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Coal and Coal Mining in Washington

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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 increased for industrial and domestic heating, 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 ground-work 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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Division of Mines and Mining.

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.

According to the statistics of the State Mine Inspector[1], the total coal mined in the State from 1860 up to and including 1942 was 133,404,296 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 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 subbituminous.

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[1] Wake, Geo. T., Annual report of coal mines (Washington), p. 7, 1942.

The various ranks are to a large degree segregated as to location, the higher-grade bituminous, coking, semianthracite, and anthracite coals being confined to the more mountainous areas, while the subbituminous ranks are found in regions of less relief. In fact, the degree of devolitization (with consequent improvement in grade) 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.

The only large and commercially important supply of coking coal in the Pacific Coast States is located in Pierce County. This fact is unquestionably of high 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.

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21. Yancey, H. F., and Geer, M. R., Mining and preparation (of Washington coal): U. S. Bur. Mines Tech. Paper 618, pp. 1-3, 1941.
22. 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

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.[1] 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, named Hewitt and Brown.[2] Some of the 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

[1] Culver, Harold E., The coal fields of southwestern Washington: Washington Geol. Survey Bull. 19, p. 16, 1919.

[2] Jenkins, Olaf P., Geological investigation of the coal fields of western Whatcom County: State Division of Geology Bull. 28, p. 17, 1923.

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. 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 the 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 Company 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 1872.① 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.

COAL AREAS OF THE STATE

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.② 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 and 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

① Saunders, E. J., The coal fields of Kittitas County: Washington Geol. Survey Bull. 9, p. 17, 1914.

② Campbell, M. R., The coal fields of the United States: U. S. Geol. Survey Prof. Paper 100-A, p. 21, 1917.

