

BITUMINOUS COAL STRIPPING IN PENNSYLVANIA

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DURING the past decade bituminous coal stripping has become a major sore spot with the general public because they see large furrows dug around hills where power shovels have worked to uncover the coal. In a short time the coal was removed and the spoil banks remain for them to look at forever. As the years have passed nothing has happened to the piles of dirt; few grasses or elementary types of vegetation have grown on them; hunters have not cared to develop them because they are too small in acreage; only recently has the State Department of Mines, Department of Commerce (State Planning Board), or the Department of Forests and Waters made any plans to assume ownership or suggest ways of utilizing the land; and only recently have the political chieftains from the districts where stripping has been a problem presented an adequate solution for legislative consideration and enactment.

Stripping results are very common sights to the motorist of Pennsylvania because he is forced to cut across stream interflaves of the Appalachian Plateau and thus has a vantage position to see many of these strippings from a higher elevation than he would if he followed the streams to reach his destination.

In Lebanon County they have been stripping² magnetite iron ore for the last hundred odd years, and the public has not complained about the surface being disturbed. Slate quarries about Quarryville and Columbia have caused no complaints. Large limestone openings at Bellefonte have raised no serious complaint, nor have silica strippings in the Ridge and Valley section caused public concern. Bituminous coal stripping has the "ability" to make people ask: "Why is this necessary?"

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² The term "stripping" is used in a broad sense. The author sees no reason for singling out coal stripping as the only major disturber of the earth's surface.

The public is not disturbed by iron-ore pit mining, limestone and slate quarrying, and silica stripping because they are usually off the main lines of traffic, on secondary public auto roads, make possible direct shipments by rail to the consumer, cover little acreage, or support a permanent population. The operators of bituminous coal strippings desire to be near hard-surfaced roads; thus they are located along the major highways, if stripping rights can be secured. For this reason they cover sizable acreages which cannot be hidden from the motorist. This industry does not support a permanent population; in fact, it demands mobile people.

HISTORY

The history of stripping is not a spectacular one, but rather a development of technology. The first stripping was done to expose the outcrop and mine it. This meant that the coal had little overburden and was weathered. Some people would not consider this stripping, but it was surface working where men had to remove the overburden to mine the coal. The coal was loaded in wheelbarrows and carts by hand. The first anthracite stripping started about 1864 at Jeansville, Pennsylvania.³

Real bituminous stripping began when overburden was removed by slip scrapers pulled by horses. The earth was disturbed or prepared for removing by plowing the overburden surface and then scraping the loose material away. In 1943 there were eighteen horse strippings in operation in Pennsylvania.⁴ It is easy to understand why this elementary stripping never yielded much tonnage nor caused much surface disturbance.

The first use of a mechanical stripper in the surface mining of bituminous coal was at Pittsburg, Kansas, in 1877.⁵ The equipment used was not suitable for the task and it took many years to develop the equipment that is used today. The greatest technological advancement was due to experience gained in building the Panama Canal.

World War I made coal costly, and stripping was a method of rapidly increasing production and lowering cost. In 1914 stripping production was important enough to be considered separately from sub-surface min-

³ "Strip Coal Mining," in *Coal Catalog 1926*, p. 1137 (Pittsburgh, Keystone Consolidated Publishing Company, 1926).

⁴ "Strip Mining to the Fore," in *Mechanization*, 9:100 (December, 1945).

⁵ R. H. Sherwood, "Twenty-five Years of Coal Mining: The Development of Strip Mining," in *Mining Congress Journal*, 31 (November, 1945).

ing.⁶ That year a production of 1,280,946 tons was recorded for the United States. The percentage in 1914 was one-fifth of one percent of the nation's production.

It is not known when or where the first power stripping began in the Pennsylvania bituminous region. It is definite that it was after many of the technical problems had been settled. The first available production statistics are for the year 1917, when 349,944 tons were produced. This was one-fifth of one percent of the state's production.

World War II found in Pennsylvania a young and rapidly expanding industry, producing 2,792,966 tons in 1939, and 22,211,661 tons in 1944. During the latter year fifteen percent of the state's total was stripped.

