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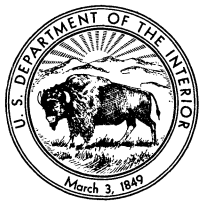
BUREAU OF MINES

ANALYSES OF WASHINGTON COALS

Supplement to Technical Papers 491 and 618

By Joseph Daniels, H. F. Yancey, M. R. Geer, R. F. Abernethy
S. J. Aresco, and F. E. Hartner



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CONTENTS

ILLUSTRATION

ANALYSES OF WASHINGTON COALS

Supplement to Technical Papers 491 and 618 [1]

WASHINGTON COALFIELDS

By Joseph Daniels[2] and H. F. Yancey[3]

THE FIVE principal coalfields of Washington are designated as King County; Kittitas County; Pierce County; southwestern Washington, which includes Thurston, Lewis, and Cowlitz Counties; and northwestern Washington, comprising Whatcom and Skagit Counties. The geographical distribution of the principal coal areas of Washington is shown in figure 1. Detailed information concerning these fields is given in Bureau of Mines Technical Paper 491.[4]

Recent additional information about the King County coalfield was made available by the Federal Geological Survey in 1945 with the issue of a geologic map and a brief description.[5] This map, on a scale of 1 inch=½ mile, shows the mines in the county.

The Federal Geological Survey also has mapped parts of southern Thurston and western Lewis Counties and made geologic studies of the coal areas in this part of the southwestern Washington field. Results of the work were published in 1951.[6] One sheet of the report contains an areal geologic map, composite stratigraphic section, structure sections, and a description of the geology, coal resources, and oil and gas possibilities. The other sheet includes an index map of drill holes, structure contour map of the base of Tono No. 1 bed in the vicinity of Tono, logs of boreholes, and tabulated data on fossil occurrences. It also gives sections and proximate analyses of the major coal beds, estimated total coal reserves, and data on mines in the eastern part of the Centralia-Chehalis district.

Another area in Lewis County east of Toledo, described by Toenges and others of the Bureau of Mines,[7] contains a lignite deposit that attracted considerable interest during World War II as a possible source of strip-mine coal.

Minor deposits occur outside the recognized fields. Some of these have had local interest and were the scene of active prospecting or mining operations on a limited scale. They occur in the following counties: Asotin, Chelan, Clallam, Clark, Columbia, Grays Harbor, Jefferson, Klickitat, Lincoln, Okanogan, Pend Oreille, San Juan, Skamania, Snohomish, Spo-

[1] Work on manuscript completed July 1955. Prepared according to the terms of a cooperative agreement between the Bureau of Mines, United States Department of the Interior, and the School of Mineral Engineering, University of Washington.

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[3] Chief, Division of Solid Fuels Technology, Region I, Bureau of Mines, Seattle, Wash.

[4] Ash, S. H., Yancey, H. F., Kiessling, O. E., Daniels, Joseph, Snyder, N. H., Plein, L. N., Fieldner, A. C., Cooper, H. M., and Osgood, F. D., Analyses of Washington Coals: Bureau of Mines Tech. Paper 491, 1931, 203 pp.

[5] Warren, W. C., Norbisrath, H., Grivetti, R. M., and Brown, S. P., Preliminary Geologic Map and Brief Description of the Coal Fields of King County, Wash.: Geol. Survey, 1945.

[6] Snavely, Parke D., Jr., Roberts, A. E., Hoover, Linn, Jr., and Pease, M. H., Jr., Geology of the Eastern Part of the Centralia-Chehalis Coal District, Lewis and Thurston Counties, Wash.: Geol. Survey Coal Investigations, Map C8, 1951.

[7] Toenges, Albert L., Turnbull, Louis A., and Cole, Willard A., Exploration, Reserves, Bed Characteristics, and Strip-Mining Possibilities of a Lignite Deposit Near Toledo, Lewis County, Wash.: Bureau of Mines Tech. Paper 699, 1947, 55 pp.

FIGURE 1. Principal Coal Areas of Washington, Showing Rank of Coal According to American Society for Testing Materials Classification.

kane, Stevens, and Yakima. Although the major coal-producing areas occupy a belt in western Washington along the west flank of the Cascade Mountains from the Canadian boundary to the Columbia River and along the east flank of the Cascades in Kittitas County, central Washington, and are largely Eocene in age, the minor occurrences generally are associated with Miocene and Oliogocene strata along the Pacific Ocean and the Straits of Juan de Fuca. The distribution of these formations is shown on a geologic map included in a report on the geology of Washington.[8]

Early descriptions of the ranks of coal do not conform with the classification used today; hence, the rank of the minor occurrences cannot always be determined. However, it appears that lignites are present in certain localities, that subbituminous rank predominates, and some anthracites have been observed. Until such time as modern methods of sampling and analysis are employed in evaluating these deposits, the early reports can be interpreted only broadly. A brown lignite occurs in glacial deposits near Auburn in King County, and another lignite is reported in the Grand Ronde River area of Asotin County. The bed at Reliance mine in Lewis County was definitely classified as lignite in 1938. The anthracites and semianthracites usually are found in highly tilted sedimentaries close to the Cascade Mountains in Whatcom, Lewis, and Yakima Counties; however, a semianthracite also occurs on Orcas Island in San Juan County. In the northeastern part of King County, away from major coalfields, an occurrence of carbonaceous lenses that have been altered to an impure graphitic material is reported.

Further information on the minor coal areas is given in two bulletins of the Washington Division of Mines and Geology.[9] [10]

COKING COALS

The deposits of coking coal in Washington are important because they are the only known occurrence on the Pacific Coast. These deposits are found in Whatcom, Skagit, King, Pierce, and Lewis Counties along the western flank of the Cascade Mountains and in western Kittitas County along the eastern flank. The deposits usually are associated with steeply dipping beds in areas of marked metamorphism.

Pierce County coals of the Wilkeson-Carbonade-Fairfax district and their extension into the Ashford district of northern Lewis County constitute the most important known coking-coal reserve on the Pacific slope. Although not so strongly coking as those of Pierce County, some of the coals of the western Roslyn field of Kittitas County are also suitable for blending with other coals lower in volatile-matter content. The reserves of the most productive bed—the Roslyn—are limited, and other beds are also now being mined.

Many analyses of coking coals are given in Technical Papers 491[11] and 618.[12] The Bureau of Mines and others have published reports covering field and laboratory studies of the coking coals, coking processes, and the properties of the cokes produced in laboratory tests and under operating conditions.[13]

The carbonizing properties of three Washington coals recently investigated by the Bureau of Mines are reported in Bulletin 510.[14] Two of the samples came from Nos. 2 and 3 beds, Wilkeson mine, Wilkeson, Pierce County, and one from No. 5 bed, Roslyn No. 3 mine, Roslyn, Kittitas County. Analyses, plastic properties, free-swelling indexes, and agglutinating values of the separate coals, together with data on yields of carbonization products and properties and analyses of cokes made singly and in blends, are given in detail. The investigation yielded considerable information about the

[8] Culver, Harold E., The Geology of Washington. I. General Features of Washington Geology (to accompany the preliminary geologic map, 1936): Washington Div. of Geol., Bull. 32, 1936, 70 pp.

[9] Glover, Sheldon L., Nonmetallic Mineral Resources of Washington With Statistics for 1933: Washington Div. Geol., Bull. 33, 1936, pp. 29–30.

[10] Valentine, Grant M., Inventory of Washington Minerals. I. Nonmetallic Minerals: Washington Div. Mines and Geol., Bull. 37, 1949, pp. 25–27.

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[13] Belden, A. W., Delameter, R. G., Groves, J. W., and Way, K. M., Washing and Coking Tests of Coal at the Fuel-Testing Plant, Denver, Colo., July 1, 1908, to June 30, 1909: Bureau of Mines Bull. 5, 1910, 62 pp.

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Daniels, Joseph, The Coking Industry of the Pacific Northwest: Univ. Washington Eng. Exp. Sta., Bull. 9, 1920, 36 pp.

[14] Davis, J. D., Reynolds, D. A., Brewer, R. E., Naugle, B. W., Wolfson, D. E., Gibson, F. H., and Birge, G. W., Carbonizing Properties: British Columbia, Matanuska Valley (Alaska), and Washington Coals and Blends of Six of Them With Lower Sunnyside (Utah) Coals: Bureau of Mines Bull. 510, 1952, 42 pp.

TABLE 1.—*Summary of methods of mining coal underground in Washington, 1940–52*

Year	Cut by hand		Shot from the solid		Cut by machines				Hand loaded		
	Net tons	Total product, percent	Net tons	Total product, percent	Net tons	Number of coal-cutting machines in use	Average output per machine, net tons	Total product, percent	Net tons	Total underground mining, percent	Grand total of State, percent
1940	217,797	13.3	647,920	39.7	768,675	49	15,687	47.0	838,898	51.3	50.8
1941	244,548	13.4	626,537	34.2	958,074	52	18,425	52.4	810,767	44.3	44.0
1942	224,971	11.7	680,487	35.6	1,008,240	58	17,383	52.7	888,485	46.4	45.5
1943	144,041	9.6	641,997	42.8	714,372	57	12,533	47.6	649,691	43.3	42.5
1944	137,121	9.4	625,047	42.7	701,547	62	11,315	47.9	629,440	43.0	41.3
1945	94,444	7.8	537,137	44.6	573,852	58	8,894	47.6	502,803	41.7	37.0
1946	91,084	10.2	387,390	43.3	415,097	57	7,282	46.5	420,574	47.1	42.4
1947	125,690	13.6	363,348	39.5	432,035	53	8,152	46.9	397,993	43.2	35.6
1948	118,650	12.4	333,001	34.7	507,650	45	11,281	52.9	317,850	33.1	26.1
1949	101,850	13.1	254,679	32.8	420,784	46	9,147	54.1	249,079	32.0	27.7
1950	83,299	10.4	237,460	29.5	482,690	46	10,493	60.1	253,319	31.5	29.0
1951	56,074	7.2	220,242	28.1	506,759	41	12,360	64.7	199,215	25.4	23.2
1952	2,387	.3	199,870	27.3	531,182	38	13,978	72.4	119,962	16.4	14.2

potentialities of these Washington coals and their cokes for future utilization as blends with other western supplies.

MECHANIZATION

UNDERGROUND

The mining methods used in Washington were described in Bureau of Mines Technical Paper 491 [15] and remain the same in general except as modified by changes in mechanization. Many of the beds mined lie on steep dips; consequently, the complete mechanization common in flat beds is difficult to achieve. Progress, however, continues in many places, particularly in Kittitas County, which is the leading producer of coal by mechanized methods. A continuous mining machine was installed in 1951, followed by 3 others, making a total of 4 in this field. A rotary boring machine developed by one operator for experimental use in driving chutes and crosscuts is described in Coal Age, May 1951, pages 101 to 105. Another machine of different design was installed at a King County mine to bore chutes in a vertical bed.

In 1952 a continuous mining machine was placed in operation in the Bellingham area of Whatcom County, making a total of five for the State. Mobile loading machines and shuttle cars also have been introduced in King County.

Summaries of the reports by operators on methods of recovery, mining practices, and loading have been prepared from Minerals Yearbooks of the Bureau of Mines. Table 1 gives data on coal mined and loaded by different methods.

Of the coal produced by underground methods, the quantity cut by hand has decreased from 13.3 percent in 1940 to 7.2 percent in 1951 and 0.3 percent in 1952; coal shot from the solid has decreased from 39.7 percent in 1940 to 27.3 percent in 1952; coal cut by machines has increased from 47.0 percent of the production of underground mines in 1940 to 72.4 percent in 1952. Thus, the trend is away from hand mining and shooting from the solid toward machine cutting. A similar trend is shown in loading of coal. In 1940 the percentage of hand-loaded coal from underground mining was 51.3; in 1952 the figure had dropped to 16.4. In the Roslyn field, shearing machines and shortwall undercutters are commonly employed but in western Washington generally are not used.

MECHANICAL LOADING

Details of mechanical loading underground are given in table 2. Since 1940 many changes have taken place in the types of equipment used. Eleven mines in 1952 reported use of machines for loading and moving coal; hand-loaded conveyors predominated. Only one mobile loading machine and no pit-car loaders were used; scrapers are gaining favor for driving counter-airways in steep beds.

Mines using both loading machines and conveyors contribute the largest proportion of coal moved, particularly since continuous-mining machines have been installed. Since annual production in the State has decreased during recent years, the tonnages moved do not reveal the percentage increase in the proportion of coal moved in the larger producing mines.

The usual method of underground haulage in Washington is by electric locomotives; 43 were in use in 1936. In 1952, 42 trolley and 5 storage-battery types were reported. Two cable-reel shuttle cars were in use.

STRIP MINING

Strip mining in Washington is difficult owing to the dip of the coal beds, mountainous topography, dense forest growth, and heavy cover of

[15] Work cited in footnote 4, p. 1.

TABLE 2.—*Mechanical loading underground in Washington coal mines, 1940–52*

Year	Mines using loading machines only [1]	Mines using conveyors only [2]	Mines using both loading machines and conveyors	Total	Mobile loading machines	Continuous mining machines	Scrapers	Conveyors equipped with duckbills and other loading devices	Hand-loaded conveyors
1940	4	7		11	1		1	8	75
1941	4	7		11	1			8	82
1942	4	7		11	1		1	11	85
1943	4	6	1	11	2			14	86
1944	5	8	1	13	2		1	11	89
1945	3	5	4	12	1		4	8	92
1946	1	4	5	10	1		5	4	91
1947	5	2	2	9	1		6	8	89
1948	3	3	4	10			9	6	86
1949	3	2	4	9			7	6	85
1950	4	2	3	9	1		8	6	84
1951	4	2	3	9	1		6	9	84
1952	5	1	5	11	1	5	8	9	87

Year	Production mechanically loaded, net tons—			Total underground production at mines using mechanical loading devices, net tons			
	By machines [1]	By conveyors [2]	Total	Loading machines only [1]	Conveyors only [2]	Both loading machines and conveyors	Total
1940	62,000	733,494	795,494	321,436	767,610		1,089,046
1941	94,760	923,632	1,018,392	385,441	932,559		1,318,000
1942	86,698	938,515	1,025,213	358,593	959,662		1,318,255
1943	158,290	692,429	850,719	287,000	718,828	14,376	1,020,204
1944	134,926	699,349	834,275	240,118	720,107	39,744	999,969
1945	103,393	599,237	702,630	93,252	220,559	510,983	824,794
1946	59,415	413,582	472,997	19,415	122,485	369,920	511,820
1947	101,777	421,303	523,080	48,629	46,644	449,481	544,754
1948	139,189	502,262	641,451	81,662	62,230	527,932	671,824
1949	89,848	438,386	528,234	45,848	45,102	438,236	529,186
1950	101,690	448,440	550,130	45,289	71,461	449,543	566,293
1951	124,598	459,262	583,860	78,774	28,615	496,242	603,631
1952	251,903	361,574	613,477	63,329	6,205	551,291	620,825

[1] Includes those mines in which all the tonnage mechanically loaded was obtained with machines that substantially eliminated hand shoveling, that is, mobile loaders, scrapers, and conveyors equipped with duckbills and other self-loading heads. Some mines in this class also use conveyors in conjunction with mobile loaders to perform initial phase of transportation.

[2] Includes those mines in which all the tonnage mechanically loaded was obtained with hand-loaded conveyors. No pit-car loaders are used in Washington.

glacial material. The first important stripping operation was begun in 1939 on the Bagley bed at Newcastle, King County. Demands for cheaper coal to meet wartime needs stimulated interest and in 1943 led to the development of other open-pit operations in King and Kittitas Counties. These operations and the strip mines in Lewis and Thurston Counties continue to supply a significant part of the State output. As shown in table 3, they reached a maximum of 21.4 percent in 1948, when 260,602 tons was produced. Production of strip coal has aggregated 1,222,990 tons since 1941.

The strip mines necessarily are small operations. In King County most of the beds dip 35° or more. Stripping thus is restricted to outcrops. Moreover, the limited demand for coal does not permit the use of the large-scale equipment required in stripping economically to any great depth. In Kittitas County areas of outcrop coal and old pillars under shallow cover have been stripped in localities where the dip of the bed is about 10°. The quantity of such coal is limited, however.

Only in the southwestern Washington field are there sizable areas of relatively flat coal amenable to stripping on a large scale. One such deposit was explored by the Bureau of Mines.[16] Apparently, Washington will not supply a large ton-

[16] Work cited in footnote 7, p. 1.

nage of strip coal, but some of the subbituminous beds of low dip in Thurston and Lewis Counties and the Toledo lignite area in Lewis County are potential sources.

TABLE 3.—*Production from strip-mine operations in Washington, 1932–52* [1]

COUNTIES

Year	Number of strip pits				Production, net tons				Average number of days mines were active				Average tons per man per day			
	King	Kittitas	Lewis	Thurston	King	Kittitas	Lewis	Thurston	King	Kittitas	Lewis	Thurston	King	Kittitas	Lewis	Thurston
1932			1													
1940	1				15,960											
1941	1				12,115											
1942	1				39,511											
1943	1	1			14,588	12,546			80	66			15.20	15.92		
1944	2	2	1		7,195	49,878	3,353		152	183	38		5.26	12.97	8.02	
1945	4	2			63,398	88,413			104	252			7.63	7.17		
1946	4	[1] 4			41,683	[2] 55,873			133	[2] 156			8.47	[2] 5.52		
1947	4	2		2	115,466	60,589		20,798	184	214		152	9.83	6.92		5.71
1948	4	2		1	152,041	86,571		21,990	229	207		165	9.63	8.71		8.91
1949	4	1		1	58,051	37,889		25,793	150	161		88	7.91	7.35		9.73
1950	2	1		1	11,449	37,819		21,272	231	213		104	6.19	8.44		8.91
1951	2	1		1	32,544	31,339		10,068	163	180		66	6.06	8.71		10.90
1952	2	2		1	43,185	64,496		3,077	157	176		21	8.88	10.45		10.47

STATE

Year	Total number of strip pits	Average number of men working daily	Average number of days mines were active	Average tons per man per day	Average value per ton, f. o. b. mines	Production, net tons	Percent of total State production
1932	1					961	
1940	1					15,960	1.0
1941	1	6				12,115	.7
1942	1	5				39,511	2.0
1943	2	21	73	15.52		27,134	1.8
1944	5	33	137	10.73		60,426	4.0
1945	6	100	162	7.35	[3] $4.98	151,811	11.2
1946	8	69	148	6.48	5.09	97,556	9.8
1947	8	97	187	8.15	5.12	196,853	17.6
1948	7	102	214	9.24	5.56	260,602	21.4
1949	6	111	136	8.04	6.14	121,733	13.5
1950	4	52	168	8.09	6.12	70,540	8.1
1951	4	67	148	7.48	7.19	73,951	8.6
1952	5	80	142	9.77	6.91	110,758	13.1

[1] Compiled from Bureau of Mines Minerals Yearbook.
[2] Includes Thurston County.
[3] Power strip mines only. Value received or charged for coal, f. o. b. mine, including selling cost.

COAL WASHING AND PREPARATION

By M. R. Geer [1]

Mechanical cleaning was introduced in Washington in 1886, and in 1952 the State still led all others in the percentage production cleaned mechanically. This percentage amounted to 97.3 in 1952, compared to the national average of 48.7.[2] The early adoption of mechanical cleaning and its wide application are attributed in part to the occurrence of interbedded impurities in many of the coals. A more cogent reason, however, is the inclination of many of the beds. In steeply pitching beds hand sorting at the face is impossible; consequently, the entire cleaning operation must take place on the surface. Thus, physical factors have always necessitated "full seam" mining, and this, whether required by physical factors or induced by mechanization, stimulates the trend toward mechanical cleaning.

The principal statistics on mechanical cleaning for the period 1940–52 are given in table 4. Average annual production for the 10-year period 1940–49 was 1,206,703 tons of clean coal from 20 plants; 16.6 percent of the raw coal was rejected as refuse. In the decade from 1943 to 1952 the annual production averaged 1,210,973 tons, a slight increase; the ratio of refuse to raw coal rose to 19.4 percent. Shipments of lump coal from mines having cleaning plants average less than 7 percent of their total sales. In fact, the market for lump sizes of Washington coal has been so reduced that some mines crush their entire production of lump coal. Even crushing of Egg and Nut sizes to supplement the natural production of smaller sizes is required at some operations.

