

At pH 5.0 or higher, Kaw big bluestem, Aldous little bluestem, Cheyene indiangrass, Osage indiangrass, El Reno sideoats grama, and Barton western wheatgrass can be established. All these species demonstrate an ability to fill in areas suitable for plant growth by self-seeding or by rhizome activity.

One of the best plantings of grasses obtained to date is a mixture of Blackwell and Kanlow switchgrass, Cheyene indiangrass, Kaw big bluestem, and Aldous little bluestem. These species are quite compatible and provide excellent forage for livestock. They also provide suitable habitat for small game, as well as upland game birds and deer. Fertilizer is not needed for maintenance.

Elkan bluestem, caucasian bluestem, weeping lovegrass, and bermudagrass are introduced warm season grasses. With the exception of weeping lovegrass, these species have been readily established. Elkan bluestem and caucasian bluestem show excellent initial establishment and survival, but without fertilizer or soil amendments they gradually diminish in quantity and vigor.

The introduced cool season grasses, Kentucky 31 fescue and Southland brome, can be established on areas with pH as low as 5.0; however, a pH of 5.5 improves success considerably. Without fertilizer or soil amendments, Southland brome has shown only low vigor. Kentucky 31 fescue has more vigor and establishes readily on suitable sites. Fertilizers and lime are needed to obtain adequate cover with Kentucky 31 fescue. It is quick to establish and is an excellent grass species for use on areas to be used in an intensive management program.

LEGUMES

Of the 11 legume species which have been tried, Emerald crownvetch, Cicer milkvetch, and Illinois bundleflower show excellent growth and spreading ability on strip-mined land. Emerald crownvetch is so aggressive that unless it is kept in check by grazing, mowing, or spraying with herbicides it will crowd out all other grasses and legumes and form a pure stand of crownvetch. It even has the ability to move in on "hot spots" once it is established on the periphery of these areas. A pH of 4.5 or better is needed before Emerald crownvetch, Cicer milkvetch, and Illinois bundleflower can be established. Prostrate lespedeza, Japanese lespedeza, Wooly lespedeza, Serecia lespedeza, birdsfoot trefoil and lespedeza bicolor have been established on spoils with pH 5.0-5.5. Where not in competition with other species, they maintain themselves readily; however, birdsfoot trefoil, which gives an excellent initial stand, thins out rapidly after the second or third growing season. Rhetan Kudzu, established by planting of crowns, is providing excellent ground cover on some strip-mined land in Cherokee County. Showy partridgepea, an annual legume, showed poor initial establishment and failed to reproduce from seed the second year after planting.

SHRUBS AND TREES

To date, six different shrub species have been planted; Cardinal autumn olive has been the most successful. Although it is not a legume, it has the ability to obtain nitrogen from a nitrifying bacteria which grows with this species in a symbiotic relationship similar to that of legume species. Stands on pH 4.0 to 4.5 spoils have been obtained consistently with this species. Arnot bristly locust, a shrub legume that grows to a height of 8-15 feet, shows promise on all areas tried to date. This species has been growing 2 years in one area and should spread from seed and root sprouts if successful.

European black alder and another non-legume plant also have symbiotic relationships with nitrifying bacteria and do well on spoils with a pH of 4.5 and higher. Tartarian honeysuckle and Amur honeysuckle, both bush types, also tolerate pH's as low as 4.5. Silky dogwood has survived on some areas but has not shown any significant growth since being planted. Woodward winterberry, first planted in 1971, has been established; however, its growing and survival ability has not been determined.

A number of tree species, principally conifers, have been planted over a 3-year period. From preliminary indications, conifers should not be planted until other adequate ground cover is established that will prevent wind-blast damage from the weathering shale. The initial loss percentage of plantings on recently worked spoils was higher than that on areas of established vegetative cover. Recent plantings have not included broadleaf species.

CONCLUSIONS

Pure stands of climatically adapted warm season grasses such as switchgrass, big bluestem, little bluestem, indiangrass and sideoats grama can be established on newly smoothed strip-mined land. A mixed stand of these species is in all respects better than pure plantings if no fertilizer or soil amendments are used. Barton western wheatgrass will give essentially the same result as the warm season grasses and would be an excellent addition to a warm season grass mix. Kentucky 31 fescue and Southland brome produce

rapid initial cover, but will not maintain themselves unless fertilizer and soil amendments are added on a regular basis. Where adequate fertility is maintained, Kentucky 31 fescue is an excellent species for cool weather grazing. Observations of Southland brome indicate that it is not as well adapted climatically to southeast Kansas as is Kentucky 31 fescue.

Illinois bundleflower is an excellent legume to be planted in conjunction with a warm season grass mix. Emerald crownvetch is excellent for erosion control, but has not been tested for grazing either in pure stands or mixed with other grass species. Cicer milkvetch provides excellent ground cover but does not compete quite as well as Emerald crownvetch.

Cardinal autumn olive and Tartarian or Amur honeysuckle are recommended for beautification and for broadening wildlife habitat. These shrubs will grow in conjunction with grasses and legumes. Arnot bristly locust and European black alder show promise for use in some situations.

MINED LAND REDEVELOPMENT AS A DEMONSTRATION. WHERE DO WE GO FROM HERE?

By E. L. Stewart, Jr.

In his state of the Union message to Congress and the nation last year, President Nixon presented a challenge to all of us—the challenge of building for tomorrow. Personally, I view the program of the Ozarks Regional Commission as one way of accepting the President's challenge. We are in business to coordinate federal, state, and local government efforts and also private programs, thereby providing a climate for private enterprise to flourish so that employment opportunity and increased incomes are available to the people. These activities, in effect, are an *alternative to welfare*. This program can serve as an *alternative to migration* of our people to urban centers.

The Ozarks Regional Commission is a federal-state-local partnership arrangement formed to promote the economic growth and development of the 3 million people living in the 205-county Ozarks region which includes 44 counties in Arkansas, 37 counties in Oklahoma, 9 counties in Kansas, and all of Missouri.

The governors of the four states and a federal co-chairman, appointed by the President, are the members of the Commission. A state co-chairman is selected on an annual basis from among the respective governors. The Commission is unique because it is the only federal program in which state governors have a vote in approving programs and projects.

The economic development goal of the Ozarks Regional Commission is to close the "income gap"—the difference between per capita income in the region and average per capita income of the nation. In 1960 the gap between personal per capita income in the Ozarks and that of the nation was over $840 ($1,372 compared to $2,215). This indicates a rate of underdevelopment, unemployment, and underemployment of 33.3 percent as compared with the rest of the country.

With a 1960 population of 2,696,878, the Ozarks region's total income gap amounted to $2.2 billion annually in 1960. By 1969 it was estimated that the region's income gap increased to $1,060 per capita, a total of $3.1 billion per year.

The loss to the people of the region may seem to be a condition the nation can allow to exist; but, the nation suffers great losses from this income gap. In 1967, by virtue of this underdeveloped region, the tax loss to the federal government alone was at least $850 million per year. Community, county, and state governments are even more affected in that they are unable to provide the standard of services necessary to support modern industry. Thus, a cycle of underdevelopment exists with major continuing costs and losses.

The Ozarks Regional Commission wants to:

(1) Help develop *employment opportunities* to generate greater personal income through wages and salaries.

(2) Help develop *resources* to generate other forms of personal income. This includes markets for agricultural production.

(3) Help develop *educational and training opportunities* so that Ozarks people can increase their earning power.

(4) Help build the *community facilities* deemed necessary to attract industry and commerce.

In the law which established the Ozarks Regional Commission, Congress and the nation's Chief Executive asked us to perform eleven functions. Included among the eleven were these mandates: "promote increased private investment in such regions, and provide a forum for consideration of the problems of the region and propose solutions. . . ."

At this time, the Ozarks region appears to be on the threshold of vast economic expansion as the result of many wise governmental policies and decisions. This is especially true in view of the opening of our region to opportunity for increased foreign and domestic trade as the long-awaited McClellen-Kerr Arkansas River Navigation System is completed. In a much smaller way, the creation of the Ozarks Regional Commission is a wise governmental decision which can aid the economy of our region.

Economic development is indeed a massive undertaking which requires imaginative planning and dedicated commitment on the part of state and local government, federal government, and most importantly, private enterprise. Moreover, *it is mandatory that efforts be coordinated* so that the people can be assured of not only efficient, but effective, marshalling of always limited resources.

In my opinion, the Commission is not the only vehicle to accomplish the mission. Revenue sharing offers the greatest hope and opportunity to bring the greatest resources possible to bear on the problems at hand. Revenue sharing, a broadened tax base, reallocation of state and local resources are all future prospects; but the Commission exists today and by its very nature offers hope to the people of this region.

The first requirement facing us was to develop plans that have practical credibility. As a result of 3 years of intensive work, the Commission recently published and distributed to other federal agencies a comprehensive regional plan and program for economic development of the Ozarks. Interesting aspects of the plan include:

A *community profile data bank* which will enable public administrators, businessmen, engineers to quickly assemble vital information on any community in the Ozarks on which to base private and public investment decisions.

A truly unique *manpower availability data system* which will relate professional, paraprofessional, and other skills to existing and expanding job opportunities.

A *priority ranked schedule of essential public investments* which will have regional impact and which are a part of the Ozarks area public investment plans of each of our states.

The Commission has recognized that the construction of a long-range plan and program is in effect a continuing process, and that all projects could not be delayed until each "brick" was complete in our planning effort. We have, however, tried to fit each ongoing project into our overall regional strategy as we saw it developing.

First by hunch, then confirmed by a rather large and expensive study, it was determined that the Ozarks region was woefully lacking in vocational technical education. Unemployment was not a major problem in the region, but rather underemployment appeared to be a primary reason for low income; these vocational training facilities became the number one priority for Commission investment. A breakdown of Commission appropriations thus far includes:

27 vocational centers	$6.0 million
47 industrial parks	5.0 million
13 airports	1.8 million
4 hospitals	0.5 million
2 recreation developments	0.4 million

These facilities represent about $14 million of Ozarks funds, roughly 27 percent of the total cost of these projects.