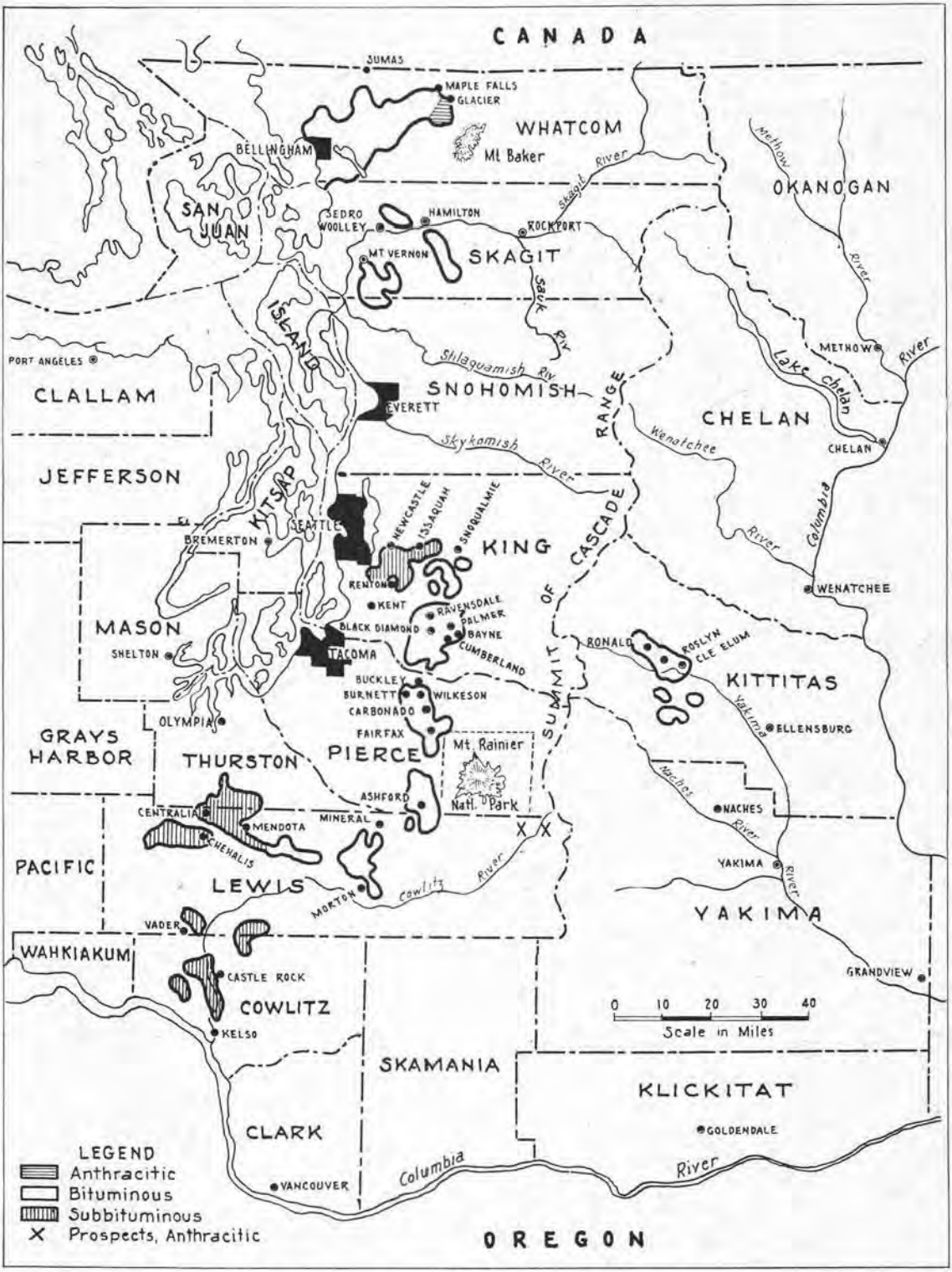

FIGURE 1— PRINCIPAL COAL AREAS OF WASHINGTON

information gained from the logs of several wells and drill holes in the area, Jenkins[1] 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 12. 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 are operating here at the present time—the Bellingham mine, one of the larger producers of the State, and the Glen Echo mine. The 1942 production for the county was 233,779 tons.

In Skagit County, no mines are operating at present. 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[2] 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 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 schist. The vein . . . has a strike of south 43° east, and a southwest pitch of 55°. 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, as they 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 Ravens-

[1] Jenkins, Olaf P., Coal fields of western Whatcom County, Washington: Washington Division of Geol. Bull. 28, p. 129, 1923.

[2] Landes, Henry, Coal deposits of Washington: Washington Geol. Survey Ann. Rept. 1902, vol. 2, pp. 178-9, 1903.

dale-Black Diamond-Franklin-Kummer-Cumberland-Bayne-Durham-Kangley districts.

King County is the second largest of the coal-producing fields of the State. In 1942, it produced 622,840 tons or 33 per cent 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 portion of the area and steeply dipping beds in the central and eastern portions. 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 River and Green River basins. Igneous sills are known, and it is rather common in the mountainous areas for dikes to cut the measures.

Though the coals of this county have possibly been more generally exploited than some of the other fields in 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 27,607 tons of coal in 1942, 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[1] 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

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

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 portion 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, also a little mining in the Mashell 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 because of somewhat difficult accessibility and also on account of certain mining problems caused by faults and igneous intrusives.

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. Three ranks of coal have been found in the area—anthracite, bituminous, and subbituminous—and all the coal measures are in rocks of the Puget Group, with the possible exception of the coal in secs. 15, 22, 28, (11-1E.), Lewis County, which may be of Oligocene Age[1]—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 12. 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; only one mine is now operating in this district. The subbituminous coal is in the western portion of the area and has been in production continuously for over 60 years.

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 wide-spread 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 Basin in the northwestern portion of the county. The coal fields are the Roslyn-Cle Elum, the Manastash, and the Taneum.

According to Saunders,[2] 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 to be present. Only three of these beds, nos. 1, 5, and 6, are being worked at this time. The mines of this field are producing the larger portion of the

[1] Warren, W. C., personal communication.

[2] Saunders, E. J., The coal fields of Kittitas County: Washington Geol. Survey Bull. 9, p. 200, 1914.

total production of the State at the present time, 953,539 tons or 51 per cent of the total output being mined in 1942.

In the Roslyn-Cle Elum field the structure is that of a large unsymetrical 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

Considerable interest having 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.

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 ranging 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 occurence, but no record of his findings is available. From 1910 to 1918, Edward 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.① 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, E. G. Woodruff② 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.

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① Private report.
② Woodruff, E. G. and Laher, C. E., Coal fields in Idaho, Washington and Oregon: U. S. Geol. Survey Bull., 541-I, p. 13, 1914.

In November, 1908, Wm. F. Dodge① in a report on 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 coal pure and simple, 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." The following tables were included in Dodge's report:

ANALYSIS 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	16.95	00.91	1.552	12693
Sample "L" Vein "A".....	02.07	06.74	89.52	01.67	00.795	1.441	14515
Sample "M" Vein "A".....	01.88	07.72	84.86	05.54	01.21	1.474	14241
Sample "N" Vein "A".....	02.02	08.78	83.88	05.32	00.995	1.465	14241

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	6.90	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.

In the Summit Creek area evidence of considerable movement is apparent. The coal measures are on the west limb of an anticline having a north-south

①Wm. F. Dodge, Mining and Consulting Engineer, Scranton, Pa., private report.

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 tipple, 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 Mining 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, and this also has 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 Mines① in 1935.

CROSS SECTION OF PRIMROSE BED

	Ft.	In.
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 on 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

①Yancey, H. F., Geer, M. R., Analysis of Washington coals; U. S. Bur. Mines Tech. paper 618, pp. 45-70, 1941.

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.

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[1] 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	Volatile matter	Fixed carbon	Ash	Sulphur	British thermal units
	Percent	Percent	Percent	Percent	Percent	
Whatcom County						
Bellingham area	5.0-13.4	35.2-40.2	41.8-48.7	13.9-22.7	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	0.90-1.01	12,920-13,960
King County						
Renton-Black River area	8.9-18.0	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	10,600-11,990
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
Pierce County						
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	8.4-26.8	0.4 -1.01	11,800-13,920
Thurston County	16.0-22.5	32.9-44.4	34.5-44.7	11.5-20.6	0.4 -1.6	8,970-11,160
Lewis County						
Centralia-Chehalis area	22.4-33.5	43.2-49.3	40.0-47.2	9.6-16.2	0.5 -2.3	10,390-11,770
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
Cowlitz County	15.2-22.2	42.8-43.4	34.8-35.9	15.7-23.0	1.2 -5.5	7,500- 9,750
Kittitas County						
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 technical paper 491, 1931. Yancey, H. F. and Geer, M. R., Analyses of Washington coals, U. S. Bur. Mines technical paper 618, 1941.