The schedule of sizes produced in the State is not burdensome in comparison with that required by the market in many areas. With few exceptions, lump is prepared on a round-hole screen of 3- or 4-inch size. Egg ranges from this size to 1⅝ or 1½ inches and Nut from 1⅝ or 1½ inches to either 1 or ¾ inch. Some mines screen no finer than ¾ inch and market a slack coal of that top size, but generally the coal is screened at about ¼ inch to give a stoker coal of ¾ or 1 to ¼ inch and a Buckwheat of ¼ inch to 0. Washed slack coal of ¾, 1⅝, or 3 inches top size often is shipped.

ROSLYN-CLE ELUM FIELD

Mechanical cleaning was not adopted in the Roslyn-Cle Elum field until 1935, when mining on steeper pitches and the introduction of

[1] Mining engineer, Division of Solid Fuels Technology, Region I, Bureau of Mines, Seattle, Wash.

[2] Young, W. H. Anderson, R. L., and Hall, E. M., Bituminous Coal and Lignite in 1952: Bureau of Mines Min. Market Rept. 2222, Oct. 13, 1953, p. 55.

TABLE 4.—*Coal cleaned mechanically in Washington by wet methods, 1940–52, net tons*

Year	Plants in operation	Raw coal moved to cleaning plants [1]	Coal obtained in cleaning process	Refuse resulting in cleaning process [1]	Ratio of refuse to raw coal	Production from mines that moved coal to cleaning plants [2]	State output cleaned mechanically, percent
1940	18	1,599,221	1,362,856	236,365	14.8	1,491,793	82.6
1941	21	1,874,768	1,632,427	242,341	12.9	1,728,864	88.7
1942	21	2,003,754	1,726,599	277,155	13.8	1,875,274	88.4
1943	23	1,569,149	1,347,160	221,989	14.1	1,461,741	88.2
1944	22	1,505,652	1,254,605	251,047	16.7	1,341,965	82.3
1945	20	1,363,774	1,114,360	249,414	18.3	1,207,045	82.1
1946	21	1,032,401	816,465	215,936	20.9	893,056	82.4
1947	19	1,209,200	954,734	254,466	21.0	1,015,285	85.4
1948	20	1,307,423	1,055,749	251,674	19.2	1,113,343	86.5
1949	19	1,001,507	802,071	199,436	19.9	829,786	89.2
1950	17	983,852	781,346	202,506	20.6	799,748	89.4
1951	17	1,034,477	809,619	224,858	21.7	833,008	94.5
1952	16	1,102,298	821,788	280,510	25.4	824,530	97.3

[1] Exact figures on raw coal or refuse could not be furnished by many operators; in such instances estimates were made from available information at hand.

[2] Based upon shipping weights; includes some marketable coal that did not pass through cleaning plants.

mechanical loading in the flatter areas had progressed to a point where the quantities of impurity hoisted with the coal were excessive. In that year cleaning plants were built by the two principal operating companies. Production in this field comes from the Roslyn, Big, and No. 6 beds. The Roslyn bed, which is the principal one, is relatively clean, and the coal is only moderately difficult to wash. Both the No. 6 and the Big beds are characterized by higher inherent ash content and by more material of intermediate density. Thus, the coal is more difficult to wash to the the ash content obtainable from the Roslyn bed.

Virtually no lump is produced in this field; coal coarser than 3 inches is crushed and cleaned with the natural slack. Jigs, supplemented by tables for the fine coal, are the principal cleaning units. Since freezing of shipments is a problem during the winter, both centrifugal and heat drying are practiced. One plant employs a refuse re-treatment circuit.

WESTERN WASHINGTON FIELDS

One of the principal beds that has been mined in King County for years has an inherent ash content of less than 3 percent and contains only a moderate amount of intermediate-density material. However, many of the other beds of western Washington, particularly the coking coals of Pierce County, are more difficult to wash to the ash content demanded by the market.

Except for one plant using the heavy-medium process and another employing a Baum-type jig, all of the coal washed in the western Washington fields is cleaned in piston jigs, and the plants using these jigs have almost identical flowsheets. Lump is produced by screening at 3-inch size on shakers; the undersize goes to jigs. The oversize is handpicked, and the clean lump may either be loaded or crushed and added to the natural 3-inch slack. Washed coal is sized on a revolving screen into Egg, Nut, Stoker, and Buckwheat. Freezing of shipments is not a problem in the market areas available to these coals, and no driers are used.

The Northwest Experiment Station of the Bureau of Mines at Seattle has published considerable information on the preparation of Washington and other coals; in addition to the references listed here,[3] others are listed in Bureau of Mines Technical Papers 491 [4] and 618.[5]

[3] Geer, M. R., Davis, Franklin, T., and Yancey, H. F., Occurrence of Phosphorus in Washington Coal and Its Removal: AIME Tech. Pub. 1586, 1943, 8 pp.; Trans. AIME, vol. 157, 1944, pp. 152–159.
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Geer, M. R., Olds, W. A., and Yancey, H. F., Cleaning Various Coals in a Drum-Type, Dense-Medium Pilot Plant: Trans. AIME, vol. 196, 1953, pp. 696–705.

[4] Ash, S. H., Yancey, H. F., Kiessling, O. E., Daniels, Joseph, Snyder, N. H., Plein, L. N., Fieldner, A. C., Cooper, H. M., and Osgood, F. D., Analyses of Washington Coals: Bureau of Mines Tech. Paper 491, 1931, 203 pp.

[5] Yancey, H. F., Geer, M. R., Daniels, Joseph, Snyder, N. H., Swingle, R. J., Cooper, H. M., and Abernethy, R. F., Analyses of Washington Coals, Supplement to Tech. Paper 491: Bureau of Mines Tech. Paper 618, 1941, 81 pp.

PRODUCTION, DISTRIBUTION, AND USE

By Joseph Daniels [1]

Production of coal from the earliest record of mining operations in Washington to the close of 1952 was estimated at 145,024,000 tons. Technical Papers 491 and 618 present the statistical picture of production, distribution, and use to the end of 1939. Most of the figures and tabulations in the present report have been assembled from data published in Minerals Yearbooks and in Mineral Market Reports of the Bureau of Mines. Unless otherwise indicated, Minerals Yearbook is the source. Statistical data dealing with bituminous coal and lignite have been limited to mines producing more than 1,000 tons a year; consequently, information about many small mines in Washington is not included in the Minerals Yearbook data. In these instances, the annual reports of the State Inspector of Coal Mines may be consulted. However, Minerals Yearbooks for 1942, 1943, 1944, and 1945 contain summarized data dealing with the small mines.

PRODUCTION AND VALUE

Annual production since 1939 has reflected the economic changes resulting from both domestic and international conditions. Table 5 gives production, value, employment, days active, man-days, and output per man per day in 1940–52, by counties. The trend in production during this period has been downward, the 844,197 tons mined in 1952 amounting to less than half of the production recorded for 1942. The value of the coal at the mine has increased steadily; it doubled during the period 1940–48 and reached a high of $7.12 in 1952. Tons per man-day followed a varied pattern from 1940 to 1949, ranging between the limits of 3.20 and 4.13. Since 1949 the trend has been steadily upward, reaching a peak of 4.30 in 1952.

The average number of employees declined from 2,325 in 1940 to 888 in 1952. The average number of days that mines were active ranged from 188 in 1940 to a maximum of 293 in 1944, followed by declines to 211 in 1946 and 194 in 1949—years in which strikes occurred. The number of active days reported for 1950, 1951, and 1952 were 201, 211, and 221, respectively; corresponding figures for the number of man-days worked were 590,508 in 1942, 201,771 in 1951, and 196,509 in 1952.

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PRODUCTION BY RANK

Every rank of coal from lignite to anthracite occurs in Washington, but current production is limited to bituminous and subbituminous. The major production is bituminous coal from King, Kittitas, Pierce, and Whatcom Counties. Production of subbituminous coal from King, Lewis, and Thurston Counties is secondary in amount. As shown in table 6, it ranged from 24 to 33 percent of the State production during the decade 1940–50 but by 1952 had decreased to 13 percent. The major production of subbituminous coal comes from King County and has constituted 37 to 76 percent of the entire county output. The entire production of Thurston County and nearly the entire production of Lewis County is subbituminous in rank, but these 2 counties contribute only 5 to 10 percent of the total State output.

SIZE OF MINES

The shrinkage in production during the past decade is reflected in changes in number and size of mines. Mines open and close with fluctuating market conditions, but the trend in number of operating mines has been definitely downward. Every county in the State has registered losses in the number of mines, many of which had been important producers for years.

Table 7 summarizes the changes that have taken place in recent years in the number and size of mines. The trend toward fewer mines and the increase in percentage of small mines of low output were noted in previous publications. Technical Paper 618 reports 75 producing mines in 1939 under the jurisdiction of the State mine inspector; in 1952 the figure was 22. In 1940, 48 mines made reports to the Bureau of Mines; in 1952 the number had declined to 25. The larger mines have shifted positions from class 1B to class 2 or class 3, and the number of mines in the lower classifications—10,000 to 50,000 and under 10,000 tons—declined in 1952 to a total of 21. Information about production of individual mines can be obtained

TABLE 5.—*Production, value, employment, days active, man-days, and output per man per day at coal mines in Washington, 1940–52*

County	Disposition of coal produced, net tons				Average number of employees								
								Surface					
	Loaded for shipment by rail or water [1]	Shipped by truck or wagon, excluding coal used by mine employees	Used by mine employees, taken by locomotive tenders at tipple, or otherwise used at mine [2]	Used at mine for heat	Total quantity	Average value per ton [3]	Underground	In strip pits	All others	Total	Average number of days mines were active	Number of man-days worked	Average tons per man per day
1940													
King	320,875	265,265	5,379	489	592,008	$3.41	667	5	190	862	214	184,493	3.21
Kittitas	690,779	23,482	36,839	9,885	760,985	2.94	738	.....	207	945	186	176,060	4.32
Lewis	9,765	27,988	95	371	38,219	2.57	39	.....	7	46	202	9,274	4.12
Pierce	23,107	15,028	381	70	38,586	3.49	57	.....	9	66	189	12,493	3.09
Other counties (Thurston and Whatcom)	174,566	41,844	1,307	2,837	220,554	3.32	337	.....	69	406	134	54,210	4.07
Total	1,219,092	373,607	44,001	13,652	1,650,352	3.16	1,838	5	482	2,325	188	436,530	3.78
1941													
King	344,294	289,325	5,070	542	639,231	3.76	694	6	156	856	228	195,228	3.27
Kittitas	821,626	23,425	79,511	11,005	935,567	3.37	730	.....	209	939	241	226,228	4.14
Lewis	6,629	27,974	90	312	35,005	2.74	27	.....	6	33	197	6,514	5.37
Pierce	7,069	13,001	132	24	20,226	4.29	20	.....	4	24	229	5,503	3.68
Other counties (Thurston and Whatcom)	159,883	46,992	1,161	3,209	211,245	3.51	241	.....	67	308	158	48,656	4.34
Total	1,339,501	400,717	85,964	15,092	1,841,274	3.52	1,712	6	442	2,160	223	482,129	3.82
1942													
King	251,271	374,227	3,847	436	629,781	4.41	647	5	159	811	270	219,043	2.88
Kittitas	854,274	36,061	49,071	11,844	951,250	3.57	739	.....	230	969	283	273,892	3.47
Lewis	9,439	42,023	106	301	51,869	3.09	45	.....	9	54	287	15,019	3.45
Pierce	6,566	20,334	194	65	27,159	4.20	26	.....	6	32	258	8,266	3.29
Other counties (Thurston and Whatcom)	213,286	74,400	1,674	3,790	293,150	3.75	232	.....	56	288	258	74,288	3.95
Total	1,334,836	547,045	54,892	16,436	1,953,209	3.87	1,689	5	460	2,154	274	590,508	3.31
1943													
King	164,305	330,604	3,027	99	498,035	5.01	425	12	128	565	278	156,849	3.18
Kittitas	622,222	41,875	42,712	10,822	717,631	4.06	531	9	215	755	291	219,754	3.27
Lewis	6,857	44,260	163	240	51,520	3.83	49	.....	9	58	256	14,867	3.47
Pierce	16,286	14,287	266	79	30,918	4.81	67	.....	20	87	202	17,562	1.76
Thurston	36,361	27,910	501	.....	64,772	4.03	40	.....	11	51	289	14,760	4.39
Whatcom	121,905	37,939	1,132	3,692	164,668	4.34	114	.....	33	147	283	41,663	3.95
Total	967,936	496,875	47,801	14,932	1,527,544	4.41	1,226	21	416	1,663	280	465,455	3.28
1944													
King	160,217	294,671	2,913	5	457,806	5.41	408	9	114	531	293	155,431	2.95
Kittitas	657,087	30,670	38,764	12,664	739,185	4.57	504	16	193	713	300	214,147	3.45
Lewis	30,731	51,497	309	120	82,657	4.20	76	8	19	103	248	25,511	3.24
Pierce	39,398	9,352	162	40	48,952	5.37	83	.....	14	97	268	25,954	1.89
Thurston	45,445	14,086	422	.....	59,953	3.58	36	.....	11	47	302	14,186	4.23
Whatcom	98,199	32,981	732	3,676	135,588	5.02	105	.....	29	134	303	40,536	3.34
Total	1,031,077	433,257	43,302	16,505	1,524,141	4.83	1,212	33	380	1,625	293	475,765	3.20
1945													
King	179,852	256,481	2,671	155	439,159	5.66	356	65	109	530	260	137,956	3.18
Kittitas	595,415	29,851	20,029	10,687	655,982	4.91	384	35	162	581	286	166,350	3.94
Lewis	10,323	58,392	349	45	66,109	4.32	65	.....	11	76	282	21,451	3.22
Pierce	8,201	7,955	120	24	16,300	5.52	16	.....	2	18	236	4,244	3.84
Thurston	54,318	8,621	436	.....	63,375	3.44	37	.....	9	46	231	10,626	5.96
Whatcom	70,854	37,790	903	3,772	113,319	5.56	93	.....	31	124	285	35,318	3.21
Total	918,963	399,090	24,508	14,683	1,357,244	5.12	951	100	324	1,375	273	375,945	3.61

1946													
King	143,645	168,029	2,029	191	313,894	5.90	343	28	114	485	190	92,389	3.40
Kittitas	393,077	22,981	17,418	9,200	442,676	5.24	372	32	199	603	223	134,340	3.30
Lewis	7,231	49,228	217		56,676	4.69	61		12	73	210	15,353	3.69
Pierce	7,598	6,748		23	14,369	5.94	17		4	21	213	4,466	3.22
Thurston	42,834	7,363		410	50,607	3.72	29	9	17	55	176	9,357	5.24
Whatcom	63,840	45,159	749	3,157	112,905	6.26	104		32	136	244	33,213	3.40
Total	658,225	299,508	20,413	12,981	991,127	5.47	926	69	378	1,373	211	289,418	3.42
1947													
King	185,376	151,420		[4] 1,162	337,958	5.88	259	44	115	418	216	90,379	3.74
Kittitas	460,331	22,850		19,089	502,270	6.12	382	33	166	581	257	149,339	3.36
Lewis	11,538	33,554		213	45,305	4.65	33		9	42	203	8,511	5.32
Pierce	14,175	5,235		58	19,468	6.46	19		6	25	212	5,298	3.37
Thurston	44,246	12,230		449	56,925	3.95	29	20	13	62	172	10,680	5.33
Whatcom	135,395	16,709		3,896	156,000	6.85	118		33	151	263	39,760	3.92
Total	851,061	241,998		24,867	1,117,926	5.99	840	97	342	1,279	238	303,967	3.68
1948													
King	187,157	164,619		[4] 1,492	353,268	6.29	251	48	85	384	223	85,620	4.13
Kittitas	562,013	18,414		17,474	597,901	6.70	402	41	146	589	243	143,022	4.18
Lewis	5,121	47,981		223	53,325	4.95	54		10	64	192	12,263	4.35
Pierce	14,580	3,521		90	18,191	7.10	20		4	24	219	5,244	3.47
Thurston	58,623	1,997		358	60,978	4.54	34	13	10	57	157	8,949	6.81
Whatcom	114,446	14,742		7,052	136,240	7.29	126		35	161	248	39,926	3.41
Total	941,940	251,274		26,689	1,219,903	6.47	887	102	290	1,279	231	295,024	4.13
1949													
King	76,213	141,963		819	218,995	6.80	199	32	76	307	186	57,093	3.84
Kittitas	427,377	16,222		15,074	458,673	6.74	397	28	156	581	213	124,004	3.70
Lewis		45,581			45,581	5.43	44		6	50	184	9,185	4.96
Pierce	5,755	2,637		145	8,537	7.09	14		3	17	147	2,495	3.42
Thurston	42,762	742		131	43,635	4.83	32	26	9	67	85	5,721	7.63
Whatcom	107,447	13,544		2,634	123,625	7.53	133		36	169	194	32,853	3.76
Total	659,554	220,689		18,803	899,046	6.71	819	86	286	1,191	194	231,351	3.89
1950													
King	82,803	93,305		485	176,593	6.94	189	8	71	268	175	46,870	3.77
Kittitas	491,121	14,641		14,747	520,509	6.65	403	19	149	571	229	130,824	3.98
Lewis		47,684			47,684	5.36	36		5	41	215	8,796	5.42
Pierce	3,858	2,533		98	6,489	6.91	10		2	12	142	1,707	3.80
Thurston	24,540	1,321		111	25,972	4.78	23	20	8	51	61	3,136	8.28
Whatcom	77,998	13,280		5,514	96,742	7.39	121		35	156	187	29,107	3.32
Total	680,320	172,714		20,955	873,989	6.67	782	47	270	1,099	201	220,440	3.96
1951													
King	106,205	85,802		279	192,286	7.40	138	24	48	210	211	44,399	4.33
Kittitas	512,606	12,561		12,931	538,098	7.08	452	17	89	558	241	134,629	4.00
Lewis	1,404	43,332		110	44,846	5.45	30		6	36	213	7,673	5.84
Pierce	4,507	2,164		54	6,725	7.09	7		2	9	176	1,584	4.25
Thurston	9,956	112			10,068	4.44		12	2	14	65	924	10.90
Whatcom	55,344	7,093		2,566	65,003	7.08	97		32	129	97	12,562	5.17
Total	690,022	151,064		15,940	857,026	7.04	724	53	179	956	211	201,771	4.25
1952													
King	101,220	86,347		1,949	189,516	7.33	128	25	41	194	203	39,358	4.82
Kittitas	563,109	10,748		14,304	588,161	7.12	450	30	91	571	246	140,264	4.19
Lewis		33,968			33,968	6.32	29		5	34	179	6,079	5.59
Pierce	1,103	2,307			3,410	6.68	3		2	5	148	741	4.60
Thurston	4,866	690			5,556	4.21	17	12	7	36	21	747	7.44
Whatcom	18,045	2,929		2,612	23,586	6.38	26		22	48	194	9,320	2.53
Total	688,343	136,989		18,865	844,197	7.09	653	67	168	888	221	196,509	4.30

[1] Includes coal loaded at mine directly into railroad cars or river barges, hauled by truck to railroad siding for shipments by rail, and hauled by truck to waterway for shipment by water.

[2] Includes coal transported from mines to points of use by conveyor or tram.

[3] Value received or charged for coal, f. o. b. mine, including selling cost (includes a value for coal not sold but used by producer, such as mine fuel and coal coked—not coke—as estimated by producer at average prices that might have been received if such coal had been sold commercially).

[4] Includes coal used by mine employees, taken by locomotive tenders at tipple, used at mine for power and heat, transported from mine to point of use by conveyor or tram, and all other uses at mine.

TABLE 6.—*Subbituminous coal produced in Washington, 1940–52* [1]

Year	King County			Lewis County		Thurston County		State	
	Tons	Percent of State output of coal	Percent of King County output	Tons	Percent of State output of coal	Tons	Percent of State output of coal	Total tons	Percent of State output of coal
1940	399, 206	24	66	39, 780	2	33, 622	2	472, 608	28
1941	428, 007	23	66	37, 374	2	39, 576	2	504, 957	27
1942	442, 561	22	71	53, 240	3	80, 180	4	575, 981	29
1943	280, 960	18	56	52, 676	4	66, 815	4	[2] 400, 783	26
1944	226, 455	15	49	75, 196	5	59, 755	4	361, 406	24
1945	268, 602	19	41	79, 733	6	64, 347	5	412, 682	30
1946	215, 599	22	68	56, 936	6	50, 594	5	323, 129	33
1947	260, 306	23	76	44, 360	4	57, 213	5	316, 879	32
1948	269, 637	22	76	52, 195	4	61, 077	5	382, 909	31
1949	139, 132	15	64	45, 655	5	43, 295	5	228, 082	25
1950	105, 204	12	63	47, 898	6	25, 916	3	179, 018	28
1951	66, 027	8	35	41, 457	5	11, 018	1	118, 502	14
1952	70, 744	8	37	34, 148	4	5, 556	1	110, 448	13

[1] Compiled from Annual Reports of Coal Mines, State of Washington, Department of Labor and Industries, Olympia, Wash.