The following table gives the tonnage stripped to 1944:

1917	349,944	1927	1,151,990	1937	853,944
1918	1,031,578	1928	1,076,871	1938	1,131,627
1919	670,507	1929	649,885	1939	2,964,839
1920	1,244,537	1930	699,040	1940	4,230,162
1921	488,253	1931	441,972	1941	8,429,778
1922	1,895,490	1932	224,512	1942	11,456,529
1923	1,299,166	1933	266,172	1943	17,177,054
1924	902,818	1934	342,098	1944	22,211,661
1925	800,615	1935	434,463		
1926	1,012,400	1936	753,784		

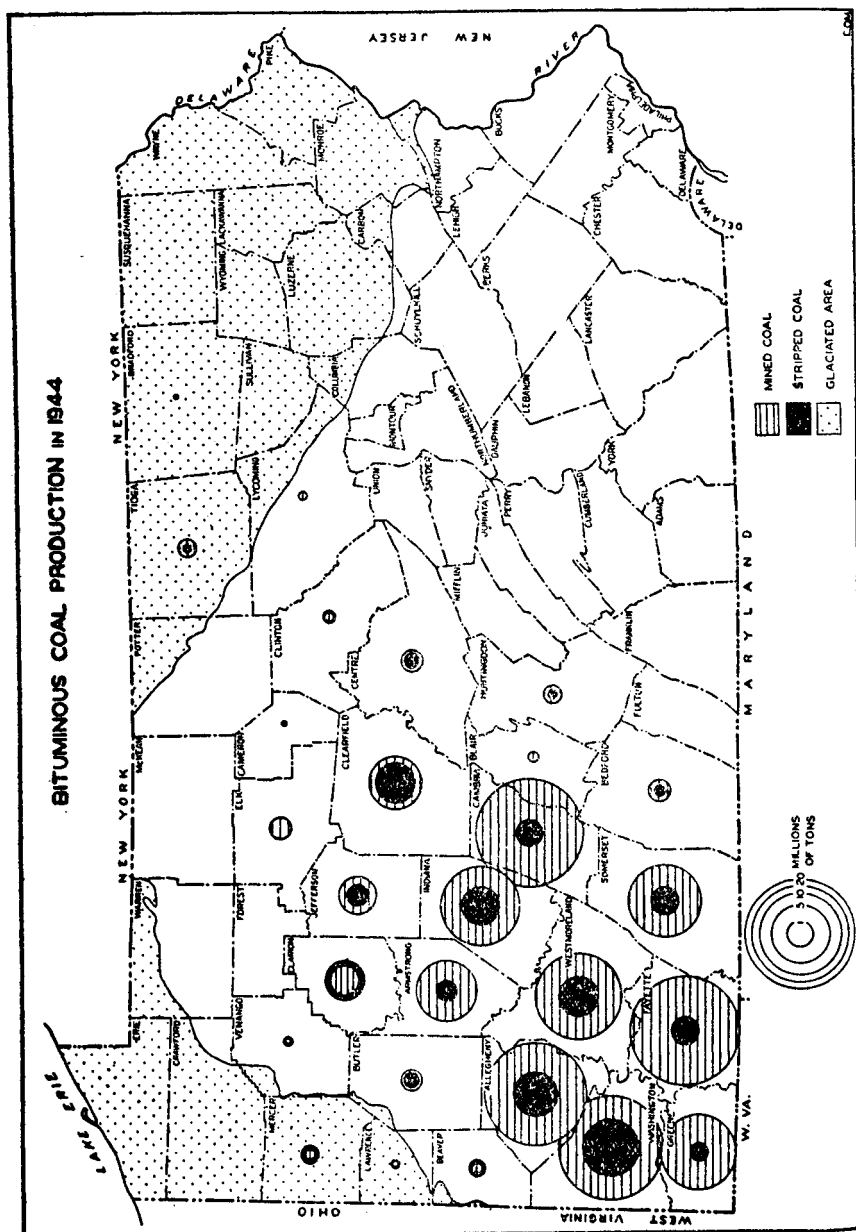
In 1943 Pennsylvania took the lead from Illinois in the number of tons stripped. It led by one million tons that year, and by the end of the next year had increased its lead to four million. Pennsylvania, Illinois, Indiana, West Virginia, and Ohio each produced ten million or more tons per year.⁷

In general, stripping is moving south and eastward in the state. In the south the tonnage produced by surface working is increasing and may be as great as twenty-two percent of sub-surface tonnage. A study of Figure I shows the relationship of the two methods of production. The eastward

⁶ All statistical data are from the U. S. Bureau of Mines, Washington, or from the Pennsylvania Department of Mines, Harrisburg.