Three areas of major concern to the Ozarks Regional Commission are roadways, waterways, and demonstration projects. The decisions for action lie elsewhere—all the Commission can do is call attention to the problems and try to push for answers.

For far too long, roads have been authorized and constructed on the basis of sufficiency or traffic count. For example, the Interstate Highway System, great achievement that it is, has become almost a mythology whose assumptions it is perilous to challenge. The fact is that federal-state financing of road systems has too often neglected developmental requirements in the urgency to answer what appears to be sufficiency needs. The Ozarks region is a case in point. The region has fairly good major highways east to west, but these east-west connections are based on historical patterns of need not necessarily related to the economic development of the region. The lack of a modern north-south road corridor connecting the Ozarks region to the new markets of the Kansas City area and the southeast is agreed by all who have analyzed the situation to be a prime developmental setback of the four-state region. Admittedly, the road will cost hundreds of millions; admittedly, the questions of specific routing and financing are extremely difficult; admittedly, construction may be long in coming. Each of these factors will eventually be solved, but there is extreme reluctance in the governmental bureaucracy toward the concept of the developmental roads of the future; that these people hang their entire program on sufficiency needs imperils efforts to create new regions for development.

Congress, to some extent, shares the view of the Commission, as evidenced by its recent passage of new highway authorization requiring that the Department of Transportation take into consideration de-

velopmental highway plans of regions such as the Ozarks. This is a major step forward, and the Ozarks Commission will continue to fight for the economic development concept in transportation.

All of us in the Ozarks region are so aware of the Arkansas waterway that I need not remind you of its tremendous potential in the economy of the Ozarks and the entire nation, if wisely utilized. Very early the Commission took an active interest in projects which seek to assure that this major new national resource have maximum benefits with the least amount of harmful fallout from its economic exploitation. The Commission has enlisted the aid of the Corps of Engineers in laying out a plan of studies and projects which will best help the utilization and protection of lands lying along the waterway. We have financed the organization and operation of a non-profit corporation with board members appointed by the governors of Arkansas and Oklahoma and the federal government. This group is coming forward with recommendations on such critical matters as how to proceed toward effective and equitable zoning and planning along the waterway—i.e., land use.

The third area of concern involves the follow-up or execution of demonstration projects. The demonstration authority is relatively new to our law and, of course, its purpose is to teach by doing. Participants of the 1972 Mined Land Redevelopment Workshop have toured a most successful demonstration—taking used land and revitalizing it! There is an old saying: "Land is valuable because God will create no more." The reclamation project in southeast Kansas is the closest thing to land creation one is likely to see!

But now that land reclamation has proven feasible, what happens? Of course, the Commission hopes that more land will be reclaimed and that the lessons learned here can be used by others. However, nothing of real significance will happen toward reclaiming the 144,000 acres of mined land in the Ozarks region until legislation is passed allowing mined land reclamation to receive the same financial benefits and programs as other existing resource conservation programs.

With your effort and help, together we can be successful in stemming the migration to the urban centers and, indeed, in reversing it! *Make rural America a better place to live!*

THE LEISURE INDUSTRY IN ITS TOTAL CONCEPT

By Jim Edwards

Leisure is destined to play an important role in Kansas and the Ozarks region. Americans are working fewer hours per week and earning more; they are retiring earlier. The business executive needs more exercise than turning his swivel chair, and today's factory worker needs relief from the monotony of coupling part A with part B—man's cultural interests are groping for satisfaction. What does "America at play" mean to an underdeveloped area? The economic potential of the leisure industry is great. Opportunities and benefits are plentiful.

THE BENEFITS OF LEISURE INDUSTRY

Government and private industry strive to increase the leisure industry within the community, region, or state because it is attractive in many ways to almost any area.

From the leisure industry are derived important social benefits, e.g., better domestic and national relations. Market surveys point out the importance of people in selection of a tourist destination, and the importance of personal contacts resulting through tourism. Aided by the news media, new transportation modes, and the enthusiasm of migrating local populace for the area's attractions and scenic beauty, the growth potential of the Ozarks region is expanding as vacation and business demands steadily increase.

Many opinions have been expressed concerning government and private roles in the expansion of the leisure/recreation industries. The most agreed-upon premise is one of economic potential—the potential to make a profit and serve the demand caused by an ever-increasing, affluent society. Modern society is placing less emphasis upon producing physical products and more upon intangible services, especially education, leisure, and health.

Historically, advancing nations have shifted employment concentration first from extractive industries to manufacturing and construction, and later to services. In part, this has been due to lower relative prices resulting from mass production of goods. In greater part, however, it is due to the allocation of rising personal incomes to more services and to leisure-time activities. This trend indicates that attention should be given to development of service industries. The term "leisure industry" means that recreational services are being sold, both to residents and non-residents. When such services are sold heavily to non-residents, they constitute "exports."

EXPORT-BASE INDUSTRY CONCEPT

Producing goods and services in a given region and selling to purchasers from other regions are export activities. The key to identifying a given industry as an export industry is to establish where the purchasers come from. If they are from outside the region, then the industry in question is part of the region's export base; but if the purchasers are from the region, the industry is part of the residentiary sector. The expansion of export industries provides the major focus of job- and income-creating economic development activities. In an interdependent modern society of regional, national, and world markets, export activities are the "base industries" or economic foundation for the existence and expansion of a region. Residentiary industries serve local residents and thus depend upon the growth of the base industries. The leisure industry is, in many ways, the ultimate export industry.

All industries are not equal in their importance. Development assistance to private industry should concetrate on the export-base industries. Once it becomes clear that the development focus is on attracting more income into an area, it then becomes possible to speak of the leisure industry and its elements, the "retirement industry," the "second-home industry." Likewise it becomes important to recognize that the location of such things as continuing-education, medical, and research centers attracts additional income.

In 1969, leisure industry expenditures amounted to $527 million within the State of Kansas. This volume of income accounted for $31 million in taxes for state and local units of government. All levels of government benefit from the leisure industry tax dollar. The leisure consumer not only pays tax directly in the form of sales, gasoline, cigarette, etc. taxes, but he helps pay real estate, business, and income taxes paid by business firms from customer revenues.

The $527 million of expenditures and the $31 million of taxes does not reflect the turn-over of these dollars within the local economy. The multiplier effect adds another dimension to the impact that export-base industries can have on local economy. A recent Michigan State University report indicates that recirculation of each direct dollar of expenditures by visitors for food, lodging, transportation, and merchandise among local businesses and employees in the host area adds an additional $1.00 to the economy. While the income multiplier effect is not as great for the leisure industry as it is for many manufacturing industries, it still adds up to a significant value—specifically, $527 million added to the $527 million of direct expenditures by visitors to the State of Kansas in 1969.

LEISURE IS NO PANACEA

The leisure industry, however, is not entirely a panacea for individuals interested in stimulating a region's economy. The visitor is often unwelcome to many local citizens who deplore overcrowded public parks and camping grounds and the stream of empty cans, bottles, and paper towels left by thoughtless visitors. To others, the attractions and service facilities built to serve the leisure industry spoil the natural beauty of a scenic area.

Even economically, leisure is far from an ideal industry. The peak demand for facilities needed to support the leisure industry is relatively short, which leads to either an extremely high price level or low return on investments. Although the leisure industry generates a considerable amount of employment, the employment is generally considered to be of poor quality. Many of the jobs are low-paying and menial, and the seasonality generates a very unstable employment pattern that is neither socially nor economically as beneficial as year-round employment.

Nevertheless, a well-planned leisure industry program is a real economic benefit to a region. The jobs may be of low-pay quality and seasonal, but still they may provide supplementary income for otherwise idle workers, thus raising the family income level. The seasonality of the leisure industry provides employment for our young people in the summertime when it is most needed. Seasonality can be balanced at least partially by the development of winter sports and off-season convention and meeting activities. The economic benefits of visitors are considerably enhanced if leisure demand is concentrated and if the host areas are capable of locally producing many of the goods and services purchased. This leads to a concept that leisure should ideally be focused in a series of destination area complexes rather than being dispersed.

Careful environmental planning and control can alleviate many of the environmental problems of the leisure industry. A community can retain its natural beauty while providing necessary accommodations and facilities for visitors.

There are a number of reasons to suspect that an ongoing leisure industry can be a magnet for other desirable developments. If families like an area well enough to suffer the rigors of camping in order to visit an area for a few days during the year, many of these same folks can be attracted to the area for longer term stays. Vacation or second homes, with a median occupancy of almost two months per year, bring

perhaps 10 to 15 percent of total family spending to an area. When families ultimately retire to their vacation or second homes, virtually all of the family spending benefits the host area.

Many industries, particularly those in the high-technology and service sectors, are locating where the traditional location factors—product transportation costs, labor pool availability, raw material and energy availability—are at a minimum. These industries have chosen to locate in a more leisure-oriented climate because living conditions in such areas are extremely attractive to the increasingly mobile professional and technical specialists. Much of the growth of southern California, Arizona, and Colorado can be ascribed to industry locating in these areas in order to attract top personnel.

Thus, there are definitely positive answers to the question, "What are the benefits of a leisure industry?" Each visitor is worth approximately $15 per day in direct expenditures and an additional $15 per day in local multiplier impact. Furthermore, the visitor may ultimately return as a full-time resident and/or employee of a new industry.

INNOVATIVE ACTION IMPLEMENTATION

In the past, many successful and some not so successful facilities have appeared within our area. The successful projects need no explanation. The failures are another matter: Why did they fail, and how do we make sure others don't follow? This cannot be answered completely because of "people" factors interjected in each individual case; but, there are some things which allow for a better chance of success, if applied properly.