FUEL BRIQUETS

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

The production of briquets in the State 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 subbituminous, 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. At the present time, no coal briquets are being 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

	Tons	*Value*
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 this State 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 four feet deep with 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 5 Klonne-type by-product ovens. These were installed 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. Since 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, 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 COKE①

	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	16.86
	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
	0.09	1.01	80.49	18.41

A revival of coke production has recently been made by the Wilkeson Products Co., who have installed a battery of 17 Curran Knowles by-product ovens in a new plant 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 company does not contemplate cracking the tar at this time, but will sell it direct to the distillers. The gas will be sold for domestic and industrial needs, and the coke will be largely used for electrometallurgical purposes. This installation is modern and complete in every respect, and may very well be the forerunner of a greatly enlarged interest in the industry.

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

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

and the Orient. Many plants are in full operation. In this connection, Fieldner① 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."

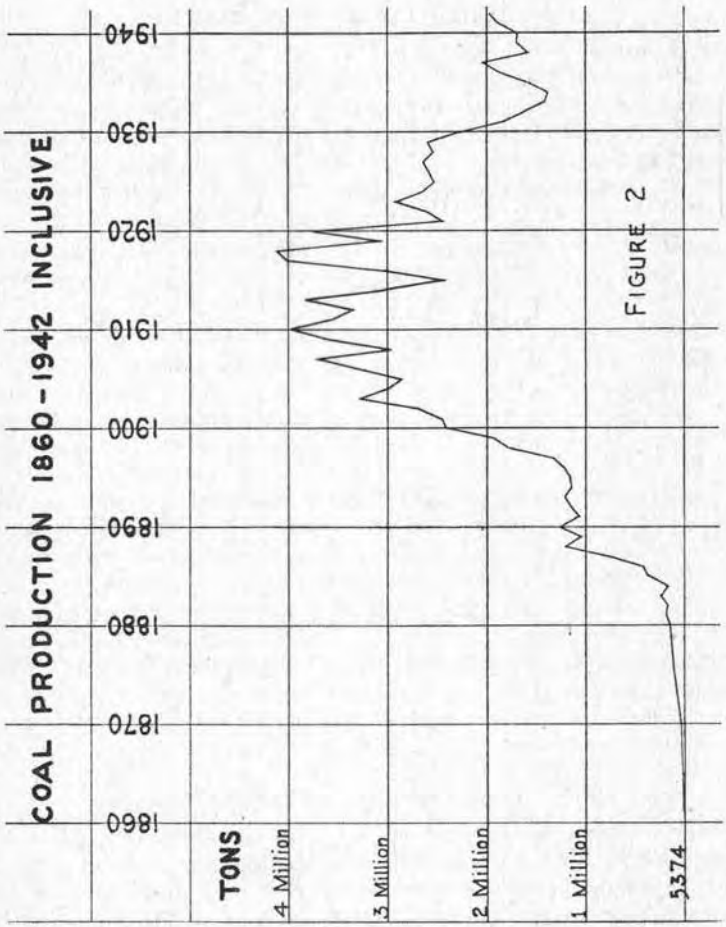
In this country the U. S. Bureau of Mines has been operating small experimental plants for some time, and recently, Harold L. Ickes, Secretary of the Interior, was reported to have asked authorization from Congress to build and operate a demonstration-type, industrial-scale, coal-hydrogenation plant or plants. 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 worthwhile if a study of this phase of the industry, in connection with the southwestern Washington subbituminous 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 was reached. Since 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, to the changed economic conditions at that time. After the low output of 1934 (and almost equally low output of 1938), the trend, although broken, has been upward, and the production in 1942 was 1,971,185 tons. With the present exceedingly active demand, both industrial and domestic, this upward trend should continue.

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



A tonnage comparison of the production by counties during the year 1918 (the peak year) and the year 1942 is given below:

COAL PRODUCTION BY COUNTIES

	1918	*1942*
King	1,331,601	622,840
Kittitas	1,739,379	953,539
Lewis	174,621	53,240
Pierce	600,917	27,607
Skagit	5,897	.....
Thurston	271,406	80,180
Whatcom	4,603	233,779
Total	4,128,424	1,971,185
Value of coal at mines	$14,564,445	$7,529,926
Number of mines operating	72	53
Number of employees:		
Inside	4,172	1,654
Outside	1,675	515
Total	5,847	2,169

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 a necessity. 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 mining coal 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 diagramatically 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.

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.

One shaft mine is in operation today in the Renton field. Prospecting is now in progress on a property in Lewis County with the object of starting a stripping operation on a 30-foot coal seam; from evidence so far obtained, there will be an average depth of about 40 feet of overburden to be removed. Another stripping operation is also being started in section 30, (15-1W.), in this county.

