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DIVISION OF MINES AND GEOLOGY  
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Report of Investigations  
No. 4R  
(Revision of R. I. 4)

# Coal and Coal Mining in Washington

By  
STEPHEN H. GREEN



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## FOREWORD

Coal, of all the mineral resources occurring in Washington, is one of the most economically important. The mining of coal has been a major industry since the early days of the state, and it will continue in future years to hold a leading place among mining operations.

Interest in coal slackened somewhat as the use of fuel oil for industrial and domestic heating increased, but a change of attitude toward coal became apparent when it was realized that oil supplies were not unlimited. For some time now production has been unable to keep pace with the expanding market, although every effort has been made to increase the output of existing mines. Also, new properties have been opened, and in many places investigations are under way that will lead to further development. The renewed and increasing attention to our coal resources has indicated the need for a short but comprehensive report that would supply general information on Washington's coal and on the status of coal mining.

This Report of Investigations has been prepared, therefore, for the use, primarily, of those now unfamiliar with the subject, or at least unfamiliar with coal mining as practiced in this state. The references that are given will be found most helpful if a more detailed treatment and further particulars are desired. Necessarily, material has been included that is already well known to the industry, in order to lay some groundwork for the benefit of others. It is believed that those now engaged in coal mining, as well as those not connected with the industry, will find the information timely and useful.

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Owing to the fact that the edition of Report of Investigations No. 4 was quickly exhausted, this revision (Report of Investigations No. 4R) has been prepared. Certain obvious errors in the text have been corrected, and the list of operating properties brought up to date.

SHELDON L. GLOVER, Supervisor  
Division of Mines and Geology



# COAL AND COAL MINING IN WASHINGTON

By STEPHEN H. GREEN

## INTRODUCTION

Coal is one of the most abundant mineral resources of this state, there being an ample tonnage available for all requirements that can now be foreseen, both industrial and domestic, not only for the present but for hundreds of years to come. According to a frequently mentioned estimate, made by the U. S. Geological Survey in 1913 and revised in 1925, the total coal reserves of the state were more than 63 billion tons. If a new survey were made at this date, later information now available would probably increase these figures appreciably; however it should be borne in mind that some beds included in such an estimate are noncommercial under present conditions, and some have been made, at least in part, nonavailable due to careless mining practice. Nevertheless, an immense tonnage exists, chiefly of bituminous and subbituminous ranks.

According to the statistics of the State Mine Inspector,<sup>①</sup> the total coal mined in the state from 1860 up to and including 1946 was 138,806,625 tons. If a depletion or exhaustion in the original resource of even three times the reported output is assumed, the amount would be only an insignificant part of the original estimated reserve, and the amount still remaining would be in excess of 60 billion tons. Washington, therefore, has an exceedingly valuable asset in its untouched coal reserves. The fact that coal has always occupied a strategic position in industrial development, and that areas amply supplied with coal have always become dominant commercially and industrially, places the state in a singularly favorable position.

Washington mines are fortunate in being located near the center of our most densely populated districts. Proximity of the mines to the principal consuming centers and also to tidewater, a mild climate that ensures favorable transportation and working conditions throughout the year, ample railroad facilities, and excellent highways that make truck transportation easy and economical, are all advantages that help to overcome possible drawbacks. Up until recent years Washington coals found a good market in Oregon and California and a fair tonnage was exported to Alaska. In the event the production of the state is again expanded, these markets will in all probability again absorb a considerable tonnage.

The coal deposits of the state (see fig. 1) are chiefly distributed along the west slope of the Cascade Mountains. Whatcom, Skagit, King, Pierce, Thurston, Lewis, and Cowlitz Counties all contain important coal fields. On the east flank of the Cascades is one major field, in Kittitas County. Some minor, and at present unimportant, deposits occur in Asotin, Clallam, Chelan, Snohomish, Stevens, and

<sup>①</sup> State Mine Inspector, Annual report of coal mines (Washington), p. 7, 1946.

other counties. The product of these various fields can meet every requirement of the fuel-consuming markets, as it embraces every rank of coal from anthracite to lignite.

The various ranks of coal are to a large extent segregated as to location; the anthracite, bituminous, and coking coals being confined to the more mountainous areas, while the subbituminous and lignite ranks are found in regions of less relief. In fact, the degree of devolatilization (with consequent improvement in grade or rank) that the coal of any particular field has undergone may be roughly gauged by the position of the field with reference to the Cascade Mountains. The subbituminous coals occur in regions of low relief and in which the coal measures have undergone only minor structural disturbance. Bituminous coals are found in the foothills, and the coking and higher-grade bituminous coals are still nearer the mountains, where the rocks are more sharply tilted and folded. The anthracite beds, in Whatcom and Lewis Counties, are yet higher in the mountains, being at elevations of from 1,000 to 5,000 feet above sea level.

The only large and commercially important supply of coking coal in the Pacific Coast States is located in Pierce County. This is unquestionably of marked significance in connection with the needs of electrometallurgical and electrochemical industries now in operation or in prospect, and it very possibly will be a major factor in the establishment of an iron and steel industry in the state at some future time. Coking coal has also been mined at Cokedale in Skagit County, and, though this property has been closed for a number of years, there is good reason to believe an extension of the seam can be found. In Kittitas County, too, the Roslyn-No. 3 seam makes a very fair grade of coke, but at present the entire production is being used for other purposes.

Anthracite occurs in both Whatcom and Lewis Counties, but though considerable prospecting has been done, no commercial development has taken place in either area.

#### SELECTED BIBLIOGRAPHY

A large number of articles and reports have been published on the various phases of the coal industry and on the geology of coal in Washington. Many of these are available from the issuing agencies, and all may be consulted in the larger libraries. The reports mentioned in the following list are of particular interest to anyone desiring additional information on the coal fields of the state, on coal mining and coal preparation, and on analyses.

1. Ash, S. H., Systems of coal mining in western Washington: *Am. Inst. Min. Met. Eng. Trans.*, vol. 72, pp. 833-873, 1925.
2. ——— The coal fields of Washington: *U. S. Bur. Mines Tech. Paper* 491, pp. 1-11, 1931.
3. Barkley, J. F., Pointers on the storage of coal: *U. S. Bur. Mines Inf. Circ.* 7211, 1942.
4. ——— The storage of coal: *U. S. Bur. Mines Inf. Circ.* 7235, 1943.
5. Bennett, W. A. G., Bibliography and index of geology and mineral resources of Washington, 1814-1936: *Washington Div. Geology Bull.* 35, 1939.

6. Chief mine inspector's reports: Annual report of coal mines, various years.
7. Culver, Harold E., The coal fields of southwestern Washington: Washington Geol. Survey Bull. 19, 1919.
8. Daniels, Joseph, The coal fields of Pierce County: Washington Geol. Survey Bull. 10, 1914.
9. ——— The coking industry of the Pacific Northwest: Univ. of Washington Engineering Experiment Station Series Bull. 9, 1920.
10. ——— Coal in Washington: Univ. of Washington Engineering Experiment Station Series Rept. 3, 1934.
11. Daniels, Joseph; Yancy, H. F.; and Geer, M. R., Production, distribution, and use (of Washington coal): U. S. Bur. Mines Tech. Paper 618, pp. 5-16, 1941.
12. Evans, G. W., The coal fields of King County: Washington Geol. Survey Bull. 3, 1912.
13. Goodman, John B., Parry, V. F., and Landers, W. S., Storage of sub-bituminous slack coal in open pits: U. S. Bur. Mines Rept. Inv. 3915, 1946.
14. Glover, Sheldon L., Nonmetallic mineral resources of Washington, with statistics for 1933: Washington Div. Geology Bull. 33, 1936.
15. Jenkins, O. P., Geological investigation of the coal fields of western Whatcom County, Washington: Washington Div. Geology Bull. 28, 1923.
16. ——— Geological investigation of the coal fields of Skagit County, Washington: Washington Div. Geology Bull. 29, 1924.
17. Kiessling, O. E., and Daniels, Joseph, Production, distribution, and use (of Washington coal): U. S. Bur. Mines Tech. Paper 491, pp. 23-34, 1931.
18. Landes, Henry, The coal deposits of Washington: Washington Geol. Survey Ann. Rept. 1901, vol. 1, pt. 4, 1902.
19. Landes, Henry, and Ruddy, C. A., Coal deposits of Washington: Washington Geol. Survey Ann. Rept. 1902, vol. 2, pt. 2, 1903.
20. Lund, R. J., and Sullivan, John D., Survey report on Washington fuel requirements and supplies to Washington State Department of Conservation and Development: Battelle Memorial Institute, January 15, 1947.
21. Parry, V. F., Questions and answers on storage of coal in the Rocky Mountain area: U. S. Bur. Mines Inf. Circ. 7214, 1942.
22. Parry, V. F. and Goodman, John B., Storage of subbituminous coal in bins: U. S. Bur. Mines Rept. Inv. 3587, 1941.
23. Saunders, E. J., Coal fields of Kittitas County: Washington Geol. Survey Bull. 9, 1914.
24. Smith, E. E., Coals of the State of Washington: U. S. Geol. Survey Bull. 474, 1911.
25. Snyder, N. H., Cooper, H. M., Geer, M. R., and others, Analyses of Washington coals: U. S. Bur. Mines Tech. Paper 618, pp. 17-78, 1941.
26. Snyder, N. H., Fieldner, A. C., Osgood, F. D., and others, Analyses of Washington coals: U. S. Bur. Mines Tech. Paper 491, pp. 35-198, 1931.
27. Various authors, U. S. Geol. Survey and U. S. Bur. Mines Mineral Resources.
28. Various authors, U. S. Bur. Mines Minerals Yearbook, 1932 and subsequent years.
29. Willis, Bailey, and Smith, G. O., Description of the Tacoma Quadrangle: U. S. Geol. Survey Geol. Atlas, Tacoma folio (no. 54), 1899.
30. Yancey, H. F., and Ash, S. H., Methods of mining and preparation of coal (in Washington): U. S. Bur. Mines Tech. Paper 491, pp. 12-22, 1931.
31. Yancey, H. F., and Geer, M. R., Mining and preparation (of Washington coal): U. S. Bur. Mines Tech. Paper 618, pp. 1-3, 1941.
32. Yancey, H. F., Johnson, K. A., and Selvig, W. A., Friability, slacking characteristics, low-temperature carbonization assay and agglutinating value of Washington and other coals: U. S. Bur. Mines Tech. Paper 512, 1932.

## HISTORICAL OUTLINE

The earliest recorded coal discovery in the state was in 1833 by Dr. Tolmie, an Englishman in the employ of the Hudson's Bay Co., who examined coal prospects on the Cowlitz and Toutle Rivers near their junction.<sup>①</sup> The next recorded location was in the same area in 1848. In 1852 coal was discovered in Whatcom County, on Bellingham Bay, and in the fall of 1853 the first coal mine in the state was opened here by Captain Howard, Sam Brannan, and others. In 1853 another seam of coal at Sehome (now a part of Bellingham) was discovered by two men, Hewitt and Brown.<sup>②</sup> Some of this coal was sent to San Francisco to be tested, and a company was formed which purchased the claims for \$20,000. Edmund C. Fitzhugh was then put in charge of the property, and he developed the old Bellingham Bay mine by means of a slope several hundred feet long, driven down the dip of the seam. The mine operated until 1867, when fire broke out. In order to extinguish the fire the mine was filled with water from the bay and it was nearly a year before the water was pumped out and mining resumed. Later, fire broke out again, and again the mine was flooded. Although somewhat discouraged, the company once more pumped out the water and continued to work the mine until 1878, when it was shut down and abandoned.

The original opening of this mine was at what is now the intersection of Myrtle Street and Railroad Avenue in Bellingham. Since then some trouble has been experienced, owing to the caving of the surface over part of old workings in the southeast corner of the block at the intersection of Railroad Avenue and Holly Street.

In 1853 Dr. M. Bigelow found coal on Black River near the present site of Renton, and a mine was opened and operated in a small way until the Indian outbreak in 1855. In 1863 coal was discovered in a creek near the present town of Issaquah, and a few months later on Coal Creek near the present site of Newcastle.

In 1873 E. M. Smithers discovered coal at Renton, and the Renton Coal Co. was organized. The first discovery of coal in the canyon of the Carbon River was between 1862 and 1863; however, the first coal development was made there in 1874, when the Flett brothers and their brother-in-law, Gale, opened a claim on Flett or Gale Creek above the present town of Wilkeson.

No authentic report of the earliest discovery of coal in Kittitas County has been found, but Isaiah Buchanan was in the Roslyn district and knew of coal there in 1871 or 1872.<sup>③</sup> In May 1886 the Northern Pacific Railway Co. had a party of engineers in the Cle Elum Valley prospecting the field, and in December 1886 the first coal was shipped.

<sup>①</sup> Culver, Harold E., *The coal fields of southwestern Washington*: Washington Geol. Survey Bull. 19, p. 16, 1919.

<sup>②</sup> Jenkins, Olaf P., *Geological investigation of the coal fields of western Whatcom County*: Washington Div. Geology Bull. 28, p. 17, 1923.

<sup>③</sup> Saunders, E. J., *The coal fields of Kittitas County*: Washington Geol. Survey Bull. 9, p. 17, 1914.