One of the most important factors for consideration in any business is the market potential of the product. Too often, the leisure/recreation development has been resource-oriented rather than market-oriented. A lake, an historical site, mountains, forests, a strip-mined area or whatever, does not generate the anticipated interest, and the percentage of visitors does not justify investment. Such misfortunes occur when classic approaches to development are employed. One approach is to start with a fixed destination and then draw circles around the site to find out what market areas might be picked up. Another approach is to gather current visitor counts and visitor-source data and base the market on a percentage of these figures. Both of these methods are very dangerous, unreliable, and grossly over-used.

A more reliable approach is one that establishes the specific size and characteristics of a facility or group of facilities within an area by determining its market, rather than vice-versa. Demand for leisure originates with people, where they live, not with the leisure/recreation resources. This approach treats demands for leisure/recreation in much the same way as demands for other consumer products. Starting with population groups at their location of residence, potential consumers are distributed among all competitive leisure/recreation areas on the basis of desirability of each facility and observed travel-distance patterns. This approach requires a more in-depth look at the desires and patterns of people. Obviously all people do not participate in the same activities—fishing, hunting, swimming, water skiing, etc. This difference in people requires a "shopping center approach," all leisure/recreational needs should be provided within a terminal area. Once multi-activity sites have been developed, they should be promoted as a "package" of attractions.

For too long, Kansas, like the rest of the region, has lingered in the rustic phase of leisure/recreation development—the hunting and fishing stage. It has been assumed that the great outdoors is sufficient in itself to attract the visitor and that no development effort is required. This ignores the fact that the modern medium- and high-income visitors demand many comforts and services in their outdoor vacationing, as well as in other activities during the year. These visitors are highly mobile and have a wide range of choices for selecting a place to visit.

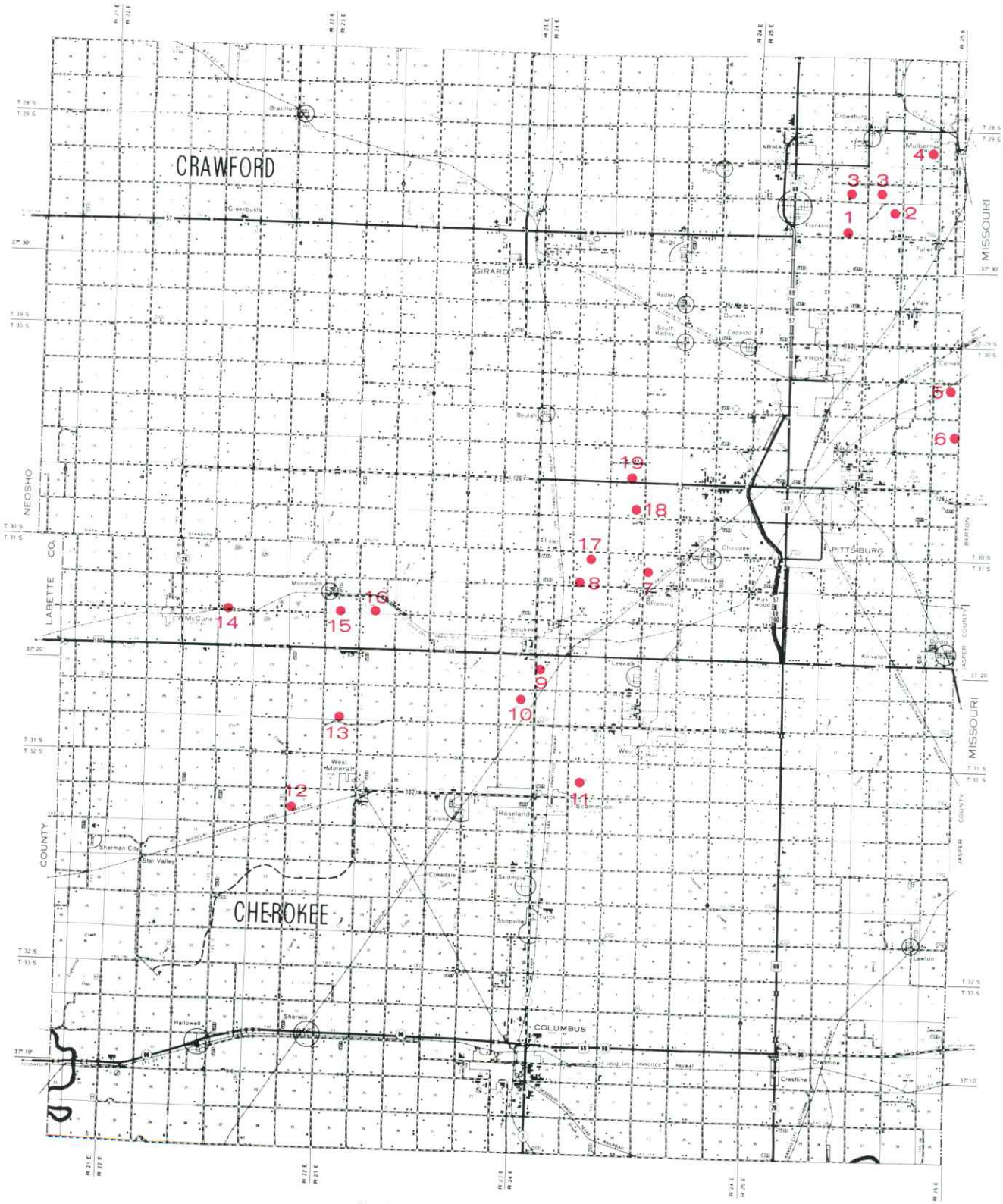
An organized planning approach like that of the modern shopping-center builder and residential developer is needed for leisure/recreation development. Each facility or activity in a local area must be complementary to other facilities or activities in the area. Does that which helps the business or the boat dock help the bowling alley, the restaurant, the motel, and the service station? This is what economists refer to as "external economies of scale." An activity that might be high cost and unprofitable by itself with limited traffic may become very profitable if planned with a number of additional and mutually supporting activities. In the past, the problem of the leisure/recreation industry in the Ozarks region has been widely scattered "mom and pop" business establishments of very small size. These usually under-capitalized businesses are impossible to organize for joint development efforts. It will take large-scale developers and large local or outside investments to make attractive centers of activity within southeast Kansas.

The Ozarks Regional Commission has funded a Leisure Industry Investment Identification Study which is being conducted in southeast Kansas. The purpose of the study is to identify opportunities within this area, using methods described in this paper. The

study should outline a very dynamic and viable program, which will be presented to local leaders prior to regional and national presentations. The Ozarks Regional Commission expects results and will do whatever is necessary to help southeast Kansas develop its potential.

SELECTED RECLAMATION SITES TOURED BY WORKSHOP PARTICIPANTS

Location	Owner	Reclaimed Acres
Site 1 16-29-25	Carroll Daniels	20 acres reclaimed of 560 acres of mined land. Leveling completed March 1, 1972.
Site 2 15-29-25	Herman Kuplen	40 acres reclaimed land, part of 194-acre farm. Leveling completed March 1, 1971.
Site 3 S½ 9-29-25 S½ 10-29-25	Clemens Coal Co.	310 acres reclaimed land (voluntary) from land mined in the 1940's. Reclaimed in Spring 1970.
Site 4 1-25-29	Wayne Lehman	28 acres reclaimed (Note: extremely rocky land). Leveling completed March 31, 1972.
Site 5 12-30-25	Fred VanBecelaere	32 acres reclaimed, part of a 40-acre motorcycle park. Leveling completed December 31, 1971.
Site 6 13-30-25	D. W. Selburg	7 acres reclaimed. Leveling completed October 1971.
Site 7 3-31-24	Robert Bryant	39 acres reclaimed, part of 924-acre farm. Leveling completed March 15, 1972.
Site 8 5-31-24	Darrel Hite	30 acres reclaimed, part of a 340-acre farm. Leveling completed August 2, 1971.
Site 9 19-31-24	Bill Potusek	24 acres reclaimed, 136 more acres of mined land. Leveling completed October 15, 1971.
Site 10 25-31-23	Ted Christiansen	19 acres reclaimed. Leveling completed February 9, 1972.
Site 11 5-32-24	John & Joe Mussa	45 acres reclaimed. Leveling completed April 9, 1971.
Site 12 12-32-22	R. W. Fowler	61 acres reclaimed. Leveling completed March 22, 1972.
Site 13 30-31-23	Dan Vandament	21 acres reclaimed, 123 more acres of mined land. Leveling completed February 24, 1972.
Site 14 10-31-22	Dorothy Parker	70 acres reclaimed for a recreational area, part of a 400-acre farm.
Site 15 7-31-23	George Wells	22 acres reclaimed. Leveling completed October 1971.
Site 16 8-31-23	Lloyd Rogers	29 acres reclaimed, part of a 300-acre farm on which all mined land has not been reclaimed. Leveling completed on August 27, 1971.
Site 17 5-31-24	Frank Morris	13 acres reclaimed. Leveling completed October 28, 1971.
Site 18 28-30-24	Emery Kennedy	16 acres reclaimed, 97 more acres of mined land on a 155-acre farm. Leveling completed August 10, 1971.
Site 19 21-30-24	Don Hight	21 acres reclaimed, 79 more of mined land, part of 320-acre farm. Leveling completed September 28, 1971.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CHEROKEE
MISSOURI
NEOSHO CO.
LABETTE CO.
JASPER COUNTY
COUNTY
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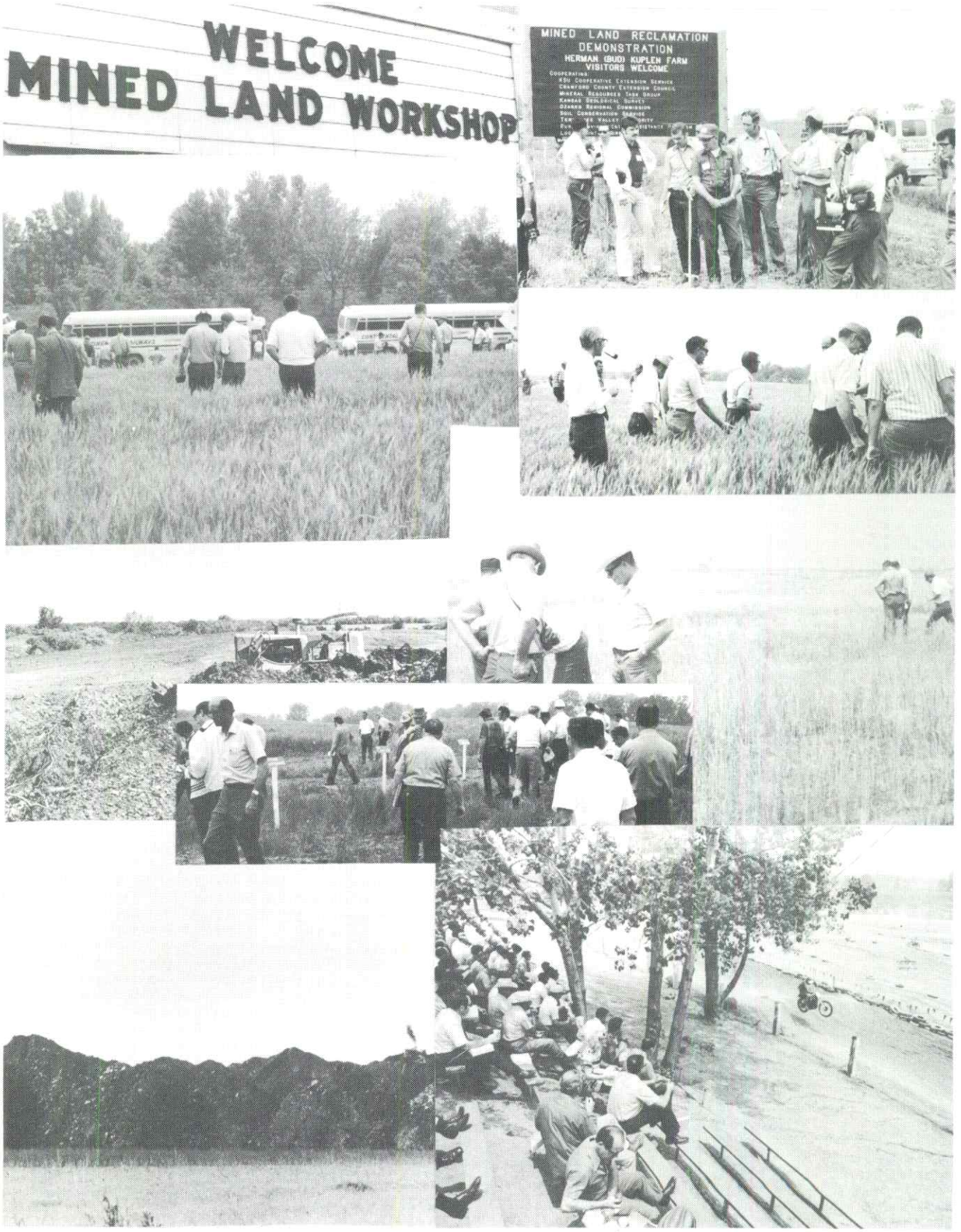
Selected reclamation sites