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 ex-

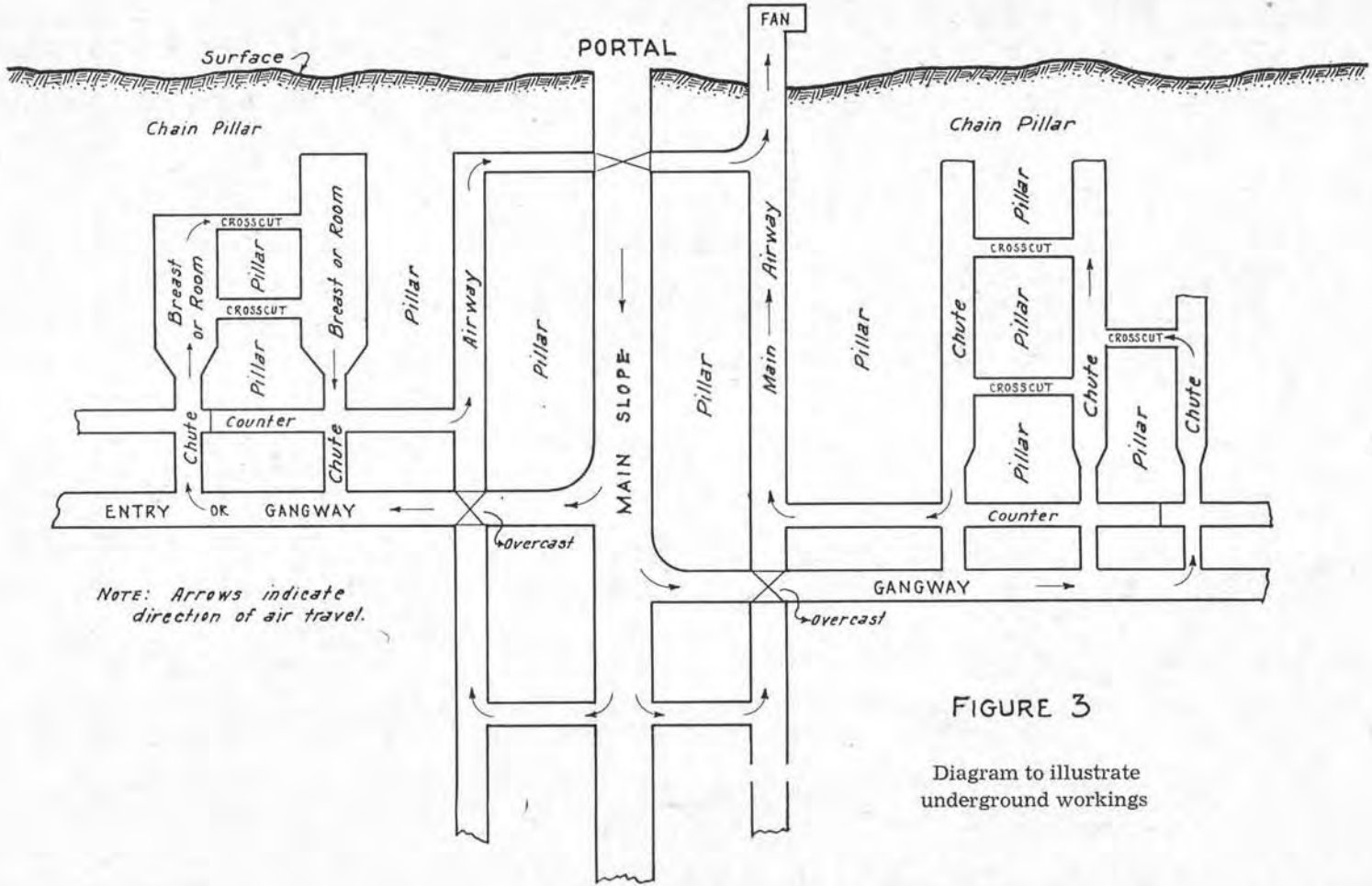


FIGURE 3

Diagram to illustrate underground workings

clusively 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 passageways not over 12 feet wide that are driven up the dip or "to the rise," from the haulage ways 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 haulage way is the air intake or "inby," and the aircourse the exhaust or "outby."

A fan is located at the exhaust end of the aircourse to pull the air through the workings. Slopes are driven 9 to 15 feet in width, and the size of the aircourse 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 aircourse, or in fact any aircourse, crosses a haulage way, 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 "overcast." 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 and 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 chutes 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 haulage ways 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 aircourse pillar is passed.

Modifications of the advance and retreat methods are used occasionally. One plan is to work panels of rooms or chutes for 10 or more places on the advance, then to leave a block of 10 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 1942, five mines were using mechanical cutting

machines and pan or shaking conveyors underground, approximately 52 percent of the State's production being machine mined. 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.

PRESENT STATUS OF THE COAL-MINING INDUSTRY

The State Division of Mines and Mining has recently completed a survey of all operating coal properties in Washington, in an endeavor to ascertain the reasons for the present lack of sufficient coal for our war industries and for domestic use.