⁷ "Strip Mining to the Fore," in *Mechanization*, 9:96 (December, 1945).

BITUMINOUS COAL PRODUCTION IN 1944



extension is into one of the oldest deep mine areas in the state. Expansion here is definitely the result of World War II and the exhaustion of easily mined sub-surface coal. The greater demand for coal during the war brought stripping to many counties for the first time.

In the counties of Beaver, Bradford, Cameron, Clarion, Clinton, Lawrence, Mercer, and Venango, the tonnage stripped is greater than that of sub-surface mining. All but one of these counties are small producers of coal. Clarion County is the only large-producing county in which strip mining exceeded deep mining by 1,988,744 to 1,308,277 tons.

PHYSIOGRAPHY AND GEOLOGY

The bituminous coal producing area lies entirely in the Allegheny division of the Appalachian Plateau. In the prehistoric past this area experienced the deposition of water-carried materials, and sandstone, shale, and limestone are the result. At various periods the area was nearly at sea level and supported a dense, luxurious vegetation; this vegetation died and fell into the coal swamp. Today this vegetation is a compact mass of carbonized plant debris. The vegetation clearly grew in swamps or water-saturated bogs, as evidenced by the spreading root systems still preserved in the fire clays that underlie the coals in many places.

The Plateau is classified as early mature by the geomorphologist. This means that the original levelness is gone, streams have cut into the former elevated plain, and rounded knobs exist. The physical landscape today presents an evenness of horizon because the ridge crests or divides separating two of the smaller streams have not been eroded far below the level of the original surface.

The eastern boundary of the Appalachian Plateau makes a southwest to northeast curve through the coal producing counties of Bedford, Blair, Centre, Clinton, and Lycoming. This is known as the Allegheny Front. It is the boundary between the relatively flat lying rock of the Plateau and the intensely folded rock layers of the Ridge and Valley Province. The Plateau may be subdivided into three important parts.⁸

⁸ After Nevin M. Fenneman, *Physiography of Eastern United States*, 279-342 (McGraw-Hill Company, 1938).

After the deposited material had been consolidated into rock and raised above sea level, and had undergone several cycles of uplift and erosion, a powerful force from the southeast apparently forced the eastern part of the Plateau to a higher elevation than the rest of the area. This portion is known as the Allegheny Mountains. Laurel Hill and Chestnut Ridge are examples of the more deformed portions of the area. The beds of rocks are mildly folded here. This deformation has tended to give rise to belts of anticlines, synclines, and monoclines. The elevations range from 2,100 to 2,200 feet on the west, and 2,600 to 2,700 farther east.

The coal in the Allegheny Mountains has more of the gas and water driven off because more pressure was applied when the area was forced to a higher elevation and the horizontal rock strata were forced into gentle synclines and anticlines. This partial devolatilization produced the low volatile or "smokeless" coal of the area. The deeply eroded stream valleys made it easier to start drift mines than to strip the surface. Rail lines were developed along the streams, thus encouraging the opening of additional slope mines.

The unglaciated Allegheny Plateau includes the greatest area of the Plateau. This area is several hundred feet less in elevation than the Mountain section because shales are easily worked by water erosion. The elevation is 1,400 to 1,500 feet, and relief, 200 to 300 feet. Most land of moderate slope is between valleys rather than in them; this is the chief reason why hill tops are stripped in this area.

Stripping operators work around the hill tops, and from the air many closed pits look like large waves with an island in the middle. The island is the unstripped area that has too much overburden to work with present-day equipment. Not everywhere do they work around the hill-tops. Some workings result in irregularly elongated spoil banks like those produced in Illinois and Indiana; the hilltop topography minimizes this last occurrence. Much of the coal stripped from these areas could not be mined by deep mining because the poor roof, or unconsolidated beds of rock over the coal, would not permit enough coal to be removed profitably and worked safely. This area has the greatest number of pits, tons produced, and largest operations.