[2] Includes a small production from Cowlitz County.

TABLE 7.—*Number and production of coal mines in Washington, classified by size of output, 1940–52*

[Exclusive of mines producing less than 1,000 tons]

Year	Class 2—200,000 to 500,000 tons				Class 3—100,000 to 200,000 tons				Class 4—50,000 to 100,000 tons			
	Mines		Production		Mines		Production		Mines		Production	
	Number	Percent	Net tons	Percent	Number	Percent	Net tons	Percent	Number	Percent	Net tons	Percent
1940	2		483, 477		4		601, 058		2		138, 278	
1941	2	4.9	614, 614	33.4	5	12.2	736, 389	40.0	1	2.4	61, 397	3.3
1942	3	7.0	802, 517	41.1	4	9.3	531, 620	27.2	4	9.3	295, 346	15.1
1943	1	2.6	226, 552	14.8	5	12.8	742, 738	48.6	4	10.2	262, 091	17.1
1944	1	2.0	231, 882	15.2	4	8.2	565, 563	37.1	4	8.2	292, 240	19.2
1945					5	10.9	670, 480	49.4	3	6.5	171, 180	12.6
1946					3	6.5	336, 939	34.0	2	4.4	164, 967	16.6
1947					3	7.7	510, 501	45.7	2	5.1	144, 493	12.9
1948	1	2.6	227, 628	18.7	3	7.7	420, 783	34.5	2	5.1	174, 645	14.3
1949					3	9.7	467, 756	52.0	1	3.2	76, 653	8.6
1950	1	3.9	228, 864	26.2	1	3.8	189, 818	21.7	2	7.7	160, 750	18.4
1951	2	8.0	436, 946	51.0					3	12.0	174, 365	20.3
1952	2	8.0	449, 038	53.2					2	8.0	120, 196	14.2

Year	Class 5—10,000 to 50,000 tons				Class 6—less than 10,000 tons				Total		
	Mines		Production		Mines		Production		Mines	Production, net tons	
	Number	Percent	Net tons	Percent	Number	Percent	Net tons	Percent		Total	Average per mine
1940	15		341, 579		25		85, 960		48	1, 650, 352	
1941	15	36.6	362, 140	19.7	18	43.9	66, 734	3.6	41	1, 841, 274	44, 909
1942	11	25.6	231, 354	11.9	21	48.8	92, 372	4.7	43	1, 953, 209	45, 423
1943	12	30.8	230, 816	15.2	17	43.6	65, 347	4.3	39	1, 527, 544	39, 168
1944	15	30.6	343, 126	22.5	25	51.0	91, 330	6.0	49	1, 524, 141	31, 105
1945	18	39.1	425, 134	31.3	20	43.5	90, 450	6.7	46	1, 357, 244	29, 505
1946	15	32.6	372, 571	37.6	26	56.5	116, 650	11.8	46	991, 127	21, 546
1947	17	43.6	388, 313	34.7	17	43.6	74, 619	6.7	39	1, 117, 926	28, 365
1948	12	30.8	292, 597	24.0	21	53.8	104, 250	8.5	39	1, 219, 903	31, 280
1949	14	45.2	304, 985	33.9	13	41.9	49, 652	5.5	31	899, 046	29, 001
1950	7	26.9	212, 512	24.3	15	57.7	82, 045	9.4	26	873, 989	33, 615
1951	11	44.0	208, 678	24.4	9	36.0	37, 037	4.3	25	857, 026	34, 281
1952	10	40.0	234, 498	27.8	11	44.0	40, 465	4.8	25	844, 197	33, 768

from the list of mines published annually by the State Inspector of Coal Mines.

USE

The coal trade and the markets for coal in Washington cannot be analyzed except in general terms owing to the lack of complete figures giving shipments into the State by origin, points of destination, and consumption data by users. Because of the rapidly changing conditions during the past 10 years, a yearly analysis or an average of several years is simply a record of past utilization and gives little more than a general index of trend. To the mining industry and to consumers interested in problems of future utilization, such figures may be useful and significant; information obtained in a canvas made by the Northwest Experiment Station of the Bureau of Mines is therefore given in this publication. Surveys by others were made in 1946, 1949, and 1950.[2]

The total quantity of coal consumed in any year is represented by the State production, together with that shipped into the State from the Rocky Mountain area and other States, plus a portion of the British Columbia and Alberta imports into both the Washington district and the Montana and Idaho customs district. Some coal from this latter district moves into Washington. From the total must be subtracted the quantity of Washington and out-of-State coal exported.

Based on the present canvas, the apparent total consumption of coal in Washington was approximately as follows during the years indicated:

Consumption of coal in Washington, net tons

1944	3, 386, 808
1945	3, 293, 967
1946	2, 651, 641
1947	2, 785, 336
1948	2, 407, 035

The 5-year total is 14,524,787 tons. The Bureau of Mines figures for Washington production—5,889,484 tons—would show 8,635,303 tons shipped into the State. The significant observation is that Washington production in each year cited was 50 percent or less of the apparent tonnage necessary to meet the coal requirements of the State.

[2] Lund, R. J., and Sullivan, John D., Survey Report on Washington Fuel Requirements and Supplies to Washington State Department of Conservation and Development: Battelle Memorial Inst., S-1097-2, Jan. 15, 1947, 369 pp.
Johnson, Maxine M., Fuel Trends in Washington: Washington State College, Bur. Econ. and Business Res. Bull. 11, November 1949, 52 pp.
Kolde, Endel J., Competitive Position of the Coal-Mining Industry in Washington State: Univ. Washington Library, unpublished thesis, May 17, 1951, 204 pp.
Western Power and Fuel Outlook: Federal Reserve Bank of San Francisco: Monthly Rev. Suppl., November 1950, 48 pp.

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CONSUMPTION BY CONSUMER USE

No adequate analyses of consumption of coal by consumer use have been made for Washington except for the years 1944, 1945, and 1946, when the Solid Fuel Administration for War, United States Department of Interior, collected statistics of distribution and use. The material collected has been tabulated by the Bureau of Mines in a series of publications.[3] (See table 8.) Railroad coal used came principally from Washington mines. Retail yards handled a small proportion of Washington coal in comparison with coal from the Rocky Mountain States. Coal used in manufactured-gas production was a negligible factor in the trade.

CONSUMPTION IN COAL MARKET, 1950

Approximate consumption in 1950 by type of plant or user, as revealed by a survey made by the Northwest Experiment Station of the Bureau of Mines, is indicated in the following summary:

Consumption of coal in Washington by type of use, 1950, net tons

Pulverized coal, cement plants and other	457, 800
Heating schools, hospitals, housing projects	47, 800
Public-utility heating	40, 200
Sugar manufacture	41, 900
Ceramic plants	18, 400
Metallurgical establishments	19, 300
Railroads	305, 200
State institutions	95, 800
Federal services and armed forces	162, 900
Government projects	450, 400
Retail and domestic	450, 000
Total	2, 089, 700

Pulverized coal includes that used in cement mills, in magnesite and ferrosilicon plants, and in steam and power plants operated by Federal, State, and private users. Federal services and the Armed Forces consume coal in civil, army, and naval establishments; other government projects utilize coal for heating and for process purposes. State institutions and public-utility heating represent installations in which coal is burned in a form other than pulverized. Sugar, ceramic, and metallurgical plants indicate specific types of use; railroad consumption includes locomotive fuel, station, and other uses. All of the preceding classes of consumption have been canvassed individually.

Retail and domestic consumption has been difficult to determine accurately because of the many ramifications of this type of market; the figure given represents a conservative estimate

[3] Bureau of Mines Mineral Market Reports, M. M. S. 1289, 1384, 1388, 1444, 1497, 1500, 1505, and 1592.

TABLE 8.—*Coal by use and source in Washington, 1944–46, net tons*

Use	Wyoming	Utah	Montana	Source, all other States [1]	Total	Washington	Grand total
1944							
Industrial	343, 135	220, 986	234, 087	2, 502	800, 710	358, 767	1, 159, 477
Retail yards	270, 407	547, 553	159, 696	20, 637	998, 293	91, 356	1, 089, 649
Byproduct and water gas						32, 958	32, 958
Railroad fuel						475, 066	475, 066
Shipped by truck [2]						322, 226	
Other [3]				2, 778	2, 778	92, 636	95, 414
Total	613, 542	768, 539	393, 783	25, 917	1, 801, 781	1, 373, 009	3, 174, 790
1945							
Industrial	389, 255	133, 066	244, 897	808	768, 026	338, 094	1, 106, 120
Retail yards	304, 323	607, 708	128, 518	38, 871	1, 079, 420	84, 001	1, 163, 421
Water gas						20, 204	20, 204
Railroad fuel						421, 483	421, 483
Shipped by truck [2]						281, 321	281, 321
Other [3]					2, 640	61, 076	63, 716
Total	693, 578	740, 774	373, 415	42, 319	1, 850, 086	1, 206, 179	3, 056, 265
1946							
Industrial	427, 966	144, 715	31, 969	3, 029	607, 679	307, 975	915, 654
Retail yards	226, 996	671, 936	76, 682	25, 327	1, 000, 941	69, 343	1, 070, 284
Water gas						11, 346	11, 346
Railroad fuel						241, 545	241, 545
Shipped by truck [2]						219, 723	219, 723
Other [3]				138	138	59, 073	59, 211
Total	654, 962	816, 651	108, 651	28, 494	1, 608, 758	909, 005	2, 517, 763

[1] Includes Pennsylvania, West Virginia, Colorado, and waterborne shipments via tidewater.
[2] Not classified as to use.
[3] Includes coal used at the mine, for private railways and conveyors, and for smithing and that for which use was not reported.

of coal delivered to retail yards for general domestic and other distribution not covered in the categories already presented. All uses totaled 2,089,700 tons, based on the estimated figure of 450,000 tons for retail and domestic.

The market analysis for 1950 indicates that the trend shown in the years 1944 to 1948 continued; namely, that consumption in the State greatly exceeds local production and that neighboring coal-producing areas having lower mining costs have expanded their markets to the disadvantage of the local industry.

FUEL BRIQUETS AND PACKAGED FUEL

Production figures for fuel briquets and packaged fuel made from coal in Washington since 1938 are not available. In that year 2 western Washington plants engaged in making coal briquets reported an output of 5,334 tons. One large briquetting plant near Seattle, whose annual output at one time exceeded 100,000 tons, was closed permanently in May 1939; a smaller plant was operated from 1934 to 1942. Utilization of screenings to make packaged fuel at a Spokane coal yard undertaken in 1936 ceased in 1942, and no State production has been reported since.

Briquets made of residual carbon obtained in the manufacture of oil gas are produced at Seattle and Portland; most of them are sold in Washington and Oregon, and some are exported to British Columbia and Alaska. A limited quantity is utilized in water-gas manufacture; the remainder is sold for heating and cooking, for use in steel and other metallurgical processes, and for other industrial applications. Exact figures of distribution and consumer use are not available. Table 9 shows production and sales of the Seattle product, including sales of Portland briquets reported by the Seattle distributor. In addition, Portland briquets are distributed in other market areas of Washington.

Production figures of briquets produced in Oregon and the quantity shipped into Washington from 1935 to 1952 are reported below. The figures for 1939 to 1950 are those reported to the Public Utilities Commission of Oregon; the figures for 1951 and 1952 represent gross sales but do not segregate the shipments into Washington.

TABLE 9.—*Production and sales of residual-carbon briquets in Seattle, 1938–52, net tons* [1]

Year	Total made at Seattle	Used in water-gas manufacture	Sales
1938	8, 573	5, 451	3, 320
1939	17, 510	9, 296	6, 707
1940	19, 411	11, 328	8, 835
1941	15, 661	10, 666	6, 522
1942	25, 732	16, 831	6, 776
1943	26, 067	18, 423	7, 963
1944	28, 009	27, 247	1, 768
1945	20, 530	19, 607	932
1946	24, 606	24, 297	201
1947	31, 129	5, 826	22, 470
1948	41, 311	14, 981	26, 491
1949	48, 429	10, 125	34, 519
1950	37, 338	7, 487	25, 625
1951	42, 033	3, 592	37, 683
1952	42, 406	829	44, 272

[1] Data from Seattle Gas Co.

Residual-carbon briquets produced in Oregon and shipped to Washington, 1939–52, net tons

Year	Total production	Shipped to Washington	Year	Total production	Shipped to Washington
1939	42, 367	9, 172	1946	102, 410	6, 722
1940	40, 143	10, 624	1947	73, 767	5, 611
1941	57, 853	22, 946	1948	[1] 178, 842	16, 625
1942	91, 606	14, 362	1949	95, 962	10, 009
1943	89, 341	7, 293	1950	[2] 92, 462	11, 242
1944	94, 562	6, 455	1951	101, 376	----------
1945	96, 678	6, 777	1952	115, 759	----------

[1] Includes 75,000 tons of lampblack for industrial use.
[2] Gross sales.

COMBUSTION

In 1939, 10 Washington plants utilized pulverized coal. Since then 15 units have come into operation, but only 12 reported consumption figures for 1953. One minor user discontinued operations in 1943; 1 cement company in 1948 and 1 central heating plant in 1953 changed to oil. Four cement plants, 1 magnesite producer, 1 sugar refinery, 1 metallurgical establishment, and 4 other units producing steam for heat and power were in operation in 1953. One municipal plant is a standby unit used only for emergency purposes.

Table 10, compiled from figures obtained by a canvass of consumers, presents an annual summary of powdered-coal consumption during 1939–53. Use, in general, has shown a steady increase from 389,784 tons in 1939 to 498,006 tons in 1950, followed by declines in 1952 and 1953. Cement and magnesite plants represent the largest consumption, followed by seven installations supplying steam for general heating, power, and processing purposes.

No exact figures showing origin or distribution are available in published form. In

TABLE 10.—*Summary of powdered-coal consumption, 1939–53, net tons* [1]

Year	Cement mills and magnesite plant	Public plants for steam distribution	Other plants [2]	Total
1939	297, 008	64, 671	28, 105	389, 784
1940	249, 399	52, 800	34, 958	337, 157
1941	235, 234	64, 200	38, 765	338, 199
1942	299, 930	73, 675	47, 371	420, 976
1943	285, 092	70, 339	45, 514	400, 945
1944	257, 004	63, 700	41, 572	362, 276
1945	180, 209	66, 700	58, 813	305, 722
1946	224, 794	55, 654	65, 102	345, 550
1947	293, 516	67, 446	83, 186	444, 148
1948	292, 982	93, 263	76, 059	462, 304
1949	242. 965	72, 216	110, 321	425, 502
1950	282, 005	50, 921	124, 859	457, 785
1951	298, 388	57, 690	141, 928	498, 006
1952	265, 717	37, 251	150, 705	453, 673
1953	279, 264	13, 880	146, 564	439, 708
Total	3, 983, 507	904, 406	1, 193, 822	6, 081, 735

[1] Figures compiled from canvass of plants in Washington.
[2] Includes 7 installations for heat, power, metallurgical use, and sugar processing.

western Washington local coals are generally purchased, although some coal from Utah and Wyoming enters this market territory; in eastern Washington competition from out-of-State coal is keener, and many plants use coal from Utah and Wyoming as well as coal from the Crow's Nest Pass area of British Columbia. The author's estimate of consumption for 1939–53 indicates that, out of the total reported consumption of 6,081,735 tons, approximately 68.0 percent was Washington coal, 16.6 percent came from British Columbia, 9.1 percent from Utah, 4.7 percent from Wyoming, and 1.6 percent from undesignated sources.

Two papers of interest, one dealing with grindability [4] and the other with abrasiveness [5] of certain Washington coals, have been published.

Spreader-type stokers have proved increasingly popular for burning Washington coals. Their ability to handle a wide range of sizes, marked differences in ash content and ash fusibility, and variations in caking properties render them particularly suitable for use in this area where such a wide variety of coals compete. Burning of Washington coals in domestic stokers has been studied intensively by the Bureau of Mines.[6]

[4] Yancey, H. F., and Geer, M. R., Ball-Mill Grindability Indexes of Some American Coals: Bureau of Mines Rept. of Investigations 3409, 1938, 9 pp.
[5] Yancey, H. F., Geer, M. R., and Price, J. D., An Investigation of the Abrasiveness of Coal and Its Associated Impurities: Trans. AIME, vol. 190, 1951, pp. 262–268.
[6] Yancey, H. F., Johnson, K. A., and Cordiner, J. B., Jr., Burning Characteristics of Washington Coals on Domestic and Underfeed Stokers: ASME, November 1940, 4 pp.; Trans. ASME, vol. 63, 1941, pp. 293–296.
Yancey, H. F., and Johnson, K. A., Burning Bituminous and Subbituminous Coals on an Anthracite, Ash-Removal Type, Domestic Stoker: Bureau of Mines Rept. of Investigations 3849, 1945, 14 pp.
Yancey, H. F., Johnson, K. A., Cordiner, J. B., Jr., Lewis, A. A., and Lunde, K. E., Burning of Washington Coals on Different Types of Domestic Stokers in the Same Hot-Water Boiler; Comparison With Hand and Oil-Firing: Bureau of Mines Bull. 475, 1949, 96 pp.

COKE

Coke production in Washington as a major industry ceased in 1937. No coke was manufactured thereafter until May 1943, when a new Curran-Knowles byproduct plant of 17 sole-flue ovens began operation at Tacoma on Wilkeson, Wash., coals and mixtures with Utah coals; it was active until December 1944 and produced 50,935 tons of coke. Only 16 percent of the product entered the industrial field; domestic heating absorbed 84 percent, of which 78 percent was taken by Government housing projects. A small amount of retort coke was produced at gasworks in the State until the end of 1947.

The coke demands of chemical, industrial, and metallurgical establishments have been supplied from outside sources. The principal shipments have come from the Crow's Nest Pass area of British Columbia, Canada, and a small tonnage has come from Alberta. The Michel, British Columbia, coke is made in Curran-Knowles ovens and the Coleman, Alberta, coke in beehive ovens. These cokes are used largely in smelters, industrial plants, and sugar refineries. For special purposes, as in some foundry and electrometallurgical applications, byproduct coke largely from eastern sources is used. Coke breeze, used mainly as a source of carbon, is shipped to some metallurgical establishments.

Accurate and complete figures are not available as to source or use of coke in Washington. Table 11 summarizes consumption of oven and beehive coke and breeze of domestic origin from 1940 to 1952. Statistics of coke imported from British Columbia and Alberta do not reveal the quantities separately destined for delivery to Washington, Idaho, Montana, and other States; consequently, the exact tonnages of domestic and imported coke used in each State are not determinable except by consumer surveys, and these have not been made. The tonnage of western Canada coke imported into the United States is shown in table 12.

TABLE 11.—*Summary of domestic oven and beehive coke and breeze consumed in Washington, 1940–52, net tons*

Year	Foundry use	Other industrial use	Total	Coke breeze
1940	3,089	1,609	4,719	
1941	8,111	3,287	11,580	2,145
1942	8,260	4,186	12,615	
1943	18,342	12,098	44,816	9,944
1944 [1]	9,035	2,292	11,327	
1945	8,294	2,284	10,793	5,996
1946	8,190	417	8,607	3,365
1947	7,613	6,219	13,832	
1948	7,653	9,335	16,988	4,447
1949	7,246	5,538	12,784	9,095
1950 [2]	9,910	6,821	16,731	7,688
1951 [3]	10,159	13,357	23,516	14,057
1952 [4]	8,536	6,656	15,192	13,055

[1] Only in this year was domestic heating an important factor; it totaled 13,678 tons.
[2] DeCarlo, J. A., and Ryan, Emma E., Distribution of Oven and Beehive Coke in 1950: Bureau of Mines Min. Market Repts., M. M. S. 2034, 1951, 35 pp.
[3] DeCarlo, J. A., Scalf, F. C., and Ryan, Emma E., Distribution of Oven and Beehive Coke in 1951: Bureau of Mines Min. Market Repts., M. M. S. 2092, 1952, 40 pp.
[4] DeCarlo, J. A., and Ryan, Emma E., Distribution of Oven and Beehive Coke in 1952: Bureau of Mines Min. Market Repts., M. M. S. 2221, 1953, 40 pp.