In spite of the fact that the State has ample reserves of coal, more than a million tons were imported from other states and Canada (some coming from as far away as Virginia) during the 6 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; it also represented 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 "out-side" men, but without a single exception, the operators are seriously handicapped by the shortage of miners. So acute is this shortage that some properties may be forced to shut down. With few exceptions development work is inadequate or impossible, and so the properties are, perforce, in the condition of exhausting their developed reserves without being able to make provision for future operations. Unless prompt and drastic action is immediately taken by those agencies of Government dealing with such problems, the Pacific Northwest unquestionably will be in a most critical situation—one which may seriously affect our vital war industries.

As coal is a basic industrial material, it would seem logical that all coal miners should most certainly be deferred from war duty, and that they should be "frozen" to the industry. Most of the miners who have left the mines have gone to other industries where the wages possibly looked more attractive. These men should be returned to the mines, as their services there are unquestionably of greater value to the expediting of our war effort than would be the case in any other line of endeavor. Their places in outside industries could better be filled with other civilians. 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 can make even in the war 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, similar to those now in use in the Roslyn field. 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 the too prevalent present "hit-and-miss" methods would return the investment many times.

There are in the State today, a total of only 40 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 1943

Below are given names and brief descriptions of the mines now (1943) operating in the State. For the sake of brevity, the usual method of showing legal land subdivisions, such as NE¼ sec. 26, T. 31 N., R. 28 E., is shortened to NE¼ 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 in consequence, repeated many times throughout the State and do not indicate a correlation.

WHATCOM COUNTY

Bellingham Coal Mine.

Operator: Bellingham Coal Mine Co.

Location: Secs. 13, 24, (38-2E.).

Opened by: 2 slopes. No. 1 is driven 600 feet on 30° dip to coal, and No. 2 driven 6,336 feet on dip of 18°.

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 jack hammers, using star bits.

Mainhoist: Vulcan 24 by 48-inch first-motion steam. Standby, Ottumwa 24 by 36-inch steam.

Underground haulage: Horses and mules.

Ventilation: Western Blower No. 9 exhaust fan, 55,000 C.F.

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 2 locomotive-type cranes—1 15-ton with 1-yard bucket, and a 25-ton with a 2-yard bucket.

Shipments: By rail and truck.
Production in 1942: 230,435 tons.

Glen Echo Mine.

Operators: West Coast Mines, Inc.
Location: Secs. 4, 5, 8, 9, (38-4E.).
Opened by: Slope, located in SW¼SW¼ sec. 4; depth, 1,200 feet with dip of 30° at top and 12° at bottom.
Seam: No. 1 Glen Echo; 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.
Mainhoist: 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 1942: 3,344 tons.

KING COUNTY

Andersen Coal Co.

Operator: James A. Andersen.
Location: Sec. 1, (22-6E.).
Opened by: Slope.
Seam: No. 7 Dale, dip 48°-60°.
Method of Mining: Room and pillar.
Mainhoist: Hercules gas engine geared to single drum.
Lights used: Closed, electric.
Underground haulage: Manual.
Ventilation: Exhaust. Buffalo fan powered with Wisconsin gas engine. Gardner compressor geared to Wisconsin gas engine supplies air for pumping and drilling.
Preparation: The raw coal is dumped over shaking screen, which makes 2 sizes, plus 1-inch eggnut, and minus 1-inch steam.
Shipments: By truck.
Production in 1942: New operation.

B. & R. Coal Co.

Operators: Joe Baima and Mike Rubitino.
Location: SE¼ sec. 27, (24-5E.).
Opened by: 39° slope.
Seams: Bagley, 8 foot; 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.
Mainhoist: Electric.
Lights used: Open.
Underground haulage: Electric motor.
Ventilation: Exhaust fans—one Western Blower, one Sirocco.
Preparation: The coal is dumped on a shaking screen and the plus 3½-inch size is taken out and hand picked; the rest, or minus 3½- 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 1942: 30,340 tons.

B. & R. Coal Co.

Operators: Joe Baima and Mike Rubitino.
Location: SW¼NW¼ 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.
Production in 1942: 4,901 tons.

Bianco Coal Mine.

Operator: Fred Bianco.
Location: Secs. 31, 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 3 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 1942: 67,631 tons.

Black Diamond Mine.

Operator: Pacific Coast Coal Co.
Location: Secs. 7, 18, (21-7E.).
Opened by: Slope, located in sec. 7.
Seam: McKay; 35° dip.
Method of Mining: Room and pillar; drilling with compressed air augurs.
Underground haulage: 2 G. E. electric battery motors—1 18-ton, 1 25-ton.
Lights used: Electric, closed.
Ventilation: Sirocco-type exhaust fan, capacity 30,000 C.F.
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 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.
Shipments: By truck from the mine, and both truck and railroad (Pacific Coast Railway Co.) from the washery plant.
Production in 1942: 67,702 tons.

Big 4 Elk Mine.

Operator: John C. Damascus, Receiver.
Location: Sec. 34, (22-7E.).
Opened by: Two slopes located in SE¼ sec. 34.
Seams: Big Elk, 5 feet; and Water Level, 3 feet 3 inches; average dip 25°.
Method of Mining: Room and pillar.
Mainhoist: 2 electric.
Lights used: Closed, electric.
Underground haulage: Manual tramming.
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 10 x 14 revolving screen into nut and steam sizes.
Shipments: By truck and rail.
Production in 1942: 28,892 tons.