The glaciated Allegheny Plateau lies at an elevation of 1,200 to 2,000 feet, the greater elevation being in the northern part of the area. This area is shown on Figure I. Many of the surface depressions that existed previous to the glacial period were filled with glacial debris when the glacier retreated. A mature drainage system has not developed since the glacier melted, thus there are many swamps and small lakes.

The stripper has a greater water pumping problem in this area because glacial debris is a good reservoir for water. Some pits must pump five thousand or more gallons of water per ton of coal produced. Oftentimes, the water must be carried great distances from the workings or it will run into the soil again and back into the pit. In Lawrence and Mercer counties more coal was produced by strip than sub-surface mining in 1944. Both counties lie almost wholly within the glaciated area.

SCIENTIFIC PROSPECTING

Opening a new stripping involves the use of modern science so that the venture may be a financial success. Test holes of several inches in diameter are drilled to determine the thickness of the coal, extent of the deposit, the quality of the coal, the slope of the bed, and the depth and character of the overburden. These holes are drilled at the corner of a square at every one, two, or three hundred feet. The test holes may show that sub-surface workings have made the advisability of exploiting the field questionable, or that one of the above-mentioned factors would limit the financial return.

This scientific survey makes it possible to know the available tonnage; the quality of the coal, which permits the operator to contact consumers of the quality of coal about to be produced; the character of the overburden, which permits an accurate estimate of the cost per ton; and the slope of the bed, which determines where the stripping pit will be opened.

One objective of scientific prospecting is to have a self draining operation. The operator, using results obtained from test hole drilling, opens the first cut at the low point of the coal bed and future cuts are carried up the slope. This permits all water to drain from the cuts opened by the shovel. Wider cuts are taken in shallow cover to provide dumping space, later, for thicker overburden. Figure II shows clearly how the

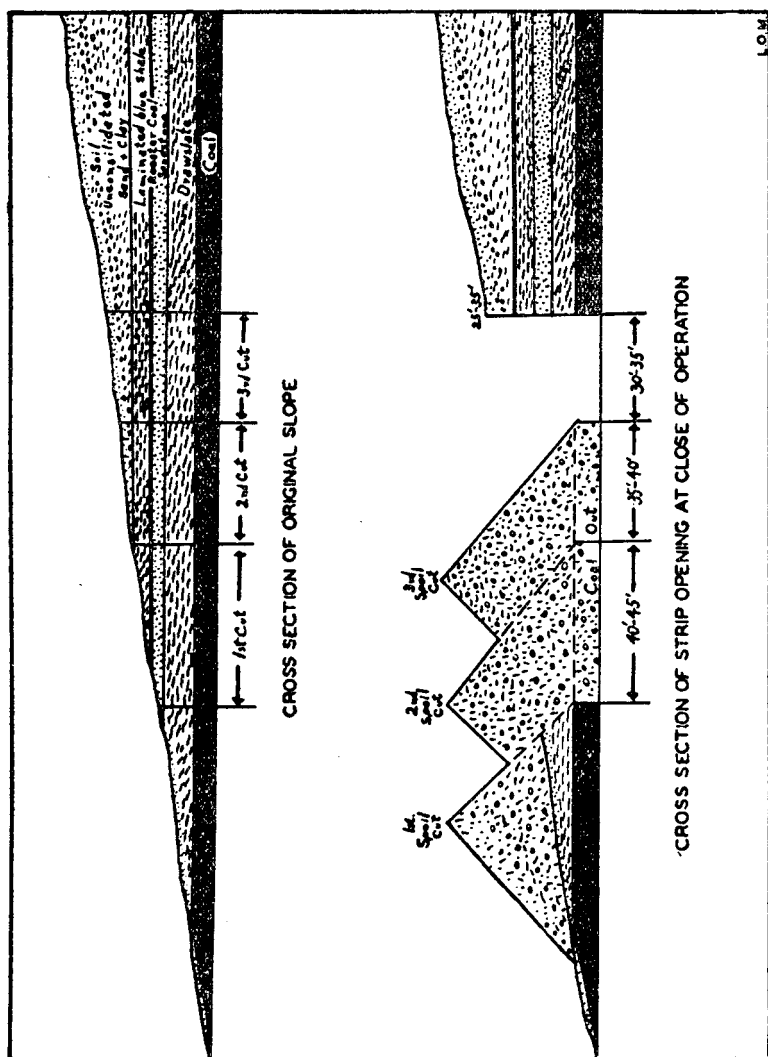


Figure II

profiles look before and after the usual operation. The figures on the drawing show the decrease in each lateral cut across the coal bed.