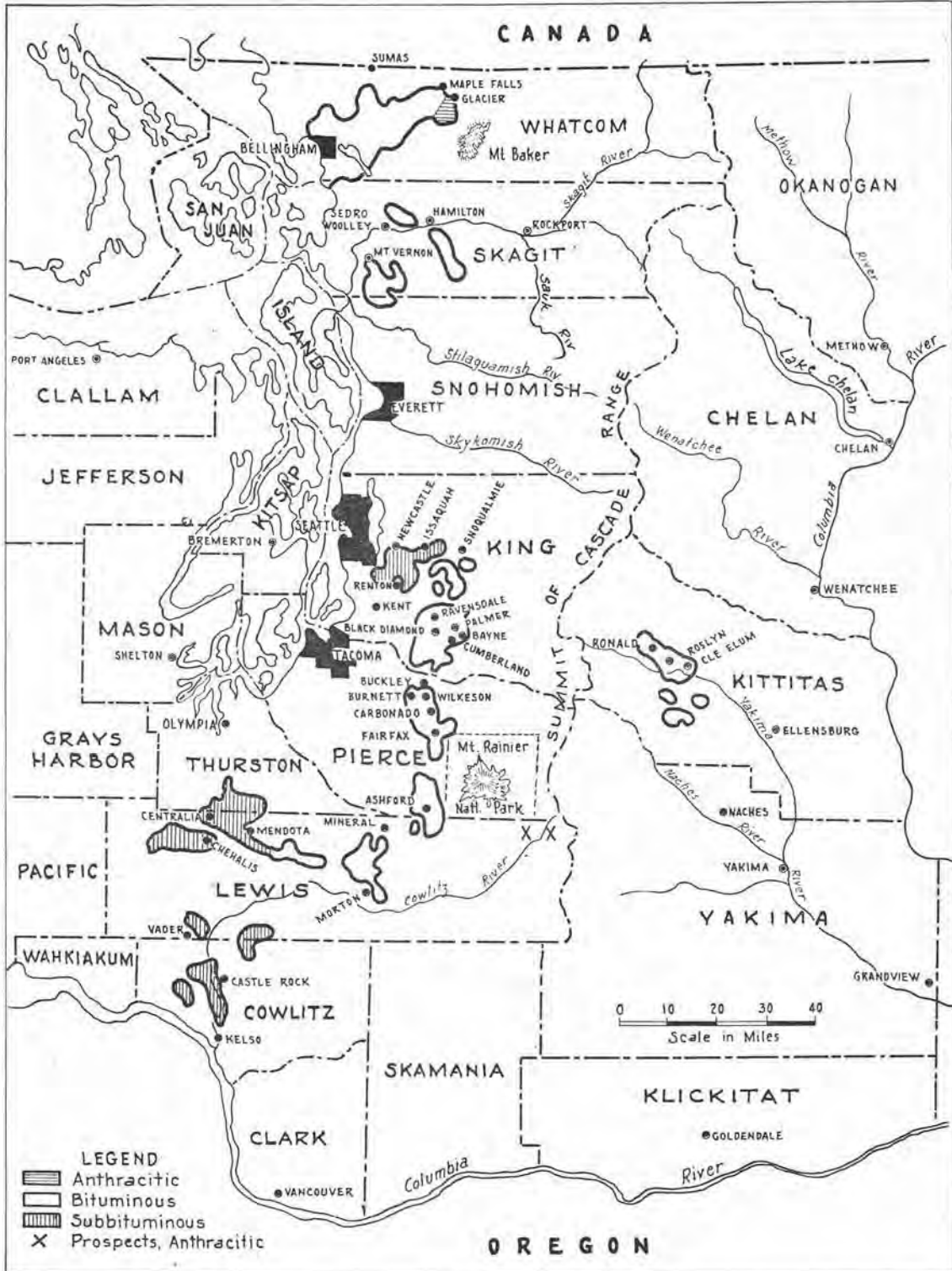


FIGURE 1— PRINCIPAL COAL AREAS OF WASHINGTON

## COAL AREAS OF THE STATE (EXCEPT ANTHRACITE)

The commercially important coal measures of the state are entirely of Eocene age. They correspond in time of deposition to the lignite measures of the Dakotas, Montana, and Texas.<sup>①</sup> Small, relatively unimportant coal occurrences in Oligocene and Miocene formations are known but are not discussed here.

## NORTHWESTERN WASHINGTON

The northwestern Washington coal field comprises large areas of Whatcom and Skagit Counties; however, the known coal beds are less extensive than those of any of the other Washington fields. The coal measures are composed mainly of massive sandstones, conglomerates, and occasional shales, all of the Chuckanut formation. An adequate understanding of the geologic structure is difficult to obtain, and a correlation of the various coal seams has not been definitely worked out. From information gained from the logs of several wells and drill holes in the area, Jenkins<sup>②</sup> gives an approximate stratigraphic measurement of 12,000 feet for the coal-bearing formation. The coals of the area range from subbituminous to anthracite and, as in the other districts, improve in quality from west to east. The anthracite, not in production, is confined to Whatcom County and is described in some detail on page 13. In general with other districts, the measures throughout the field show considerable folding and faulting—features that increase in magnitude and severity as the coal increases in quality.

In Whatcom County the Bellingham seam lies near the top of the series and the veins worked at the old Blue Canyon mine are at the base. Only two mines were operating here in 1946—the Bellingham mine, one of the larger producers of the state, and the Glen Echo mine. The 1946 production for the county was 109,374 tons.

In Skagit County no mines were operating in 1946. A considerable tonnage of good coking coal was formerly mined from a property at Cokedale, about 4 miles northeast of Sedro Woolley, but operations have been suspended for many years. A few miles east of Cokedale, near the town of Hamilton, is another region of coal-bearing rocks. The district lies chiefly between Cumberland and Day Creeks, and extends south from the Skagit River to the neighborhood of Rick Creek. Landes<sup>③</sup> states:

At several places in the Hamilton district coal veins of commercial importance are known to outcrop. . . . The coal is of good quality, and of a variety that may be made into coke. As a rule the coal veins lie in such a position that they may be worked very readily.

On the property of the Skagit Cumberland Coal Company . . . , near the mouth of Cumberland creek, there are a number of outcropping coal veins. The first of these is located on the bank of Cumberland creek, not far from the contact of the coal measures with the underlying mica

<sup>①</sup> Campbell, M. R., The coal fields of the United States: U. S. Geol. Survey Prof. Paper 100-A, p. 21, 1917.

<sup>②</sup> Jenkins, Olaf P., Coal fields of western Whatcom County, Washington: Washington Div. Geology Bull. 28, p. 129, 1923.

<sup>③</sup> Landes, Henry, Coal deposits of Washington: Washington Geol. Survey Ann. Report, 1902, vol. 2, pp. 178-9, 1903.

schist. This vein . . . . has a strike of south 43 degrees east, and a southwest pitch of 55 degrees. It lies between sandstone walls, and has a thickness of about 7 feet of clean coal. About a hundred feet stratigraphically above [this vein] is a second coal seam having approximately the same dip and strike, with a thickness of over 5 feet. Above the outcrop [of this vein], at varying heights on the mountain side, are outcrops of several other veins of coal with thicknesses ranging from a few inches to 4 feet. . . . .

[Other seams crop out] in the region about Day Lake . . . . [and] in secs. 13 and 24, T. 34 N., R. 6 E., the coal veins have a thickness varying from 8 to 12 feet.

#### KING COUNTY

The King County coal fields are in an area that is bounded on the west by Puget Sound, on the east by the foothills of the Cascade Mountains, on the north by Sammamish Lake and the Snoqualmie River, and on the south by the White River. This area could be divided into seven districts, which are to some extent segregated both as to location and rank of coal. These are the Renton-Black River, the May Creek-Cedar Mountain, the Newcastle-Coal Creek-Issaquah-Grand Ridge, the Tiger Mountain-Raging River, the Hobart-Taylor, the Danville, and—largest and most productive—the Ravensdale-Black Diamond-Franklin-Kummer-Cumberland-Bayne-Durham-Kangley districts.

King County is the second largest of the coal-producing fields of the state. In 1946 it produced 316,294 tons, or 32 percent of the total state production. The coals of the county are of bituminous and subbituminous rank and occur in rocks of the Puget group. The coal measures are quite variable in structure, having gently dipping beds in the western part of the area and steeply dipping beds in the central and eastern part. Numerous faults are found in practically all the beds; these are particularly prevalent, and frequently of large displacement, in the area lying between the Cedar and Green Rivers. Igneous sills are known, and in the mountainous areas it is rather common for dikes to cut the measures. Though the coals of this county have possibly been more generally exploited than those of some of the other fields of the state, large known reserves of both ranks still remain untouched.

#### PIERCE COUNTY

The coal fields of Pierce County occupy a relatively small part of the total area of the county. They extend in a north-south belt on either side of Meridian 122°, including Townships 15-19 North, and Ranges 6 and 7 East, an area of approximately 90 square miles. The present productive portion of the belt is the northern part, known as the Wilkeson-Carbonado field; it lies in the drainage of the Carbon River and its tributaries—South Prairie, Gale, and Evans Creeks—between Burnett on the north and Montezuma on the south, an area of about 25 square miles. The county produced 14,580 tons of coal in 1946, but this is little indication of past performance or of potential production.

The measures are a part of the Puget group. They have been subjected to intense folding and faulting, so that beds dip at almost

any degree of inclination up to vertical, and average about 60°. Intimately connected with the folding of the measures are several overthrust faults that trend northwestward, more-or-less parallel to the axis of one dominant anticline. These faults have resulted in displacements ranging from 1 foot to 2,000 feet. As an example of their effect on the coal beds, in the Burnett mine an overthrust fault caused the no. 1 and no. 2 seams to repeat themselves on the east dip, and also brought the no. 3 seam up to the level of the workings on the second-level rock tunnel. Normal faulting in the field was later than the overthrust faulting and in general crosses the dip of the seams. The normal faults range in size from those of small displacement, affecting mining but little, to that of the large one at Carbonado which has a horizontal displacement of about 1,300 feet. The coal beds vary in thickness, extent, and character throughout the entire field. Willis<sup>①</sup> reports "127 carbonaceous beds in the Wilkeson (stratigraphic) section of which 17 are workable coal veins 3 to 15 feet thick."

All the Pierce County seams are of bituminous rank, but the composition varies between wide limits in the same seam and between associated seams. Generally, the upper beds of the series carry the highest ash; the amount of both ash and volatile matter decreases progressively and the fixed carbon increases as the lower seams are reached. As an illustration, the Burnett seams are well adapted to steam generation, and the Wilkeson and Carbonado seams excel in gas and coking properties.

The southern part of the Pierce County coal field lies between the Puyallup and Nisqually Rivers in Townships 15 and 16 North, Ranges 6, 7, and 8 East. Some prospecting has been done in this area, and also a little mining has been carried on in the Mashel River and Ashford areas. A mine at Ashford shipped approximately 1,000 tons but has been closed for many years. The coal is of fairly high rank, but interest in the area has been small, chiefly because of somewhat difficult accessibility.

#### SOUTHWESTERN WASHINGTON

The southwestern Washington coal fields are those that occur in the south-central part of Thurston County, much of Lewis County, and a small north-central part of Cowlitz County. Four ranks of coal have been found in the area—anthracite, bituminous, sub-bituminous, and lignite. All the coal measures are in rocks of the Puget group, with the possible exception of the coal in secs. 15, 22, and 28, (11-1E), Lewis County, which may be of Oligocene age<sup>②</sup>—a fact, however, that has not been definitely determined.

Anthracite occurs in the eastern part of Lewis County, well up in the main Cascade Range; considerable prospecting has been done here, but so far no commercial production has been obtained. Further information on this anthracite area is given on page 14.

<sup>①</sup> Willis, Bailey, Report on the coal fields of Washington Territory: Tenth Census of the United States, vol. 25, pp. 759-771, 1886.

<sup>②</sup> Warren, W. C., personal communication.

The bituminous coal occurs in the foothills of the Cascade Mountains in the central part of the area and has been developed to a small extent in the Morton-Mineral district. The subbituminous coal is in the western part of the area and has been in production continuously for over 60 years. The lignite is a relatively new discovery and occurs in an area in Lewis and Cowlitz Counties a few miles east of Toledo.

The number and extent of the coal beds in southwestern Washington are not definitely known. The correlation of the beds is extremely difficult, owing to the lack of sufficient exploratory work, frequent interruption of the continuity of strata owing to erosion, the widespread concealed areas, and the presence in some places of igneous intrusions and faults. It is believed, however, that a very large tonnage of recoverable coal still lies untouched in this general area.

#### KITTITAS COUNTY

Kittitas County lies on the eastern slope of the Cascade Mountains, in central Washington, and its coal areas are in the Yakima River drainage in the northwestern portion of the county. The coal fields are known as the Roslyn-Cle Elum, the Manastash, and the Taneum.

According to Saunders,<sup>①</sup> the Roslyn formation, in which the coal beds of the Roslyn-Cle Elum field occur, is about 3,500 feet in thickness. Eleven beds of coal, having a total thickness of approximately 47 feet, are known. Only three of these beds, nos. 1, 5, and 6, are being worked at this time. In 1946 the mines of this field were producing the largest part of the total production of the state, 442,941 tons or 45 percent of the total output being mined.

In the Roslyn-Cle Elum field the structure is that of a large unsymmetrical syncline pitching to the southeast; it has gentle dips on the north side, but steeper dips—above 30° and as high as 54°—on the south side. Only one true fault has been found in the field; this is an overthrust having a displacement of about 16 feet in the No. 5 mine. Very little evidence of folding has been reported in any of the workings in this field, but a number of rolls in the deeper workings of the Roslyn bed have been encountered. These rolls, however, do not present any particular problem in mining other than a small loss of coal where they occur.

No beds of commercial importance under present conditions have as yet been discovered in either the Manastash or Taneum areas.

#### ANTHRACITE AREAS

As considerable interest has been shown lately in the use of anthracite for local metallurgical requirements, some details are given of the two areas in the state where this rank of coal occurs.

<sup>①</sup> Saunders, E. J., The coal fields of Kittitas County: Washington Geol. Survey Bull. 9, p. 200, 1914.

## WHATCOM COUNTY

The Glacier field is on State Highway No. 1, directly south of the town of Glacier, approximately 32 miles northeast of Bellingham. In this vicinity a prominent mountain ridge extends westward from Mount Baker. From a local summit on the ridge a well-rounded spur trends northward to the North Fork of Nooksack River and includes most of the anthracite field. The Chicago, Milwaukee, St. Paul and Pacific Railway crosses the northern end of the field, and a good graveled forest road traverses the area.