TABLE 12.—*Coke imported from British Columbia and Alberta through Washington, Montana, and Idaho customs districts for consumption in the United States, 1937–50, net tons*

Year	Washington		Montana and Idaho	
	Net tons	Value	Net tons	Value
1937	17,900	$97,798	28,833	$157,051
1938	6,563	40,758	28,902	162,154
1939	6,499	39,188	26,688	148,183
1940	2,721	18,988	26,885	141,598
1941	3,485	19,873	37,339	201,793
1942	7,015	32,203	38,877	218,241
1943	13,150	63,816	31,798	192,626
1944	1,070	6,905	38,345	398,653
1945	1,514	11,396	30,614	236,808
1946	33	308	40,428	309,307
1947	35	398	61,993	544,695
1948	615	7,223	62,342	696,024
1949	592	3,275	69,157	774,573
1950	1,577	1,474	70,859	781,101

An analysis of production sources and distribution of oven coke and breeze consumed in Washington from 1948 to 1952, representing coke shipped by rail from United States sources, is given in table 13. Coke has been supplied from as far as Alabama, but major shipments of foundry coke have come from States such as Wisconsin and Minnesota that have more favorable freight rates. Utah coke predominates.

GAS MANUFACTURE

The gas industry in Washington has undergone many changes in operating practice and in the use of raw materials since the publication of Bureau of Mines Technical Papers 491 and 618. In 1934, 216 retorts were used in making bench gas from coal; in 1936, 186; in 1937, 168 which continued service until 1946, when the number was reduced to 120. In 1948 use of these bench-gas units was discontinued. Oil gas was not manufactured in Washington until 1937, when the Seattle gas plant replaced a battery of Klönné byproduct ovens with oil-gas equipment. Water gas, using coke and coal as raw materials, continued to be made but with some replacement of coal and coke by residual-carbon briquets from oil-gas manufacture. Butane-air gas was introduced in the late 1930's and propane-air in 1945. Statistical data concerning the gas industry in the State from 1939 through 1952 are given later in this report.

TABLE 13.—*Source and quantity of oven coke and breeze consumed in Washington, 1948–52, net tons*

Source	[1] 1948				[2] 1949			
	Foundry	Other industrial use	Total		Foundry	Other industrial use	Total	
			Coke	Breeze			Coke	Breeze
Alabama						999	999	
California								254
Colorado								
Illinois					165		165	
Indiana and Kentucky	645		645		514		514	
Michigan and Wisconsin	33	37	70		863	40	903	
Minnesota	1,307	1,284	2,591		848	895	1,743	
Missouri	5,577		5,577		4,825		4,825	
Pennsylvania	[3] 91		[3] 91					
Tennessee					31	114	145	
Utah		8,014	8,014	4,447		3,490	3,390	8,841
Total	7,653	9,335	16,988	4,447	7,246	5,538	12,784	9,098

Source	[4] 1950				[5] 1951				[6] 1952			
	Foundry	Other industrial use	Total		Foundry	Other industrial use	Total		Foundry	Other industrial use	Total	
			Coke	Breeze			Coke	Breeze			Coke	Breeze
Alabama		421	421		167		167		228		228	
California				265				1,467				
Colorado	179		179		2,369	3,308	5,677	4,728	259	3,225	3,484	3,958
Illinois												
Indiana and Kentucky	556		556		387		387		196		196	
Michigan and Wisconsin	3,041	40	3,081		1,498		1,498		3,245		3,245	
Minnesota	2,374	289	2,663		3,290	66	3,356		2,553	47	2,600	
Missouri	3,760		3,760		2,448		2,448		2,055		2,055	
Pennsylvania												
Tennessee		321	321			160	160			457	457	
Utah		5,750	5,750	7,423		9,823	9,823	7,862		2,927	2,297	9,097
Total	9,910	6,821	16,731	7,688	10,159	13,357	23,516	14,057	8,536	6,656	15,192	13,055

[1] DeCarlo, J. A., and Otero, Maxine M., Distribution of Oven and Beehive Coke in 1948: Bureau of Mines Min. Market Repts., M. M. S. 1783, 1949, 34 pp.

[2] Otero, Maxine M., DeCarlo, J. A., and Corgan, J. A., Distribution of Oven and Beehive Coke in 1949: Bureau of Mines Min. Market Repts., M. M. S. 1912, 1950, 35 pp.

[3] Beehive coke.

[4] DeCarlo, J. A., and Ryan, Emma E., Distribution of Oven and Beehive Coke in 1950: Bureau of Mines Min. Market Repts., M. M. S. 2034, 1951, 35 pp.

[5] DeCarlo, J. A., Scalf, F. C., Ryan, Emma E., Distribution of Oven and Beehive Coke in 1951: Bureau of Mines Min. Market Repts., M. M. S. 2092, 1952, 40 pp.

[6] DeCarlo, J. A., and Ryan, Emma E., Distribution of Oven and Beehive Coke in 1952: Bureau of Mines Min. Market Repts., M. M. S. 2221, 1953, 40 pp.

Consumption of raw materials by the manufactured-gas industry of Washington from 1939 to 1949 is indicated by the approximate figures given below. For the one plant in the State (Tacoma) using coal to make water gas, the consumption of coal in the generator was 17,700 tons, 14,800, 13,900, and 13,100 in the years from 1950 through 1953, respectively.

Average annual consumption of coal, coke, residual-carbon briquets, oil, tar, butane, and propane used in the manufacture of gas in Washington, 1939–49

	Tons	*Gallons*
Coal for bench gas [1]	30,000	
Coal for water gas	17,145	
Coke for water gas [1]	5,074	
Carbon briquets for water gas	16,600	
Coal for boiler fuel	9,400	
Coke for bench fuel	3,003	
Oil for boiler fuel		3,746,000
Tar, etc., for boiler fuel		2,200,000
Oil for water gas		6,628,000
Oil for oil gas		19,232,000
Butane for butane-air gas		2,723,300
Propane for propane-air gas [2]		1,717,000

[1] 1939–47. [2] 1946–49.

Coal for making bench or retort gas averaged 30,000 tons per year from 1939 to 1947, when this method of operation ceased. Coal consumption for water-gas manufacture averaged 17,145 tons per year from 1939 to 1949, while coke consumption for water gas was insignificant, averaging slightly over 5,000 tons per year during the period 1939 to 1947, when its use was discontinued. Residual-carbon briquets have been used steadily since 1939 and have averaged 16,600 tons per year.

Coal for boiler fuel, averaging 9,400 tons per year, has given place to oil, of which the average annual consumption from 1939 to 1949 was reported to be 3,746,000 gallons or approximately 90,000 barrels. A small quantity of coke, approximately 3,000 tons annually, was used at the coal-gas plants for bench fuel. In addition to the heavy oil purchased for boiler fuels, a large quantity of tar, over 2 million gallons obtained as a byproduct, has been utilized.

Oil used for carbureting in water-gas produc-

TABLE 14.—*Coal imported and exported through Washington ports, 1939–52, net tons* [1]

Year	Imports						Exports					
	Seattle	Bellingham	Anacortes	Port Angeles	Tacoma	Other Puget Sound ports [2]	Seattle cargo	Seattle bunker	Tacoma cargo	Grays Harbor bunker	Olympia bunker	Vancouver cargo
1939	42,198	1,227	311	400	200		1,089					
1940	28,856	890	286	396			618					
1941	17,912	1,214	245				183	22,238				
1942	40,568	5,250						40,568				
1943	10,404		56				15,969	84,040	2,136	1,751	2,868	
1944	21,118	18,167					2,722	28,000				
1945	22,362	14,175						34,264				
1946	22,708	10,134					123,108	2,300				
1947	9,658	421					296,743					3,900
1948	7,240	523				392	322,439		393			
1949	11,282	596				610	28,007					
1950	13,340	614	305				5					
1951	1,661						122,683					
1952	822						221,140					

[1] Figures from district engineer, Corps of Engineers, U. S. Army, Seattle district.
[2] Not reported before 1948.

tion averaged approximately 6,628,000 gallons or 157,800 barrels annually over the period 1939–49. Oil for making oil gas averaged approximately 19,232,000 gallons or 458,000 barrels annually, the greater part being heavy oil, although some light oils were used occasionally. One plant used heavy oil for residual operations. It is estimated that 8 million barrels of fuel oils were consumed by the gas industry from 1939 to 1949.

EXPORT OF COAL FROM WASHINGTON

Before World War II the movement of coal from ports in Washington was limited to a small tonnage shipped to Alaska and occasional small consignments to Hawaii. As shown in table 14, a demand for bunker coal developed during the war years, attaining a peak of 90,000 tons in 1943. In the same year exports reached nearly 16,000 tons. After the war the demand for coal in Japan increased exports greatly. In 1948 cargo coal moving through the port of Seattle aggregated 322,439 tons.

Washington coal comprised a substantial part of the export volume during 1951 and 1952 only, when 90,505 and 94,530 tons, respectively, were shipped to Japan. This coal originated largely in the Roslyn-Cle Elum field of Kittitas County.

COMPETITION WITH COAL FROM OTHER FIELDS AND WITH OTHER FUELS

IMPORTS OF CANADIAN COAL INTO WASHINGTON

Bituminous coal from Vancouver Island and the east Kootenay district of British Columbia and from western Alberta enters the Washington market. Some lower rank coal from Alberta moves into the United States, but very little is sold in Washington. In any analysis of coal-consumption figures for Washington, the Canadian imports are significant. Table 15 shows the tonnages of coal from Canada entering the Washington, Montana, and Idaho customs districts from 1938 to 1952.

TABLE 15.—*Coal imported into the United States through Washington, Montana, and Idaho customs districts, 1938–52, net tons*

Year	Washington	Montana and Idaho	Total
1938	41,344	95,511	136,855
1939	38,709	103,408	142,117
1940	39,396	127,274	166,670
1941	41,392	140,796	182,188
1942	60,058	247,836	307,894
1943	106,183	498,072	604,255
1944	71,243	430,734	501,977
1945	83,643	276,055	359,698
1946	52,164	242,668	294,842
1947	18,069	213,313	231,382
1948	15,434	153,777	169,211
1949	12,068	143,926	155,994
1950	15,264	164,973	180,237
1951	1,594	157,500	159,094
1952	1,127	129,876	131,003

Exact figures showing the quantities of coal actually destined for sale and use in Washington alone are difficult to obtain.

WOOD

Wood continues to be an important fuel in the State for domestic, commercial, and industrial heating, as well as power production. Some hogged fuel is used in metallurgical operations. However, the shifting of lumbering operations farther from centers of population and the growing practice of debarking to provide wood fiber for process use are factors that limit the availability of wood for fuel. Reliable figures on

the current consumption of wood as fuel are not available.

A number of lumber mills in the Pacific Northwest make wood briquets, known as Presto-logs, from selected waste sawdust or shavings; these are approximately 4 inches in diameter and 12 inches in length and weigh 8 pounds. They first came on the market in the early 1930's and are used extensively for household range, fireplace, and furnace heating, as well as for cooking on railroads and in steamships and restaurants. Production has grown steadily; manufacture and sales are geared not to the demand but to the volume of wood waste available at plants where briquetting machines are installed. Some nearby out-of-State plants ship these briquets into Washington, and some Washington plants, in turn, ship into adjacent territory. Approximate production and sales in Washington are indicated in the following summary:

Production of wood briquets, 1939–52, net tons

Year	Manufactured at Washington plants	Sold in Washington from out-of-State plants	Total sold in Washington
1939	39, 618	17, 160	56, 778
1940	35, 196	17, 820	53, 016
1941	57, 411	27, 683	85, 094
1942	81, 280	32, 326	113, 606
1943	72, 034	35, 198	107, 232
1944	70, 066	34, 150	104, 216
1945	56, 770	35, 450	92, 220
1946	55, 245	30, 380	85, 625
1947	68, 386	29, 292	97, 678
1948	67, 793	35, 100	102, 893
1949	81, 516	36, 630	118, 146
1950	88, 477	39, 782	128, 259
1951	86, 615	29, 490	116, 105
1952	109, 301	28, 244	137, 545

GAS

Table 16, compiled from reports of the Washington Public Service Commission,[7] presents the salient features of the changes in the manufactured-gas industry of the State from 1939 to 1952. Data for 1950, 1951, and 1952 included the total operations of the Portland, Oreg., plant with those of the establishments in Washington because some gas made in Oregon is used in Washington. Production and sales have shown a steady increase from 1939 to 1950—the reported sale in 1939 was 3,575,587 M cubic feet and in 1950 the figure had risen to 6,266,672. No natural gas has been produced in the State since 1941; water-gas production has declined, and oil gas produced from heavy residual oils now leads in output. Propane-air and butane-air gases are distributed directly to many communities, and propane and butane are used as enriching agents in mixed gas. In 1952, 15 companies—3 propane plants, 6 butane, 2 propane-butane, 1 water-propane-butane, 1 propane-butane-water gas-oil, 1 oil-propane-butane, and 1 water-gas—supplied gas to 40 cities and communities.

Production of water gas rose from 1,704,662 M cubic feet in 1939 to a maximum of 3,760,886 in 1946, a gain from 43 to 56 percent of the combined figures for in-State production and imports, but it declined steadily thereafter to 1,027,231 M cubic feet in 1952, 17 percent of the total.

Oil gas produced in the one Washington plant at Seattle in 1939 amounted to 1,578,350 M cubic feet, and sales from another plant in Portland, Oreg., to Washington customers contributed 84,614 M cubic feet; the 2 plants totaled 42.1 percent of the combined total of State production and sales. The Seattle oil-gas installation had been expanded until its output in 1950 reached 4,017,554 M cubic feet or 58.5 percent of the State production. Production declined in 1951 and 1952, but the output is well over 50 percent of all gas manufactured in Washington. The Portland installation, serving a limited market area in the vicinity of Vancouver, Wash., makes a steady contribution of oil gas to this area.

Production of butane-air gas in 1939 amounted to 66,055 M cubic feet or 1.67 percent; in 1952 the reported figure was 1,172,013 M cubic feet or 19.29 percent of the total. Propane-air gas was first produced in 1945, when 4,874 M cubic feet was reported (less than 0.10 percent of total gas); by 1950 production had increased to 410,670 M cubic feet but declined in 1951. However, a recovery to 403,665 M cubic feet was indicated for 1952. The figures published by the Washington Public Service Commission appear to include propane and butane used as enriched as well as for direct gas-air distribution.

The annual sales of liquefied petroleum gases in Washington were not reported for earlier years, but the figures for 1950 to 1952 are now available [8] and are shown in table 17 by principal uses.

FUEL OIL

Fuel oil sales in Washington from 1938 to 1952, excluding kerosine, are reported in table 18. The greatest part of the distillate and residual oils was shipped from California to tidewater points and distributed by trucks and tank cars. One refinery at Spokane contributed a small proportion and other sources south and southeast of Washington supply part of the

[7] Statistics of Washington gas companies, Department of Public Service, Olympia, Wash., 1939–43; Department of Public Utilities, 1944–47; Public Service Commission, 1948–52.

[8] Coumbe, A. T., and Avery, I. F., Bureau of Mines Min. Market Repts., M. M. S. 1999, 2090, 2184.

TABLE 16.—*Production of gas in Washington, 1939–52, M cubic feet* [1]

Type of gas	1939		1940		1941		1942		1943		1944		1945	
	Production	Percent	Production	Percent	Production	Percent	Production	Percent	Production	Percent	Production	Percent	Production	Percent
Natural														
Coal	87,350	2.21	36,323	0.90	879	0.02								
Water	429,665	10.87	430,556	10.69	421,589	9.49	429,279	8.65	410,452	7.63	451,761	7.89	455,753	7.31
Oil	1,704,662	43.15	1,794,875	44.58	1,879,106	42.29	2,441,829	49.23	2,426,228	45.12	2,911,807	50.83	3,281,767	52.64
Butane-air	1,578,350	39.96	1,560,013	38.75	1,892,916	42.60	1,749,220	35.26	2,015,320	37.47	1,617,502	28.24	1,942,082	31.15
Propane-air	66,055	1.67	103,013	2.56	120,016	2.70	160,521	3.24	307,828	5.72	520,701	9.09	289,475	4.64
													4,874	.08
Total produced in State	3,866,083	97.86	3,924,780	97.48	4,314,505	97.10	4,780,848	96.38	5,159,828	95.94	5,501,771	96.05	5,973,951	95.82
Oil gas imported into State	84,615	2.14	101,524	2.52	138,591	2.90	179,752	3.62	218,537	4.06	225,971	3.95	260,899	4.18
Total gas produced and imported	3,950,698	100.00	4,026,304	100.00	4,443,096	100.00	4,960,600	100.00	5,378,365	100.00	5,727,742	100.00	6,234,850	100.00
Gas sold	3,575,587		3,691,815		4,022,233		4,544,451		4,896,740		5,213,992		5,759,197	
Number of operating companies	13		13		14		14		14		14		14	
Coal gas produced at Spokane	277,511		272,393		261,287		260,427		220,622		246,116			
Coal gas produced at Walla Walla	63,148		70,500		74,117		82,919		94,599		97,531		108,390	
Coal gas produced at Yakima	98,006		87,663		86,185		85,933		95,231		108,114		104,252	
Number of retorts in operation [2]	168		168		168		156		156		168		168	

Type of gas	1946		1947		1948		1949		1950		1951		1952	
	Production	Percent	Production	Percent	Production	Percent	Production	Percent	Production	Percent	Production	Percent	Production	Percent
Natural														
Coal	388,836	5.82	188,709	2.76										
Water	3,760,886	56.28	1,926,639	28.16	2,158,180	31.02	1,878,249	26.01	1,574,788	22.94	1,225,817	19.58	1,027,231	16.91
Oil	1,792,436	26.82	3,728,520	54.50	3,610,264	51.89	3,836,869	53.13	4,017,554	58.52	3,432,418	54.81	3,174,267	52.25
Butane-air	442,388	6.62	538,605	8.53	660,063	9.48	968,165	13.40	[3] 544,227	7.93	[3] 1,010,677	16.14	[3] 1,172,013	19.29
Propane-air	38,676	.58	92,826	1.36	215,528	3.10	234,462	3.25	[3] 410,670	5.98	[3] 297,851	4.76	[3] 403,665	6.64
Total produced in State	6,423,221	96.12	6,520,299	95.31	6,644,035	95.49	6,917,745	95.79	6,547,239		5,966,763		5,777,176	
Oil gas imported into State	259,479	3.88	321,204	4.69	313,922	4.51	303,749	4.21	318,156	4.63	294,737	4.71	298,177	4.91
Total gas produced and imported	6,682,700	100.00	6,841,503	100.00	6,957,957	100.00	7,221,494	100.00	[4] 6,865,395		[4] 6,261,500		[4] 6,075,353	
Gas sold	5,984,929		6,078,478		6,200,631		6,043,891		[4] 6,266,672		[4] 5,521,986		[4] 5,543,529	
Number of operating companies	15		15		14		15		15		15		15	
Coal gas produced at Spokane	203,573		72,800											
Coal gas produced at Walla Walla	66,270													
Coal gas produced at Yakima	118,993		115,909											
Number of retorts in operation [2]	168		120											

[1] Compiled from statistics of Washington gas companies, Department of Public Service, Olympia, Wash., 1939–43. Department of Public Utilities, 1944–47; Public Service Commission, 1948–52.
[2] In 1934 the number of retorts in use was 216; in 1936, 186; in 1937, 168.
[3] Includes butane-air, propane-air, butane, and propane used as enrichers.
[4] Does not include hydrogen gas.