ADVANTAGES OF STRIPPING

The advantages of surface mining are many. It is a way of mechanizing a working to one hundred percent and of recovering nearly all the coal. None of the other methods of mining can approach it in these two respects.

The greatest interest in stripping arises from economy of production. In 1942 the average Pennsylvania surface worker produced twice as many tons per day as a sub-surface worker, 9.78 to 4.71.⁹ The investment in machinery for each workman is much greater in surface than in sub-surface mining, but the salvage value of this equipment is much greater than that of sub-surface equipment. No item of expense is charged to ventilation because the work is all out in the open where any gas may be dispersed into the atmosphere. No timber is required for props and underground repair. This is a major economy now that timber prices have risen and more is required for deep mines.

There is a minimum of state mine inspection for the strip mine owners. They were free of this inspection until 1941.¹⁰ An inspector has little to inspect in such an operation in comparison with sub-surface workings.

The use of explosives is decreased because large shovels are able to disturb the overburden, or horizontal blast holes are drilled into the banks and increase the effectiveness of the explosive. The character of overburden determines how extensive the use of explosives will be. A shale overburden requires little; a solid layer of rock may require much. Small amounts may be needed to loosen the coal so that loading shovels may work it.

The return on money invested in surface operations is quick. Within a few weeks after moving equipment to an operation, coal may be reaching the consumer in sizable quantities. Sub-surface operations require much time and investment to start drifts or shafts and develop the mine

⁹ *Minerals Yearbook 1943*, pp. 892, 930.

¹⁰ Pennsylvania, *Laws*, act of June 18, 1941 (no. 71).

for many men to work. On the average, it requires two men underground to produce what one does on the surface.

There is little tradition in the field of stripping. Other types of mining have established standard engineering practices, but stripping is a new field and there is no limit to new methods that scientists may try. These workings often operate on a twenty-four hour basis, two or three shifts a day. Labor unions have not resisted the new methods. They have been concerned in having the mines unionized only to the extent that the pay is comparable for sub-surface and surface operators. "Practically all large strippers have wage agreements with the United Mine Workers of America."¹¹

Insurance for surface miners is 2.1 percent per hundred dollars of payroll; sub-surface is between 4.3 and 4.8 percent. The minimum premium payment for a stripper is forty-five dollars and one hundred and fifty for his competitor.¹² The number of people killed and injured in sub-surface mining per million tons produced is far greater than for stripping.

Larger equipment may be used to carry the coal from the pit. For those hauling coal to the consumer without the process of sizing or cleaning this eliminates much work.

Title to most surface worked land remains with the owner and the stripper is free of tax liability after coal removal. A 1945 law permits the commonwealth to buy the surface rights, or accept them as a gift, from coal companies.¹³

LAND OWNERSHIP

Many operators do not purchase the land they strip. This is definitely to the advantage of the operator and the landowner. It has been the tendency of taxing bodies to continue high assessments on land owned by strippers after workings had been closed. The landowner has an opportunity to exploit the other, sub-surface, minerals at a future time,

¹¹ K. C. Adams, editor, *United Mine Workers Journal*, personal correspondence, 1945.

¹² Pennsylvania Compensation and Rating Bureau, *Pennsylvania Manual of Compensation, 1945, Rules and Rates*.

¹³ "A Conservation Program for Pennsylvania," in *Pennsylvania Planning*, vol. 9, no. 6, p. 34 (1945).

and the local tax assessor has been inclined to lower his tax. Much of western Pennsylvania is underlain with natural gas or petroleum and the owners look forward to secondary recovery and do not part with their legal rights to sub-surface minerals. The extension of stripping into the eastern coal producing counties was a result of World War II and the coal leasing practice was carried there.