The south end of the field has an elevation of 5,200 feet; the north end, 950 feet. The coal measures have a known area of approximately 4,000 acres, and are involved in a north-plunging syncline having dips varying from about 32° to 52°. The coal area is drained by several small tributaries of the Nooksack River and Glacier Creek—Coal, Deep, Gallup, and Cornell Creeks.

The anthracite was first discovered in sec. 29, T. 39 N., R. 7 E. by two hunters in the year 1907. In 1908 William Griffiths, a geologist from Scranton, Pennsylvania, examined the occurrence, but no record of his findings is available. From 1910 to 1918 Dinan, a mining engineer from Pennsylvania, made several examinations and, in 1918, reported the presence of 7 known and proved seams and at least 3 more unclassified seams.<sup>①</sup> He found evidence of only very slight local disturbance, believed to be largely due to heavy erosion which had caused excessive surficial sliding. He reported the coal to be a high-grade anthracite and estimated from 45 to 50 million tons available for extraction above the 950-foot level.

In 1914 Woodruff<sup>②</sup> stated that the field had some coal in pockets, but that at the time of his examination prospecting had not developed enough coal to warrant the expectation that the field would produce coal in commercial quantity.

In November 1908 Dodge,<sup>③</sup> a mining engineer from Scranton, Pennsylvania, in a report of the Glacier property stated:

The coal is bright in appearance and ignites freely, being fully as lasting in duty as the better grades of Pennsylvania anthracite coal of the same specific gravity and density. To my mind there is no question but that the coal found on these lands is anthracite . . . of the best quality. The coal is not exceedingly bright, but hard and brittle and free from smut, and in fracture, when blasted with slow powder and properly treated through machinery adapted to the manufacture of anthracite coal, will be an attractive commodity for market and will closely resemble the product of the Mammoth vein, the purest and best of all the anthracite veins of Pennsylvania.

① Dinan, Edward, private report.

② Woodruff, E. G., and Leshner, C. E., Coal fields in Idaho, Washington, and Oregon: U. S. Geol. Survey Bull. 541-I, p. 13, 1914.

③ Dodge, Wm. F., private report.

The following analyses were included in Dodge's report:

ANALYSES AND HEATING VALUE OF GLACIER ANTHRACITE COAL

W. H. Dean, Wilkes-Barre, Pa., Analyst

	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	Specific gravity	Calorific value B. t. u.
Sample "K" Vein "A".....	01.42	07.57	74.06	10.95	00.91	1.552	12,693
Sample "L" Vein "A".....	02.07	06.74	89.52	01.67	00.795	1.441	14,515
Sample "M" Vein "A".....	01.88	07.72	84.89	05.54	01.21	1.474	14,241
Sample "N" Vein "A".....	02.02	08.78	83.88	05.32	00.965	1.465	14,241

ANALYSTS	Moisture	Volatile matter	Fixed carbon	Sulphur	Ash	Specific gravity
Dr. C. W. Drew Analytical Chemist, Minneapolis, Minnesota .....	1.70	7.50	85.61	.68	4.51	.....
Peter Daley, Assayer, Tacoma Smelter, Tacoma, Washington .....	1.09	5.91	88.00	.....	5.00	1.44
R. W. Thatcher, Director and Chemist, State Agriculturist, Statistician, Pullman, Washington .....	0.88	7.20	86.36	.65	4.94	1.4785
Chas. M. Fassett, Assayer, Spokane, Washington .....	2.70	6.99	84.44	.....	5.87	.....
Milnor Roberts, Dean, University of Washington, Seattle, Washington .....	1.75	6.10	87.76	.53	3.86	1.46

LEWIS COUNTY

The Summit Creek field is at the headwaters of the Cowlitz River, in the northeast corner of Lewis County. It is also known as the Carlton Pass field and Cowlitz Pass field. Topographically it is a region of high relief, as it includes a deeply incised area of the Cascade Mountains. Carlton and Summit Creeks are the largest streams in the vicinity.

Evidence of considerable movement is apparent in the Summit Creek area. The coal measures are on the west limb of an anticline having a north-south trend, and the normal footwall would therefore be the east wall. At the main tunnel, however, the limb is overturned and dips east instead of west, thus making the west wall the footwall.

Considerable prospecting has been performed in the area and several tunnels driven. On Summit Creek a tippie, which included a washer, was built and the main tunnel, 433 feet in length, was driven. Some coal was produced and shipments were made to both Yakima and Portland, but it is reported that these efforts to develop

a commercial operation were not successful as the coal did not prove satisfactory as a fuel.

A recent investigation by the State Division of Mines and Geology has led to the conclusion that, owing to the large amount of ash material contained in the various beds and also to the very intimate interstratification of the coal and thin shale seams, the difficulty of making a clean separation of the coal from its impurities would be very great, and it is believed that such separation could not be accomplished efficiently or at a cost that would make the field of economic interest. The investigation also developed the fact that the extent of this field is considerably smaller than was originally believed to be the case, a factor having a definite bearing on the economic value of the area.

A cross section and sample for analysis of the Primrose bed, on which the main tunnel was driven, was taken by the U. S. Bureau of Mines<sup>①</sup> in 1935.

*Section of Primrose bed*

	<i>Ft.</i>	<i>in.</i>
Roof, soft, dark shale (east wall):		
Shale, dark, soft.....	*4	0
Shale, carbonaceous, soft, mining.....	*1	6
Coal, bright .....	2	1
Shale .....		*2
Coal .....		4
Bone .....	*1	6
Coal .....	1	0
Shale, dark .....		*2
Coal .....		6
Bone .....		*5
Shale, hard (immediate wall).....	*1	6
Shale, carbonaceous .....	*1	6
Shale .....	*1	0
Shale, carbonaceous .....	*1	0
Bone and shale.....	*3	0
Floor, rough and broken (west wall):		
Thickness of bed.....	19	8
Thickness of sample.....	3	11

\*Not included in sample.

The analysis of this sample gave the following results:

	As received	Moisture-free	Moisture- and ash-free
Moisture (percent) .....	5.8		
Volatile matter (percent).....	8.9	9.4	12.5
Fixed carbon (percent).....	62.2	66.1	87.5
Ash (percent) .....	23.1	24.5	
B. t. u.....	10,640	11,300	14,970

It will be noted that, of the 19 feet 8 inches in this bed, a total of 15 feet 9 inches, described as bone or shale, was eliminated in taking the sample.

<sup>①</sup> Yancey, H. F., and Geer, M. R., Analyses of Washington coals: U. S. Bur. Mines Tech. Paper 618, pp. 45-70, 1941.



## GENERAL QUALITY OF WASHINGTON COALS

As is to be expected, the quality of coal occurring in the various fields, and in the various beds of those fields, differs markedly. A considerable difference may even exist in the quality of coal from two or more mines operating on the same bed; for coal, as shipped to the consumer, will vary in analysis depending on the care with which it is mined, washed, or otherwise treated in preparation for the market. It cannot be said, therefore, that one field or one coal seam will consistently produce coal of one definite analysis, but within general limits it is possible to indicate the approximate nature of coal from a given field or portion of that field.

Detailed analyses are available<sup>①</sup> for many hundreds of samples, representative of all the principal coal mines and prospects of the state, and may be consulted if more exact data are needed. From these and other analyses the following compilation has been made in order to indicate the general characteristics of the coal that is being produced in the different areas. For the sake of uniformity and to facilitate comparisons these proximate analyses give moisture on an "as received" basis and the other factors on a "dry-coal" basis. The figures used are common ranges in percentages, and it may be assumed that coal received from any of these areas will come within these ranges.

## INDICATIVE ANALYSES OF WASHINGTON COALS BY COUNTIES OR PRINCIPAL COAL-PRODUCING AREAS WITHIN COUNTIES

County and area	Moisture Percent	Volatile matter Percent	Fixed carbon Percent	Ash Percent	Sulphur Percent	British thermal units
<b>Whatecom County</b>						
Bellingham area .....	5.0-13.4	35.2-40.2	41.8-48.7	13.0-22.7	0.3-0.6	10,390-11,820
Glacier field .....	4.3- 5.8	7.8- 9.4	79.4-82.2	7.8-10.2	0.96-1.01	12,020-13,060
<b>King County</b>						
Renton-Black River area .....	8.0-18.0	36.2-45.4	43.2-52.4	6.8-17.4	0.6-1.8	10,920-12,730
May Creek-Cedar Mountain area .....	14.2-23.0	37.1-39.9	47.2-48.8	12.0-14.1	0.3-0.8	9,740-11,710
Newcastle-Issaquah area .....	12.3-18.2	37.2-42.2	42.6-52.2	11.2-18.5	0.4-0.7	10,600-11,960
Ravensdale-Black Diamond area .....	4.9-13.4	38.6-44.7	46.3-53.1	3.7-15.2	0.4-0.8	11,090-13,290
Cumberland-Palmer area .....	3.9- 7.2	24.9-38.6	38.7-51.2	11.1-23.1	0.5-1.2	10,120-12,880
Danville area .....	10.5-18.1	38.4-39.3	47.4-50.9	9.8-13.3	0.4-0.6	11,950-12,110
<b>Pierce County</b>						
Ashford area .....	4.1- 5.8	16.2-25.4	37.5-58.1	25.7-39.6	0.4-0.7	10,740-11,050
Wilkeson area .....	1.5- 5.5	19.1-38.5	51.4-60.8	8.5-16.7	0.4-1.02	11,380-13,850
Carbonado area .....	2.5- 5.3	21.4-38.4	46.8-58.2	8.4-20.8	0.4-1.01	11,800-13,020
<b>Thurston County</b> .....	16.0-22.5	32.9-44.4	34.5-44.7	11.5-20.6	0.4-1.6	8,970-11,160
<b>Lewis County</b>						
Centralia-Chehalis area...	22.4-33.5	43.2-49.3	40.0-47.2	9.6-16.2	0.5-2.3	10,300-11,770
Morton area .....	4.1- 8.6	32.7-43.0	39.0-57.9	17.5-25.1	0.7-1.1	10,650-11,580
<b>Cowlitz County</b> .....	15.2-22.2	42.8-43.4	34.8-35.9	15.7-23.0	1.2-5.5	7,500- 9,750
<b>Kittitas County</b>						
Cle Elum area .....	3.1- 5.8	34.4-39.4	47.0-52.0	11.4-14.5	0.3-0.5	12,240-13,250

① Ash, S. H., Analyses of Washington coals: U. S. Bur. Mines Tech. Paper 491, 1931.  
Yancey, H. F., and Geer, M. R., Analyses of Washington coals: U. S. Bur. Mines Tech.  
Paper 618, 1941.

PROCESSED COAL

COAL BRIQUETS

Briquets manufactured from fine sizes of bituminous and sub-bituminous coal were produced in this state for several years. They form an excellent fuel, not only from a combustion standpoint but also because of ease of handling, absence of dust, and good storage qualities.

The production of briquets was initiated in 1911 at the Seattle plant of the United Collieries Co., an operation that was discontinued in 1913. In the following year, the Pacific Coast Coal Co. installed a plant at Renton and started production, using a mixture of sub-bituminous, bituminous, and coking coal and a 10 percent asphalt binder. This plant operated until May 1939. In 1926 the Wilkeson Coal & Coke Co. started a plant at Fairfax and the Calkins Pressed Fuel Co. started one at Renton, each of which operated for a few years. In 1928 the Northern Briquetting Co. commenced operations at Ravensdale, and in 1929 this plant was acquired by the Paramount Briquet Co., who moved it to a new site on Lake Union in Seattle. The new plant, however, operated for only a very short period. For many years no coal briquets have been produced in the state.

The decrease in briquetting operations in the Pacific Northwest may be attributed to changing conditions in the fuel market, to the introduction of coal stokers and oil burners, and to competition from another form of briquet made from oil and gas residues. The future outlook for coal briquets is very problematical; changes in existing conditions may once more bring about an interest in this product; or briquets of somewhat different character may appear, made from char, or the residue from coal distillation. This last material is an excellent fuel and may be briquetted to advantage; it would be available when by-product coal-treatment plants are established.

Annual production figures are available for only the four years 1928 to 1931, inclusive. The figures for other years were concealed to prevent disclosure of individual operations.

ANNUAL BRIQUET PRODUCTION

	<i>Tons</i>	<i>Value</i>
1928 .....	63,221	\$412,603
1929 .....	49,455	356,291
1930 .....	36,924	272,828
1931 .....	19,770	136,258

COKE

The coke industry in Washington started in the year 1884, with the production of 400 tons by the Tacoma Coal & Coke Co. at Wilkeson. The coke was made by primitive methods in pits 4 feet deep having stone walls on the sides and ends. The success of this operation induced the company to build two beehive ovens in 1885. From this time forward more ovens were built by various companies, until in 1919 a total of 457 beehive ovens were in operation. In the year 1914 the Seattle Lighting Co. constructed at its plant in Seattle a battery of five Klonne-type by-product ovens. These were in-

stalled primarily for the manufacture of gas, and the coke produced was sold largely for domestic use; however, at different periods, some of the coke was used for metallurgical purposes.

From a production of 400 tons in 1884, the tonnage rose steadily until the year 1915, when the peak of 136,552 tons with a value at the ovens of \$700,832 was reached. From 1915 the output steadily declined until 1937, at which time the production of coke in the state ceased. The total tonnage of coke produced in the state, up to 1938, including that from both beehive and by-product ovens, has been 2,357,100 tons with a value at the ovens of \$15,414,891.