TABLE 17.—*Sales of liquefied petroleum gases in Washington by principal uses and kind, 1950–52, M gallons*

	1950	1951	1952
Domestic:			
Butane	120		53
Propane	7,320	10,836	13,204
Mixture	1,392	1,030	2,899
Total	8,832	11,866	16,156
Gas manufacture:			
Butane	1,893	2,986	2,140
Propane	2,864	3,434	3,381
Mixture	958	2,579	1,694
Total	5,715	8,999	7,215
Industrial:			
Butane	722	1,515	1,345
Propane	821	1,167	1,457
Mixture			
Total	1,543	2,682	2,802
Internal combustion:			
Butane			
Propane	139	18	161
Mixture			
Total	139	18	161
All other:			
Butane			
Propane		14	64
Mixture			
Total		14	64
Total sales:			
Butane	2,735	4,501	3,538
Propane	11,144	15,469	18,267
Mixture	2,350	3,609	4,593
Total	16,229	23,579	26,398

demand of eastern Washington. A pipeline from Salt Lake City to Pasco was extended to Spokane in October 1953, and a second is expected from a refinery at Billings, Mont. In the Puget Sound area two refineries were under construction at Anacortes and Ferndale in 1953, and a third is planned to receive crude oil by extension of a pipeline delivering Alberta oil to Vancouver, British Columbia. These refineries are located so they may receive waterborne oil from other sources.

Changes in consumer use from year to year are shown in the figures of thousands of barrels sold and in the percentage of each used. Residual or heavy fuel oil comprised approximately half the sales in 1950–52. Heating oils make up the largest single use, followed by smelters, mines, and manufacturing industries. The total for gas and electric power plants has remained fairly steady but varies with weather conditions and fluctuations in hydroelectric water supply. Very little fuel oil is consumed normally by public-utility electric plants, but in periods of water shortage an increase occurs in consumption by both public and private producers of electrical energy.

USE OF FUELS FOR ELECTRIC POWER PRODUCTION

Table 19, compiled from figures reported annually by the Federal Power Commission, summarizes the production of power for public use in Washington by type of plants and gives information about fuel consumption for the period 1938–52. Figures of production by industrial plants are not included.

Production of power from all sources in 1938 totaled 3,400,683 M kw.-hr., of which 95.2 percent represented hydro, 4.7 percent steam, and 0.1 percent internal combustion. By 1951 the total production had risen to 19,914,303 M kw.-hr., of which 19,754,721 or 99.2 percent came from hydro and the remainder from fuel installations.

The question of steam plants for standby and for primary generation constantly receives much attention and is often discussed in the Pacific Northwest.[9] Increased demands for electric power, shortages in water supplies from time to time, and less activity in construction of dams and hydroelectric plants have indicated a need for fuel-burning installations. The future interplay of supplies and cost of competing fuels may lead to the use of Washington coal at strategic points for generating electric power.

[9] Robbins, Floyd D., Steam Plants and the Northwest Power Shortage. The Trend in Engineering at the University of Washington: Univ. of Washington Eng. Exp. Sta. Quart. Pub., vol. 3, No. 4, 1951, pp. 5–9.

TABLE 18.—*Sales of distillate and residual fuel oil in Washington, by uses and grades, 1938–52, in thousand barrels of 42 gallons* [1]

Uses	[2] 1938	[2] 1939	[2] 1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952
Railroads	1,628	1,108	1,089	1,472	2,009	2,308	2,110	2,002	2,130	2,538	2,612	2,066	2,631	2,032	1,712
Vessels (including tankers)	1,336	1,493	1,144	1,233	976	3,063	3,061	3,213	1,934	2,554	1,760	1,692	2,009	2,630	3,019
Gas and electric power plants	596	599	621	905	1,244	1,126	993	1,035	1,273	1,372	1,431	1,608	1,305	1,394	2,846
Smelters, mines, and manufacturing industries	1,971	2,076	2,150	2,877	3,828	4,110	4,574	4,753	5,006	5,558	5,878	5,381	5,841	6,279	6,812
Heating oils	2,929	3,236	3,723	4,363	4,838	5,176	5,584	6,144	8,042	9,529	10,751	10,514	12,780	13,630	14,152
No. 1 fuel oil sold as range oil	150	31	6		5										
Oil-company fuel	116	146	148	159	175	192	226	248	230	219	255	255	280	288	293
U. S. Navy, Army, and Coast Guard	76	46	94	398	2,157	1,937	1,462	1,702	735	645	250	148	221	923	[3] 1,080
Miscellaneous	439	458	713	792	797	733	819	1,084	1,201	1,336	1,372	1,594	1,602	1,613	2,034
Grand total (excluding No. 1 fuel oil sold as range oil)	9,241	9,193	9,688	12,199	16,029	18,645	18,829	20,201	20,551	23,751	24,309	23,258	[4] 26,669	[4] 28,789	[4] 31,948
	Percent of total														
Railroads	17.6	12.1	11.2	12.1	12.5	12.4	11.2	10.0	10.4	10.7	10.8	8.9	9.9	7.1	5.4
Vessels (including tankers)	14.5	16.2	11.8	10.1	6.1	16.4	16.3	15.9	9.4	10.8	7.3	7.3	7.5	9.1	9.4
Gas and electric power plants	6.4	6.5	6.4	7.4	7.7	6.0	5.3	5.1	6.2	5.8	5.9	6.9	4.9	4.8	8.9
Smelters, mines, and manufacturing industries	21.3	22.6	22.2	23.6	23.8	22.0	24.3	23.6	24.4	23.4	24.3	23.1	21.9	21.8	21.3
Heating oils	31.7	35.2	38.4	35.8	30.2	27.8	29.6	30.4	39.1	40.1	44.4	45.2	47.9	47.4	44.3
Oil-company fuel	1.3	1.6	1.5	1.3	1.1	1.0	1.2	1.2	1.1	.9	1.0	1.1	1.1	1.0	.9
U. S. Navy, Army, and Coast Guard	.8	.5	1.0	3.2	13.4	10.4	7.8	8.4	3.6	2.7	.6	.6	.8	3.2	3.4
Miscellaneous	6.4	5.3	7.5	6.5	5.2	4.0	4.3	5.4	5.8	5.6	5.7	6.9	6.0	5.6	6.4
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Grades of oil, in thousand barrels														
Gas oil and distillate [5]	1,690	1,865	2,258	2,690	3,373	4,071	4,231	4,568	5,964	7,372	8,506	8,489	10,235	10,932	11,320
Diesel fuel	778	789	840	1,027	1,225	1,583	1,702	2,018	1,731	2,230	2,499	2,726	2,719	3,213	3,584
Navy grade	20	1	6				198	352	135						
Residual fuel	6,753	6,538	6,561	8,482	11,431	12,991	12,698	18,263	12,701	14,149	13,304	12,043	13,715	14,644	[3] 17,044
Crude oil			23	23					20						
Total	9,241	9,193	9,688	12,199	16,029	18,645	18,829	20,201	20,551	23,751	24,309	23,258	[4] 26,669	[4] 28,789	[4] 31,948

[1] Survey of fuel-oil sales in the Pacific Coast marketing areas made by E. T. Knudsen, Petroleum Economics Division, Bureau of Mines, San Francisco, Calif. Figures for 1950–52 taken from Mineral Market Reports, M. M. S. 2003, 2091, and 2188.

[2] Grand total differs slightly from total of individual uses.

[3] Includes jet fuel.

[4] Includes grade No. 1 fuel oil sold as range oil.

[5] Designation changed to distillate fuel in 1940.

TABLE 19.—*Production of electric power for public use in Washington and fuel consumption, 1938–52* [1]

Year	Number of plants	Capacity, kw.				Production by type of plant, thousand kw.-hr.				Production by type of fuel, thousand kw.-hr.			Fuel consumption	
		Total plants [2]	Hydro	Steam	Internal combustion	Total	Hydro	Steam	Internal combustion	Wood	Coal	Oil	Coal, net tons	Fuel oil, barrels
1938	66	1,012,108	794,025	216,470	1,613	3,400,683	3,238,965	160,373	1,345	101,189	226	42,051	50	116,378
1939	67	1,002,495	785,427	215,320	1,748	3,642,610	3,420,262	221,140	1,208	164,925	13,512	28,882	10,071	79,102
1940	65	1,018,016	800,270	215,856	1,890	3,944,184	3,682,506	260,246	1,432	206,588	----	38,972	69	105,192
1941	62	1,127,430	908,180	217,500	1,750	4,521,251	4,151,144	368,124	1,983	235,435	1,322	117,125	3,699	336,057
1942	63	1,342,530	1,136,635	203,870	2,025	6,494,920	6,092,014	401,011	1,895	207,445	10,240	177,740	8,785	533,076
1943	63	1,718,305	1,512,410	203,870	2,025	8,926,679	8,634,389	290,146	2,144	136,299	1,796	144,893	3,919	448,349
1944	62	1,823,725	1,619,380	202,320	2,025	10,311,897	10,105,091	204,517	2,289	107,208	512	100,110	31	319,357
1945	62	1,813,625	1,609,280	202,320	2,025	9,689,862	9,526,146	161,057	2,659	70,268	493	93,941	35	306,398
1946	60	1,738,025	1,533,680	202,320	2,025	9,038,842	8,862,066	173,527	3,249	34,919	2,397	139,460	4,626	429,551
1947	58	1,846,855	1,642,212	202,320	2,323	11,226,271	10,997,201	224,755	4,315	69,991	2,710	156,369	4,047	530,104
1948	55	2,076,944	1,872,736	200,820	3,388	13,881,239	13,609,304	267,585	4,350	82,615	16,507	172,813	10,741	572,224
1949	54	2,441,838	2,240,576	197,820	3,442	15,079,298	14,753,477	321,383	4,438	85,009	25,253	215,559	16,568	670,880
1950	53	2,765,298	2,564,036	197,820	3,442	17,370,986	17,245,481	120,382	5,123	----	2,246	61,745	1,521	239,744
1951	54	3,104,062	2,902,536	197,820	3,706	19,914,303	19,754,721	154,037	5,545	----	----	99,602	----	307,690
1952 [3]	54	----	----	----	----	19,471,605	18,830,480	[4] 641,125	----	----	----	----	----	1,679,207

[1] Compiled from electric-power statistics; production of electric energy and capacity of generating plants; consumption of fuel for production of electric energy: Federal Power Commission, Washington, D. C.

[2] Privately and publicly owned.

[3] Preliminary figures.

[4] Includes internal-combustion figures.

RELATIONSHIP OF MINE SAMPLES TO COMMERCIAL SHIPMENTS

By S. J. Aresco [1]

The proper sampling of coal is of primary importance to both the producer and consumer. Analyses of coal have no value if the samples were improperly collected or the purpose for which the samples were collected is not understood.

There are two types of samples in ordinary use: (1) Mine or face samples and (2) tipple or delivered samples. The method of sampling employed depends on the purpose of the investigation. Mine or face samples generally represent the quality of the seam of coal with impurities removed. These samples are collected primarily for the use of the mine operator and form a permanent record of the coal seam at the point sampled. Tipple or delivered samples represent the quality of coal that was shipped at the time of sampling. Analyses of these samples are used to determine whether or not the coal delivered agrees with contract specifications and, in the case of guaranteed contracts, forms the basis of payment.

The methods of collecting the two types of samples are briefly described below.

METHOD OF COLLECTING MINE SAMPLES

Mine samples are collected according to the standard method adopted by the Bureau of Mines and the Geological Survey.[2]

The location of each sample is tentatively determined from a mine map, if available, before sampling because some of the samples should indicate the character of the deposit. The number of samples varies with the uniformity of the coal bed and output. No less than 3 samples are collected in an operating mine that produces up to 300 tons daily, and the number increases proportionally with increase in daily output.

In taking the sample the face of the seam is cleared of dirt and loose coal for a width of about 5 feet. In the center of this cleared area, a space 1 foot wide and at least 1 inch deep is cut to square up the face and get perfectly clean coal. A cut 2 inches deep and 6 inches wide or 3 inches deep and 4 inches wide in the softer coals, is made from the roof to the floor down the center of the foot-wide cut. The channel must be very uniform in depth and width, and at least 6 pounds of coal should be taken for each foot in thickness of the seam. Partings more than ⅜ inch thick and sulfur concretions or other impurities more than 2 inches in maximum diameter or ½ inch thick are excluded from the sample. The sample thus taken is caught on a sampling cloth spread on the floor, crushed to 3/16 inch or finer, thoroughly mixed, and reduced to approximately 3½ pounds by cone and quartering or by using riffle buckets. It is then placed in an airtight container and forwarded to the laboratory for analysis.

Owing to the exclusion of the impurities in the seam from roof to floor, the mine sample tends to represent the best quality that can be produced by any given mine. To the experienced buyer who knows the impurities in the seam and to what extent they are eliminated in mining and preparation, the mine sample may serve as a reliable guide in the purchase of coal. However, to the average purchaser, dependence on mine samples may be misleading.

METHOD OF SAMPLING COAL FOR SHIPMENT OR DELIVERY

In sampling coal for shipment or delivery the samples are collected and prepared in accordance with definite procedures adopted by the Bureau of Mines and used by all Government agencies in the sampling of delivered coals.[3] The coal is sampled as it is loaded into or unloaded from conveyances. "Top sampling" of railroad cars and stockpiles is generally unreliable. The methods briefly outlined here must be strictly followed whether the shipment of coal to be sampled consists of a few tons or several hundred tons.

For coal over three-fourth inch in size a 1,000-pound gross sample is collected. For minus-three-fourth-inch coal a gross sample of not less than 500 pounds is required. Increments of approximately equal weight are collected by cutting the stream of coal at regular intervals, so that the entire shipment sampled will be properly represented in the sample. The gross sample should contain the same proportion of lump, fines, and impurities as is contained in the consignment sampled. The sample is systematically crushed, mixed, and

[1] Chief, Fuel Inspection Section, Bureau of Mines, Region V, Pittsburgh, Pa.

[2] Holmes, J. A., The Sampling of Coal in the Mine: Bureau of Mines Tech. Paper 1, 1918, 17 pp.

[3] Snyder, N. H., Handbook on Coal Sampling: Bureau of Mines, 1950, 10 pp.

reduced to convenient size for transmittal to the laboratory. It is then reduced by mechanical means or by hand, but great care must be taken not to lose or add impurities.

Since coal is a heterogeneous material, the result of one sample is only representative of the lot sampled. The average quality of a particular coal can be determined only by averaging the analyses of a number of samples over a period of time.

INTERPRETATION OF SAMPLING RESULTS

Mine or face samples represent the coal in place, generally with the impurities excluded. They should not be used as a basis for purchase unless the buyer is thoroughly familiar with the seam of coal and knows to what extent the impurities are eliminated in mining and preparation. Also, it must be remembered that the mine or face sample represents the seam in its entirety and that the component parts of the seam may vary greatly owing to the manner in which those containing high or low ash may break down in mining and preparation.

The sample of coal as shipped or delivered is more useful to the consumer for evaluating bids and grade of coal delivered. The results of these samples, however, are variable and may change over a period of time owing to changing mining practices, adoption of different methods of coal preparation, mining of new seams, and market conditions.

Table 22 (p. 29) gives analyses of samples collected as shipped or delivered and provides valuable data for use in evaluating future purchases. These analyses indicate the quality of coal that a purchaser is likely to receive. The amount of coal represented, the number of analyses, and the year in which the samples were collected are of primary importance to those using these records. Coal analyses may lose their essential value within a short period owing to changes in mining and/or preparation methods.

In summation, the mine samples represent the quality of coal that can be obtained when the impurities are readily separated from the coal; the delivered or tipple samples represent the quality of coal that can be expected from commercial shipments.

ANALYSES OF MINE, TIPPLE, AND DELIVERED SAMPLES

By R. F. Abernethy,[1] S. J. Aresco,[2] and F. E. Hartner [3]

EXPLANATION OF TABLE OF ANALYSES

The analyses in table 22 are arranged alphabetically with respect to counties, towns, and mines and are grouped as follows:

1. Proximate analysis—moisture, volatile matter, fixed carbon, and ash.
2. Ultimate analysis—sulfur, hydrogen, carbon, nitrogen, oxygen, and ash.
3. Fusibility of ash, when such determinations were made.
4. Agglomerating index, when such tests were made.
5. Mineral-matter-free basis:
   (*a*) Dry fixed carbon and B. t. u.
   (*b*) Moist B. t. u.

Ultimate analyses and B. t. u. for mine and tipple samples are given for three conditions, as follows: (1) As-received, (2) moisture-free, and (3) moisture- and ash-free. Proximate analyses and B. t. u. for tipple and delivered samples are given for two conditions—as-received and moisture-free.

The as-received condition represents the sample as received at the laboratory and for mine samples approximates closely the condition of the coal in the mine; the moisture-free condition represents the composition and heating value of the dry coal; the moisture- and ash-free condition approximates the composition and heating value of the dry combustible matter.

The analyses are given to the nearest 0.1 percent and the B. t. u. to the nearest 10, although the laboratory determinations are recorded to the nearest 0.01 percent and the nearest B. t. u.

CLASSIFICATION OF COAL BY RANK

All mine samples of fresh coal have been classified by rank, that is, according to their degree of metamorphism or progressive alteration in the natural series from lignite to anthracite. This classification conforms to the Standard Specifications for Classification of Coals by Rank (D388–38) of the American Society for Testing Materials.[4]

A coal containing 69 percent or more dry, mineral-matter-free fixed carbon is classified according to fixed carbon, but one containing less than 69 percent is classified according to moist, mineral-matter-free B. t. u. Weathering and agglomerating properties are used to differentiate between certain adjacent groups Table 20 shows the various divisions.

The method of calculating to the mineral-matter-free basis follows:

Parr [5] formulas:

$$\text{Dry, mm-free FC} = \frac{\text{FC} - 0.15\text{S}}{100 - (\text{M} + 1.08\text{A} + 0.55\text{S})} \times 100 \quad (1)$$

$$\text{Moist, mm-free B. t. u.} = \frac{\text{B. t. u.} - 50\text{S}}{100 - (1.08\text{A} + 0.55\text{S})} \times 100 \quad (2)$$

where:

Mm—mineral matter,
B. t. u.—British thermal units,
FC—percentage of fixed carbon,
M—percentage of moisture,
A—percentage of ash,
S—percentage of sulfur.

Moist refers to coal containing its natural bed moisture but not including visible water on the surface of the coal.

The as-received analysis, or the analysis of the coal as it is in the coal bed, is used in these formulas.

An information circular [6] on the use of formulas and curves for convenient determination of the classification of coals has been issued by the Bureau of Mines.

AGGLOMERATING INDEX

The agglomerating index is a rough indication of the caking properties of coal. It is determined by visual and physical examination of the residue from the standard volatile-matter determination. All coals analyzed since November 15, 1934 (laboratory No. B300), have been classified according to agglomerating properties in accordance with table 21.

Column 7 of table 22 gives the agglomerating index for tipple and mine samples.

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[3] Clerk, Analysis Section, Bureau of Mines, Region V, Pittsburgh, Pa.
[4] American Society for Testing Materials, Standard Specifications for Classification of Coals by Rank (ASTM Designation: D388–38, ASA M20.1–1938): ASTM Standards, 1952, pt. 5, pp. 872–877.
[5] Parr, S. W., The Classification of Coal: Illinois Eng. Exp. Sta. Bull. 180, 1928, 62 pp.
[6] Barkley, J. F., and Burdick, L. R., Curves for the Classification of Coal: Bureau of Mines Inf. Circ. 6933, 1937, 6 pp.

TABLE 20.—*Classification of coals by rank* [1]

[Legend: FC—fixed carbon. VM—volatile matter. B. t. u.—British thermal units.]

Class	Group	Limits of fixed carbon or B. t. u., mineral-matter-free basis	Requisite physical properties
I. Anthracitic	1. Meta-anthracite	Dry FC, 98 percent or more (dry VM, 2 percent or less).	Nonagglomerating.[2]
	2. Anthracite	Dry FC, 92 percent or more and less than 98 percent (dry VM, 8 percent or less and more than 2 percent).	
	3. Semianthracite	Dry FC, 86 percent or more and less than 92 percent (dry VM, 14 percent or less and more than 8 percent).	
II. Bituminous [3]	1. Low-volatile bituminous coal.	Dry FC, 78 percent or more and less than 86 percent (dry VM, 22 percent or less and more than 14 percent).	
	2. Medium-volatile bituminous coal.	Dry FC, 69 percent or more and less than 78 percent (dry VM, 31 percent or less and more than 22 percent).	
	3. High-volatile A bituminous coal.	Dry FC, less than 69 percent (dry VM, more than 31 percent); and moist [4] B. t. u., 14,000 [5] or more.	
	4. High-volatile B bituminous coal.	Moist [4] B. t. u., 13,000 or more and less than 14,000.[5]	
	5. High-volatile C bituminous coal.	Moist B. t. u., 11,000 or more and less than 13,000.[5]	Either agglomerating or nonweathering.[6]
III. Subbituminous	1. Subbituminous A coal	Moist B. t. u., 11,000 or more and less than 13,000.[5]	Both weathering and nonagglomerating.
	2. Subbituminous B coal	Moist B. t. u., 9,500 or more and less than 11,000.[5]	
	3. Subbituminous C coal	Moist B. t. u., 8,300 or more and less than 9,500.[5]	
IV. Lignitic	1. Lignite	Moist B. t. u., less than 8,300	Consolidated.
	2. Brown coal	Moist B. t. u., less than 8,300	Unconsolidated.