A contract is entered into by the landowner and operator for a remuneration of a certain amount per ton of coal removed. The usual contract requires the operator to pay ten to twenty-five cents per ton for all coal removed, the average price being twelve to fifteen cents per ton. The return to the owner is large if the bed of coal is thick and covers much area. One vertical inch of coal per square acre yields 135 tons, a three-foot vein, 4,860, or \$583 at twelve cents per ton. It would take many years to produce agricultural crops of such value per acre. It is little wonder that landowners have contracted for coal removal because several acres may yield a greater cash return than the whole farm is worth. Much of the land under contract to the stripper would be classified as sub-marginal by the land economist. Such land should be returned to forest cover if the owner would like any financial return other than that from stripping. Stripping offers a greater and more immediate return.

FACTORS IN SELECTING A STRIP PIT

The factors entering into the selection of a strip pit are: a yield of twenty-five to fifty thousand tons per change of location, good quality of coal and thickness of thirty inches or more, adequate ratio between bed and overburden, proximity to large consumer with low freight rates, nearness to good roads, and non-flooding pits.¹⁴

The loss in production and the expense of moving equipment from one working to another is a major item of expense and cessation of supply for the consumer. Most operators will not select a location that does not yield the minimum tonnage mentioned above. In 1944 nearly one-half of the pits produced more than the minimum tonnage desired per move. The average production per pit was nearly forty-eight thousand

¹⁴ Data from field work in 1942.

tons. The pits producing more than twenty-five thousand tons produce a greater annual tonnage than the greater number of pits under that tonnage. The following table gives some idea of the tonnage stripped per pit:

500,000 and more	2	25,000 - 50,000	77
250,000 - 500,000	22	10,000 - 25,000	104
100,000 - 250,000	50	5,000 - 10,000	59
75,000 - 100,000	23	Less than 5,000	66
50,000 - 75,000	43		

In general, a good quality of coal may be determined by selecting by name the coal bed to be worked. The Pittsburgh and Connellsville coal beds meet the high standards set by industrial users. The coal most desired has 14,000 B.t.u. (British thermal units), minimum of sulphur, low volatile, fusion, low moisture, and ash of eight percent. The problem is to select an area that has enough overburden to protect the coal from weathering, but not so much as to make the operation too costly. The character of the overburden, rather than its depth, may determine if the coal is weathered; a hard cap rock or an impervious material may protect the coal from weathering. Selling weathered coal was one of the reasons for considering strip coal "dirt" in the early days of the industry.

The 1939 Bituminous Coal Report of the Commonwealth of Pennsylvania listed the following coal beds being worked: Pittsburgh; Connellsville; Upper and Lower Freeport; Upper, Middle, and Lower Kittanning; Clarion; Brookville; and Sharon Block. The coal beds ranged in thickness from thirty to one hundred and eight inches.

It is common practice to speak of the ratio between bed and overburden as one to twelve. This means that an operator would remove thirty feet of overburden to strip thirty inches of coal. This cannot be substantiated by actual commercial practice. In 1939 operators were removing from fifteen to forty feet of overburden to strip the thirty to one hundred and eight inches of coal. Operators believe the ratio of one to six or eight is better.¹⁵ This is in agreement with production through-

¹⁵ Data from field work in 1942.

out the United States; the great bulk of coal comes from pits with ratios of from five to eleven.¹⁶

Nearly all surface mined coal moves to the consumer by rail. In the counties of small production much of it is for domestic use and moves to the consumer by truck. Motor competition requires rail operators to furnish adequate equipment to satisfy shipping needs with a minimum of expense for sidings and special rail construction.

Every operator desires to be near a hard-surfaced road to reduce the expense of road building, year round operation, and repair of equipment. Coal is removed from the pits by motor power and most of it moves from pit to loading point over public highways.

A non-flooding location is desirable to permit work at any time, reduce the amount of equipment and expense of operation, and minimize the engineering problems. Pits in flood plains may be flooded from streams during flood periods, those in glacial areas may have constant seepage, and those that cannot be opened at the low point of the coal bed may require constant pumping.

EQUIPMENT USED

A visit to a surface working proves that much equipment is used. There are test-hole drilling machines; mechanical drills for drilling horizontal blast holes; bulldozers for cleaning debris from coal or helping the power shovel remove overburden; a carry-all grader if the surface is unconsolidated enough to handle by this means; water pumping machines; mechanical sweepers and air pressure machines to clean the coal before the loading shovel starts; flood lights if the operation is carried on during the night period; tool sheds; dump trucks; a field office; and a minimum of two shovels—a stripper and a loader.