PRODUCTION OF COKE FROM 1884 TO 1937

	Tons	Value at ovens
1884-1922 .....	1,624,229	\$10,087,638
1923-1933 .....	629,423	4,702,472
1934 .....	28,893	178,092
1935 .....	31,219	186,385
1936 .....	28,680	172,368
1937 .....	14,656	87,936
Total .....	2,357,100	\$15,414,891

Typical analyses of Washington coke are difficult to obtain because of the varying product from the various plants under differing conditions. However, a few analyses from three of the plants are given below:

SOME ANALYSES OF WASHINGTON COKE ①

	Moisture at 105° C. Percent	Volatile matter Percent	Fixed carbon Percent	Ash Percent
Wilkeson .....	0.76	1.99	79.58	18.67
	0.72	2.81	78.20	18.27
	0.70	1.26	77.70	20.34
	0.78	1.53	77.71	20.98
Carbonado .....	1.12	2.81	79.21	16.88
	0.55	1.25	78.44	19.76
Fairfax .....	0.52	1.25	79.49	18.74
	0.07	1.04	80.49	18.40
	0.18	1.35	79.47	19.00
	0.00	1.01	80.49	18.41

A renewal of coke production recently occurred when the Wilkeson Products Co. (in 1944), installed a battery of 17 Curran-Knowles by-product ovens at Tacoma. The plant has an annual capacity of 75,000 tons of coke, 900,000 gallons of tar, and 450,000,000 cubic feet of gas. The tar was sold direct to the distillers and the gas was sold for domestic and industrial needs. The coke was largely used for electrometallurgical purposes. However, this plant was closed down late in 1944 and its possible future activity is unknown.

① Daniels, Joseph, The coking industry of the Pacific Northwest: University of Washington Engineering Experiment Station Series Bull. 9, p. 14, 1920.

## CARBONIZATION AND HYDROGENATION OF COAL

In recent years much interest has been evinced in low- and high-temperature carbonization and also in hydrogenation of coal, especially in Europe and the Orient. Many plants were in full operation before the war. In this connection, Fieldner<sup>①</sup> states:

The total German capacity for the production of gasoline by hydrogenation of low-temperature tar, lignite, and bituminous coal was said to be about 800,000 metric tons of gasoline per annum on January 1, 1937 . . . .

One hundred thousand tons of gasoline were produced from creosote oil, low-temperature tar, and bituminous coal by the hydrogenation plant of Imperial Chemical Industries at Billingham, England, during the first year of operation, ended May 1, 1936 . . . . In Japan, a plant for the production of 50,000 tons of gasoline per year is being erected by the Chosen Coal Industry Co., another with 20,000 tons capacity is being constructed at Fushun by the South Manchurian Railway, a third of 10,000 tons capacity is being planned by the Japanese Electric Co., in North Sakhalin, and a fourth of 25,000 tons capacity by the Mitsui Co. at North Kiushu. In France, plants having a combined capacity of 50,000 tons of gasoline per year have been erected at Bethune and Lievin.

In this country the U. S. Bureau of Mines has been operating small experimental plants for some time. Considerable research and experimental work on the distillation and carbonization of Washington coals has already been carried on, indicating the desirability of establishing this as a permanent industry. In 1921 A. L. Knouse was operating a semicommercial distillation plant at the Beacon coal mine, near Seattle, and recently the Coalene Co. has been obtaining some very interesting results at an installation in Tacoma.

It would be well worth while if a study of this phase of the industry, in connection with the southwestern Washington sub-bituminous field, were made. There is a known large reserve of coal in this area, which, due to its high moisture content, is not in great demand for fuel purposes. If a plant or plants for coal distillation were installed in the field, a very large tonnage of this coal would be utilized and the returns realized would be considerably higher than could possibly be obtained from its sale as a straight fuel.

## COAL PRODUCTION

Available records, starting in 1860, show the coal production in that year amounted to 5,374 tons, and that the annual production increased almost steadily year by year until 1918, when a peak of 4,128,424 tons were reached. From 1918 the production showed a general decline until 1934, when the smallest tonnage was mined of any year since 1897. This decline was due to various factors—as for instance, the greatly increased use of fuel oil, both for industrial power and domestic heating; the increased use of electricity and gas for domestic heating and cooking; and, in some measure, changing economic conditions. After the low output of 1934 (and almost equally low output of 1938) the trend, although broken, has been upward, and the production of 1946 was 990,719 tons. With the present exceedingly active demand, both industrial and domestic, this upward trend should continue.

<sup>①</sup> Fieldner, Arno C., Recent developments in coal preparation and utilization: U. S. Bur. Mines Minerals Yearbook, 1937, pp. 950, 951, 1937.

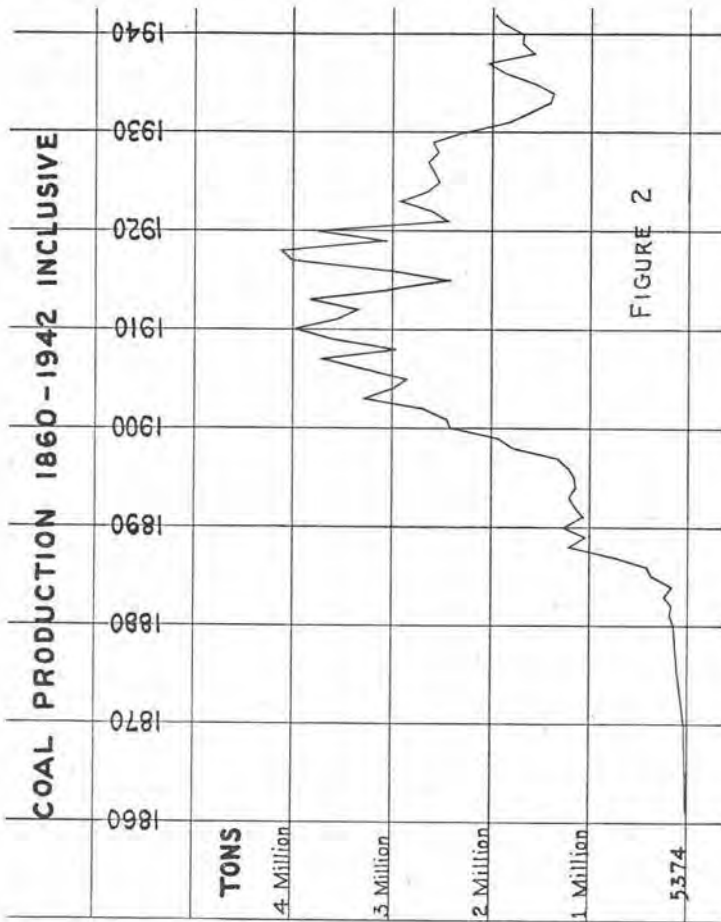


FIGURE 2

A tonnage comparison of the production by counties during the year 1918 (the peak year) and the year 1946 is given below:

COAL PRODUCTION BY COUNTIES		
	1918	1946*
King .....	1,331,601	316,294
Kittitas .....	1,739,379	442,941
Lewis .....	174,621	56,936
Pierce .....	600,917	14,580
Skagit .....	5,897	.....
Thurston .....	271,406	50,594
Whatcom .....	4,603	109,374
<b>Total .....</b>	<b>4,128,424</b>	<b>990,719</b>
Value of coal at mines .....	\$14,564,445	\$5,339,975
Number of mines operating .....	72	47
Number of employees:		
Inside .....	4,172	948
Outside .....	1,675	442
<b>Total .....</b>	<b>5,847</b>	<b>1,390</b>

\* Labor strikes during 1946 reduced the production for this year.

### CONDITIONS AFFECTING MINING

Since the time of their formation, all the coal measures of Washington have been folded and deformed by many and varied earth movements. As a result, the measures, instead of lying flat in easily mined beds, commonly are tilted to moderate or steep angles and their strikes are sinuous; also the continuity of beds, either in dip or strike, is commonly interrupted by faults. All these conditions contribute to the difficulties and costs of mining.

Prospecting for new beds and tracing the extension of known seams are frequently difficult owing to a dense cover of vegetation, heavy overburden, and faults that offset the beds.

In some mines the conditions are sufficiently uniform for one system of mining to be maintained throughout; in others the dip of the bed ranges from almost horizontal to almost vertical, necessitating varied methods or systems of extraction in the same mine. Roof conditions may be so poor that excessive timbering and forepoling are necessary. Extreme gaseous conditions also add to the difficulties that must be overcome in some mines. The necessity for careful preparation and cleaning of the coal, and the fact that much of the easily mined coal from above water-level entries is rapidly becoming exhausted (so that workings have to be extended to greater depth) are other contributing factors to high cost.

However, all these difficulties, at least to a very large extent, may be overcome by carefully considered development and efficient, capable management. It is entirely possible for coal mining to be profitable. The discouragement and failures which have attended some operations are no indictment of the industry, but they do indicate the care with which mining should be planned and carried on.

### COAL MINING METHODS

The following outline of coal-mining procedure is not intended as a full discussion of mining methods or practices, but rather, as a simple and general outline of the more common features of coal mining for those unfamiliar with the subject. Figure 3 shows diagrammatically the main underground features of a coal mine; it should be borne in mind that the workings illustrated are in the plane of the dipping coal bed.

#### UNDERGROUND MINING AND COAL PREPARATION

In the early days of mining in the state, most of the coal was mined from "water levels," or self-draining tunnels; however, as the coal above these water levels has been practically exhausted, slopes driven down on the dip of the seam are now in the majority.

Slopes are usually sunk at dips not to exceed 40° in order that cars may be used for bringing the coal to the surface, and generally are held to 30° or less by sinking the slope diagonally across the full dip when necessary.

The "room and pillar," or "breast and pillar," method is used almost exclusively in the gentler dipping seams, and the "chute and pillar" method in the steeply dipping beds. Modifications of these two methods are occasionally used, such as the "panel" and "modified longwall" systems.

In coal-mining practice in this state, the term "chute" is used for passage-ways not over 12 feet wide that are driven up the dip or "to the rise," from

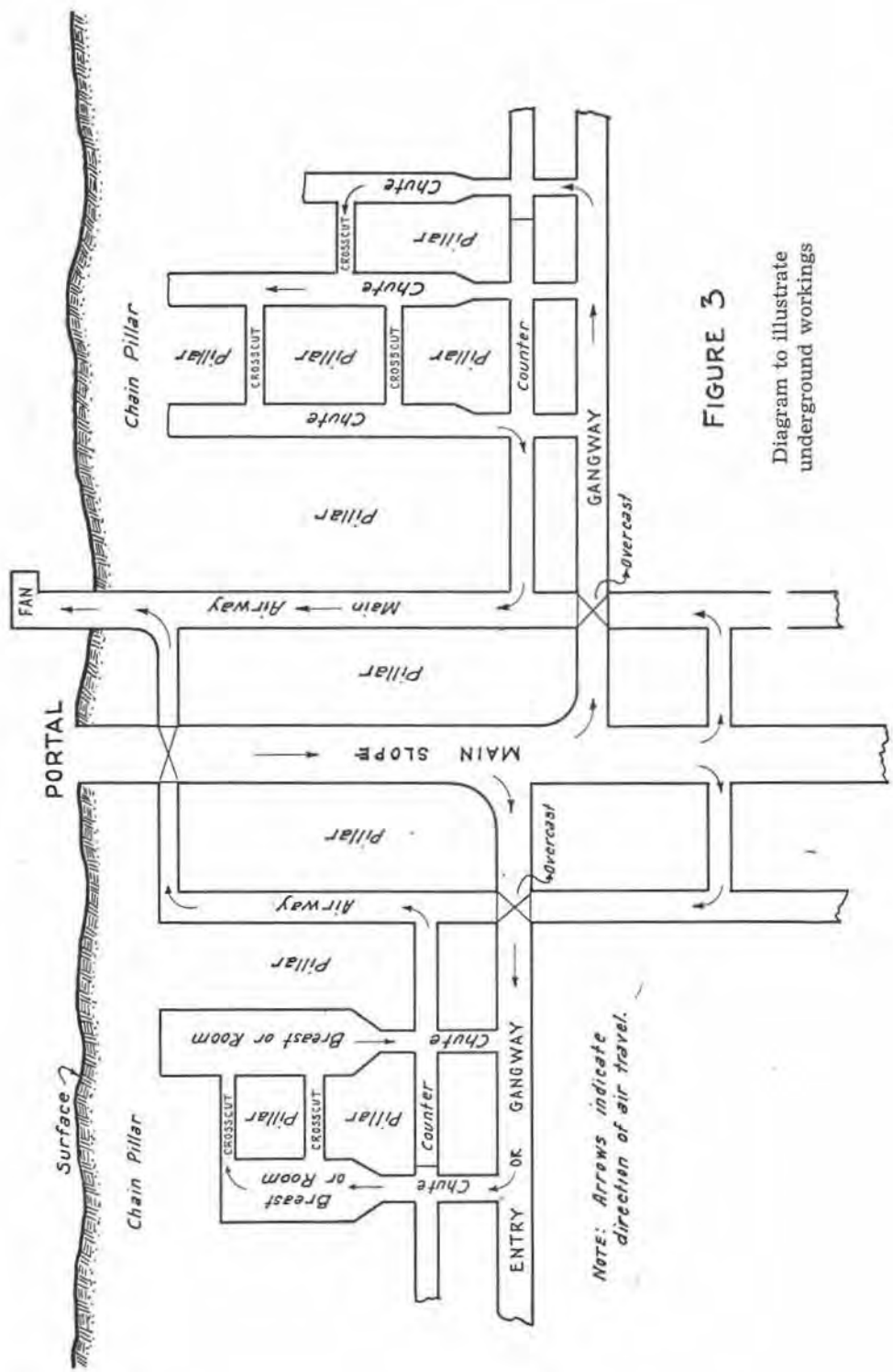


FIGURE 3

Diagram to illustrate underground workings

the haulageways or gangways, for the purpose of extracting the coal between the different levels. When this passageway exceeds 12 feet in width it is called a "room" or "breast." The terms "room" and "breast" are synonymous, breast being used in the steeper pitching veins, and room in the flatter ones. The terms "gangway" and "entry" are also synonymous, the former is generally used in the mines of western Washington and the latter in the Roslyn field of eastern Washington.