WELCOME
MINED LAND WORKSHOP
MINED LAND RECLAMATION
DEMONSTRATION
HERMAN (BUD) KUPLEN FARM
VISITORS WELCOME


Kansas:
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MINED LAND POTENTIAL FOR RAISING TIMBER CROPS

By WAYNE A. GEYER

ABSTRACT

Raising timber on coal spoils should be considered for two distinct land forms—unleveled land with established woody vegetation and recently graded land void of vegetation. Products that may be harvested from trees grown on unleveled dumps include cottonwood pulpwood, firewood, charcoal wood, and saw timber. Most recently graded spoils also will support tree growth; few spoils are toxic to woody plants. Reasonably short-term crops or activities yielding a fair rate of return on establishment costs are cottonwood pulpwood, southern pine posts, Christmas trees, and combination nut-log-grazing programs.

INTRODUCTION

Planting of trees on surface-mined land has been studied for many years by the United States Forest Service. Reclamation handbooks are available on how and where to plant and what species to use in the eastern United States; however, little has been reported on the economics of reforesting mined areas. Pennsylvania foresters claim that on many mined areas growing pulpwood can provide a good income, but nothing has been published on rating economic alternatives.

In 6 years of research on strip-mined areas in Kansas, I have attempted to 1) evaluate woody plant growth on mined lands; 2) develop practical planting techniques; and 3) determine how the grading of mined spoils affects plant growth.

Raising timber crops on coal spoils in Kansas now seems reasonably feasible and desirable, even though the area is in a region of transition of forest to prairie —that is, in a borderline area for growing trees except in such desirable environments as along stream sides and on good bottomlands. Through some 20 years of experience, we have some idea of what and how well timber will grow on unleveled spoils in the area. But we are not quite sure how well trees will grow on the leveled spoils resulting from the current practice of grading. We do know, from limited studies in Kansas and Missouri, that tree growth has been reduced on similar spoils graded with a dragline, as compared to growth on nongraded dumps. More information is needed to determine if this would hold true on all spoils.

Because raising forest crops is a long-term project, it is difficult to compare this type of land use with other uses. Nationally, however, we are running into timber shortages. Though no one knows how much timber is really needed, demand is putting a strain on supplies. A U.S. Forest Service report suggests that U.S. consumption will increase by 40 percent in the next 30 to 40 years. In Kansas there are roughly 1.5 million acres of commercial woodlands rated as above average.

The main questions concerning reclamation are: What use is to be made of mined lands? How practical or feasible are proposed uses for Kansas and the nation? Two types of mined land must be considered, land mined years ago and land mined only recently (since the beginning of the Kansas Reclamation Law).

OLD MINED LAND (UNLEVELED)

Most of the old spoil banks in Kansas are small dumps on which logging is now possible. The forest vegetation is composed predominantly of pole-size and small saw timber species of the elm-ash-cottonwood type. The decision of whether or not to allow these young forests to grow another 10 to 50 years is important. Consideration must be given to aesthetic aspects. Products that may be harvested include cottonwood pulpwood, charcoal wood, firewood, and saw timber. Quite possibly it may be one or two decades before saw timber (larger trees) can be cut.

Table 1 summarizes the timber products that could be harvested from old unleveled spoil banks. Because the trees were put there by nature after man disturbed the soil, no rate of return is included in this table; taxes would constitute the only investment.

TABLE 1.—Timber products and values on old mined areas (unleveled).

Product	Species	Tree Diameter (in.)	Age (yr.)	Value ($)
Pulpwood	Cottonwood	4 to 16	20	25/acre, forest
Charcoal	All (except walnut, cottonwood, willow, hedge)	4 to 18	20+	100/acre, plant
Firewood	Hardwood (e.g., ash, hackberry, elm, oaks, sycamore)	2 to 8	15+	150/acre, home
Saw timber	Walnut	12 to 24+	50-100	10 to 200+/ tree, forest
	Bur & chinkapin oak	18+	50+	100/acre, forest
	Other hardwoods	18+	50+	100/acre, forest

Pulpwood

Cottonwood, probably the only species in southeastern Kansas that can be harvested for pulpwood, has been cut on some strip-mined areas near Cherokee.

Material from that small operation was shipped by rail to Pryor, Oklahoma. Though much cottonwood is being harvested on non-mined land around Hutchinson in south-central Kansas, little has been cut in the state's strip-mined areas. One reason is that as yet the market is limited. Price paid for the Cherokee stand was $1.00 per cord stumpage (1 cord equals 128 cu. ft. of stacked bolts amounting to roughly 70 solid cu. ft. of wood). Trees cut for pulpwood in this area are 15 to 35 years old. Diameters of the trees at breast height (DBH; = 4½ feet above ground) range from 4 to 16 inches. Such trees produce 10 to 30 cords per acre.

Charcoal

All hardwoods except walnut, and cottonwood, willow, and hedge can be used for making charcoal, but in this area the practice is limited to the vicinity (probably a 35-mile radius) of Chetopa. Though ideally only trees of poor quality should be used, both good and poor are used. Much of the wood used results from land-clearing or thinning operations during the winter. Yields range from 5 to 20 cords per acre, and net value per acre is about $100 ($8-$10 per cord).

Firewood

A hardwood species having hard, dense wood—elm, ash, oak—is desirable for firewood. In southeastern Kansas small trees about 15 years old are used, ranging in diameter from 2 to 8 inches. Delivered in town, the wood sells for $12 to $17 per rick (approximately one-half to one-third cord). Operations, which are localized, may net $150 an acre.

Saw Timber

Saw timber is harvested and sold by species. The most valuable tree, the walnut, should be marked individually for sale. Though logs as small as 12 inches DBH can be sold, it is unwise to sell logs less than 20 inches in diameter. Value of individual trees ranges upward from $10.

Other saw timber species are bur oak and chinkapin oak; these should be sold separately from other hardwoods. Trees should be 18 inches or larger when cut. At 5-7 cents/board foot, bur and chinkapin oaks are worth from $4 to $10 each.

Other hardwoods used as rough lumber are worth from 1 to 5 cents per board foot and usually are cut when 16 to 18 inches in diameter. The yield per acre averages 3,000 board feet. A higher yield may be expected on very good sites (stocked at a spacing of 30 to 40 feet) and a lower yield on some of the sparsely stocked strip-mined areas. Value per acre averages about $100 for 50-year-old stands. Cutting perhaps could be repeated in about 25 years. Tops and limbs left from cutting trees for saw timber can be salvaged locally for firewood, and yield from 4 to 8 cords per acre.

RECENTLY MINED LAND (LEVELED)

Because of the length of time required to raise timber crops it is unwise to grow only saw timber on mined land in southeastern Kansas. From the standpoint of return on investment, short-term crops are better. Short-term crops include cottonwood (for pulpwood), southern pine (for posts), and Scotch pine (for Christmas trees). In addition it can be profitable to raise trees (black walnut or pecan) for nut crops and sawlogs on the same land planted to fescue (or other grass) for grazing.