The shovels are what attract the public. The stripper removes the overburden from the coal by drag line operation or by the usual shovel method; it is usually a much larger machine than the loader. The loader is the regular size construction shovel. It loads the coal into trucks and

¹⁶ *Mining Bituminous Coal by Stripping Methods*, in U. S. Bureau of Mines, *Information Circular*, No. 6383, p. 13 (Washington, 1930).

they transport it to the railroad cars or the consumer. At a convenient distance, in the center of the area that the stripper will ultimately work, a coal loading, cleaning, and sizing plant may be located.

In 1943 there were 742 shovels in operation. Of these, 699 were small shovels of three cubic yards capacity or less. Pennsylvania had only two large shovels of twelve yards capacity or more.¹⁷ There are several types of power shovels.

Of the shovels in operation in 1943, six hundred and seventy were internal combustion, seven electric, and sixty-five steam. The power shovel has replaced the steam shovel because it does not require large amounts of manual labor to have clean, mineral-free boiler water, keep water equipment from freezing, load coal, keep the fire burning, and watch that hot ashes do not set the coal seam on fire. The largest and most modern equipment is electrically operated. It furnishes the smoothest and most efficient operation. It is doubtful that Pennsylvania will ever have large equipment like Illinois and Indiana because there are no large acreages available for stripping in a single block.

Now that the war is over operators may purchase more modern machines to increase their production and to lower costs. Many of the Diesel shovels will be returned to construction work and the steam shovels will operate in small pits to satisfy local demand. This reduction in equipment will partly offset the loss of coal orders due to cessation of the peak war demand.

TRANSPORTATION AND PREPARATION

Nearly all coal from strip pits moves by motor trucks carrying three to ten tons. The loading and stripping shovels open the cuts so that the trucks move over the hard surface from which the coal is being removed. The use of the top of the strata that is beneath the coal lowers the cost of production because it does not require special labor to build roads. The ideal opening is nearest the hard-surfaced road, this being conditioned by drainage. Hard-surfaced roads make for rapid movement of motorized equipment and a minimum of equipment repair.

Most coal is trucked a few miles to a loading tippie where trucks

¹⁷ "Strip Mining to the Fore," in *Mechanization*, 9:100 (December, 1945).

dump their loads, or machines load the coal, into the railroad cars. A wise operator has many acres under contract before he moves his equipment and the loading tippie is centralized with reference to both present and future operations.

Most stripped coal passes to the consumer, industrial or domestic, as run-of-mine coal. This means that all sizes of coal are present and few if any impurities are removed. Some coal is sized and impurities are removed. This requires the construction of much permanent equipment and more workers to operate it. During World War II the demand for coal was so great that the consumer could not be too selective. The same condition existed during World War I, but after that war the consumer demanded a cleaner product, and mining practices were changed to keep his trade. More catering to the consumer interest will come now that the demand is more normal.

LAND RESTORATION AND USE

In the 1945 session of the Pennsylvania legislature a bill was passed which requires all operators planning bituminous stripping to post a bond of two hundred dollars per acre for every anticipated acre of stripping, to the amount of two thousand dollars at least, "to aid thereby in the protection of birds and wild life, to enhance the value of such land for taxation, to decrease soil erosion, to aid in the prevention of the pollution of rivers and streams, to prevent combustion of unmined coal, and generally to improve the use and enjoyment of said lands."¹⁸ The law permits the restored land to be planted with other vegetation than trees, but most specialists believe that needle bearing trees are best adapted to the available soil. Broad leafed trees would add more humus to the earth and enrich the soil much faster, but they are not so well adapted to the acid soil. Some grasses will grow on soil banks without adding chemicals to the soil.

The law further provides that "within one year after the operation is completed the operator shall place sufficient overburden in the open cut to cover the exposed face of the unmined coal, which shall begin at least three feet above the top of the coal and shall extend to the bottom of the

¹⁸ Pennsylvania, *Laws*, act of May 31, 1945 (no. 418).

pit at an angle not to exceed forty-five degrees." If the operator does not restore the stripped land, the Secretary of the Department of Forests and Waters may use the deposited fund for the purpose of foresting and reclaiming any stripped land within the county which the liability bond specified.