[1] This classification does not include a few coals that have unusual physical and chemical properties and that come within the limits of fixed carbon or B. t. u. of the high-volatile bituminous and subbituminous ranks. All of these coals either contain less than 48 percent dry, mineral-matter-free fixed carbon or have more than 15,500 moist, mineral-matter-free B. t. u.

[2] If agglomerating, the coal is classified in low-volatile group of bituminous class.

[3] It is recognized that there may be noncaking varieties in each group of the bituminous class.

[4] Moist B. t. u. refers to coal containing its natural bed moisture but not including visible water on the surface of the coal.

[5] Coals containing 69 percent or more fixed carbon on the dry, mineral-matter-free basis shall be classified according to fixed carbon, regardless of B. t. u.

[6] There are three varieties of coal in the high-volatile C bituminous-coal group, namely: (1) Agglomerating and nonweathering; (2) agglomerating and weathering; (3) nonagglomerating and nonweathering.

SOURCES OF INFORMATION

The analyses in tables 22 and 23 supplement those published in Bureau of Mines Technical Papers 491 [7] and 618 [8] and are published here for the first time. The mine and tipple samples were taken by engineers of the Bureau of Mines and geologists of the Federal Geological Survey. The delivered samples were collected systematically from deliveries at Government installations by representatives of the Government departments under direction supplied by the Bureau of Mines.

The analyses were made by the Bureau of Mines in accordance with procedures given in Bulletin 492.[9]

FUSIBILITY OF ASH

Three critical temperatures are observed in the process of melting the test cone in the fusibility-of-ash determination. The first (initial deformation temperature) is defined as the temperature at which the apex of the cone begins to round or melt; it is lower than the second critical point (softening temperature). The softening temperature is that temperature at which the cone has fused down to a spherical lump; it is lower than the fluid temperature, the third critical point. The fluid temperature

[7] Ash, S. H., Yancey, H. F., Kiessling, O. E., Daniels, Joseph, Snyder, N. H., Plein, L. N., Fieldner, A. C., Cooper, H. M., and Osgood, F. D., Analyses of Washington Coals: Bureau of Mines Tech. Paper 491, 1931, 203 pp.

[8] Yancey, H. F., Geer, M. R., Daniels, Joseph, Snyder, N. H., Swingle, R. J., Cooper, H. M., and Abernethy, R. F., Analyses of Washington Coals, Supplement to Bureau of Mines Tech. Paper 491: Tech. Paper 618, 1941, 81 pp.

[9] Fieldner, A. C., and Selvig, W. A., Methods of Analyzing Coal and Coke: Bureau of Mines Bull. 492, 1951, 51 pp.

TABLE 21.—*Agglomerating properties of coals based upon examination of residue incident to the volatile-matter determination* [1]

Designation		Appearance of residue from standard method for determination of volatile matter in coal
Class	Group	
Nonagglomerating [2]—button shows no swelling or cell structure and will not support a 500-gram weight without pulverizing.	NA (nonagglomerate)	NAa—Noncoherent residue. NAb—Coke button shows no swelling or cell structure and after careful removal from the crucible will pulverize under a weight of 500 grams carefully lowered on button.
Agglomerating [2]—button shows swelling or cell structure or will support a 500-gram weight without pulverizing.	A (agglomerate)—button dull black, sintered; shows no swelling or cell structure; will support a 500-gram weight without pulverizing.	Aw (weak agglomerate)—button comes out of crucible in more than one piece. Af (firm agglomerate)—button comes out of crucible in one piece.
	C (caking)—button shows swelling or cell structure.	Cp (poor caking)—button shows slight swelling with small cells; has slight gray luster. Cf (fair caking)—button shows medium swelling and good cell structure; has characteristic metallic luster. Cg (good caking)—button shows strong swelling and pronounced cell structure, with numerous large cells and cavities; has characteristic metallic luster.

[1] Based upon Agglomerating and Agglutinating Tests for Classifying Weakly Caking Coals, by R. E. Gilmore, G. P. Connel, and J. H. H. Nicolls: Trans. AIME, Coal Div., vol. 108, 1934, pp. 255–265.

[2] Agglomerating index—coals which in the volatile-matter determination produce either an agglomerate button that will support a 500-gram weight without pulverizing or a button showing swelling or cell structure shall be classified as agglomerating.

is that temperature at which the molten mass spreads out into a flat layer over the refractory base holding the cone. These temperatures are determined by prescribed methods in a test furnace in which the cones are surrounded by a slightly reducing atmosphere.

The most significant of these three temperatures is the second, or softening temperature, and it is more easily reproduced.

The values obtained on individual samples are given in tables 22 and 23, columns 18, 19, and 20.

EXPLANATION OF SYMBOLS USED IN TABLE OF ANALYSES

Rank (column 3, table 22):

Lvb—low-volatile bituminous.
Mvb—medium-volatile bituminous.
Hvab—high-volatile A bituminous.
Hvbb—high-volatile B bituminous.
Hvcb—high-volatile C bituminous.
Suba—subbituminous A.
Subb—subbituminous B.
Subc—subbituminous C.
Lig—lignite.

Size or other description (column 4, table 22):

AC—air cleaned.
W—washed.

Agglomerating index (column 7, table 22):

NAa—nonagglomerate, noncoherent residue.
NAb—nonagglomerate, coherent residue.
Aw—weak agglomerate.
Af—firm agglomerate.
Cp—poor caking.
Cf—fair caking.
Cg—good caking.

Formulas for calculating dry, mineral-matter-free fixed carbon and moist, mineral-matter-free B. t. u. are given on p. 26. The formula for calculating dry, mineral-matter-free B. t. u. follows:

$$\text{Dry, mineral-matter-free B. t. u.} = \frac{\text{B. t. u.} - 50\,\text{sulfur}}{100 - (\text{moisture} + 1.08\,\text{ash} + 0.55\,\text{sulfur})} \times 100$$

TABLE 22.—*Analyses of mine, tipple, and delivered samples*

County, town, and mine	Bed	Rank [1]	Size or other description [1]	Kind of sample [2 3]	Condition [4]	Agglomerating index [1]	Proximate, percent: Moisture	Volatile matter	Fixed carbon	Ash	Ultimate, percent: Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen	Calorific value, B. t. u.	Fusibility of ash: Initial deformation temperature, °F.	Softening temperature, °F. [3]	Fluid temperature, °F.	Mineral-matter-free basis [1]: Fixed carbon, dry basis, percent	Calorific value: B. t. u., dry basis	B. t. u., moist basis	Laboratory No. or index No.	Reference, page in this report
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
KING COUNTY																								
Black Diamond:																								
Franklin	McKay	Hvbb		M	1	Cp	5.3	43.8	46.5	4.4	0.6					13,070	2,280	2,320	2,630	51.8	14,550	13,740	C21218	48
Do	do	Hvbb		M	1	Cp	6.3	41.1	44.1	8.5	.5					12,210	2,440	2,500	2,860	52.2	14,460	13,460	C21219	
Do	do	Hvbb		M	1	Cp	6.8	41.2	43.4	8.6	.6					12,160	2,720	2,800	2,860	51.8	14,510	13,420	C21220	
Do	do	Hvbb	Composite of C21218 to C21220.	M	1	Cp	6.3	41.6	44.9	7.2	.6	5.9	68.9	1.9	15.5	12,470				52.3	14,530	13,540	C21221	
					2			44.4	47.9	7.7	.6	5.6	73.5	2.0	10.6	13,300								
					3			48.1	51.9		.6	6.0	79.6	2.2	11.6	14,400								
Do	do	Hvbb	3-inch lump	T	1	Cp	5.3	42.6	47.9	4.2	.5	6.1	72.8	1.9	14.5	13,090	2,190	2,260	2,520	53.2	14,540	13,730	B99032	72
					2			45.0	50.5	4.5	.5	5.8	76.8	2.0	10.4	13,820								
					3			47.1	52.9		.5	6.1	80.4	2.1	10.9	14,460								
Do	do		3- by 1-inch (W)	T	1	Af	8.3	39.3	42.0	10.4	.5					11,650	2,810	2,860	2,910+				B99034	
					2			42.9	45.8	11.3	.6					12,710								
Do	do		1- by 3/32-inch (W)	T	1	Af	11.2	38.4	42.1	8.3	.5					11,560	2,810	2,870	2,910+				B99035	
					2			43.3	47.3	9.4	.6					13,020								
Do	do	Hvbb	3-inch by 0	T	1	Af	7.1	36.4	39.7	16.8	.6					10,750	2,790	2,840	2,910+				B99033	
					2			39.2	42.7	18.1	.6					11,570								
Do	do		1-inch by 0	T	1	Af	11.2	37.6	39.8	11.4	.7					10,970	2,660	2,790	2,910				B63744	
					2			42.3	44.9	12.8	.8					12,360								
Do	do		3/32-inch by 0	T	1	Af	28.8	29.5	34.0	7.7	.5					9,080	2,760	2,820	2,910+				B99036	
					2			41.5	47.7	10.8	.7					12,750								
Franklin Gem	Gem	Hvcb		M	1	Aw	9.6	38.0	41.9	10.5	.8	5.7	61.8	1.8	19.4	11,070	2,910+			53.2	14,030	12,500	C21380	48
					2			42.0	46.4	11.6	.9	5.1	68.3	2.0	12.1	12,240								
					3			47.6	52.4		1.0	5.8	77.3	2.3	13.6	13,850								
Do	do		1-inch lump	T	1	NAb	10.9	34.2	44.5	10.4	.6	5.8	60.9	1.7	20.6	10,940	2,910+						[5]B98791	72
					2			38.4	49.9	11.7	.6	5.1	68.4	1.9	12.3	12,270								
					3			43.5	56.5		.7	5.8	77.4	2.1	14.0	13,900								
Do	do		1-inch by 0	T	1	NAb	12.4	33.0	43.6	11.0	.7					10,530	2,860	2,890+					[5]B98792	
					2			37.6	49.9	12.5	.8					12,020								
Franklin No. 10	Franklin No. 10, upper bench.	Hvbb		M	1	Cp	7.4	35.7	40.7	16.2	.6	5.5	60.9	1.3	15.5	10,960	2,760	2,860	2,890	54.3	14,620	13,300	D7808	49
					2			38.5	44.0	17.5	.7	5.0	65.7	1.4	9.7	11,830								
					3			46.7	53.3		.8	6.1	79.7	1.7	11.7	14,350								
Do	Franklin No. 10, lower bench.	Hvbb		M	1	Cp	5.4	34.8	40.0	19.8	1.1	5.2	59.2	1.2	13.5	10,680	2,620	2,680	2,780	54.8	14,630	13,620	D7809	
					2			36.8	42.3	20.9	1.2	4.8	62.5	1.3	9.3	11,280								
					3			46.5	53.5		1.5	6.1	79.0	1.7	11.7	14,260								
Gem No. 1		Hvcb or Suba		M	1	NAa	14.8	33.2	34.9	17.1	.3	5.6	51.8	1.6	23.6	9,130	2,690	2,810	2,880	52.4	13,690	11,200	B62407	49
					2			38.9	41.1	20.0	.4	4.7	60.8	1.9	12.2	10,710								
					3			48.6	51.4		.5	5.8	76.0	2.4	15.3	13,400								
Gem No. 2	Gem	Hvcb or Suba		M	1	NAa	12.1	34.1	37.5	16.3	.4	5.5	54.6	1.8	21.4	9,700	2,890	2,910+		53.4	13,810	11,780	[5]C21382	49
					2			38.8	42.7	18.5	.5	4.8	62.2	2.0	12.0	11,030								
					3			47.6	52.4		.6	5.9	76.3	2.5	14.7	13,530								
Hi Heat	Franklin No. 10, upper bench.	Hvbb		M	1	Cp	5.5	37.9	39.4	17.2	.5	5.3	61.7	1.5	13.8	11,020	2,490	2,540	2,730	52.0	14,540	13,550	C21223	50
					2			40.1	41.7	18.2	.5	5.0	65.3	1.6	9.4	11,670								
					3			49.0	51.0		.6	6.1	79.9	1.9	11.5	14,260								

[1] See Explanation of Symbols (p. 28).
[2] M, mine sample; T, tipple sample; D, delivered coal.
[3] The bold-faced figure indicates the number of deliveries averaged.
[4] 1, Sample as received; 2, dried at 105° C.; 3, moisture- and ash-free.
[5] Volatile matter by modified method.

416655°—58——3

TABLE 22.—*Analyses of mine, tipple, and delivered samples*—Continued

County, town, and mine	Bed	Rank [1]	Size or other description [1]	Kind of sample [2 3]	Condition [4]	Agglomerating index [1]	Proximate, percent				Ultimate, percent					Calorific value, B. t. u.	Fusibility of ash			Mineral-matter-free basis [1]			Laboratory No. or index No.	Reference, page in this report
							Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen		Initial deformation temperature, °F.	Softening temperature, °F. [3]	Fluid temperature, °F.	Fixed carbon, dry basis, percent	Calorific value			
																					B. t. u., dry basis	B. t. u., moist basis		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
KING COUNTY—Con.																								
Black Diamond—Con.																								
Hi Heat	Franklin No. 10, lower bench.	Hvbb		M	1	Cf	6.1	39.7	42.4	11.8	0.4	5.8	63.9	1.4	16.7	12,030	2,380	2,470	2,580	52.3	14,840	13,809	C21224	50
					2			42.3	45.1	12.6	.4	5.4	68.0	1.5	12.1	12,800								
					3			48.4	51.6		.5	6.2	77.8	1.7	13.8	14,650								
Do	Franklin No. 10, upper and lower benches.	Hvbb	Composite of C21223 and C21224.	M	1	Cf	5.7	38.7	41.1	14.5	.4	5.6	63.3	1.4	14.8	11,530				52.3	14,680	13,680	C21225	
					2			41.0	43.6	15.4	.5	5.3	67.2	1.5	10.1	12,220								
					3			48.4	51.6		.5	6.2	79.4	1.8	12.1	14,440								
J. & P	Kummer No. 1	Hvcb or Suba		M	1	NAa	14.3	34.2	39.0	12.5	.3	5.7	55.1	1.2	25.2	9,740	2,660	2,730	2,790	54.1	13,500	11,260	[5] C21222	50
					2			39.9	45.5	14.6	.4	4.8	64.2	1.4	14.6	11,360								
					3			46.7	53.3		.4	5.7	75.3	1.6	17.0	13,310								
Kummer	Kummer No. 4	Subb		M	1	NAa	18.7	32.7	32.9	15.7	.6	5.8	49.0	1.0	27.9	8,309	2,370	2,450	2,680	51.2	13,390	10,360	[5] C40881	50
					2			40.3	40.4	19.3	.7	4.6	60.2	1.3	13.9	10,580								
					3			49.9	50.1		.9	5.6	74.7	1.6	17.2	13,120								
Landsburg			1⅝- by 3/16-inch	D	1		11.3	36.0	43.1	9.6	.5					10,870		2,860					1	72
					7																			
					2			40.6	48.6	10.8	.6					12,260		5						
Do			1⅝-inch by 0	D	1		11.0	36.8	43.1	9.1	.4					11,010		2,890					2	
					29																			
					2			41.4	48.4	10.2	.5					12,370		11						
Do			do	D	1		10.5	36.0	43.3	10.2	.6					10,930		2,810					3	
					9																			
					2			40.2	48.4	11.4	.7					12,210		5						
Do			do	D	1		10.6	37.1	42.5	10.4	.6					10,920		2,780					4	
					2			41.2	47.2	11.6	.7					12,130		11						
Palmer Nos. 10 and 12.	Franklin Nos. 10 and 12		4- by 1¼-inch (W)	T	1	Af	5.8	39.7	41.7	12.8	.6					11,740	2,840	2,910+					D21490	72
					2			42.2	44.2	13.6	.6					12,460								
Do	do		3½- by 1¼-inch	D	1		6.7	38.0	41.0	14.3	.6					11,370		2,890					5	
					22																			
					2			40.7	44.0	15.3	.6					12,190		3						
Do	do		1½- by 3/32-inch (W)	T	1	Af	7.6	38.0	42.6	11.8	.6	5.6	64.4	1.5	16.1	11,490	2,780	2,840	2,860				D90362	
					2			41.1	46.1	12.8	.7	5.2	69.7	1.6	10.0	12,440								
					3			47.1	52.9		.8	6.0	79.9	1.8	11.5	14,270								
Do	do		1¼- by 3/16-inch (W)	T	1	Cp	7.1	37.9	43.9	11.1	.6					11,820	2,870	2,910+					D21491	
					2			40.8	47.2	12.0	.6					12,720								
Cumberland:																								
Durham	Durham No. 2	Hvab		M	1	Cg	3.4	31.4	47.8	17.4	.9	5.0	65.4	1.0	10.3	11,590	2,560	2,620	2,730	61.7	14,930	14,300	C22079	51
					2			32.4	49.5	18.1	.9	4.7	67.6	1.1	7.6	11,990								
					3			39.6	60.4		1.1	5.8	82.5	1.3	9.3	14,640								
Hyde	McKay	Hvbb		M	1	Cf	6.1	39.4	40.9	13.6	.7	5.7	63.9	1.6	14.5	11,610	2,910+			51.8	14,690	13,630	C21558	51
					2			41.9	43.6	14.5	.7	5.4	68.0	1.7	9.7	12,310								
					3			49.0	51.0		.8	6.3	79.5	2.0	11.4	14,390								
National	No. 1		Run-of-mine	T	1	Cf	7.5	33.5	41.4	17.6	.5	5.4	60.7	1.2	14.6	10,930	2,530	2,680	2,780	56.4	14,900	13,510	B99848	72
					2			36.3	44.7	19.0	.5	5.0	65.7	1.3	8.5	11,820								
					3			44.8	55.2		.7	6.1	81.1	1.5	10.6	14,600								
Olson No. 1			1½-inch by 0	D	1		3.7	41.6	42.1	12.6	.8					12,160		2,880					6	72
					1			43.2	43.7	13.1	.8					12,620		1						
Enumclaw:																								
Green River	Kummer No. 4 (?)	Hvcb or Suba		M	1	NAa	14.6	30.0	37.1	18.3	.3	5.3	51.4	.8	23.9	8,980	2,380	2,530	2,760	56.7	13,690	11,200	[5] C21381	52
					2			35.1	43.5	21.4	.3	4	3	60.2	1.0	12.8	10,510							
					3			44.7	55.3		.4	5.5	76.6	1.2	16.3	13,380								