In the "room and pillar" method the general practice is to drive double slopes and entries, one being used for haulage and the other for ventilation purposes. Usually the haulageway is the air intake or "inby," and the air course the exhaust or "outby."

A fan is located at the exhaust end of the air course to pull the air through the workings. Slopes are driven 9 to 15 feet in width, and the size of the air course is dependent on the amount or volume of air required for ventilation purposes when the mine is fully developed. Entries which are turned off the main slope on the strike of the seam are driven in pairs also. One is usually called the "gangway" and is used for haulage purposes, and the other is called the "counter" and is used as a traveling way for the return air. Where the main air course, or in fact any air course, crosses a haulageway, it is carried overhead in an airtight and fireproof tunnel usually shot out of the roof and floored with reinforced concrete; this is called an "over-cast." The gangways are usually about 8 feet in width, and where the seam is not sufficiently high, the roof rock is "brushed" to give the necessary height.

On long gangways "partings," or sidetracks, are constructed at intervals to facilitate the handling of the loaded and empty "trips" or cars. Rooms are driven off the gangway to the rise, starting as "necks" about 8 feet wide for approximately 40 feet and then widened to the desired width. They are driven at intervals in order to leave between them pillars of coal from 20 to 40 feet in thickness. Crosscuts from one room to the next are driven about 4 feet wide at intervals of not to exceed 60 feet. These are used for both traveling ways and ventilation. Two types of chutes are in use: (1) the narrow chute, about 4 to 6 feet in width, and (2) the compartment chute, from 8 to 12 feet in width. Several factors control the selection of the type of chute to be used: (1) the dip and thickness of the seam, (2) the thickness and quantity of the partings (intervening rock strata) in the seam, (3) the strength and characteristics of the roof and footwall, (4) the presence and extent of faults, (5) gas conditions, and (6) the length of the "lift," or distance up the chute. Where narrow chutes are used, they are generally driven about 6 feet wide from the gangway up to the counter, on 40- to 60-foot centers, and from the counter to the top of the lift they are driven from 4 to 6 feet wide. Timbering in the chutes varies with the condition of the ground; but while driving, unless the ground is "heavy," only a center post and cap, about 5 feet apart, is usual. The posts are used primarily to enable the miner to reach the working face from the last crosscut, also to carry a brattice for ventilation of the face. As soon as the pillar is about to be "drawn" or mined, it is customary to put in 3-piece sets for added protection to the miner. It is impossible to use the narrow chutes as traveling ways while the mined coal is moving down to the haulageway; so that every fourth chute is generally made into a manway with a permanent ladderway installed, the miner reaching the other pillars through the crosscuts. The practice in most general use is to drive the compartment-type chute. These are, as a rule, driven from 6 to 10 feet wide up to the counter, on 50- to 70-foot centers; above the counter the chutes are widened to an average of 12 feet. They are timbered with 3-piece sets on 6-foot centers. A wooden brattice up the center of the chute divides it into two equal compartments: one to run the coal down, and the other, in which a ladder is built, for a manway. A hole is cut in the brattice at each crosscut to give access across the chute for persons traveling from one pillar to another, and a battery is placed on the high side to hold the coal back when loading out is not in progress. The length of the chute varies in different localities, but generally is around 400 feet, as experience has shown that this is usually the economical limit. "Chain pillars" are left between the top of the chutes and the level above, for protective purposes.

Pillars are extracted by starting at the top block and mining successive "skips" or slices until the coal is all recovered. In order to hold back caves



and falling rock while extracting the pillars, wood "batteries," or bulkheads are put in with either posts or cogs for support.

The "booming" method is used where the coal is too thick for the roof to be securely timbered. Though various methods are used dependent on local conditions, booming is usually worked by mining the bottom bench of the pillar, then, after batteries are placed below to hold back the loosened coal, the pillar is drilled and shot to bring down all the coal. The loose coal is then run through the battery until the roof rock, which has fallen with the shooting, is encountered. If the roof is strong a large recovery of the total coal is gained by this method, but in the event of a weak roof much coal is lost, owing to the amount of rock that falls on the coal.

Both the "retreating" and "advance" methods of extraction are in use. In the retreating method the gangway and counter are driven to the mine boundary before any chutes are turned off or driven, then when the boundary is reached the chutes are started and the pillar coal is taken on the retreat. This is by far the most economical method, as the percentage of coal extracted is higher, the cost of maintenance of the haulageways much less, and, in the event of bad gas condition, the ventilation problem is greatly simplified. The initial investment, however, is of course higher, as the cost of the development comes before any returns are realized from the coal developed.

In the advance method, the extraction of the coal takes place as soon as the gangway or entry is turned off, the first chute being driven up just as soon as the slope and air course pillar is passed.

Modifications of the advance and retreat methods are used occasionally. One plan is to work panels of rooms or chutes for ten or more places on the advance, then to leave a block of ten or more unworked, taking this coal on the retreat; another plan is to leave each succeeding chute and pillar, the coal so left being recovered on the retreat. The nature of the ground that is being worked is the prime factor in deciding the best method of extraction.

The coal is usually drilled with augur-type drills—either hand, electrically, or air driven—then is shot with permissible explosives and the broken coal loaded by hand. However, in 1946 fourteen mines were using mechanical cutting machines and pan or shaking conveyors underground, approximately 66 percent of the state production being mechanically handled. More use could undoubtedly be made of mechanization in the more gently dipping veins of Lewis and Thurston Counties at such time as an increased demand for this type of coal arises.

Shaker screens are employed generally in preparing lump coal and, at the larger mines, for screening the smaller sizes. The smaller mines use revolving screens, commonly with square openings, to prepare sizes smaller than lump. A few mines are equipped with vibrating screens for sizes up to 1¾ inches, and some—particularly truck mines interested mainly in the domestic market—use gravity screens at the point of loading to remove fines produced by degradation, but this practice is not common at the larger operations.

Many mines employ crushers, usually of the toothed double-roll variety, to crush bone and pieces of interstratified coal and impurity, the crushed product being added to the feed for the washers. The crushing of coarse coal to supplement the normal production of smaller sizes, principally those suitable for use in stokers, has become common practice in recent years—the natural result of an increase in the demand for stoker sizes and a decrease in the market requirements for lump coal. The larger mines are equipped with pick breakers and toothed double-roll crushers, alone or in combination, for crushing lump sizes, while the smaller operations usually use only the roll crushers. Some mines, principally in the Roslyn-Cle Elum field, crush nearly their entire production of lump coal.

Many of the coal beds contain impurities, such as clay, shale, carbonaceous shale, and bone, interstratified with the coal; these impurities, together with materials from the roof and floor that become mixed with the coal in mining, usually constitute such a large proportion that they must be removed to prepare a marketable product.

In 1946 about 90 percent of the state production came from mines having cleaning plants. In the King County, Roslyn-Cle Elum, and Whatcom fields

almost the entire production of coal smaller than lump size (3 inches) is washed; but in the southwestern Washington field, where the more gently dipping beds permit handsorting at the face, a smaller proportion of the coal is cleaned mechanically. In the Pierce County field, where the current production is from small operations, little mechanical cleaning is done.

Washing equipment in the state includes sealed and free-discharge rheolavoure units; jigs of the Brawn pulsator, plunger, and pan varieties; wet tables; and a pneumatic table. Two heat driers—one rotary and one shaking-screen type—are used in the Roslyn-Cle Elum field, where freezing of shipments in winter is a problem. This field also has one installation of dust-proofing equipment of the hot oil spray variety.

#### STRIPPING SYSTEM

Open-pit work or stripping applies to the mining of those coal deposits that are in sufficiently thick beds and lie so close to the surface that the material overlying them may be removed and the coal quarried out at a profit. The advantages of this system are: all the coal may be extracted without any loss in pillars or through squeezes; a greater percentage of more desirable or larger sizes can be obtained; no timbering is required; unprofitable underground workings do not have to be kept open and in repair; there is less danger from roof falls and blasting; there is practically no danger from fires; artificial lights are not required; mining can be done more economically, as larger faces are open and larger blasts can be used; the results in tons obtained per employee are much greater; and the output can be increased, as required, almost indefinitely.

Recovery of bituminous coal by the "strip" or "open-pit" method began in Pennsylvania as early as 1812. At places where the coal beds cropped out or lay at shallow depths, the overburden was removed by teams and scrapers, and the coal was loaded by hand into wheelbarrows or wagons. These operations were small and, for the most part, carried on by individuals who mined for their own consumption. In 1866 a strip mine at Danville, Ill., was opened on a commercial basis, becoming the first large-scale operation of record. However, this method of mining did not become popular for many years. In fact, it was not until the advent of World War I, with a consequent greatly expanded market for coal, a shortage of manpower, and the development of more practical mechanical equipment, that strip mining began to assume a prominent place in the industry. Since that time and especially after the start of World War II this type of coal mining has progressed steadily. Nationally, the production of coal by the open-pit method increased 79.5 percent between 1941 and 1944, and in 1945 more than 106,000,000 tons, or approximately 19 percent of the nation's total coal production, was from this source.

In the State of Washington some open-pit mining has been carried on at various times, and in 1946 nine operations were on an active basis. Inasmuch as several areas in the state are well suited to this method of extraction, and in view of the present labor situation, a considerable local increase in this type of mining can be expected.

#### PRESENT STATUS OF THE COAL-MINING INDUSTRY

The State Division of Mines and Geology has recently completed two surveys of all operating coal properties in Washington, in an endeavor to ascertain the reasons for the present lack of sufficient coal to take care of market requirements. In spite of the fact that the state has ample reserves of coal, more than a million tons were imported from other states (some coming from as far away as Virginia) during the six months from October 1942 to April 1943. This tonnage not only took the car space of vitally needed defense materials, but it was a serious additional burden on our transportation systems. During the year 1946 approximately 1½ million tons were imported from other states; this represents a very considerable financial loss to our own state industry.

Several factors contributing to this condition were found, but beyond all question the outstanding cause is the lack of miners—actual producers at the working face. Practically all mines have sufficient “day” or “outside” men, but with very few exceptions the operators are seriously handicapped by the shortage of “inside” men. So acute is this shortage that some properties may be forced to shut down. In most properties development work is inadequate or is impossible to do, and so the properties are, perforce, in the condition of exhausting their developed reserves without being able to make provision for future operations. Most of the miners who have left the mines have gone to other industries where the wages possibly appeared to be more attractive. Were the miners available, some mines now idle would be reopened, additional shifts would be operated at several properties, and the opening of new properties would be possible. If merely enough miners to fill the vacant working places in the present operations could be obtained, another million tons of coal per year could be produced in the state.

Experience has shown that approximately a one-third increase in tons per man is gained when the miners are on contract instead of day wages. A miner on contract frequently makes higher earnings per day than he could make in the other industries. This might be one solution to the present migration of men from the mines and certainly deserves careful consideration.

Mines should be mechanized to a greater extent wherever possible. In some cases, where the dip is too steep for undercutting machines, an increased output could very possibly be obtained by the installation of shearing machines. Also, the installation of mechanical conveyors would greatly facilitate the movement of coal in many instances.

Owing principally to poor mining practices, a very large tonnage of coal has been lost in the state. Before any operation is started, a careful study of all conditions affecting the property should be made and a plan of operation carefully outlined, looking to the successful extraction of the largest possible percentage of the total tonnage contained in the property. This would, very possibly, entail a larger initial outlay, but the additional coal recovered over that obtainable by the too-prevalent “hit-and-miss” methods would return the investment many times.

In 1946 there were in the state a total of only 47 coal properties in operation. Of these a majority are very small, and one of our vital needs is for the entrance into the field of more companies with a large enough capitalization to develop the properties on a basis of sufficient magnitude to insure the profit necessary to maintain and operate them efficiently. The opportunity is certainly here, and with proper investigation it can be shown that mining coal can be made equally as lucrative as any other type of mining.

## PROPERTIES OPERATING IN 1946

Below are given names and brief descriptions of the mines operating in the state in 1946. For the sake of brevity, the usual method of showing legal land subdivisions, such as NE $\frac{1}{4}$  sec. 26, T. 31 N., R. 28 E., is shortened to NE $\frac{1}{4}$  sec. 26, (31-28E). Because of complex folding and faulting, marked variation in intervals between given coal beds, variations in the coal beds themselves, and, in general, inadequate geologic data, a correlation of the various coal beds in even a given field is extremely difficult; no attempt has been made to correlate beds between separate fields. For this reason, the beds, with few exceptions, have been given local names or numbers. The seam numbers are, therefore, repeated many times throughout the state and do not indicate a correlation.

## WHATCOM COUNTY

**Bellingham Coal Mines.**

Operator: Bellingham Coal Mine Company, Bellingham, Washington.  
Location: Secs. 13 and 24, (38-2E).  
Opened by: 3 slopes. No. 1 is driven 600 feet on 30° dip to coal, No. 2 is driven 2,000 feet on 18° dip to 3rd level and then continues on coal seam for another 4,500 feet. No. 3 (new air course) is driven 335 feet on 54° dip until it intercepts the coal.  
Seam: Bellingham No. 1, average thickness 12 feet 6 inches, of which only 7 or 8 feet is taken.  
Method of mining: Room and pillar; drilling is done with Ingersoll-Rand jackhammers, using star bits.  
Main hoist: Vulcan 24- by 48-inch first-motion steam. Standby Ottumwa 24- by 36-inch steam.  
Underground haulage: Horses.  
Ventilation: Western Blower No. 9 exhaust fan, 55,000 c.f.m.  
Lights used: Edison model K electric.  
Preparation: Cars are dumped through a rotary dump onto shaking screens, and the plus 4-inch size goes to the picking tables. The undersize is then screened through a revolving screen, and the nut and finer sizes go to separate washers. There are 3 Forrester jigs with a Foust jig for the pea size. The 5/16-inch and finer sizes go over a battery of 5 Deister-Overstrom tables. Storage and shipping bunkers have a capacity of 1,000 tons. Yard storage is handled by two locomotive-type cranes—one 15-ton with 1-yard bucket, and a 25-ton with a 2-yard bucket.  
Shipments: By rail and truck.  
Production in 1946: 105,369 tons.