Carbon Fuel Co.

Operator: James Baldi.
Location: Sec. 22, (21-7E.).
Opened by: Slope, 35°, located in NE¼ sec. 22.
Seam: Bayne No. 3; thickness 5 feet 6 inches; dip 35°-40°.
Method of Mining: Chute and pillar; drilling with electric augurs.
Mainhoist: 11 x 13 Willamette donkey, steam.
Lights used: Closed, electric.
Underground haulage: Mules.
Ventilation: Western Blower Sirocco-type exhaust fan.
Preparation: All coal is trucked to a washery at Bayne (about 2 miles from the slope) where it is screened through a revolving screen into 3 sizes. The chestnut and steam sizes are washed in a Forrester washer and then screened and conveyed to a storage bunker.

Note: The present mine will be exhausted shortly. A new slope on the Carbon seam overlying the Bayne seam has been started.
Shipments: By truck and rail.
Production in 1942: 17,148 tons.

Franklin Gem Mine.

Operator: George T. Wake, Jr.
Location: Secs. 7, 18, (27-7E.).
Opened by: Slope, 32° dip, in NE¼ sec. 18.
Seam: Gem; 3 feet; dip 32°.
Method of Mining: Breast and pillar.
Mainhoist: Gas engine.
Lights used: Open.
Underground haulage: Manual tramming.
Ventilation: Sirocco-type exhaust fan, 5,000 C.F.
Preparation: The coal is screened over shaking screen making 4 sizes.
Shipments: By truck.
Production in 1942: 3,979 tons.

McKay Mine.

Operator: Continental Coal Co.
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.
Mainhoist: 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 picking table. The under size 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 1942: 114,224 tons.

New Lake Young Mining Co.

Operator: Dave Culjat.
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.
Mainhoist: Steam.
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 1942: 14,384 tons.

Newcastle King (Old Scalzo Mine).

Operator: R. L. Young.
Location: Sec. 28, (24-5E.).
Opened by: Water level opening in the bottom of a canyon and 38° incline to the top of canyon where bunkers are situated.
Seam: Primrose; 5 feet 6 inches; dip 38°.
Method of Mining: Room and pillar; hand mining with breast augurs.
Mainhoist: 50 H.P. electric.
Lights used: Closed.
Underground haulage: Manual.
Ventilation: Exhaust fan.
Preparation: The raw coal goes over a shaking screen where lump is extracted and hand picked; the undersize is washed and then screened by a trommel screen making 3 sizes.
Shipments: By truck.
Not operating in 1942.

O'Kay Coal Co.

Operators: J. Campbell, R. Whetten, and F. E. Donley.
Location: Sec. 8, (21-7E.).
Opened by: Water level entry on Green River.
Seams: Number 10 Franklin series. 3 seams are worked, a 20-foot, 3-foot, and 4-foot. The seams dip 60°.
Method of Mining: Chute and pillar; drilling with breast augurs.
Mainhoist: Converted automobile engine geared to single drumhoist, pulling car up a 400-foot incline from river level to bunkers.
Lights used: Open.
Underground haulage: Manual tramming.
Ventilation: Natural.
Preparation: The coal is dumped over a shaking screen and is separated into 4 sizes.
Shipments: By truck.
Production in 1942: 1,444 tons.

Palmer Coking Coal Co. (Durham Mine).

Operator: Morris Brothers.
Location: Sec. 2, (21-7E.).
Opened by: Water-level entry, located in NW. corner of section. The entry is on 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.
Mainhoist: Electric, 75 H.P.
Lights used: Closed, electric.
Underground haulage: Mules and some rope haulage.
Ventilation: Sirocco-type exhaust fan, 8,000 C.F.

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 1942: 31,326 tons.

Palmer Coking Coal Co. (Danville Mine).

Operator: Morris Brothers.
Location: Secs. 24, 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.
Mainhoist: 125 H.P. electric.
Lights used: Closed, electric.
Underground haulage: Rope and electric motors.
Ventilation: Sirocco-type exhaust fan, 12,000 C.F.
Preparation: The coal is washed in a one-cell Forrester jig and sized through a revolving screen.
Shipments: Truck and rail. Mine is located ¼ mile from the C. M. St. P. & P. Ry. and ¾ mile from Northern Pac. Ry.
Production in 1942: 28,359 tons.

Renton Mining Co.

Operator: Robert Wilson.
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.
Mainhoist: 125 H.P. 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 buckwheat.
Shipments: By truck.
Production in 1942: 4,856 tons.

Springbrook Mining Co.

Operator: F. D. Plant.
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.
Mainhoist: 70 H.P. electric Lidgerwood.
Lights used: Closed, electric.

Underground haulage: Combination battery and trolley motor.
Ventilation: Exhaust fan 12,000 C.F., 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 1942: 15,250 tons.

Spring Glen Coal Co.

Operator: Chas. Starkovich.
Location: SE¼ sec. 29, (23-5E.).
Opened by: 375 ft. 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.
Mainhoist: Electric, 30 H.P.
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 1942: 8,493 tons.