Table 2 summarizes timber products that might be grown profitably on leveled land. Detailed analyses of the alternatives are given in Tables 3 through 7.

TABLE 2.—Timber products and values on recently mined areas (leveled).

Product	Species	Age (yr.)	Gross value ($/acre)	Rate of return* (%)
Pulpwood	Cottonwood	20	25, 50	3 or 6½†
Posts	Southern pine	20	100	6
Christmas trees	Scotch pine	10	1200	30
Nuts & Logs	Walnut	50	10, 2100‡	<1, 7¾‡
	Pecan	50	60, 3040‡	9½, 8¼‡

* Excludes cost of leveling.
† Stumpage @ $1 or $2/cord.
‡ Nuts @ 10 years, nuts and logs @ 50 years.

TABLE 3.—Cottonwood pulpwood costs and returns on leveled land, acre basis.*

Cost	
Planting stock @ $20/1000	$ 4.00
Planting (hand) @400 trees/day @$2/yr.	8.00
Trucking	2.00
Total Establishment	$14.00/acre
Return	
Stumpage (20 years) of $1/cord for 25 cords @ $25/acre	
Profit of $11/acre (taxes not included)	
Rate of Return	
$(1+i)^n+V_n/V_o$	
$(1+i)^{20}=25/\$14=1.785714$	
i=3%	
If $2/cord then, i=6½%	

* Cost of leveling excluded. Any costs incurred near harvest time deducted from gross to give net return.

Pulpwood

Cottonwood is the best species to consider for pulpwood production. Cutting could begin in 15 to 20 years with an expected yield of 25 cords/acre. Stands could be clearcut or thinned with the remaining trees cut for saw timber in 10 more years. Markets for

pulpwood are in Oklahoma where stumpage sold recently for $1/cord ($25/acre)—a rate of return of 3 percent.

TABLE 4.—Southern pine posts costs and returns on leveled land, acre basis.

Cost	
Planting stock	$ 8.60
Planting (hand)	17.20
Trucking	2.00
Total Establishment	$27.80/acre
Return	
Post stumpage @ 20 years	$100.00/acre
Profit of $72.20/acre	
Rate of Return i=6%	

TABLE 5.—Christmas trees costs and returns on leveled land, acre basis.

Cost	
Planting stock	$17.78
Planting (hand)	35.56
Trucking	2.00
Total Establishment	$55.34
Mowing (8 years) @ $10	$80.00
Shearing (5 years) @ $50	250.00
Harvesting (5 years) @ $30	150.00
Total Growing	$480.00
Return (Wholesale)	
$1200—$480=$720/acre	
Profit of $720—$55.34=$664.66/acre	
Rate of Return i=30%	

TABLE 6.—Nuts and logs (walnut) costs and returns on leveled land, acre basis.

Cost	
Planting stock	$ 0.50
Planting (hand)	3.00
Trucking	1.00
Weed Control (3 yr.)	15.00
Total Establishment	$19.50
Pruning (13 ft.)	5.00
Fertilization	10.00
Total Cultural	$15.00
Return	
Nuts starting at 10 years	$10.00
Nuts 10 to 50 years (start at 10 years)	$2000.00
Logs (12 ft.)	100.00
Total Nut & Log	$2100.00
Profit of $2100—19.50—15.00—$667 (harvest ⅓ gross)=$1398.5	
Approximate Rate of Return	
Nuts @ 10 years	<1%
Nuts & Logs	7¾%

Posts

The best species for production of posts are shortleaf and loblolly pine. However, they should be grown only along the eastern border of Crawford and Cherokee counties, or within 30 or 40 miles of Joplin, Missouri, which has a post-treating plant. Trees could be cut within 15 to 20 years, giving a value of about $100/acre (5 percent return).

TABLE 7.—Nuts and logs (pecan) costs and returns on leveled land, acre basis.

Cost	
Planting stock	$ 5.00
Planting (hand)	3.00
Trucking	1.00
Weed control (3 yr.)	15.00
Total Establishment	$24.00
Pruning (13 ft.)	5.00
Fertilization	10.00
Total Cultural	$15.00
Return	
Nuts starting at 10 years	$90.00
Nuts 10 to 50 years (start at 10 years)	$3000.00
Logs (12 ft.)	50.00
Total Nut & Log	$3050.00
Profit of $3050—24.00—15.00—1000 (⅓)=$2011	
Approximate Rate of Return	
Nuts @ 10 yrs.	9½%
Nuts & Logs @ 50 yrs.	8¼%

Christmas Trees

Scotch pine is the most suitable species for growing Christmas trees in southeastern Kansas. Currently only a local market is available, but a regional market could be developed. Crops of closely spaced small trees could be marketed in about 7 years. Wholesale prices of 60 cents per linear foot would earn $1,200/acre, a return of about 30 percent. Selling trees individually at $1/foot would yield around $2,100 per acre. Returns might not be as high as indicated because of the skill necessary to care for plants and the cultural costs involved.

Nuts and Logs

Two species—black walnut and pecan—could be used in a combination nut-log-grazing program. Both species will grow with fescue. Planting at 40-foot spacing results in about 25 trees per acre, but pecan eventually should be reduced to 10 trees per acre. Harvesting of nut crops can be accomplished in about 10 years. Hulled walnuts selling for 4 cents a pound and pecans selling for 30 cents a pound would yield about $10 (walnuts) and $60 (pecans) per acre, with a rate of return of less than 1 percent, and 9½ percent, respectively. Pruning the butt log of all limbs up to 12 feet and allowing trees to grow for 50 years likely would gross a total nut and log crop of $2,100 and of $3,050 per acre, at a rate of 7¾ and 8¼ percent. After the first crop pecan yields increase, then level off, and finally decline. Walnut yields are greater and continue for a longer time. Value accruing from grazing operations is in addition to nut crop value.

RECOMMENDATIONS

In light of the nation's timber needs much of the mined area in southeastern Kansas should be planted

to trees. Most Kansas spoils (except the few that are very acidic) will support tree growth. Some of the old areas, for example, the state lake and park just north of Pittsburg, show excellent tree growth. Possibly enough of the old land naturally reclaimed to trees exists to help support the wood-fiber needs of the nation. It would be a mistake to clearcut these old lands and put in other crops especially if the trees in such areas are 20 years old or older (half that age for cottonwood).

On the other hand, from the small landowner's viewpoint, where timber is less than 20 years old and where an additional unit of cleared land would improve grazing or other operations, grading enough land to fill the need might be considered.

Newly graded spoils, as required under the recent state regulations, encourage agricultural operations—grazing or growing grain crops. Grading also facilitates timber harvesting and cultural practices, but may reduce tree growth. Probably the best timber operation to try on a small scale would be Christmas tree plantings. At first plantings should be restricted to about 1 to 5 acres of land; acreage eventually could be enlarged. Numerous time-consuming cultural practices would have to be implemented—shearing in June and July and harvesting and marketing—but rate of return on investment should be high.

The nut-log-grazing combination appears to be quite feasible. Initial planting to 10 acres would not involve excessive time. The acreage probably should not be grazed until the trees become established and the landowner learns how best to care for them. If, after 5 years, the trees and grass are growing well together, and nut trees starting to produce, then the operation can be expanded.

Production of pulpwood would seem to be one of the better uses of mined areas. Though return is not high, cultural requirements and harvesting problems are almost nil. Such projects, however, should be carried out on a large scale, and markets must be further developed. If the timber grows well on leveled spoil banks, it would bring at least $1 per cord at today's prices. Planting at the scale necessary would require the efforts of many individuals, or the efforts of, for instance, a large coal company.

Returns on tree planting are marginal, considered from the small landowner's viewpoint; he cannot afford to tie up much money in a long-term investment. Investment by large companies depends on their policies regarding public relations, taxes, and numerous other factors.

Converting leveled spoils to range land includes providing water holes (with drainage) for livestock and wildlife, as well as providing brush and tree species to provide both food and cover; this, however, does not require much land.

Trees and land have value that cannot be measured in dollars. Aesthetics can never be so evaluated, nor can watersheds or areas for wildlife. In my opinion, those who own land with no tree areas, no strips or shelterbelts or corners, no brush for wildlife, are merely using the land, not really implementing its best multiple use.

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DATA COLLECTED FROM THE DEMONSTRATION SITES

By KATHLEEN Q. CAMIN

In order to encourage redevelopment of land disturbed by strip mining and to demonstrate that reclamation is physically and economically feasible, a number of demonstration sites were established on southeastern Kansas mined areas. Leveling work on the first site began in February 1971.

Although other uses of reclaimed land have been demonstrated, much of the research has been directed towards establishing grasslands on strip-mined areas in southeastern Kansas.

CONVERSION TO GRASSLAND

The reclamation process for conversion to grassland involves six steps: (1) leveling, (2) soil testing, (3) seedbed preparation, (4) lime application, (5) fertilizer application, and (6) seeding.

Leveling

The leveling process includes bulldozing, followed by one dragging and one offset disking. Dragging is

accomplished by pulling a heavy, 20-foot I-beam behind the bulldozer. The purpose of dragging is to further smooth out small ridges and fill small holes. This operation improves drainage and provides a uniform surface which makes it possible to disk at a uniform depth. Offset disking differs from regular farm disking in that it provides deeper penetration, necessary to loosen soil compacted by the first two phases of the leveling process.

Spoil banks must be leveled so that slopes on 90 percent of the site are 10 percent or less and slopes on the remaining 10 percent of the site are 15 percent or less. Such slopes are sufficiently flat to allow farm machinery to work the ground.

Using bulldozers, trees are pushed over into low areas between spoil banks and covered with material from the peaks of the spoil banks. A gentle rolling terrain with proper drainage is the goal.

Spoil banks resulting from mining with a shovel consist of roughly parallel continuous ridges. Spoil banks resulting from dragline operations are parallel but irregularly piled mounds of dirt. Proper drainage is more difficult to attain in the latter type.