**Glen Echo Mine.**

Operator: West Coast Coal Company, Rt. 4, Box 420, Bellingham, Washington.  
Location: Secs. 4, 5, 8, and 9, (38-4E).  
Opened by: Slope, located in SW $\frac{1}{4}$ SW $\frac{1}{4}$  sec. 4, 1,200 feet long with dip of 30° at top and 12° at bottom.  
Seam: No. 1 Glen Echo, thickness 5 feet, dip 12°.  
Method of mining: Breast and pillar; coal is undercut by Sullivan shortwall machine and conveyed to entry on a Vulcan shaking conveyor.  
Main hoist: Electric.  
Underground haulage: Mule; airtuggers in some places.  
Ventilation: Exhaust fan, Sirocco type.  
Lights used: Closed, electric.

Preparation: The raw coal is dumped on a shaking screen and lump taken out and hand-picked. The undersize goes to a Forrester jig washer. The washer product is screened through a revolving screen and sized into eggnut, pea, stoker, and buckwheat.

Shipments: By truck.

Production in 1946: 4,005 tons.

#### KING COUNTY

##### Andersen Coal Co.

Operator: James A. Andersen, Ravensdale, Washington.

Location: Sec. 1, (21-6E).

Opened by: Slope.

Seam: No. 7 Dale, dip 48°-60°.

Method of mining: Room and pillar.

Main hoist: Hercules gas engine geared to single drum.

Lights used: Closed, electric.

Underground haulage: Manual.

Ventilation: Exhaust. Buffalo fan powered with Wisconsin gas engine. Gardner-Denver compressor geared to Wisconsin gas engine supplies air for pumping and drilling.

Preparation: The raw coal is dumped over a shaking screen, which makes 2 sizes—plus 1-inch eggnut, and minus 1-inch steam.

Shipments: By truck.

Production in 1946: 8,684 tons.

##### B. & R. Coal Co.

Operators: Joe Baima and Mike Rubitino, Box 389, Renton, Washington.

Location: SE $\frac{1}{4}$  sec. 27, (24-5E).

Opened by: 39° slope.

Seams: Bagley, 8 feet; and the May Creek, 4 feet 8 inches; the latter is reached by rock tunnel.

Method of mining: Breast and pillar; drilling with electric augurs.

Main hoist: Electric.

Lights used: Open.

Underground haulage: Electric motor.

Ventilation: 2 exhaust fans—one Western Blower, one Sirocco.

Preparation: The coal is dumped on a shaking screen and the plus 3 $\frac{1}{2}$ -inch size is taken out and hand-picked; the rest, or minus 3 $\frac{1}{2}$ -inch, all goes to an Elmore single-cell jig and from there through 2 revolving screens making eggnut, stoker, and buckwheat sizes.

Shipments: By truck.

Production in 1946: 24,009 tons.

##### B. & R. Coal Co.

Operators: Joe Baima and Mike Rubitino, Box 389, Renton, Washington.

Location: SW $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 33, (24-6E).

Opened by: Water-level entry.

Seam: Bagley, 8 feet, dip 30°.

Method of mining: 12-foot chutes are driven up on the advance, and the pillars are pulled on the retreat.

Lights used: Open.

Underground haulage: Electric battery motor.

Ventilation: Western Blower Sirocco-type exhaust fan.

Preparation: No preparation is done.

Shipments: No shipments are made. All coal produced is trucked to the company plant at Newcastle, approximately 11 miles, for preparation.

Production in 1946: 12,911 tons.

##### Bianco Coal Mine.

Operator: Fred Bianco, Issaquah, Washington.

Location: Secs. 31 and 32, (24-6E).

Opened by: Water-level entry, located in the center of sec. 32.

Seams: Upper Bagley, 4 feet 6 inches; lower Bagley, 6 feet; and Muldoon, 5 feet 6 inches. All three seams are reached by rock tunnels from the main entry.

Method of mining: Chute and pillar in lower Bagley, breast and pillar in upper Bagley and Muldoon. Pick mining and drilling with electric augurs.

Underground haulage: Electric trolley motors.

Lights used: Open.

Ventilation: 2 Sirocco-type exhaust fans.

Preparation: The raw coal goes over a shaking screen, and the plus 3-inch size is taken out and hand-picked; the minus 3-inch goes to an Elmore jig washer and is then separated into 3 sizes by a revolving screen.

Shipments: By truck.

Production in 1946: 31,350 tons.

#### **Big Four Coal Co. (Elk Mine).**

Operator: Pete Pergolius, Palmer, Washington.

Location: Sec. 34, (22-7E).

Opened by: Two slopes located in SE $\frac{1}{4}$  sec. 34.

Seams: Big Elk, 5 feet; and Water Level, 3 feet 3 inches; average dip 25°.

Method of mining: Room and pillar.

Main hoist: 2 electric.

Lights used: Closed, electric.

Underground haulage: Manual tramping.

Ventilation: 2 Western Blower exhaust fans.

Preparation: The coal is dumped over a shaking screen, and lump coal is hand-picked. The rest goes to a Forrester jig for washing. The product of the washer is screened through a 10- by 14-foot revolving screen into nut and steam sizes.

Shipments: By truck and rail.

Production in 1946: 29,916 tons. Stripping operations are now progressing on the Big Elk seam.

#### **Black Diamond Mine.**

Operator: Pacific Coast Coal Company, Seattle, Washington. (This mine was closed down August 1, 1946.)

Location: Secs. 7 and 18, (21-7E).

Opened by: Slope, located in sec. 7.

Seam: McKay and Fulton, 35° dip.

Method of mining: Room and pillar; drilling with compressed-air augurs.

Underground haulage: Two G. E. electric battery motors—one 18-ton, one 25-ton.

Lights used: Electric, closed.

Ventilation: Sirocco-type exhaust fan, capacity 30,000 c.f.m.

Preparation: The coal is dumped through a rotary dump onto a shaking screen and the plus 3-inch size is taken out and hand-picked. All minus 3-inch is trucked to a washery located on the site of old No. 11 mine at Black Diamond, a distance of 3 miles; there it is washed in a 2-cell Elmore jig washer, and then screened into 3 sizes by a revolving screen.

Stripping operation on the Fulton seam continued in 1946.

Shipments: By truck from the mine, and both truck and railroad (Pacific Coast Railway Co.) from the washery plant.

Production in 1946: 39,092 tons.

#### **Black Nugget Coal Mine.**

Operators: Bziyak, Erzen, and Reporz, 1401 7th Ave., Renton, Washington.

Location: SE $\frac{1}{4}$  sec. 14, (24-6E).

Opened by: Water level.

Seam: Grand Ridge No. 4, thickness 5 to 6 $\frac{1}{2}$  feet, dip from 37° to 73°.

Method of mining: Chute and pillar.  
 Lights used: Open.  
 Underground haulage: Manual.  
 Ventilation: Natural.  
 Preparation: Shaking screen making 3 sizes.  
 Shipments: By truck.  
 Production in 1946: 2,063 tons.

#### **Carbon Fuel Co.**

Operator: James Baldi, Cumberland, Washington.  
 Location: Sec. 21, (21-7E).  
 Opened by: Water level.  
 Seam: Unnamed, thickness 27 feet of which 7 feet is taken, dip 25°.  
 Method of mining: Chute and pillar; drilling with electric augurs.  
 Lights used: Closed, electric.  
 Underground haulage: Mules.  
 Ventilation: Western Blower exhaust fan.  
 Preparation: All coal is trucked to the washery at Bayne, where it is screened through a revolving screen into 3 sizes. Small sizes are washed in a Forrester washer.  
 Shipments: By truck and rail.  
 Production in 1946: 13,242 tons.

#### **Fireking Coal Mining Co. (Old Red Devil).**

Operator: William Pillatos, Manager, Renton, Washington.  
 Location: Sec. 26, (23-5E).  
 Opened by: Slope.  
 Seam: Cavanaugh No. 2, thickness 6 feet, dip 30°.  
 Method of mining: Chute and pillar.  
 Main hoist: Electric, 52 hp.  
 Lights used: Open.  
 Underground haulage: Manual.  
 Ventilation: Exhaust fan, motor driven.  
 Preparation: Shaking and revolving screens make 3 sizes, small sizes are washed on Forrester-type jig.  
 Shipments: Truck.  
 Production in 1946: 3,208 tons.

#### **Franklin Gem Mine.**

Operator: George T. Wake, Jr., Black Diamond, Washington.  
 Location: Secs. 7 and 18, (27-7E).  
 Opened by: Slope, 32° dip, in NE $\frac{1}{4}$  sec. 18.  
 Seam: Gem, 3 feet, dip 32°.  
 Method of mining: Breast and pillar.  
 Main hoist: Gas engine.  
 Lights used: Open.  
 Underground haulage: Manual trammimg.  
 Ventilation: Sirocco-type exhaust fan, 5,000 c.f.m.  
 Preparation: The coal is screened over a shaking screen making 4 sizes.  
 Shipments: By truck.  
 Production in 1946: 5,555 tons.

#### **Green River Coal Co.**

Operators: J. B. Lombardini and H. J. Henry, Black Diamond, Washington.  
 Location: Sec. 36, (21-6E).  
 Opened by: Slope.  
 Main hoist: Gas engine.  
 Seam: Kummer No. 4, thickness 9 feet, of which 6 feet is mined, dip 28°.  
 Method of mining: Chute and pillar; electric augurs.  
 Lights used: Open.  
 Underground haulage: Mule.  
 Ventilation: Exhaust fan, motor driven.  
 Preparation: Shaker and revolving screens, Forrester-type washer.  
 Shipments: By truck.  
 Production in 1946: 2,150 tons.

**Hi-heat Coal Co.**

Operator: Ole Peterson, Black Diamond, Washington.  
Location: Secs. 8 and 9, (21-7E).  
Opened by: Water level.  
Seam: Franklin No. 10, thickness 6 feet, dip 44°.  
Method of mining: Chute and pillar.  
Lights used: Open.  
Underground haulage: Manual.  
Ventilation: Natural.  
Preparation: Shaking screens making 3 sizes.  
Shipments: By truck.  
Production in 1946: 557 tons.

**Hyde Mines Inc., Cumberland, Washington.**

Operator: Olsen Fuel Company, Seattle, Washington.  
Location: Sec. 29, (21-7E).  
Opened by: Slope.  
Seam: McKay, thickness 5 feet 4 inches, dip 45°.  
Method of mining: Chute and pillar.  
Main hoist: Electric.  
Lights used: Edison electric.  
Underground haulage: Manual.  
Ventilation: Exhaust fan.  
Preparation: Shaking screens and Forrester-type washer.  
Shipments: By truck.  
Production in 1946: None.

**Issaquah Coal Co.**

Operator: B. F. Harris, P. O. Box 635, Issaquah, Washington.  
Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$  sec. 13, (24-6E).  
Opened by: Strip pit.  
Seam: Bagley, 17 feet, dip 73°.  
Coal is taken by truck from the pit to bunkers, 2 $\frac{3}{4}$  miles.  
Preparation: Shaking screens make 4 sizes. Small sizes are washed in Forrester-type jig washer.  
Shipments: By truck.  
Production in 1946: None.

**Johnson Coal Co.**

Operator: E. S. Johnson, Box 71, Black Diamond, Washington.  
Location: Sec. 26, (21-6E).  
Opened by: Water level on Green River. Coal is raised to bunkers up a 250-foot incline by gasoline-driven hoist.  
Seam: Kummer No. 1, thickness 5 feet, dip 49°.  
Method of mining: Chute and pillar, using breast augur.  
Lights used: Open.  
Underground haulage: Manual.  
Ventilation: Natural.  
Preparation: Fixed inclined screens, making 3 sizes.  
Shipments: By truck.  
Production in 1946: 2,222 tons.

**Kummer Coal Co.**

Operators: Wetton and Campbell, Black Diamond, Washington.  
Location: Secs. 25 and 26, (21-6E).  
Seam: Kummer No. 4, dip 48°, thickness 16 feet of which 6 feet is mined.  
Opened by: Slope.  
Main hoist: Electric.  
Method of mining: Chute and pillar.  
Lights used: Open.  
Underground haulage: Manual.  
Ventilation: Exhaust fan.



Preparation: Shaker and revolving screens; fine sizes washed in Forrester type jig.  
 Shipments: By truck.  
 Production in 1946: 3,106 tons.

**Lahey Coal Co.**

Operator: L. Roy Lahey, 801 Pacific Ave., Tacoma, Washington.  
 Location: Sec. 32, (24-6E).  
 Opened by: Water level.  
 Seam: Dolly Varden, thickness 4 feet 1 inch, dip 42°.  
 Method of mining: Chute and pillar.  
 Lights used: Open.  
 Underground haulage: Mule.  
 Ventilation: Exhaust fan.  
 Preparation: Shaking screens and Elmore-type jig washer,  
 Shipments: By truck.  
 Production in 1946: 4,590 tons.

**McKay Mine.**

Operator: Northwestern Improvement Company, Ravensdale, Washington.  
 Location: Sec. 1, (22-6E).  
 Opened by: Slope located on township corner. Inside slope from second to fifth levels.  
 Seam: McKay; dip varies from 37°-70°. Seam is 11 feet thick but only 5 feet is taken.  
 Method of mining: Chute and pillar; electric augurs.  
 Main hoist: 2 electric, 1 on each slope.  
 Lights used: Closed, electric.  
 Underground haulage: Jeffery and G. E. battery motors.  
 Ventilation: 5-foot Jeffery Aerodyne exhaust fan.  
 Preparation: The coal is dumped over a shaking screen and the lump-size goes to a picking table. The undersize all goes to an Elmore jig washer and is then rescreened to 3 sizes. The minus 3/32-inch goes over Deister tables for additional cleaning. Discharge waters all go to a settling tank where sludge is recovered.  
 Shipments: By truck and rail.  
 Production in 1946: 45,656 tons.  
 A strip pit was being operated in 1946-47 at this location on the McKay seam.