Strain Coal Co.

Operator: William Strain.
Location: Secs. 25, 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.
Mainhoist: Electric, 200 H.P.
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. Adjacent to the slope, stripping is done on the same seam. A D-7 caterpillar removes the overburden, which averages in thickness between 12 and 14 feet. Vertical holes, 22 feet deep, are then drilled with C.P. jackhammers and shot. The coal is picked up with a ¾-yard Northwest shovel and trucked to the preparation plant. A 75-foot face is carried on the footwall side.
Shipments: By truck.
Production in 1942: 131,753 tons.

Note: The stripping operation was exhausted and closed down during 1943.

PIERCE COUNTY

Apex Coal Co.

Operators: Suman and Rogala.
Location: NW¼ sec. 27, (19-6E.).
Opened by: Water-level entry; also an inside slope.
Seam: No. 4 Wilkeson; 3-foot; dip 58°.
Method of Mining: Chute and pillar; breast augurs.
Mainhoist: 50 H.P. steam hoist on inside slope.
Lights used: Open.
Underground haulage: Manual tramming.
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 1942: 5,531 tons.

East Miller Coal Co.

Operators: Onrufi, Chromoga, and A. Oranto.
Location: SW¼ 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 1942: 6,714 tons.

Gale Creek Coal Co.

Operator: George Savage.
Location: NE¼ 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°.
Method of Mining: Combination chute and panel; electric augur drills.
Mainhoist: Steam donkey; auxiliary slope, 5 H.P. electric.
Lights used: Open.
Underground haulage: Manual.
Ventilation: No. 4 Sirocco on main aircourse, 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 1942: 2,346 tons.

Wilkeson-Wingate Coal Co.

Operators: Lock and Serack.
Location: SW¼ sec. 27, (19-6E.).

Opened by: Water-level entry.
Seam: East dip of No. 4 Wingate; dip 55°-60°.
Method of Mining: Chute and pillar; breast augurs.
Lights used: Open.
Underground haulage: Horse.
Ventilation: Small exhaust fan.
Preparation: The coal is dumped over a fixed-bar screen, making 2 sizes. No further preparation.
Shipments: By truck.
Production in 1942: 3,510 tons.

Wilkeson Mine.

Operator: Wilkeson Products Co.
Location: Secs. 27, 28, 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.
Mainhoist: 400 H.P. 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.
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. At present all the output of this mine is shipped to the company's coke-oven plant at Tacoma.
Production in 1942: Operations started in 1943.

THURSTON COUNTY

Bucoda Coal Mining Co.

Operators: James H. Pascoe, George V. Morris.
Location: Secs. 16, 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 down on a dip of 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 1942: 79,714 tons.

D and F Coal Mining Co.

Operator: John Fusco.
Location: Sec. 18, (15-1E.).
Opened by: Water level 900 feet.
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 1942: Not operating.

Monarch Coal Mining Co.

Operator: George Sheatsly.
Location: Sec. 30, (15-2W.).
Opened by: Slope, located in SW¼SW¼.
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.
Mainhoist: 75 H.P. 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 1¾-inch; all the minus 1¾-inch goes to an im-

proved 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 ¼ mile from both the Northern Pacific Railway and the Chicago, Milwaukee, St. Paul and Pacific Railway.
Production in 1942: 20,345 tons at Kopiah property.

LEWIS COUNTY

Black Prince Coal Co.

Operator: J. G. Parkin.
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, ½ 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 1942: 3,362 tons.

Columbia Coal Co.

Operator: Thomas A. Sweeney.
Location, NW¼ sec. 10, (14-1E.).
Opened by: Slope 240 feet.
Seam: Mendota, 7 feet 6 inches; dip 3°.
Method of Mining: Room and pillar.
Mainhoist: Donkey engine, gas powered.
Lights used: Open.
Underground haulage: Manual.
Ventilation: Exhaust fan.
Preparation: Coal is dumped on a shaker screen and the plus 3-inch taken out. The under 3-inch goes through a revolving screen, but present plan is to crush everything below 3 inches to stoker size. Future plans include installation of a washer.
Shipment: By truck.
Production in 1942: Not operating.

Golden Glow Coal Co.

Operators: H. H. French and L. Howell.
Location: Secs. 22, 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 tramming.
Ventilation: Natural.

Preparation: The coal is dumped over a fixed-bar screen, making 2 sizes. No washing is done.
Shipments: By truck.
Production in 1942: 830 tons.

Majestic Coal Mining Co.

Operator: E. E. Colias.
Location: Secs. 29, 32, (15-2W.).
Opened by: Slope, located in NW¼SW¼ sec. 29.
Seam: Nonpareil; 8 feet 4 inches.
Method of Mining: Room and pillar; breast augurs.
Lights used: Open.
Underground haulage: Electric battery motor.
Ventilation: Exhaust fan, Buffalo electric, 10,440 C.F.
Preparation: The raw coal is dumped over a fixed-bar screen taking out plus 3½-inch size, which is hand picked, the rest goes to a Forrester washer and the product of the washer goes through a revolving screen, making 3 sizes—range, nutpea, and buckwheat.
Shipments: By truck.
Production in 1942: 9,677 tons.