The spoil bank originating from the box cut (the first cut into the ground in the mining process) presents a problem when it lies adjacent to a roadway and can be spread in only one direction. Overburden from the box cut is placed on top of the ground adjacent to the pit. As successive pits are dug, the overburden from the current pit is placed in the previous pit. The spoil banks from all successive pits are smaller in size than the spoil bank from the box cut. When the box-cut spoil bank lies adjacent to the road, the leveling process means moving dirt in one direction—away from the road. The larger amount of material in the box-cut spoil bank plus the added distance it must be moved increases the leveling cost per acre. On small reclamation sites it may be necessary to adjust leveling specifications when a box-cut spoil bank is adjacent to a road.

Initial estimates of leveling costs were substantiated by data from the demonstration sites. Frank Fox, a former conservation contractor who is Reclamation Consultant for the demonstration projects, visited over 400 sites involving 23,000 acres in Crawford and Cherokee counties; at each site he estimated leveling cost per acre. Mr. Fox estimated the cost per acre to range from $55 to $210 with an average of $156 per acre. The Fox estimates are supported by actual leveling cost information from the demonstration sites. The average cost of leveling based upon data from 44 sites involving 892 acres was $156/acre, although two of the sites had abnormally high costs ($375 and $500/acre) because of problems involving a box-cut spoil bank and type of bulldozer used by the landowner/reclaimer.

Soil Testing

Soil samples at the demonstration sites were collected on a grid pattern after leveling was completed. An average of one soil sample per acre was collected. Each of these soil samples was a composite of four samples taken at a depth of 6-8 inches on the perimeter of a circle whose radius was 2 feet. Because of the nonuniform character of spoil banks, extensive and systematic soil testing is necessary.

The pH of the soil samples was analyzed by Shirley Buckle of the Mined Land Redevelopment Office staff, an official Crawford County Soil Tester. Samples were then further composited and tested for available organic matter, available phosphorus, and available potassium. The results of all soil tests are given to the County Extension Agricultural Agent who makes soil treatment recommendations. The pH data (spatial distribution) provide the basis for lime recommendations.

Seedbed Preparation

Seedbed preparation includes all the normal farming operations which prepare the ground for soil treatment and seeding. This would include disking, harrowing, and dragging by farm tractor. Information regarding tractor size and machine and man hours is still being collected so costs of seedbed preparation are not yet available.

Lime Application

Information regarding lime use on reclaimed mined land is based upon data from 40 sites involving 834 acres. Lime use on the 834 acres is broken down as follows:

Application	*Percent*
(1) No lime required on site	42
(2) One small area of low pH per site	18
(3) Site requires two different rates	13
(4) Site requires uniform lime application	27
	100

If the acres in category (1) and those in category (2) which required no lime are combined, 60 percent of the demonstration acreage required no lime at all. The remaining acres received an average application of 7,500 lbs. Effective Calcium Carbonate (ECC) per acre. If all demonstration acres are included (from the 0 lime to 13,700 lbs. ECC/acre), the average use of lime is 3,000 lbs. ECC/acre.

The Agricultural Stabilization and Conservation Service has provided special Rural Environmental Assistance Program (REAP) funds to cost-share the lime, fertilizer, and seed for these demonstration sites. REAP will not cost-share on more than 4,000 lbs. ECC/acre. Our experience indicates that when lime is needed, it is needed in much larger quantities than are now being cost-shared under REAP's maximum of 4,000 lbs. ECC/acre.

Fertilizer Application

To determine fertilizer application rates, the soil test information on organic matter, available phosphorus, and available potassium is used by the county extension agricultural agent in conjunction with information on grass species and nurse crop to be planted.

Type and amount of fertilizer used on sites is based on data obtained from 700 demonstration acres. The fertilizer applications on a per acre basis have averaged 55 units of nitrogen, 59 units of phosphate, and 41 units of potash. Fertilizer costs are not yet available.

Seeding

Seeding data from the demonstration sites, such as amounts per acre and cost per acre, are not yet available. Kentucky 31 fescue is the dominant grass species planted. In general, fall plantings have been made with fescue, with wheat as a nurse crop. Spring plantings of fescue have used oats as a nurse crop. Two pure wheat stands have been attempted, as have several pure fescue stands.

RECREATIONAL AND INDUSTRIAL POTENTIAL

Although the majority of the demonstration acreage has been converted to grassland, other productive uses of reclaimed land were eligible for cost-share funds and four sites have been established. Three sites involve recreational use of mined land; one site is for industrial use.

Grading specifications for grassland must not be used on recreational projects. Recreational development should encourage the maintaining of the rough, wilderness flavor of the aged spoil banks. Development should focus on roads, water, sewers, electricity, and other structures.

The recreational potential of mined land is large. Almost all of the strip pits contain water suitable for fish and almost all pits are stocked with fish. Until now, the excellent strip pit fishing has been largely restricted to local residents because of the lack of camping or rental facilities. New facilities will bring fishermen and campers from areas such as Wichita and Kansas City, which means recreational dollars for the strip pit area and "instant wilderness" for city dwellers within easy driving distance.

"Red" Fox, a local conservation contractor, has 500 acres of mined land near Pittsburg. Part of this area is available as a camping-fishing area on a membership basis and part of the area has been developed for overnight campers. Electricity and water hookups, shower facilities, swimming, a meeting hall, and a few rental cabins are available.

Dorothy Parker's "Cottonwood," near McCune, Kansas, is a campsite for both transient and long-term campers. This camping area will open in August 1972 and will feature a grocery store, and a heated dock for winter fishing.

Fred VanBecelaere has developed a European-style motocross track for motorcycle enthusiasts—Freddy Van's Cycleland. The race track, just east of Pittsburg, opened March 9, 1972, and features twice-monthly (first and third Sundays) motocross races for trophies and cash.

The fourth non-grassland site is an industrial park. A lead and zinc tailing area near Galena, Kansas, has been leveled and cleared for use as an industrial park. A road system has been developed through this 24-acre site.

CONCLUSIONS

Continual reevaluation of all phases of the grasslands demonstration project indicates several important factors for reclamation. Extensive soil testing is necessary. One composite sample every 200 feet is recommended, with an average of one composite per acre. Each composite should be made up of 4 to 8 probes.

Two results from seeding experiments seem important: (1) fall plantings of fescue have been much more successful than spring plantings; (2) when fall plantings of fescue are made, they must be made before October 15. All demonstration plantings of fescue after October 15 failed to survive the winter. The recommended seeding time is September 1.

The unique feature of the demonstration program is that it *is* a "demonstration" program. We can learn from our mistakes and insure that redevelopment of mined land in southeastern Kansas is both profitable to the individual and beneficial to the region.

PRELIMINARY RESULTS OF HYDROLOGIC STUDIES IN SOUTHEASTERN KANSAS COAL FIELDS

By THOMAS J. MCCLAIN

INTRODUCTION AND PURPOSE

As part of its continuing efforts in mined-land reclamation, the Kansas Geological Survey conducted a hydrologic reconnaissance in and around several strip-mined areas in southeastern Kansas. The purpose of the study was to correlate surface water (pond) and ground-water levels. Quality of ground and surface water was studied, and the characteristics of the spoil as an aquifer were determined. The study was conducted with the help of Charles Bayne, Water Resources Section, Kansas Geological Survey, and the Survey's Mineral Resources Section.

LOCATION

Five test holes were augered into bedrock near Cherokee, Kansas, in secs. 24 and 25, T 31 S, R 23 E; two additional test holes were augered into reclaimed spoil banks near West Mineral, Kansas, in secs. 25 and 35, T 31 S, R 22 E (see Fig. 1).

METHODS OF INVESTIGATION

Selected test holes were drilled with a truck-mounted auger, cased with 1¼ in. slotted pipe, and pumped by compressed air. The wells were tested for water level and yield, and samples were taken to determine chemical quality.

GEOLOGY

Test holes near Cherokee ranged from 21 to 48 feet in depth and penetrated the upper part of the Cherokee Group. Mining of mineral coal in nearby pits indicates that the section drilled is approximately between the Verdigris Limestone Member and the Mineral coal bed.

The two holes near West Mineral were drilled in reclaimed spoil banks created by coal mining operations prior to 1950. In the spoil area, as was expected, drilling was very easy except where large blocks of rock were encountered. When rock prevented further penetration, the auger was moved over a few feet. Both test holes in the spoil were drilled to bedrock at a depth of 33 feet.

HYDROLOGY

Figure 2 shows generalized hydrologic conditions in the area of investigation. Water levels in test holes indicate that shallow ground water moves from topographically high areas and discharges into streams and ponds. After heavy rains, stream and pond levels may be temporarily above local ground-water levels. Recharge to the ponds comes directly from rainfall and indirectly from infiltration of precipitation into the spoil banks after which the ground water flows into the ponds.

YIELD OF WELLS

Augered test holes were cased with 1¼ in. diameter galvanized iron pipe in which slots had been cut by acetylene torch. These wells were then pumped using a small air compressor and a long rubber tube extending to the bottom of the well. The compressed air forced the water up and out of the pipe.

The only bedrock test hole pumped was on the north side of sec. 24, T 31 S, R 23 E. Yield was approximately ½ gallon per minute (gpm). Through proper drilling and development techniques, the yield could be increased several times.

The spoil-bank well near West Mineral in sec. 35, T 31 S, R 22 E was augered, cased, and yielded less than 1 gpm. The water had a high concentration of suspended solids. The low yield is thought to be caused by the drilling technique employed, which consisted of forcing the auger slowly through the spoil material and bringing it up often to clean off the sticky clay and shale adhering to the auger flights. This method probably caused both smearing and compaction of the hole walls, effecting a seal and reducing the yield. The water pumped from this well was high in suspended solids and did not clear up during pumping operations.