At first glance this seems to be a solution to the problem, but it is doubtful that it is. Many pits use only small shovels that formerly were used by road contractors and builders. They cannot remove many feet of overburden because they lack light weight dippers, dump their buckets at a short distance from the center of rotation, have short booms, and do not have enough power to remove harder overburden without expensive blasting.

If the dirt is piled four feet beyond the top of the coal seam, operators with modern, large equipment may not open them again. It has been a practice, where small machines were used, to have several operators work a pit after the first operator could no longer handle the overburden with his equipment. The price of coal and size of equipment will determine if it is profitable to remove this placed overburden and remove greater depth of original overburden.

No sizable acreage of stripped land has been leveled or planted on a voluntary basis. Some land owners, as part of their contract, require the operator to level land near their houses. Trees have been planted on spoil banks only to hide these spoil banks from the public.

Grove City, Pennsylvania, has developed a two hundred and twenty-five acre municipal park from spoil banks. On four acres, picnic sheds, a swimming pool, a bath house, swings, slides, a wading pool, and tennis courts have been constructed. The remainder of the area has been planted with evergreen trees, and drives have been developed. The trees now average fifteen to twenty feet in height.¹⁹ Other cities might follow this example, because many of these pits are on the outskirts of towns.

PROBABLE FUTURE

No one can forecast exactly what lies ahead for any industry, but it seems certain that 1944 will stand as the peak year for strip production.

¹⁹ W. D. Breckenridge, City Manager, personal correspondence, 1945.

Industrial demand was high and steady throughout the year. The next year both fronts of the global war closed and reconversion and industrial strife followed, thus terminating the steady and heavy demands that had existed.

The 1945 session of the Pennsylvania legislature passed the law which requires the operators to level the land suitable for planting grass and trees. This added expense may discourage surface operators and hinder production. At present this law is being contested in the Dauphin County Court²⁰ by coal strippers of the Allegheny Mountain Section. Their attack is against leveling the spoil banks and a registration fee. Society has made it clear that it is not interested in one hundred percent efficiency in coal mining unless conservation of the landscape for beauty and future utility is practiced.

The area that may be stripped is definitely limited in acreage. Only a small percentage of the total coal area is suitable for surface mining. During the past five years more than twelve thousand acres of land have been stripped.²¹ The use of small machines limits the amount of overburden that can be stripped. At present the size of machine is limited to those that can move short distances on their own power, and those that can be transported on trailers of eight or ten wheels. If large acreages in a single block were more abundant, large machines would be used more. If the price of coal increases, operators will find it profitable to work greater overburden and strip greater acreage.

A factor encouraging stripping is the exhaustion of many of the choice coal beds and the increased cost of deep mining. The easily machine-mined hilltop coal was by-passed in the early development of the coal field. Outcrop coal along streams was much easier to secure than coal from which the surface had to be removed. Technology has changed this trend.

SUMMARY

Bituminous stripping is contrary to industrial tendency. Most minerals are first surface-worked and then deep-mined. Technology and economic factors have stimulated stripping.

²⁰ *Clearfield Progress*, January 4, 1946.

²¹ Joseph J. Walsh, Deputy Secretary of Mines, personal correspondence, 1946.

The economic advantages of stripping are so great that hundreds of hilltops will be stripped in the future if the owners are willing to contract for coal removal. The comparative advantage of strip mining is great today. The difference in selling price may be twenty-five cents a ton at the pit. Labor unions are not opposed to the operators and many strip mines work more days per year than deep mines. Labor difficulties and shutdowns have been fewer in strip workings.

If we pick two of the largest and two of the smallest strippings for the year 1944, we find a production per man per day of 16.8 and 15.01 for the largest and 5.57 and 8.33 for the smallest. For the largest with 680,158 tons to the smallest with 334 tons, the average production is greater than that from the average deep mine. Some mines average more than fifty tons per day per man. The economy of production is definitely on the stripping side. Total strip production cannot equal deep mining because of limited stripping areas and technological limitations.

The industry is young and vigorous. Its methods are scientific and not limited by tradition. With future leveling of spoil banks and reforestation, the landscape may not be disfigured as much as by the culm piles of the deep mines.