Stoker Coal Mining Co.

Operator: T. E. Martin.
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 1942: 18,721 tons.

Sunburst Coal Co., Inc.

Operators: Dr. C. C. Hale, R. L. Stitt, Edward Husband.
Location: Sec. 12, (14-4E.).
Opened by: 2 tunnels.
Seams: Ladd No. 1, 8 feet; and Ladd No. 2, 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.
Lights used: Closed, electric.
Preparation: The raw coal is dumped on a bar screen taking out the plus 1½-inch size which is hand picked. The minus 1½-inch goes over a Deister table for cleaning and the product of the table is sep-

arated into steam and stoker sizes by a vibrating screen. The plus 1½-inch size is sold as eggnut.
Shipment: By truck.
Production in 1942: Not operating.

KITTITAS COUNTY

Jonesville Coal Co. No. 4.

Operator: Jonesville Coal Co.
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.
Mainhoist: 200 H.P. 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."
Shipments: By truck.
Production in 1942: 8,003 tons.

Lake Mine.

Operators: P. Petrovich, W. B. Johnson, and Teofil Malavy.
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 1942: 1,144 tons.

Roslyn No. 3.

Operator: Northwestern Improvement Co.
Location: Sec. 7, (20-15E.).
Opened by: Slope.
Seams: No. 1 Roslyn, of which 5 feet is taken; and Roslyn No. 5, 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.
Mainhoist: 1,800 H.P. 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.
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 jack hammers for rock work.
Drainage: 2 electrically driven Cameron centrifugal pumps of 250 H.P., handling 600 G.P.M. against 840-foot head.
Shipments: By rail.
Production in 1942: 328,485 tons.

Roslyn No. 5.

Operator: Northwestern Improvement Co.
Location: Sec. 21, (20-15E.).
Opened by: Slope.
Seam: No. 5 Roslyn, 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 on shaking pan conveyors. In some working places where the dip is sharp, planes of about 45° angle are driven.
Mainhoist: 800 H.P. Nordberg, double drum; electric.
Lights used: Closed, electric.
Underground haulage: Electric trolley motors.
Ventilation: Exhaust fan 75,000 C.F.; 30,000 C.F. 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 jack hammers.
Drainage: One 200 H.P. Cameron centrifugal, handling 600 G.P.M. against 700 foot head, and 1 Allis Chalmers 150 H.P., handling 400 G.P.M. against 700-foot head.
Shipments: By rail.
Production in 1942: 176,836 tons.

Roslyn No. 9.

Operator: Northwestern Improvement Co.
Location: Sec. 20, (20-15E.).
Opened by: Slope.
Seam: No. 5 Roslyn, 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 are now being started on the No. 4 side.
Mainhoist: 850 H.P. Allis Chalmers electric.
Lights used: Closed, electric.
Underground haulage: Electric trolley motors.
Ventilation: 2 Sirocco exhaust fans, 130,000 C.F.
Preparation: All raw coal is loaded on railroad cars and taken to a central cleaning plant.
Drainage: 2 Cameron pumps in series, one 240 H.P. handling 600 G.P.M. against 840-foot head, and one 75 H.P. 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 1942: 262,779 tons.

Northwestern Improvement Co., Central Coal-Cleaning Plant, Roslyn.

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 are made by rail.

Roslyn Cascade Coal Co.

Operator: Roslyn Cascade Coal Co.

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

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

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.

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 1942: 110,967 tons.

NEW DEVELOPMENTS

Hi-Way Mine.

Sec. 24, (9-2W.). Cowlitz County.
Raymond Hendrie and Frank Farris are reopening this mine. It is planned to crush the entire production to stoker size.

Harris Mine.

N½S½ sec. 32, (24-6E.). King County.
G. Leahy, Tacoma, is reopening this mine by a new entry under the highway near Issaquah.

New Prospect.

Sec. 18, (21-7E.). King County.
John Klapach and R. Farrow are driving a water level on the No. 10 Franklin seam near Franklin.

New Prospect.

Sec. 26, (21-6E.). King County.
Ole Peterson and Ed S. Johnson are driving a water level on the No. 1 Kummer seam on Green River.

Hyde Mines, Inc.

Sec. 29, (21-7E.). King County.
Sam Hyde is sinking a slope on the No. 12 seam and plans to drive a crosscut to the McKay seam which overlies the No. 12 seam at a horizontal distance of 215 feet. The slopemouth is 300 feet southwest of the center sec. 29.

Coalbank Rapids Mine.

Sec. 30, (10-1E.). Cowlitz County.
Henry Spillman of Silver Lake is reopening this mine. New bunker has been installed. Shipments will be made by truck.

New Prospect.

S½SE¼ sec. 15, (11-1E.). Lewis County.
NE¼S½ sec. 22, (11-1E.). Lewis County.
NE¼NE¼ sec. 28, (11-1E.). Lewis County.
Graham Bros. and Smedley of Chehalis are prospecting on a proposed strip pit.

New Prospect.

Sec. 30 (15-1W.). Lewis County.
Graham Bros. and Smedley of Chehalis are opening a strip pit on the old Royal Mine property.