The second test hole drilled in the spoil bank (sec. 25) was drilled as rapidly as possible in order not to seal the hole walls. When cased and pumped, the yield of this well was about 5 gpm; the water cleared rapidly after a few minutes of pumping. After about an hour the yield declined to almost nothing, probably the result of caving and subsequent plugging of casing slots. The initial measured water level was very low, and has been abnormally low in subsequent measurements. However, with a larger diameter hole, proper gravel pack, screen, and well developing techniques, the yield of this well could probably approach from 10 to 50 gpm.

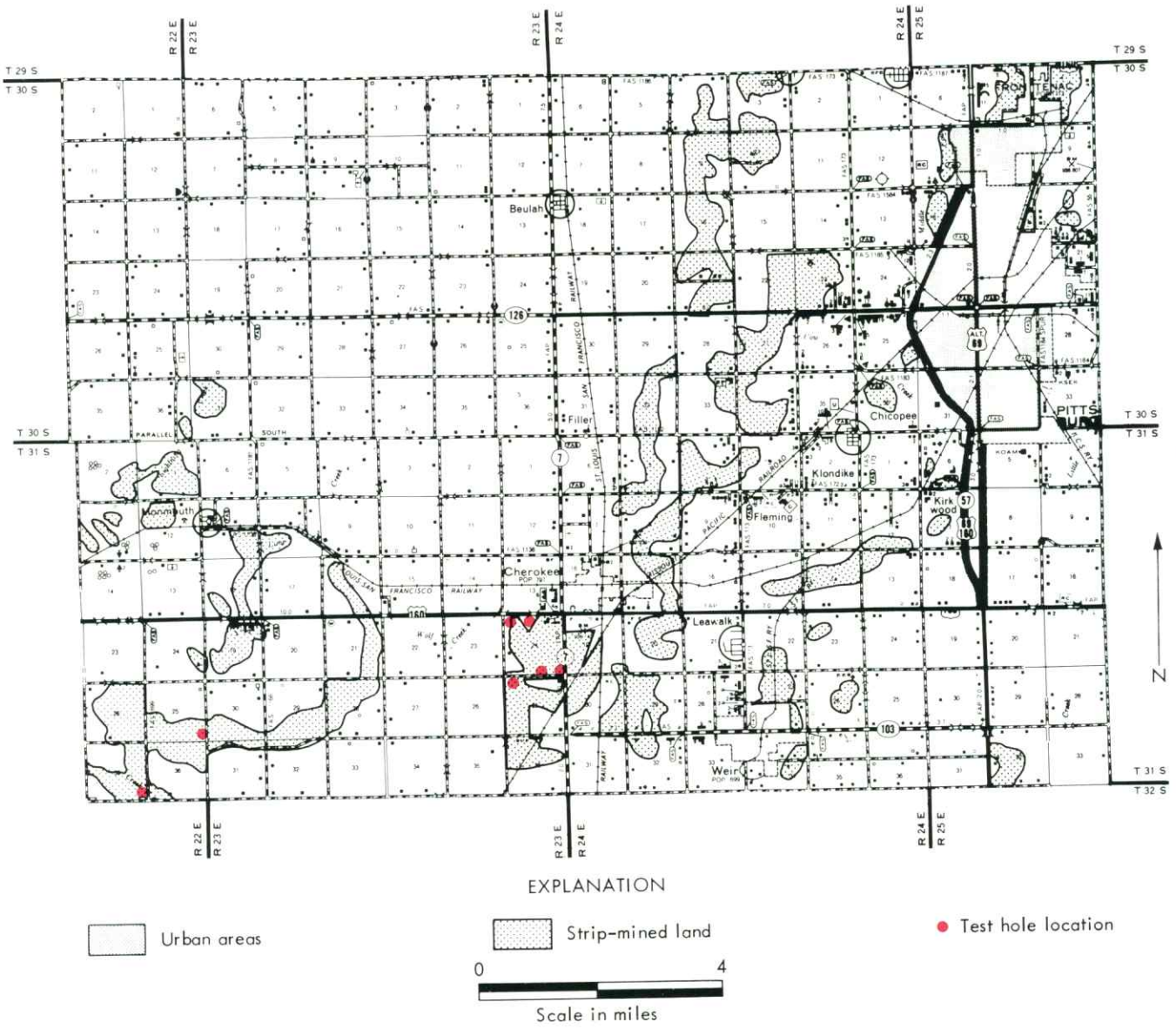

FIGURE 1.—Locations of augered test holes.

WATER QUALITY

Ground-water samples from the spoil banks were high in dissolved solids. The pH from two samples was 7.4 and 8.1, with total solids of 2,928 and 4,340 mg/1 respectively. Specific conductances were 3.40 and 5.03 micromhos/cm^2 respectively.

The water in the pits is generally of better quality. The two samples taken were lower in total dissolved solids; pH values were 8.3 and 8.1.

SUMMARY

In summary, it seems that this study has raised more questions than it has answered. From the limited data available we do know:

(1) It should be fairly easy to drill a well into spoil.

(2) A limited water supply is available to be pumped from storage in the leveled spoil banks (with the proper well installation).

(3) The quality of ground water in the spoil is rather poor but it does have an alkaline pH.

(4) Where surface ponds are available it would be less difficult and less expensive to obtain water from them.

(5) Pond water is of better quality than spoil-bank water.

A few of the questions to be answered are:

(1) How much water is stored in the spoil banks and how much can be recovered?
(2) How does the ground-water and pond-water quality vary in different areas?
(3) What would happen to stream levels if spoil banks were pumped extensively?
(4) When water is pumped from a pond, how does ground-water recharge affect the quality of the water in the pond?

Several of the problems posed by the questions above are the subjects of continuing investigation.

GENERALIZED HYDROLOGIC CONDITIONS

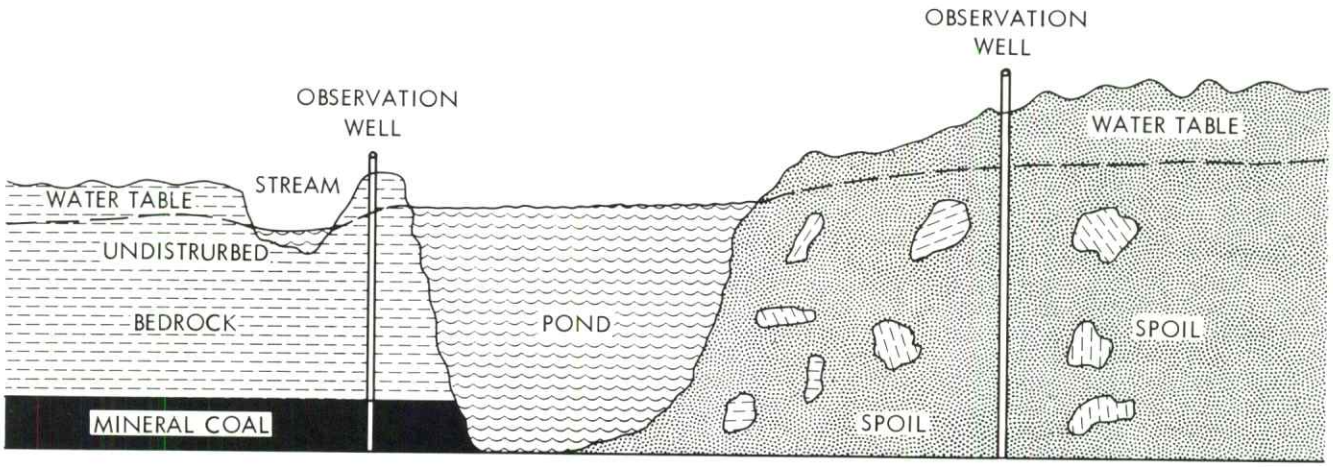

FIGURE 2.—Generalized hydrologic conditions.

THE USE OF FLY ASH ON THE ACID SOIL OF RECLAIMED MINED LAND

By WILLIAM J. KOVACIC

It may be said in general that, while fly ash will improve mined land and be especially effective where acid conditions exist, the delivered cost of fly ash is such that at present it is not feasible to use this material for this purpose in eastern Kansas. However, it is conceivable that at a mine-mouth power plant it would be advantageous to return the fly ash to the spoil bank as a means of disposal and/or soil conditioning. The cost of transporting fly ash is a critical factor which even for mine-mouth disposal seems to create a reluctance on the part of power companies to dispose of it in this manner.

A canvass of the power plants using coal within a radius of 150 miles of Pittsburg, Kansas, reveals some rather interesting facts. First, there are presently ten power plants burning coal and by 1980 there will be two more. Present coal consumption is 3.6 million tons annually and by 1980 this figure is projected to be 7 million tons. Fly ash production is about 500,000 tons and by 1980 it is expected to be 1 million tons.

At present there are limited quantities of fly ash used in concrete, agriculture, asphalt filler, soil stabilization, and lightweight aggregate. Fly ash sales for concrete work and other uses is currently only 71,000 tons at an average price of $1.35 per ton. There is a considerable gap here between the amount of fly ash produced and the amount consumed. Efforts should be made to close this gap and change fly ash from a waste product into a valuable resource. The application of fly ash to reclaimed mined land is but one use which could close part of this gap. It is necessary to determine a use requiring large tonnages of an inert material of varying composition, and of such value as to absorb transportation costs.

Inasmuch as the land being disturbed by strip mining for coal in eastern Kansas is mainly used for agriculture, it seemed only natural to first investigate the possible advantages of using fly ash in mined land reclamation. As a start, fly ash was applied to mined land spoil with high acid characteristics and such areas were subsequently planted to grasses.

From our test plots we have demonstrated adequately that fly ash is useful for agricultural purposes, particularly for areas where fescue is to be planted for grazing by cattle.

A recommended process for reclamation work using fly ash is as follows: (1) land shaping or "leveling"; (2) dragging; (3) application of fly ash (By use of proper fly ash trucking equipment, the fly ash can be spread directly from the haulage truck. This eliminates spreading costs.); (4) heavy offset disking; (5) farm disking and harrowing; (6) fertilizing; (7) second farm disking and harrowing; (8) seeding; (9) second fertilizing 6 months later (top-dress with nitrogen).