**New Lake Young Mining Co.**

Operator: W. Pillatos, Renton, Washington.  
 Location: Sec. 36, (23-5E).  
 Opened by: 850-foot slope, dip varying from 22°-47°.  
 Seam: Lake Young No. 2, dip 47°, thickness average 3 feet 5 inches.  
 Method of mining: Chute and pillar.  
 Main hoist: Electric, 50 hp.  
 Lights used: Open.  
 Underground haulage: Mules.  
 Ventilation: Exhaust fan with booster underground.  
 Preparation: The raw coal is passed over a shaker screen to take out the lump size, the undersize then goes to a Forrester jig, and the washed product is elevated and passes through a revolving screen which sizes it to eggnut, stoker, and buckwheat. Sludge is caught in a settling tank and returned to the buckwheat bunker.  
 Shipments: By truck.  
 Production in 1946: 1,824 tons.

**Palmer Coking Coal Co. (Durham mine).**

Operator: Morris Brothers, Enumclaw, Washington.  
 Location: Sec. 2, (21-7E).  
 Opened by: Water-level entry, located in NW. corner of section. The entry is on a hillside above the bunkers and is reached by a 1,500-foot incline.

Seam: No. 2 Durham; 18 feet in thickness, but only 8 feet is taken; dip 32°.

Method of mining: Chute and pillar; electric augur drills.

Main hoist: Electric, 75 hp.

Lights used: Closed, electric.

Underground haulage: Mules and some rope haulage.

Ventilation: Sirocco-type exhaust fan, 8,000 c.f.m.

Preparation: The raw coal goes through a crusher and then is elevated to a one-cell Forrester washer. The product of the washer is screened through a revolving screen for sizing.

Shipments: By truck and rail.

Production in 1946: 12,039 tons.

A strip pit on No. 1 seam here was opened in 1946 and closed in 1947.

#### **Palmer Coking Coal Co. (Danville mine).**

Operator: Morris Brothers, Enumclaw, Washington.

Location: Secs. 24 and 25, (22-6E).

Opened by: Slope located in SE corner sec. 24, 500 feet long, 40° dip.

Seam: No. 1 Danville, 7 feet 10 inches, dip 87°.

Method of mining: Chute and pillar; electric augur drills.

Main hoist: 125 hp. electric.

Lights used: Closed, electric.

Underground haulage: Rope and electric motors.

Ventilation: Sirocco-type exhaust fan, 12,000 c.f.m.

Preparation: The coal is washed in a one-cell Forrester jig and sized through a revolving screen.

Shipments: Truck and rail. Mine is located one-fourth of a mile from the C. M. St. P. & P. Ry. and three-fourths of a mile from the N. P. Ry.

Production in 1946: 20,416 tons.

#### **Renton Mining Co.**

Operator: Robert Wilson, Box 596, Renton, Washington.

Location: SE¼SW¼ sec. 29, (23-5E).

Opened by: Shaft, 450 feet deep.

Seam: Springbrook, of which 8 feet 6 inches of upper bench is taken; dip 55°-60°.

Method of mining: Chute and pillar; drilling with electric augur.

Main hoist: 125 hp. electric, with skip.

Lights used: Closed, electric.

Underground haulage: Electric battery motor.

Ventilation: Exhaust fan, 8-foot Western Blower.

Preparation: The raw coal goes over a shaking screen where the plus 3½-inch size is taken out and hand-picked; the minus 3½-inch size is washed in a Forrester jig and from there goes to another shaking screen which takes out the eggnut and pea, the undersize then going to a revolving screen which separates the stoker and buck-wheat.

Shipments: By truck.

Production in 1946: 19,929 tons.

#### **Springbrook Mining Co.**

Operator: F. D. Plant, Rt. 1, Renton, Washington.

Location: SW¼SE¼ sec. 29, (23-5E).

Opened by: 600-foot slope, dip 55°.

Seam: Springbrook; dip 55°; upper bench 6 feet 9 inches, lower bench 7 feet 9 inches.

Method of mining: Chute and pillar; drilling with electric augurs; and shooting off the solid.

Main hoist: 70 hp. electric Lidgerwood.

Lights used: Closed, electric.

Underground haulage: Combination battery and trolley motor.

Ventilation: Exhaust fan 12,000 c.f.m., boosters are used in the workings.

Preparation: Mine cars are dumped into raw-coal bins, the coal then goes by conveyor to shaking screens where the plus 3-inch size is taken out and hand-picked. The minus 3-inch size all goes to a Forrester jig washer and from there to another shaking screen where it is separated into nut, stoker, and steam sizes.

Shipments: By truck.

Production in 1946: 7,475 tons.

#### Spring Glen Coal Co.

Operator: Chas. Starkovich, 532 Tobin Ave., Renton, Washington.

Location: SE $\frac{1}{4}$  sec. 29, (23-5E).

Opened by: 375-foot slope, dip 45°.

Seam: Springbrook; dip 55°; upper bench 6 feet 9 inches, lower bench 7 feet 9 inches.

Method of mining: Chute and pillar; drilling with electric augurs.

Main hoist: Electric, 30 hp.

Lights used: Open.

Underground haulage: Small rope and motor.

Ventilation: Exhaust fan.

Preparation: The raw coal is passed over a shaking screen, making 4 sizes—lump, nutpea, stoker, and buckwheat. It is planned to install a washer in the near future.

Shipments: By truck.

Production in 1946: 3,999 tons.

#### Strain Coal Co.

Operator: William Strain, Old Times Building, Seattle, Washington.

Location: Secs. 25 and 26, (24-5E).

Opened by: Slope 38°, located in center of sec. 26.

Seam: Bagley; 38 feet, of which 21 feet is taken.

Method of mining: Chute and pillar; drilling with B. & D. electric augurs.

Main hoist: Electric, 200 hp.

Lights used: Open.

Underground haulage: Trolley motors.

Ventilation: 2 Western Blower Sirocco-type fans—1 forcing and 1 exhaust.

Preparation: The coal is dumped over a shaking screen, and the plus 3-inch size is taken out and hand-picked; the minus 3-inch is crushed to minus 1-inch and goes to a 4-cell Elmore jig washer. The washer product goes over vibrating screens, then to dewatering elevator and bunkers.

Shipments: By truck.

Production in 1946: 32,301 tons.

### PIERCE COUNTY

#### Apex Coal Co.

Operators: Suman and Rogala, Wilkeson, Washington.

Location: NW $\frac{1}{4}$  sec. 27, (19-6E).

Opened by: Water-level entry, also an inside slope.

Seam: No. 4 Wilkeson, 3-foot, dip 53°.

Method of mining: Chute and pillar; breast augurs.

Main hoist: 50 hp. steam hoist on inside slope.

Lights used: Open.

Underground haulage: Manual tramping.

Ventilation: Small exhaust fan.

Preparation: The coal is dumped over a fixed-bar screen, making 2 sizes—lump and steam.

Shipments: By truck.

Production in 1946: 2,271 tons.

**Carbonado Coal Co.**

Operator: Tony Basseli, Carbonado, Washington.  
Location: SW $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 4, (18-6E).  
Opened by: Water-level entry.  
Seam: Wilkeson No. 7.  
Method of mining: Chute and pillar.  
Lights used: Electric.  
Underground haulage: Mules.  
Ventilation: Exhaust fan.  
Preparation: Coal is screened to 3 sizes.  
Production in 1946: 2,781 tons.

**East Miller Coal Co.**

Operators: Onruffi, Chromoga, and A. Oranto, Wilkeson, Washington.  
Location: SW $\frac{1}{4}$  sec. 27, (19-6E).  
Opened by: Water-level entry.  
Seam: East dip of No. 5 Wingate, dip 55°-60°.  
Method of mining: Chute and pillar; breast augurs.  
Lights used: Open.  
Underground haulage: Horse.  
Ventilation: Small exhaust fan.  
Preparation: The car is hauled up a short incline to a bunker, and the coal is dumped over a fixed-bar screen. Only 2 sizes are made, lump and steam.  
Shipments: By truck.  
Production in 1946: None.

**Gale Creek Coal Co.**

Operator: George Savage, Wilkeson, Washington.  
Location: NE $\frac{1}{4}$  sec. 28, (19-6E).  
Opened by: Slope, 600 feet long. Auxiliary slope is driven down from bottom parting on the west dip.  
Seam: No. 1 Burnett, 42-inch, dip 24°.  
Main hoist: Steam donkey; auxiliary slope, 5 hp. electric.  
Lights used: Open.  
Underground haulage: Manual.  
Ventilation: No. 4 Sirocco on main air course, with small Sirocco as a booster on west-dip workings.  
Preparation: The raw coal is dumped over a fixed-bar screen, making lump and steam sizes.  
Shipments: By truck.  
Production in 1946: 1,048 tons.

**Wilkeson-Wingate Coal Co.**

Operators: Lock and Serack, Wilkeson, Washington.  
Location: SW $\frac{1}{4}$  sec. 27, (19-6E).  
Opened by: Water-level entry.  
Seam: East dip No. 4 Wingate, dip 55°-60°.  
Method of mining: Chute and pillar; breast augurs.  
Lights used: Open.  
Underground haulage: Trolley motor.  
Ventilation: Small exhaust fan.  
Preparation: The coal is dumped over a fixed-bar screen, making 2 sizes, the small size being washed by jig-type washer.  
Shipments: By truck.  
Production in 1946: 8,259 tons.

**Wilkeson Mine.**

Operator: Wilkeson Products Company, Wilkeson, Washington.  
Location: Secs. 27, 28, and 34, (19-6E).  
Opened by: 30°, 9- by 12-foot rock slope, 900 feet long. At bottom of slope is a parting 300 feet long, 18 feet wide, and 11 feet high. From this parting a rock tunnel has been driven approximately

4,000 feet, midway between the No. 2 and No. 3 Wilkeson seams. From this tunnel, angle rock chutes on 45° are driven up the dip to the coal, which dips from 80°-85°. Chutes are driven in pairs in the coal, and no pillars will be drawn until the boundary is reached, then they will be taken on the retreat. Future development contemplates another rock tunnel to intersect seams No. 6 and No. 7.

Main hoist: 400 hp. electric.

Lights used: Closed, electric.

Underground haulage: Westinghouse-Baldwin permissible storage-battery 7-ton motors. Sanford-Day 6-ton automatic drop-bottom cars are used.

Ventilation: Multi-blade electric exhaust fan, 40,000 c.f.m.

Preparation: The mine cars are automatically dumped through an opening in the track near the top of the main haulage slope into a raw-coal bin with a capacity of 120 tons. From this bin a reciprocating feeder (capacity, 100 tons per hour) feeds the coal to a 9- by 14-foot Bradford breaker, with 1-inch round holes; from there it goes to a pump sump and is pumped up to the raw-coal classifier. From the classifier the coal goes to the No. 1 Vissac jig and then to the No. 2 jig.

The product of the jigs, after the middlings are screened out, goes to a tank and is elevated by the table-feed elevator and delivered to a battery of 6 Deister tables. From the tables the coal goes to a large clean-coal settling tank, and from there via a dewatering elevator (capacity 75 tons per hour) to a distributing flight conveyor, which distributes it to 6 drainage shipping bins (capacity 850 tons). The middlings from the jigs are taken by an elevator to a 4- by 8-foot vibrating screen with ¼-inch openings, and the oversize goes to a 30- by 20-inch roll-disintegrator and then back over the vibrating screen. The product of this screen then goes via the table-feed elevator back to the Deister tables. All water discharge goes to a sump tank and is pumped up to a large cone-settling tank; the sludge recovered here goes back over the Deister tables for recleaning.

Shipments: By rail. The output of this mine was shipped to the company's coke-oven plant at Tacoma.

Production in 1946: Not operating.

#### THURSTON COUNTY

##### D. and F. Coal Mining Co.

Operator: John Fusco, Centralia, Washington.

Location: Sec. 18, (15-1E).

Opened by: Water level, 900 feet. Inside slope started in 1946.

Seam: 5 feet, dipping 8°-10°.

Method of mining: Narrow work only.

Underground haulage: Horse.

Ventilation: Sirocco-type fan, exhaust.

Lights used: Open.

Preparation: Screened through bar screens making two sizes.

Shipments: By truck.

Production in 1946: Not operating.

##### Penn-Bucoda Coal Co.

Operator: Robert D. MacAfee, General Superintendent, Bucoda, Washington.

Location: SW¼SW¼ sec. 7, NW¼NW¼ and S½ of sec. 18, also N½NW¼ and NW¼NE¼ sec. 19, (15-1W).

Opened by: Strip pit.

Preparation: Raw coal is delivered to vibrating grizzly, and plus 3-inch goes to lump bin, minus 3-inch goes over vibrating screens which make 3 sizes. Storage bins have a capacity of 1,000 tons. Installation of washer is planned.

Shipments: By rail and truck.

Production in 1946: 1,165 tons.

**Tono Mine.**

Operator: Strain Coal Company, Tono, Washington.  
 Location: Secs. 16 and 21, (15-1W).  
 Opened by: 3 slopes. The main slope is No. 2, which goes down from surface; Nos. 1 and 3 join into No. 2 at the bottom, or in the synclinal basin; No. 2 slope is driven 2,400 feet on a dip at 4° to the bottom of the syncline, where the cars are then taken by horses to the foot of the anticline and then are hoisted by inside electric hoists.  
 Seam: No. 1 Tono. The vein is 18 feet thick, but only 10 feet is taken, the rest, which is very bony, being left up for roof.  
 Method of mining: Panel system. Horses take the cars to the working face. The coal is undercut with shortwall machines and drilled with Sioux electric augurs.  
 Underground haulage: Horses.  
 Ventilation: Plenum or forcing.  
 Preparation: The coal is dumped over a shaking screen and 2 sizes are made—plus 3-inch lump, and 3-inch to 2-inch "range." The minus 2-inch is washed in a Blair washer and then screened through a revolving screen into stoker and steam sizes.  
 Shipments: Truck and rail.  
 Production in 1946: 49,429 tons.