Do.	do.		3¼-inch by 0 (W)	T	1	NAa	15.5	30.6	39.2	14.7	.2	5.6	52.7	.7	26.1	9,260	2,420	2,490	2,730				[5] C60717	72
					2			36.1	46.5	17.4	.3	4.6	62.3	.8	14.6	10,950								
					3			43.8	56.2		.3	5.6	75.5	1.0	17.6	13,270								
Issaquah: Grand Ridge			12- by 3½-inch	D	1		13.8	31.8	38.5	15.9	.4					9,510							7	72
				1	2			36.9	44.6	18.5	.5					11,030								
Do.			3½- by 1-inch	D	1		14.5	33.4	39.3	12.8	.4					9,880							8	
				1	2			39.1	45.9	15.0	.5					11,560								
Harris No. 2	Jones	Hvcb or Suba		M	1	NAb	13.8	35.2	36.2	14.8	.6	6.1	54.7	1.2	22.6	9,890	2,910+			51.7	14,110	11,780	B75318	52
					2			40.9	41.9	17.2	.7	5.3	63.5	1.4	11.9	11,470								
					3			49.3	50.7		.8	6.3	76.6	1.7	14.6	13,850								
Issaquah	Lower Bagley		Run-of-mine	T	1	NAa	16.2	31.7	34.9	17.2	.4	5.7	50.2	1.0	25.5	8,910	2,810	2,890	2,910+	53.5	13,680	10,950	[5] B96353	72
					2			37.8	41.7	20.5	.4	4.6	59.8	1.2	13.5	10,630								
					3			47.5	52.5		.5	5.8	75.3	1.6	16.8	13,370								
Lahee	Dolly Varden	Hvcb or Suba		M	1	NAb	15.6	33.6	37.1	13.7	1.4	6.0	53.8	1.4	23.7	9,750	2,570	2,800	2,860	53.6	14,060	11,470	[5] D19163	52
					2			39.8	44.0	16.2	1.6	5.1	63.7	1.6	11.8	11,540								
					3			47.5	52.5		1.9	6.1	76.0	1.9	14.1	13,780								
Queen No. 1	Muldoon	Suba		M	1	NAa	13.3	31.7	36.8	18.2	.4	5.5	51.8	1.3	22.8	9,200	2,720	2,780	2,830	54.9	13,740	11,460	[5] D18545	53
					2			36.6	42.4	21.0	.5	4.6	59.8	1.5	12.6	10,620								
					3			46.3	53.7		.6	5.9	75.7	1.9	15.9	13,430								
Do.	Lower Bagley, 75 percent; May Creek, 25 percent.		3-inch lump	T	1	NAa	13.4	36.6	40.9	9.1	.4					10,570	2,620	2,700	2,780	53.3	13,780	11,730	B62575	72
					2			42.2	47.3	10.5	.5					12,200								
Do.	Lower Bagley, 60 percent; Upper Bagley, 20 percent; Muldoon, 20 percent.		do.	T	1	NAa	12.3	34.4	38.2	15.1	.7					9,980	2,620	2,730	2,910	53.7	14,010	11,940	[5] B96671	
					2			39.2	43.6	17.2	.8					11,390								
Do.	do.		3- by 1-inch (W)	T	1	NAa	13.2	33.4	33.4	20.0	.7					9,000	2,790	2,890	2,910+				[5] B96672	
					2			38.5	38.5	23.0	.8					10,370								
Do.	do.		3- by 1-inch	D	1		14.5	33.8	37.1	14.6	.8					9,570		2,750					9	
				4	2			39.5	43.4	17.1	.9					11,190		**2**						
Do	do.		do.	D	1		13.7	33.7	36.0	16.6	.7					9,400							10	
				14	2			39.1	41.7	19.2	.8					10,890								
Do.	Upper Bagley, 70 percent; May Creek, 30 percent.		3- by ¾-inch (W)	T	1	NAa	12.8	33.1	38.8	15.3	.3					9,770	2,860	2,910+					[5] B61222	73
					2			37.9	44.5	17.6	.4					11,200								
Do	Lower Bagley, 60 percent; Upper Bagley, 20 percent; and Muldoon, 20 percent.		1- by 3⁄16-inch (W)	T	1	NAa	16.0	31.6	37.2	15.2	.6					9,410	2,780	2,850	2,910+				[5] B96673	
					2			37.7	44.2	18.1	.8					11,200								
Do.	do.		3-inch by 0	T	1	NAa	14.5	31.5	34.1	19.9	.5					8,790	2,740	2,820	2,910+				[5] B96675	
					2			36.8	40.0	23.2	.6					10,270								
Do.	do.		3⁄16-inch by 0 (W)	T	1	NAa	20.7	29.8	36.8	12.7	.5	6.2	50.6	1.1	28.9	9,080	2,710	2,790	2,910				[5] B96674	
					2			37.6	46.4	16.0	.6	4.9	63.8	1.4	13.3	11,460								
					3			44.8	55.2		.7	5.8	76.0	1.6	15.9	13,640								
Palmer: Elk No. 3	Dutch	Hvbb		M	1	Cp	5.5	32.3	35.0	27.2	.7	4.9	53.7	1.2	12.3	9,730	2,840	2,910+		53.9	14,980	13,800	B61445	53
					2			34.2	37.0	28.8	.7	4.5	56.8	1.2	8.0	10,300								
					3			48.0	52.0		1.0	6.4	79.8	1.7	11.1	14,480								
Do.	do.	Hvbb		M	1	Af	6.1	31.3	30.8	31.8	.5	4.7	48.9	1.1	13.0	8,810	2,730	2,840	2,910+	51.8	14,820	13,440	D1342	
					2			33.3	32.8	33.9	.6	4.2	52.1	1.2	8.0	9,380								
					3			50.4	49.6		.9	6.4	78.8	1.7	12.2	14,180								
Do.	"A" or Victory, upper bench.	Hvbb		M	1	Cp	9.1	33.4	36.8	20.7	.7	5.4	56.1	1.3	15.8	10,090	2,360	2,470	2,600	53.9	14,750	13,020	D1344	
					2			36.8	40.4	22.8	.7	4.8	61.6	1.4	8.7	11,100								
					3			47.6	52.4		.9	6.2	79.8	1.9	11.2	14,370								
Do.	"A" or Victory, lower bench.	Hvbb		M	1	Cp	5.4	35.4	40.0	19.2	.9	5.2	60.0	1.4	13.3	10,750	2,570	2,680	2,730	54.4	14,590	13,590	D1343	
					2			37.4	42.3	20.3	1.0	4.8	63.4	1.5	9.0	11,360								
					3			46.9	53.1		1.2	6.1	79.5	1.9	11.3	14,250								
Do.	Big Elk		Run of-mine	T	1	Cp	6.4	25.6	29.7	38.3	.4					7,660	2,680	2,790	2,890	56.9	14,690	13,080	B96020	73
					2			27.4	31.7	40.9	.5					8,170								
Do.	Victory		do.	T	1	Cp	7.0	31.5	33.7	27.8	.6					9,230	2,640	2,710	2,850	53.6	14,680	13,210	B96021	
					2			33.8	36.3	29.9	.7					9,920								
Do.	Victory, 66⅔ percent; Big Elk, 33⅓ percent.		do.	T	1	Cp	6.6	27.7	31.6	34.1	.5					8,310	2,740	2,810	2,910+	56.0	14,720	13,170	B96019	
					2			29.7	33.8	36.5	.6					8,890								
Do.	do.		4-inch lump	T	1	Cp	4.3	38.0	42.6	15.1	.6	5.5	65.1	1.5	12.2	11,700	2,480	2,590	2,730	53.8	14,760	14,000	B96016	
					2			39.7	44.5	15.8	.6	5.2	68.0	1.6	8.8	12,230								
					3			47.2	52.8		.7	6.2	80.8	1.8	10.5	14,520								
Do.	do.		4- by 1½-inch (W)	T	1	Cp	5.5	34.1	37.1	23.3	.7					10,200	2,890	2,910+					B96017	
					2			36.1	39.2	24.7	.7					10,800								
Do.	do.		1½-inch by 0 (W)	T	1	Cp	9.2	31.6	38.4	20.8	.7					10,110	2,890	2,910+					B96018	
					2			34.8	42.3	22.9	.7					11,130								

[1] See Explanation of Symbols (p. 28).
[2] M, mine sample; T, tipple sample; D, delivered coal.
[3] The bold-faced figure indicates the number of deliveries averaged.
[4] 1, Sample as received; 2, dried at 105° C.; 3, moisture- and ash-free.
[5] Volatile matter by modified method.

TABLE 22.—*Analyses of mine, tipple, and delivered samples*—Continued

County, town, and mine	Bed	Rank [1]	Size or other description [1]	Kind of sample [2 3]	Condition [4]	Agglomerating index [1]	Proximate, percent				Ultimate, percent					Calorific value, B. t. u.	Fusibility of ash			Mineral-matter-free basis [1]			Laboratory No. or index No.	Reference, page in this report
							Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen		Initial deformation temperature, °F.	Softening temperature, °F.[3]	Fluid temperature, °F.	Fixed carbon, dry basis, percent	Calorific value: B. t. u., dry basis	Calorific value: B. t. u., moist basis		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
KING COUNTY—Con.																								
Palmer—Continued																								
Elk No. 3	"A", 80 percent; Big Elk, 20 percent.		7/8-inch by 0 (W)	T	1	Cp	6.2	34.5	42.0	17.3	0.6					11,130	2,630	2,710	2,840				B61370	73
					2			36.8	44.8	18.4	.6					11,870								
Ravensdale:																								
Anderson No. 7			12- by 1½-inch	D	1		13.6	32.7	40.3	13.4	.5					9,620							11	73
					2			37.9	46.6	15.5	.6					11,140								
Do			12- by 1¼-inch	D	1		15.1	33.5	38.3	13.1	.5					9,540							12	
					4			39.4	45.2	15.4	.6					11,240								
Do			do	D	1		15.0	32.6	38.7	13.7	.5					9,440							13	
					6			38.4	45.5	16.1	.6					11,100								
Do			1¼-inch by 0	D	1		17.5	33.0	38.4	11.1	.5					9,410		2,540					14	
					2			40.0	46.6	13.4	.6					11,410		2						
Do			do	D	1		17.4	31.7	38.0	12.9	.6					9,090		2,620					15	
					2			38.4	46.0	15.6	.7					11,010		1						
Danville No. 1	Frazier	Hvcb or Suba		M	1	NAa	15.0	32.6	43.4	9.0	.6					10,140	2,590	2,710	2,790	57.8	13,490	11,240	[5] B51279	54
Do	do	Hvcb or Suba		M	1	NAa	15.9	32.7	42.9	8.5	.5					10,130	2,530	2,660	2,690	57.3	13,540	11,160	[5] B51280	
Do	do	Hvcb or Suba	Composite of B51279 and B51280.	M	1	NAa	15.4	32.5	43.4	8.7	.5	6.0	57.4	1.6	25.8	10,140				57.8	13,500	11,200	[5] B51281	
					2			38.5	51.2	10.3	.6	5.0	67.8	1.9	14.4	11,990								
					3			42.9	57.1		.7	5.6	75.6	2.2	15.9	13,370								
Do	do	Hvcb	3½-inch lump	T	1	NAb	9.9	36.4	39.2	14.5	1.4					10,410	2,490	2,640	2,770	52.9	14,040	12,370	B99772	
					2			40.4	43.6	16.0	1.6					11,550								
Do	do		3½- by 3/16-inch (W)	T	1	NAb	13.2	33.9	37.5	15.4	.9					9,840	2,700	2,800	2,910+				B99773	
					2			39.1	43.1	17.8	1.0					11,340								
Do	do		7/8- by 3/8-inch (W)	T	1	NAa	16.4	32.0	41.2	10.4	.5					9,760	2,520	2,800	2,870				[5] B51603	
					2			38.3	49.2	12.5	.6					11,670								
Do	do		7/8- by 3/16-inch (W)	T	1	NAb	15.7	33.6	38.8	11.9	.9	6.0	55.7	1.3	24.2	10,040	2,720	2,790	2,900				B99774	
					2			39.8	46.1	14.1	1.1	5.1	66.0	1.5	12.2	11,900								
					3			46.3	53.7		1.2	5.9	76.9	1.8	14.2	13,860								
Do	do		3/16-inch by 0 (W)	T	1	NAb	21.2	30.8	33.1	14.9	.8					8,780	2,720	2,770	2,910				B99775	
					2			39.0	42.1	18.9	1.1					11,140								
Danville No. 2	Eight-Foot	Hvcb or Suba		M	1	NAb	10.5	37.4	40.0	12.1	1.0	5.7	60.0	1.4	19.8	10,630	2,730	2,840	2,910+	52.5	13,940	12,250	C22080	54
					2			41.8	44.7	13.5	1.2	5.1	67.1	1.5	11.6	11,880								
					3			48.3	51.7		1.3	5.8	77.6	1.8	13.5	13,750								
Do	do	Hvcb or Suba		M	1	NAb	7.4	38.9	40.6	13.1	.8	5.5	61.7	1.5	17.4	11,020	2,710	2,750	2,810	51.9	14,080	12,860	D90541	
					2			42.0	43.9	14.1	.8	5.0	66.6	1.6	11.9	11,900								
					3			48.9	51.1		1.0	5.8	77.6	1.9	13.7	13,860								
Do	Landsburg No. 1	Hvcb or Suba		M	1	NAb	11.3	35.5	39.7	13.5	.3	5.7	57.4	1.5	21.6	10,260	2,420	2,500	2,620	53.7	13,850	12,020	[5] D21493	
					2			40.0	44.8	15.2	.3	5.0	64.7	1.7	13.1	11,560								
					3			47.2	52.8		.4	5.9	76.3	2.0	15.4	13,640								
Do	do		6- by 1½-inch (W)	T	1	NAb	9.5	37.5	43.8	9.2	.4					11,270	2,730	2,860	2,910+				[5] D65014	73
					2			41.5	48.3	10.2	.4					12,460								

Do	do		1½- by 3⁄32-inch (W)	T	1	Aw	12.3	38.1	40.1	9.5	.6	5.9	60.3	1.5	22.2	10,720	2,800	2,850	2,890				D90363	
					2			43.5	45.7	10.8	.6	5.2	68.7	1.8	12.9	12,230								
					3			48.7	51.3		.7	5.8	77.0	2.0	14.5	13,700								
Do	Landsburg No. 1, lower bench.	Hvcb		M	1	Aw	11.0	39.4	43.0	6.6	.3	6.0	64.4	1.6	21.1	11,380	2,420	2,660	2,700	52.5	13,910	12,260	D42878	55
					2			44.3	48.3	7.4	.4	5.3	72.3	1.8	12.8	12,780								
					3			47.8	52.2		.4	5.8	78.1	2.0	13.7	13,800								
Do	Six-Foot	Hvcb		M	1	Aw	9.0	39.9	41.2	9.9	.5	5.7	62.5	1.6	19.8	11,250	2,360	2,420	2,540	51.4	14,030	12,610	D56374	
					2			43.9	45.2	10.9	.5	5.2	68.7	1.7	13.0	12,360								
					3			49.2	50.8		.6	5.8	77.2	1.9	14.5	13,880								
McKay	McKay, upper bench	Hvcb or Suba		M	1	NAb	10.9	38.5	45.3	5.3	.4	6.0	64.8	1.8	21.7	11,380	2,100	2,190	2,520	54.4	13,660	12,080	[5] C96786	55
					2			43.2	50.8	6.0	.4	5.3	72.8	2.0	13.5	12,770								
					3			45.9	54.1		.4	5.7	77.4	2.1	14.4	13,590								
Do	McKay, lower bench	Hvcb or Suba		M	1	NAb	10.2	39.0	47.0	3.8	.6	6.2	67.4	1.8	20.2	12,020	2,150	2,210	2,550	54.9	14,040	12,550	[5] C95581	
					2			43.5	52.3	4.2	.6	5.7	75.1	2.0	12.4	13,390								
					3			45.4	54.6		.7	5.9	78.4	2.1	12.9	13,980								
Do	McKay		3½-inch lump	T	1	NAb	9.7	39.6	46.4	4.3	.7	6.2	66.9	1.8	20.1	11,990	2,100	2,140	2,300	54.3	14,020	12,590	[5] B95540	73
					2			43.9	51.4	4.7	.7	5.7	74.1	2.0	12.8	13,280								
					3			46.0	54.0		.8	5.9	77.8	2.1	13.4	13,930								
Do	do		do	D	1		9.1	37.9	48.5	4.5	.6					11,940							16	
				1	2			41.7	53.4	4.9	.7					13,140								
Do	do		3½- by 1¼-inch (W)	T	1	NAb	10.2	38.6	46.4	4.8	.6					11,840	2,060	2,100	2,310				[5] B95541	
					2			42.9	51.7	5.4	.7					13,180								
Do	do		3½- by 1¼-inch	D	1		10.6	37.0	47.3	5.1	.6					11,770							17	
				10	2			41.4	52.9	5.7	.7					13,170								
Do	do		do	D	1		9.3	39.1	46.7	4.9	.5					11,970							18	
				8	2			43.1	51.5	5.4	.6					13,200								
Do	do		3½- by 1-inch	D	1		7.9	42.0	46.1	4.0	.8					12,320							19	
				2	2			45.6	50.1	4.3	.9					13,380								
Do	do		3- by 1-inch	D	1		8.9	40.9	45.4	4.8	.6					12,040							20	
				18	2			44.9	49.8	5.3	.7					13,220								
Do	do		1¼- by 1-inch (W)	T	1	NAb	11.0	37.7	46.3	5.0	.6					11,790	2,140	2,190	2,340				[5] B95542	
					2			42.4	52.0	5.6	.6					13,250								
Do	do		1¼- by 3⁄32-inch	D	1		12.1	38.7	44.6	4.6	.6					11,750							21	
				6	2			44.0	50.8	5.2	.7					13,370								
Do	do		1- by 3⁄8-inch	D	1		12.3	36.1	46.9	4.7	.5					11,600							22	
				1	2			41.2	53.4	5.4	.6					13,220								
Do	do		1- by 3⁄32-inch (W)	T	1	NAb	10.6	39.0	45.0	5.4	.6					11,700	2,260	2,320	2,520				[5] B95543	
					2			43.7	50.2	6.1	.6					13,100								
Do	do		1- by 3⁄32-inch	D	1		10.5	39.4	45.4	4.7	.6					11,810							23	
				20	2			44.0	50.7	5.3	.7					13,190								
Do	do		do	D	1		12.5	38.4	43.3	5.8	.6					11,360		2,330					24	
				8	2			43.9	49.5	6.6	.7					12,980		7						
Do	do		do	D	1		11.1	39.8	42.8	6.3	.8					11,450		2,340					25	
				6	2			44.8	48.1	7.1	.9					12,880		5						
Do	do		3½-inch by 0	T	1	NAb	12.8	36.0	41.0	10.2	.7					10,630	2,240	2,290	2,490				[5] B95545	
					2			41.3	47.0	11.7	.8					12,190								
Do	do		2-inch by 0	D	1		10.9	36.3	48.0	4.8	.5					11,720							26	
				12	2			40.7	53.9	5.4	.6					13,150								
Do	do		3⁄32-inch by 0 (W)	T	1	NAb	15.0	35.0	45.2	4.8	.4					11,050	2,320	2,380	2,520				[5] B95544	
					2			41.1	53.3	5.6	.5					13,000								
McKay strip	do		3½- by 1⅜-inch (W)	T	1	NAb	11.7	39.6	43.4	5.3	.4					11,420	2,910+						[5] D50537	73
					2			44.8	49.2	6.0	.4					12,920								
Do	do		1⅜-inch by ½-mm. (W).	T	1	NAb	13.6	37.3	43.7	5.4	.4					11,040	2,910+						[5] D50538	
					2			43.2	50.5	6.3	.4					12,780								
Ravensdale strip	Nos. 3, 3½, and 4		4½- by 1⅝-inch (W)	T	1	Aw	6.8	38.0	39.4	15.8	1.0					10,880	2,680	2,840	2,910+				E14606	73
					2			40.7	42.4	16.9	1.1					11,670								
Do	do		3½- by 1¼-inch	D	1		9.9	36.1	39.9	14.1	.7					10,450		2,850					27	
				22	2			40.1	44.2	15.7	.8					11,600		1						
Do	do		1⅝-inch by 0 (W)	T	1	Af	8.7	38.0	40.4	12.9	.8					11,020	2,700	2,780	2,880				E14266	
					2			41.7	44.2	14.1	.9					12,080								
Do	do		do	T	1	Cp	8.0	37.4	40.3	14.3	1.1					11,000	2,680	2,740	2,870				E10304	
					2			40.7	43.8	15.5	1.2					11,960								
Ravensdale No. 4 strip.	No. 4		4- by 3⁄32-inch (W)	T	1	Cp	8.4	38.3	42.2	11.1	.5					11,430	2,670	2,700	2,750				E1657	73
					2			41.8	46.1	12.1	.5					12,470								
Do	do		Modified 1¾- by 3⁄32-inch (W) (¾- by ⅜-inch removed).	T	1	Cp	9.0	36.4	39.5	15.1	.9					10,750	2,810	2,890	2,910+				E37813	
					2			40.0	43.4	16.6	1.0					11,810								
Do	do		¾- by ⅜-inch (W)	T	1	Cp	8.9	37.1	39.2	14.8	.9					10,810	2,760	2,850	2,910+				E37814	
					2			40.7	43.1	16.2	1.0					11,860								

[1] See Explanation of Symbols (p. 28).
[2] M, mine sample; T, tipple sample; D, delivered coal.
[3] The bold-faced figure indicates the number of deliveries averaged.
[4] 1, Sample as received; 2, dried at 105° C.; 3, moisture- and ash-free.
[5] Volatile matter by modified method.