Data on estimated cost of reclamation and revenue from reclamation are presented in Tables 1, 2, and 3.

TABLE 1.—Estimated cost of reclamation per acre.

Assume: 25 tons/acre		
25 miles from power plant to site		
5¢/ton mile		
Leveling	$155.00	
Loading fly ash	3.13	
Hauling fly ash	31.25	
Seedbed preparation	5.15	
1st fertilizing	15.30	
Wheat seed	2.00	
Fescue seed	3.20	
2nd fertilizing	6.00	50 units of N
Total	$221.03	

TABLE 2.—Revenue per acre after reclamation.

	Cost	Revenue
First year:		
Haul wheat	$ 1.28	
Beef-Fertilizer	12.00	
Wheat harvest		$ 4.04
Beef production		26.00
Total	$13.28	$30.04
Net Revenue		$16.76
Second year on:		
Harvest fescue seed	$ 4.04	
Haul fescue seed	2.13	
Fertilizer	12.00	
Sale of fescue seed produced		$22.50
Beef production		30.00
Total	$18.17	$52.50
Net Revenue		$34.33

TABLE 3.—Present value of net revenue from reclamation.

Year following reclamation	Net revenue	(1+n)t n=10%	Present value of net revenue col. 1 / col. 2	Present value of net revenue stream
1	$16.76	1.1	$15.24	$ 15.24
2	34.33	1.21	28.37	43.61
3	34.33	1.331	25.79	69.40
4	34.33	1.4641	23.45	92.85
5	34.33	1.6105	21.32	114.17
6	34.33	1.7715	19.38	133.55
7	34.33	1.9486	17.62	151.17
8	34.33	2.1434	16.02	167.19
9	34.33	2.3577	14.56	181.75
10	34.33	2.5934	13.24	194.99
11	34.33	2.8527	12.03	207.02
12	34.33	3.1379	10.94	217.96
13	34.33	3.4516	9.95	227.96
14	34.33	3.7967	9.04	236.95
15	34.33	4.1763	8.22	245.17
16	34.33	4.5939	7.47	252.64
17	34.33	5.0532	6.79	259.43
18	34.33	5.5585	6.18	265.61
19	34.33	6.1143	5.61	271.22
20	34.33	6.7257	5.10	276.32

$256.33 investment returned after 16½ years and 8% annual profit realized.

Where there is an abundance of inexpensive limestone available, the advantages of higher effective lime content nullifies the benefits of fly ash as a soil conditioner, particularly if transportation costs for fly ash are equal to or higher than limestone transportation costs. However, judging from the figures presented in Tables 1-3, it would seem feasible for power and coal mining companies to pool their efforts and dispose of fly ash by returning it to spoil banks, especially in the case of mine-mouth power plant operations.

METAL RECOVERY FROM COAL ASH TO DEFRAY COSTS OF MINED LAND RECLAMATION

By Charles Immich

It is obvious that a vital necessity for land redevelopment in the future is cash funding for additional work. Without cost-sharing or alternate government support, the costs of foresting or recreational development, or of land leveling, liming, fertilizing, and seeding are just too high for most independent landowners. However, without the support of landowners, an extensive, nation-wide, full-scale program of mined land reclamation will never get off the ground.

For this reason I wish to propose an alternative to government funding—the direct mining of coal ignition residues. Recovery of metals concentrated in coal ignition residues could provide the economic foundations necessary to successfully attack future financial difficulties of mined land redevelopment.

What must be explained is: (1) why coal ignition residues constitute an economic source for various elements; (2) what exactly this economic value consists of; (3) how readily adaptable coal ash is to a mining process for the recovery of these elements; (4) what the benefits of such a program would be to mined land reclamation in the future; and (5) what the few requirements are for the initiation of a coal residue mining operation.

The methods involved in the formation of coal ash easily explain why coal ignition residues constitute an economic source for various substances. Initial elemental concentration occurred during the Pennsylvanian and Cretaceous periods, when the plant life of the coal swamps and forests selectively absorbed certain elements from their surrounding environment. Additional concentration occurred during and after coalification and lithification of these swamps, with percolating ground water again redepositing these various elements within the organic matter. These first two biogeochemical processes produced in the coal an enrichment of specific substances in excess of normal crustal abundances. It is the oxidation of this carbonaceous material, burning of the coal, a purely mechanical process, that provides the final concentration, leaving behind only the selectively absorbed, noncombustible elements originally within the coal. This final concentrate, in the form of coal ignition by-products, represents a ready-made source of metals and other elements awaiting sound economic extraction.

Trace element analyses indicate that several elements of value are present in coal ash in quantities sufficient to warrant extraction by modern mining techniques. Those most significant are germanium, rubidium, thorium, uranium, vanadium, and titanium, with silver, chromium, nickel, gallium, tungsten, and mercury present in lower, by-product recovery concentrations. Table 1 presents data on the six most important elements.

Table 1.—Valuable elements in coal ash.

Element	Concentration ppm	Value per ton of coal ash	Major use
Germanium	300	$115	Electronics
Rubidium	130	78	Photocells
Thorium	2,000	40	Nuclear fuel
Uranium	660	10	Nuclear fuel
Vanadium	1,200	9	Metallurgy
Titanium	15,000	180	Metallurgy

Value are based on elemental analyses conducted at Wichita State University and by other investigators, with the market price determined from U.S. Bureau of Mines values for 1971. Total assay value on these elements is placed at around $400 per ton of coal ash, assuming 100 percent extraction.

Why has coal ash not been mined before if it is such a valuable material? The last study of the feasibility of coal ash mining was apparently conducted by the U.S. Bureau of Mines in 1953. The changes since then are tremendous. Ten years ago demand for the elements present in coal ash was largely restricted to research programs and other minor uses. Today, the demand has skyrocketed, with further increases indicated in the future. Germanium and rubidium are now important in the field of micro- and photoelectronics. Uranium and thorium are valuable in government and private studies of peaceful applications of atomic energy. Vanadium and titanium are "vitamin" elements in today's steel industry, where high-speed aviation and space technology require new, more innovative alloy materials. Advances in mining recovery processes have been made in the decade. New leaching techniques for the mining of relatively insoluble materials have enabled extraction of elements from previously low-value ores. Increased demand and increased mining capabilities have stimulated renewed interest in the feasibility of coal ash mining. The economic value of coal ash justifies selective extraction.

To fully understand the feasibility of ash mining, one must examine, step by step, the modern-day mining operation and see how readily adaptable coal residues are to such a process. Five basic operations exist in mining ventures today: (1) ore removal, (2)

ore transportation, (3) ore crushing, (4) extraction of valuable elements, and (5) environmental recycling and control. Today, any mining recovery process must follow this or a similar scheme.

The first step, removal of the ore body from the earth, usually generates high production costs in most mining operations because of the large quantity of manpower and equipment required to complete the task. When coal ash is used as the ore material, excavation and the high costs it entails are virtually eliminated.

Transportation of ore to the extraction plant also tends to generate high production costs. Many mining firms are forced to construct elaborate highway or railway systems in order to rapidly move the ore from the excavation site to the processing site. Again, coal ash readily adapts to this phase of the mining operation. Ash heaps are located on preexisting transportation paths, and the highways or railways used to move coal to the industries generating coal residues could also be used to return this material to centrally located, residue-mining operations.

Another advantage of the use of coal ash as an ore material exists in the third step of the mining process, ore crushing and preparation. At present, approximately 70 percent of all coal by-products is collected in the form of fly ash. This finely powdered, particulate residue requires no additional alteration prior to extraction processes. This innate property of coal ash again serves to lower operation costs of such a mining program.

The extraction of the desired elements from the ore is the most complex step of the mining process, and therefore offers a variety of possibilities and problems in methodology. Coal ash would probably adapt effectively to multisolvent leaching techniques, with electrolytic purification the last step in the separation of valuable elements. Exact procedure details are dependent on the diverse chemical properties of this material, and further investigation is necessary and critical to the recycling concept of today.

For most mining ventures, the fifth and final process of the mining operation, environmental recycling and control, means mined land redevelopment and waste by-product disposal. At this phase of the operation, coal ash becomes most beneficial.

After the coal ignition residues have been transported to the processing plant, and the valuable elements have been extracted and marketed, the only material requiring disposal is the particulate matter remaining after leaching. This by-product would be nothing more than cleaned, chemically stabilized coal ash. These mining residues could be reintroduced into neighboring strip-mined land, thus improving soil texture and increasing water retention capacities of the mixture. The capital from the mining operation could be used to purchase the liming and fertilizing material necessary to assure proper biological reclamation. In the final analysis, we would have not only a program to reclaim extensively mined spoil acreage and utilize coal ash in large quantities, but an effective operation of environmental reconditioning independent of the financial assistance of government, industrial, and private agencies. In essence, the problems would pay for their own solution.

This is, however, a program of the future. Its existence and accompanying success are dependent on two vital requisites. First, a full-scale coal ash mining venture must have the cooperation and support of involved industries and the government and private organizations concerned with resolution of ash disposal and land reclamation. Secondly, such a program requires the development of inexpensive and efficient extraction methods adaptable to various ash materials from differing geographic locations. A solution to this requirement would be to explore the following sequence of metal recovery.

Initially, a laboratory "mini-plant" should be developed in order to obtain the extraction chemistry adequate for the process. Next would come the construction of a pilot plant, about 1 to 100 scale, in order to assess the proper industrial systematics of the program, with an ensuing field plot study to determine the economics and methods of the ash mining refuse as a soil modifier. The final step would be completion of a full-scale plant to determine exact equipment and manpower requirements, ore processing capacities, and other information necessary for the development of additional programs throughout the country.

If these requirements of cooperation and methodology can be met, the development of a large-scale program for attacking the problems of coal ash disposal and mined land reclamation will no longer be a goal, but a reality.

Mined Land Redevelopment Workshop
Holiday Inn
May 23-24
Pittsburg, Kansas

Photo by Terry Gladieux