## LEWIS COUNTY

**Atlas Coal Co.**

Operator: Hugh Eldridge, Sec., Box 217, Morton, Washington.  
 Location: Sec. 12, (12-4E).  
 Opened by: Slope.  
 Seam: No name, 9 feet, dip from 18° to 26°.  
 Method of mining: Room and pillar.  
 Main hoist: Electric.  
 Lights used: Open.  
 Underground haulage: Manual.  
 Ventilation: Exhaust fan.  
 Preparation: Coal passes over shaking screens, and fine product is washed in an Elmore-type washer.  
 Shipments: By truck.  
 Production in 1946: Not operating.

**Black Prince Coal Co.**

Operator: J. G. Parkin, Centralia, Washington.  
 Location: Sec. 28, (15-1W).  
 Opened by: Water-level entry. A small steam engine pulls the cars up from mine entrance to top of hill and then lowers them on opposite side to bunkers, one-half mile from mine entry.  
 Seam: Parkin; 16 feet, of which 7 feet is taken.  
 Method of mining: Room and pillar; breast augurs.  
 Lights used: Open.  
 Underground haulage: Mule.  
 Ventilation: Natural.  
 Preparation: The coal is dumped over a shaking screen which separates it into 3 sizes. No washing is done.  
 Shipments: By truck.  
 Production in 1946: 4,444 tons.

**Columbia Coal Co.**

Operators: Owens and Whittaker, Lewis and Clark Hotel, Centralia, Washington.  
 Location: NW¼ sec. 10, (14-1<sup>w</sup>E).  
 Opened by: Slope, 240 feet.  
 Seam: Mendota, 7 feet 6 inches, dip 3°.  
 Method of mining: Room and pillar.  
 Main hoist: Electric hoist.

Lights used: Open.  
 Underground haulage: Manual.  
 Ventilation: Exhaust fan.  
 Preparation: Coal is dumped on shaker screen and the plus 3-inch goes to lump bin. The minus 3-inch size then goes through a revolving screen making 2 sizes. When market demands, these sizes can be by-passed through crusher for stoker size. Small sizes are washed in Elmore-type jig washer.  
 Shipment: By truck.  
 Production in 1946: 5,458 tons.

#### Golden Glow Coal Co.

Operators: H. H. French and L. Howell, Centralia, Washington.  
 Location: Secs. 22 and 23, (14-2W).  
 Opened by: 2 water-level entries close to section line between secs. 22 and 23.  
 Seam: Shelton, 5 feet 10 inches, dip 15°-20°.  
 Method of mining: Room and pillar; breast augurs.  
 Lights used: Open.  
 Underground haulage: Manual tramping.  
 Ventilation: Natural.  
 Preparation: The coal is dumped over a fixed-bar screen, making 2 sizes. No washing is done.  
 Shipments: By truck.  
 Production in 1946: 745 tons.

#### K. & K. Mining Co.

Operators: Henry C. Kilgus, Frank Kuhuski, and Frank Hoberecht, Fox Theater Building, Centralia, Washington.  
 Location: Sec. 34, (15-1W).  
 Opened by: Slope.  
 Main hoist: Electric.  
 Seam: Third seam of Mendota series, dip 15°, thickness 9 feet of which 7 feet is taken.  
 Method of mining: Room and pillar; drill with electric augurs.  
 Lights used: Open.  
 Underground haulage: Horses.  
 Ventilation: Exhaust fan.  
 Preparation: Shaking screens making 3 sizes.  
 Shipments: By truck.  
 Production in 1946: 3,543 tons.

#### Monarch Coal Mining Co.

Operator: George Sheatsly, Centralia, Washington.  
 Location: Sec. 30, (15-2W).  
 Opened by: Slope, located in SW $\frac{1}{4}$ SW $\frac{1}{4}$ .  
 Seam: Foron (Fords Prairie), 7 feet, dip 15°.  
 Method of mining: Room and pillar; electric augurs. Future plans call for plane system, using undercutting machines and shaking conveyors.  
 Main hoist: 75 hp. electric.  
 Lights used: Open.  
 Underground haulage: Electric battery motor.  
 Ventilation: Sturtevant exhaust fan.  
 Preparation: The raw coal goes over a shaking screen, making 2 sizes—plus 3-inch and 3- to 1 $\frac{3}{4}$ -inch; all the minus 1 $\frac{3}{4}$  inch goes to an improved Link-Belt Forrester-type washer and then to a revolving screen, making nut, pea, and buckwheat.  
 Shipments: By rail and truck. Bunkers are situated less than a quarter of a mile from both the Northern Pacific Railway and the Chicago, Milwaukee, St. Paul and Pacific Railway.  
 Production in 1946: 36,095 tons.

**Stoker Coal Mining Co.**

Operator: T. E. Martin, Centralia, Washington.  
Location: Sec. 29, (15-2W).  
Opened by: Water-level entry in center of section.  
Seam: Foron, 8 feet 6 inches.  
Method of mining: Chute and pillar.  
Lights used: Open.  
Underground haulage: Gasoline motor.  
Ventilation: Western Blower; forcing or plenum.  
Preparation: The raw coal goes over a shaking screen, where lump coal is taken out and hand-picked. All minus 3½-inch goes to a Forrester washer and then over vibrating screens, where it is sized into range, nutpea, and buckwheat.  
Shipments: By truck.  
Production in 1946: 6,651 tons.

**Sunburst Coal Co., Inc.**

Operators: Dr. C. C. Hale, R. L. Stitt, Edward Husband, Mineral, Washington.  
Location: Sec. 12, (14-4E).  
Opened by: 2 tunnels.  
Seams: Ladd No. 1, thickness 8 feet; and Ladd No. 2, thickness 4 feet 6 inches; dip 45°.  
Method of mining: Room and pillar.  
Power plant: Generate electric power with steam.  
Underground haulage: Manual. Trolley motor planned.  
Ventilation: Exhaust. Sturtevant fan. 10,000 c.f.m.  
Lights used: Closed, electric.  
Preparation: The raw coal is dumped on a bar screen taking out the plus 1½-inch. The minus 1½-inch goes over a Deister table for cleaning and the product of the table is separated into steam and stoker sizes by vibrating screen. The plus 1½-inch size is sold as eggnut.  
Shipment: By truck.  
Production in 1946: Not operating.

## KITTITAS COUNTY

**Jonesville Coal Co. No. 4.**

Operator: Jonesville Coal Company, Ronald, Washington.  
Location: Sec. 12, (20-14E).  
Opened by: Slope, 1,150 feet on a 12° dip.  
Seam: Roslyn No. 6; 4 feet 6 inches, with 5-inch parting in center.  
Method of mining: Room and pillar; 40-foot rooms with 2 necks; hand-pick and breast augurs.  
Main hoist: 200 hp. steam.  
Lights used: Open.  
Underground haulage: Mules.  
Ventilation: Western Blower Sirocco-type exhaust fan.  
Preparation: No preparation is done at the present time; all coal is shipped "run-of-mine." It is planned to install a washer.  
Shipments: By truck.  
Production in 1946: 3,435 tons.

**Lake Mine.**

Operators: Burnett, Garki, and Firman, Ronald, Washington.  
Location: NE¼SE¼ sec. 2, (20-14E).  
Opened by: Water-level entry.  
Seam: Tom Wright, 5-foot, dip 15°.  
Method of mining: Room and pillar with McGinties.  
Lights used: Open.  
Underground haulage: Manual.  
Ventilation: Exhaust fan.



Preparation: The raw coal is dumped over a bar screen, making 2 sizes.  
Shipments: By truck.  
Production in 1946: 168 tons.

**Roslyn No. 3.**

Operator: Northwestern Improvement Company, Roslyn, Washington.  
Location: Sec. 7, (20-15E).  
Opened by: Slope.  
Seams: No. 1 Roslyn, thickness 19 feet of which 5 feet is taken; and Roslyn No. 5, thickness 5 feet 4 inches of which 4 feet 6 inches is taken.  
Method of mining: Room and pillar on retreat. The coal is undercut by machines and after being shot down is conveyed to the entries by shaking pan conveyors.  
Main hoist: 1,800 hp. Kenny & Co. steam.  
Lights used: Closed, electric.  
Underground haulage: Electric trolley motors.  
Ventilation: 1 Sirocco and 1 Jeffrey exhaust fan; total air 134,000 c.f.m.  
Preparation: All raw coal is loaded on railroad cars and taken to a central cleaning plant.  
Equipment: 17 cutting machines—15 shortwall and 2 shearing, 22 shaking conveyors, 10 trolley-type electric haulage motors, 17 compressed-air augur drills, 10 electric augur drills, and 5 jackhammers for rock work.  
Drainage: 2 electrically driven Cameron centrifugal pumps of 250 hp., handling 600 g.p.m. against 840-foot head.  
Shipments: By rail.  
Production in 1946: 126,617 tons.

**Roslyn No. 5.**

Operator: Northwestern Improvement Company, Roslyn, Washington.  
Location: Sec. 21, (20-15E).  
Opened by: Slope.  
Seam: No. 5 Roslyn, thickness 5 feet 4 inches of which 4 feet 6 inches is taken.  
Method of mining: Room and pillar retreating; undercutting machines are used on flat dip, and shearing machines on the steeper dips. Coal is conveyed to entries by shaking pan conveyors. In some working places where the dip is sharp, planes of about 45° angle are driven.  
Main hoist: 800 hp. Nordberg, double drum; electric.  
Lights used: Closed, electric.  
Underground haulage: Electric trolley motors.  
Ventilation: Exhaust fan, 75,000 c.f.m. from this mine goes to No. 9 mine (with which it is connected).  
Preparation: All raw coal is loaded on railroad cars and taken to a central cleaning plant.  
Equipment: 5 shortwall machines, 5 shearing machines, 21 shaking conveyors, 11 trolley-type haulage motors, 20 pneumatic augurs, 4 electric augurs, 7 jackhammers.  
Drainage: One 200 hp. Cameron centrifugal, handling 600 g.p.m. against 700-foot head, and one Allis-Chalmers 150 hp., handling 400 g.p.m. against 700-foot head.  
Shipments: By rail.  
Production in 1946: 118,675 tons.

**Roslyn No. 9.**

Operator: Northwestern Improvement Company, Roslyn, Washington.  
Location: Sec. 20, (20-15E).  
Opened by: Slope.  
Seam: No. 5 Roslyn, thickness 5 feet 4 inches of which 4 feet 6 inches is taken.

Method of mining: Room and pillar retreating; coal is undercut by machine and conveyed to entry by shaking pan conveyor. Where dip is steeper, shearing machines are used. Some planes were being started in 1946 on the No. 4 side.

Main hoist: 850 hp. Allis-Chalmers electric.

Lights used: Closed, electric.

Underground haulage: Electric trolley motors.

Ventilation: 2 Sirocco exhaust fans, 130,000 c.f.m.

Preparation: All raw coal is loaded on railroad cars and taken to a central cleaning plant.

Drainage: 2 Cameron pumps in series, one 240 hp. handling 600 g.p.m. against 840-foot head, and one 75 hp. handling 600 g.p.m. against 300-foot head. At all three mines, the sumps are above the pumps to assist in overcoming the static head.

Shipments: By rail.

Production in 1946: 101,422 tons.

#### **Northwestern Improvement Co., Central Coal-Cleaning Plant, Roslyn, Washington.**

The coal from Nos. 3, 5, and 9 mines is all brought on railroad cars to this plant for cleaning. There are 3 storage tracks above the plant, so that coal from the different mines can, as desired, be handled separately or mixed in any combination. The railroad cars used are drop-bottom gondolas, and the coal is dumped into track hoppers. A feeder delivers it onto an 18° belt conveyor which takes it to the top of the cleaning plant. From the raw bin it goes to the vibrating screens for separation into 3 sizes. The coal is then washed in 3 Vissac jigs. The minus ¼-inch goes over an American air table for additional cleaning. After washing and cleaning, the coal is recombined or separated into any desired mixture and is loaded direct into railroad cars for shipment. The reject from the Vissac jigs is crushed and put through an Elmore jig and then over two Deister tables. The coal thus recovered goes to a Vissac dryer and is then elevated back and rejoins the other cleaned coal.

Shipments: By rail.

#### **Roslyn Cascade Coal Co.**

Operator: Roslyn Cascade Coal Company, Ronald, Washington.

Location: Sec. 6, (20-15E).

Opened by: 2,400-foot tunnel on upward grade of 2° to where the main incline starts to top of the hill. Main incline driven 4,800 feet on 10° slope.

Seam: Roslyn No. 6, width 3½ feet with 6-inch parting. Entire seam, including parting, is taken.

Method of mining: Room and pillar; 45-foot rooms with double necks. Coal is undercut by machines (Sullivan shortwall) and dropped with top holes. Pan conveyors are installed in all rooms. Entries are driven to the boundaries, and all coal taken on retreat.

Lights used: Closed, electric.

Underground haulage: Motors and rope.

Ventilation: 5-foot Sirocco electric-driven exhaust fan, 80,000 c.f.m.

Preparation: The raw coal goes over a shaking screen with 3-inch round holes; the oversize goes to a Naughton-McNally pick breaker, and is broken to 3 inches; it then goes, together with the coal from the shaking screen, to a Naughton-McNally washer. This washer is controlled automatically by air and requires no manual attention. The product is then screened and the minus ¼-inch is further cleaned in a Stump air cleaner. The reject from the washer is returned to the washer for secondary washing. All fines are dried in a Ruggles rotary drier and then passed over a cooling scraper conveyor before elevation to the storage bunkers. All discharge water from washer is pumped to a 63,000-gallon cone-settling tank, where 5 to 7 tons of sludge is recovered from the average day's run.

Shipments: By rail.

Production in 1946: 92,624 tons.