TABLE 22.—*Analyses of mine, tipple, and delivered samples*—Continued

County, town, and mine	Bed	Rank [1]	Size or other description [1]	Kind of sample [2 3]	Condition [4]	Agglomerating index [1]	Proximate, percent: Moisture	Volatile matter	Fixed carbon	Ash	Ultimate, percent: Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen	Calorific value, B. t. u.	Fusibility of ash: Initial deformation temperature, °F.	Softening temperature, °F.[3]	Fluid temperature, °F.	Mineral-matter-free basis [1]: Fixed carbon, dry basis, percent	Calorific value: B. t. u., dry basis	Calorific value: B. t. u., moist basis	Laboratory No. or index No.	Reference, page in this report
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
KING COUNTY—Con.																								
Renton:																								
Coal Creek prospect	No. 3½	Hvcb or Suba		M	1	NAa	16.3	32.0	38.9	12.8	1.1	5.8	54.0	1.3	25.0	9,580	2,180	2,420	2,470	55.9	13,610	11,010	[5] D65685	55
					2			38.2	46.5	15.3	1.3	4.8	64.5	1.6	12.5	11,450								
					3			45.1	54.9		1.6	5.7	76.1	1.8	14.8	13,520								
Ivan Jones prospect		Hvcb or Suba		M	1	NAb	11.1	40.5	42.4	6.0	.7	6.3	64.8	1.8	20.4	11,670	2,310	2,490	2,680	51.6	14,180	12,490	[5] B78372	56
					2			45.6	47.7	6.7	.8	5.7	73.0	2.1	11.7	13,140								
					3			48.9	51.1		.8	6.1	78.2	2.2	12.7	14,080								
New Black Diamond	Jones		6- by 1-inch	D	1		9.5	39.3	46.0	5.2	.4					11,900							28	74
					5			43.4	50.8	5.8	.4					13,150								
Do	do		3- by 1-inch	D	1		11.8	35.9	39.3	13.0	.4					10,350							29	
					2			40.7	44.6	14.7	.5					11,740								
Do	do		7/8- by 3/8-inch	D	1		12.3	33.9	41.7	12.1	.4					10,450							30	
					14			38.6	47.6	13.8	.5					11,920								
Newcastle	do	Suba		M	1	NAb	11.6	37.5	41.3	9.6	.7	6.0	61.3	1.4	21.0	10,970	2,730	2,800	2,870	53.1	14,080	12,250	[5] D18546	56
					2			42.4	46.7	10.9	.7	5.3	69.3	1.6	12.2	12,410								
					3			47.6	52.4		.8	6.0	77.8	1.8	13.6	13,930								
Do	Bagley, 66⅔ percent; May Creek, 33⅓ percent.		Run-of-mine	T	1	NAa	15.6	30.2	34.8	19.4	.4					8,720	2,360	2,500	2,760	54.9	13,760	11,040	[5] B96407	74
					2			35.8	41.2	23.0	.5					10,330								
Do	do		3½-inch lump	T	1	NAa	13.2	34.0	37.2	15.6	.3					9,710	2,680	2,780	2,910+	53.3	13,890	11,680	[5] B96403	
					2			39.2	42.9	17.9	.4					11,190								
Do	do		3½- by 1-inch (W)	T	1	NAa	14.4	35.0	36.1	14.5	.4					9,640	2,890	2,910+					[5] B96404	
					2			40.9	42.1	17.0	.4					11,260								
Do	do		1- by ¼-inch (W)	T	1	NAa	18.0	32.5	37.0	12.5	.4					9,430	2,750	2,910+					[5] B96405	
					2			39.6	45.2	15.2	.4					11,500								
Do	do		¼-inch by 0 (W)	T	1	NAa	19.4	31.9	36.6	12.1	.4	6.2	52.3	1.2	27.8	9,240	2,510	2,750	2,910				[5] B96406	
					2			39.6	45.3	15.1	.5	5.0	64.9	1.5	13.0	11,470								
					3			46.6	53.4		.6	5.8	76.4	1.8	15.4	13,510								
Do	Bagley and May Creek		3- by 1⅝-inch	D	1		12.1	36.0	38.3	13.6	.4					10,220							31	
					2			41.0	43.5	15.5	.5					11,630								
Do	do		3- by 1-inch	D	1		11.5	35.9	38.4	14.2	.4					10,130							32	
					5			40.6	43.3	16.1	.4					11,450								
Do	do		7/8- by 3/8-inch	D	1		14.6	34.2	40.3	10.9	.4					10,260							33	
					16			40.1	47.1	12.8	.5					12,010								
Do			3- by 1-inch	D	1		12.9	34.8	40.4	11.9	.6					10,430							34	
					1			40.0	46.3	13.7	.7					11,970								
Do			1- by 3/16-inch	D	1		10.9	35.6	42.3	11.2	.7					10,760							35	
					1			39.9	47.5	12.6	.8					12,080								
Newcastle (Coal Creek).	Upper Bagley, 20 percent; Lower Bagley, 60 percent; Muldoon, 20 percent.		3- by 1 3/16-inch (W).	T	1	NAa	12.1	35.8	40.8	11.3	.4					10,560	2,660	2,780	2,910				[5] B61223	74
					2			40.7	46.4	12.9	.4					12,020								
Do	Upper Bagley, 50 percent; Lower Bagley, 30 percent; Muldoon, 20 percent.		1 3/16- by 5/16-inch (W).	T	1	NAa	14.9	35.2	39.9	10.0	.4					10,320	2,520	2,670	2,830				B61684	
					2			41.4	46.8	11.8	.5					12,130								

Do	Bagley		Run-of-mine	T	1	NAa	12.8	32.5	33.3	21.4	.3					8,840	2,610	2,750	2,850	52.1	13,810	11,500	[5] B96402	
					2			37.3	38.1	24.6	.3					10,130								
Do	do		3½-inch lump	T	1	NAa	13.1	34.3	42.3	10.3	.4	5.6	58.9	1.4	23.4	10,460	2,710	2,790	2,910+	55.8	13,820	11,780	[5] B96398	
					2			39.5	48.7	11.8	.4	4.8	67.9	1.6	13.5	12,050								
					3			44.8	55.2		.5	5.4	76.9	1.8	15.4	13,660								
Do	do		6- by 1-inch	D	1		11.6	36.2	41.6	10.6	.4					10,730							36	
				18	2			40.9	47.1	12.0	.5					12,140								
Do	do		3½- by 1¼-inch	D	1		12.0	34.9	38.2	14.9	.5					10,040							37	
				5	2			39.7	43.4	16.9	.6					11,410								
Do	do		do	D	1		12.9	34.5	37.0	15.6	.5					9,780							38	
				9	2			39.6	42.5	17.9	.6					11,230								
Do	do		3½- by 1-inch (W)	T	1	NAa	13.2	34.2	38.5	14.1	.4					9,970	2,790	2,910+					[5] B96399	
					2			39.4	44.4	16.2	.4					11,480								
Do	do		1- by ¼-inch (W)	T	1	NAa	17.3	32.8	38.6	11.3	.3					9,730	2,730	2,850	2,910+				[5] B96400	
					2			39.7	46.7	13.6	.4					11,760								
Do	do		¼-inch by 0 (W)	T	1	NAa	17.8	32.1	38.9	11.2	.3					9,680	2,690	2,740	2,850				[5] B96401	
					2			39.1	47.3	13.6	.4					11,780								
New Lake Young	No. 2		⅞- by ⅜-inch	D	1		9.9	39.6	41.3	9.2	1.3					11,350							39	74
				9	2			43.9	45.9	10.2	1.4					12,600								
Springbrook No. 3	Springbrook No. 2, upper bench.		Run-of-mine	T	1	NAa	15.5	28.2	33.8	22.5	.4					8,210	2,280	2,420	2,590	56.2	13,650	10,850	[5] B96087	74
					2			33.4	40.0	26.6	.5					9,710								
Do	do		3-inch lump	T	1	NAa	13.9	33.1	39.4	13.6	.3					9,780	2,310	2,470	2,610	55.3	13,710	11,470	[5] B96083	
					2			38.4	45.8	15.8	.4					11,360								
Do	do		3- by 1-inch (W)	T	1	NAa	14.5	32.9	39.5	13.1	.4					9,770	2,320	2,500	2,750				[5] B96084	
					2			38.5	46.2	15.3	.5					11,430								
Do	do		1- by ⅛-inch (W)	T	1	NAa	17.4	31.2	39.4	12.0	.4	6.0	53.4	1.3	26.9	9,460	2,310	2,520	2,730				[5] B96085	
					2			37.8	47.7	14.5	.5	4.9	64.7	1.6	13.8	11,450								
					3			44.2	55.8		.6	5.7	75.7	1.8	16.2	13,390								
Do	do		⅛-inch by 0 (W)	T	1	NAa	22.5	27.0	36.0	14.5	.5					8,390	2,320	2,480	2,730				[5] B96086	
					2			34.8	46.5	18.7	.6					10,830								
Talbot	Springbrook, middle bench.	Hvcb or Suba		M	1	NAa	15.1	34.9	39.6	10.4	.8	5.9	56.8	1.3	24.8	10,150	2,590	2,640	2,770	53.9	13,810	11,450	[5] C21559	56
					2			41.1	46.6	12.3	.9	5.0	66.9	1.6	13.3	11,960								
					3			46.8	53.2		1.0	5.7	76.2	1.8	15.3	13,630								
Do	Springbrook, upper bench.		3½-inch lump	T	1	NAa	13.8	32.8	40.2	13.2	.9					9,890	2,310	2,450	2,720	56.1	13,780	11,550	[5] C1143	74
					2			38.1	46.5	15.4	1.0					11,480								
Do	do		3½- by 1-inch (W)	T	1	NAa	14.2	34.5	40.5	10.8	.7					10,230	2,470	2,590	2,800				[5] C1144	
					2			40.2	47.2	12.6	.9					11,920								
Do	do		1- by ⅛-inch (W)	T	1	NAa	17.4	33.3	39.2	10.1	.7	6.1	54.9	1.2	27.0	9,840	2,370	2,520	2,760				[5] C1145	
					2			40.3	47.5	12.2	.8	5.1	66.4	1.5	14.0	11,910								
					3			45.9	54.1		1.0	5.8	75.6	1.7	15.9	13,560								
Do	do		⅛-inch by 0 (W)	T	1	NAa	28.0	28.0	33.8	10.2	.6					8,370	2,340	2,470	2,720				[5] C1146	
					2			38.9	46.9	14.2	.9					11,620								
KITTITAS COUNTY																								
Ronald: Jonesville No. 4	Wright (Roslyn No. 6)		Run-of-mine	T	1	Cf	4.2	31.0	42.4	22.4	.4	4.9	60.7	1.1	10.5	10,970	2,610	2,670	2,780	59.3	15,340	14,490	B97524	74
					2			32.4	44.2	23.4	.4	4.7	63.4	1.2	6.9	11,450								
					3			42.3	57.7		.5	6.1	82.7	1.5	9.2	14,950								
Ronald No. 2	Big (Roslyn No. 1)		Run-of-mine (crushed to 2½-inch).	T	1	Cf	4.3	34.9	39.4	21.4	.3					10,830	2,690	2,740	2,910	54.4	14,930	14,100	B97304	74
					2			36.5	41.1	22.4	.3					11,320								
Do	do		2½- by 1⅝-inch (W)	T	1	Cf	3.3	35.8	43.1	17.8	.3					11,640	2,910+						B97299	
					2			37.0	44.6	18.4	.3					12,040								
Do	do		1⅝- by ¾-inch (W)	T	1	Cf	3.8	37.0	43.6	15.6	.3					11,990	2,910+						B97300	
					2			38.5	45.3	16.2	.3					12,470								
Do	do		¾- by ¼-inch (W)	T	1	Cf	5.8	37.7	45.4	11.1	.3	5.8	68.7	1.9	12.2	12,510	2,910	2,910+					B97301	
					2			40.0	48.2	11.8	.3	5.5	72.9	2.0	7.5	13,270								
					3			45.4	54.6		.3	6.3	82.6	2.3	8.5	15,040								
Do	do		1⅝-inch by 0 (W)	T	1	Cf	5.3	36.3	44.0	14.4	.3					11,930	2,850	2,910+					B97302	
					2			38.3	46.4	15.3	.3					12,600								
Do	do		¼-inch by 0 (AC)	T	1	Cf	5.5	35.7	43.4	15.4	.3					11,690	2,570	2,660	2,820				B97303	
					2			37.8	45.9	16.3	.3					12,380								
Ronald No. 4	Roslyn No. 6		Run-of-mine	D	1		5.1	34.7	45.7	14.5	.5					11,550							40	74
				4	2			36.6	48.1	15.3	.5					12,170								
Do	do		4- by 1⅝-inch (W)	T	1	Cf	3.8	35.7	46.8	13.7	.4					12,300	2,380	2,430	2,660				B97622	
					2			37.1	48.7	14.2	.5					12,790								
Do	do		3- by 1⅝-inch	D	1		2.4	34.9	41.8	20.9	.5	9.5				11,010							41	
				4	2			35.8	42.8	21.4	.5					11,280								
Do	do		do	D	1		2.9	35.8	44.5	16.8	.4					11,540							42	75
				3	2			36.9	45.8	17.3	.4					11,880								

[1] See Explanation of Symbols (p. 28).
[2] M, mine sample; T, tipple sample; D, delivered coal.
[3] The bold-faced figure indicates the number of deliveries averaged.
[4] 1, Sample as received; 2, dried at 105° C.; 3, moisture- and ash-free.
[5] Volatile matter by modified method.

TABLE 22.—*Analyses of mine, tipple, and delivered samples*—Continued

County, town, and mine	Bed	Rank [1]	Size or other description [1]	Kind of sample [2 3]	Condition [4]	Agglomerating index [1]	Proximate, percent				Ultimate, percent					Calorific value, B. t. u.	Fusibility of ash			Mineral-matter-free basis [1]			Laboratory No. or index No.	Reference, page in this report
							Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen		Initial deformation temperature, °F.	Softening temperature, °F. [3]	Fluid temperature, °F.	Fixed carbon, dry basis, percent	Calorific value			
																					B. t. u., dry basis	B. t. u., moist basis		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
KITTITAS COUNTY—Continued																								
Ronald—Continued																								
Ronald No. 4	Rosslyn No. 6		3- by 1-inch (W)	T	1	Cf	3.6	36.1	46.2	14.1	0.5					12,310	2,420	2,530	2,710				B63151	75
					2			37.4	48.0	14.6	.5					12,760								
Do	do		3- by 1-inch	D	1		4.0	36.6	44.0	15.4	.4					11,910							43	
					2			38.1	45.9	16.0	.4					12,410								
Do	do		do	D	1		3.9	35.3	43.1	17.7	.4					11,500							44	
					2			36.7	44.9	18.4	.4					11,970								
Do	do		1⅝- by ¾-inch (W)	T	1	Cf	5.2	36.2	44.7	13.9	.4					12,060	2,600	2,670	2,800				B97623	
					2			38.2	47.2	14.6	.4					12,730								
Do	do		1⅝- by ¾-inch	D	1		2.6	36.0	45.9	15.5	.5					12,180		2,910+					45	
					2			37.0	47.1	15.9	.5					12,500		1						
Do	do		¾- by ¼-inch	T	1	Cf	5.2	36.4	45.9	12.5	.4	5.7	68.1	1.5	11.8	12,340	2,600	2,690	2,860				B97624	
					2			38.4	48.5	13.1	.5	5.4	71.9	1.6	7.5	13,010								
					3			44.3	55.7		.5	6.2	82.8	1.8	8.7	14,980								
Do	do		do	D	1		7.0	36.2	46.3	10.5	.4					11,890							46	
					2			38.9	49.8	11.3	.4					12,790								
Do	do		do	D	1		4.8	34.9	45.0	15.3	.5					11,810		2,780					47	
					2			36.7	47.2	16.1	.5					12,410		1						
Do	do		4-inch by 0	D	1		6.0	35.2	46.1	12.7	.4					11,770							48	
					3			37.4	49.1	13.5	.4					12,520								
Do	do		1⅝-inch by 0	D	1		8.7	34.1	42.8	14.4	.4					11,290		2,710					49	
					1			37.3	46.9	15.8	.4					12,360		1						
Do	do		do	D	1		4.2	33.8	44.1	17.9	.5					11,410		2,830					50	
					1			35.3	46.0	18.7	.5					11,910		1						
Do	do		1-inch by 0	D	1		5.7	33.7	43.2	17.4	.5					11,140		2,710					51	
					2			35.7	45.8	18.5	.5					11,810		2						
Do	do		do	D	1		3.8	34.4	44.2	17.6	.4					11,640							52	
					2			35.8	45.9	18.3	.4					12,100								
Do	do		¾-inch by 0 (W and AC).	T	1	Cf	7.3	33.3	43.5	15.9	.4					11,380	2,550	2,620	2,780				B97625	
					2			35.9	47.0	17.1	.4					12,270								
Do	do		¾-inch by 0	D	1		4.7	35.4	45.1	14.8	.4					11,790		2,720					53	
					2			37.1	47.4	15.5	.4					12,370		2						
Do	do		do	D	1		5.1	35.3	45.5	14.1	.4					11,830		2,750					54	
					8			37.2	47.9	14.9	.4					12,470		8						
Do	do		do	D	1		3.3	34.2	44.6	17.9	.5					11,500		2,660					55	
					2			35.4	46.1	18.5	.5					11,890		1						
Do	do		do	D	1		2.2	35.8	45.2	16.8	.5					12,020							56	
					1			36.6	46.2	17.2	.5					12,290								
Roslyn No. 3	Roslyn (No. 5)	Hvab		M	1	Cf	2.8	37.8	48.9	10.5	.4					13,010	2,200	2,270	2,310	57.0	15,170	14,690	B56460	57
					2			38.9	50.3	10.8	.4					13,390								
					3			43.6	56.4		.5					15,020								
Do	do	Hvab	Run-of-mine (crushed to 3-inch).	T	1	Cf	3.7	35.1	38.9	22.3	.3					10,950	2,200	2,260	2,440	54.0	15,180	14,440	B97306	75
					2			36.4	40.5	23.1	.3					11,360								
Do	do	Hvab	3-inch lump	T	1	Cf	2.6	39.2	44.8	13.4	.4					12,540	2,180	2,260	2,430	54.0	15,140	14,680	B97305	
					2			40.3	45.9	13.8	.4					12,870								

Do	do		3- by 1⅝-inch (W)	T	1	Cf	3.2	38.4	44.8	13.6	.3					12,520	2,210	2,290	2,470				B97307	
					2			39.7	46.2	14.1	.3					12,930								
Do	do		1⅝- by ¾-inch (W)	T	1	Cf	4.0	38.4	44.4	13.2	.3					12,470	2,210	2,270	2,450				B97308	
					2			40.0	46.3	13.7	.3					13,000								
Do	do		¾- by ¼-inch (W)	T	1	Cf	6.0	38.4	44.9	10.7	.3	5.9	69.2	1.7	12.2	12,580	2,200	2,270	2,450				B97309	
					2			40.9	47.7	11.4	.4	5.6	73.6	1.8	7.2	13,390								
					3			46.1	53.9		.4	6.3	83.1	2.1	8.1	15,100								
Do	do		¾- by 3/16-inch (W)	T	1	Cf	2.9	39.4	47.4	10.3	.3					13,140	2,310	2,360	2,540				D41275	
					2			40.5	48.9	10.6	.4					13,520								
Do	do		1⅝-inch by 0 (W)	T	1	Cf	5.2	36.9	43.5	14.4	.3					12,040	2,210	2,280	2,440				B97310	
					2			38.9	46.0	15.1	.3					12,710								
Do	do		do	T	1	Cf	2.7	38.2	47.7	11.4	.4	5.6	70.9	1.9	9.8	12,880	2,310	2,360	2,520				D41273	
					2			39.3	48.9	11.8	.4	5.4	72.9	1.9	7.6	13,240								
					3			44.5	55.5		.4	6.1	82.6	2.2	8.7	15,010								
Do	do		do	T	1	Cf	6.9	37.2	44.1	11.8	.3	5.9	67.5	1.7	12.8	12,150	2,180	2,280	2,440				C97934	
					2			39.9	47.5	12.6	.3	5.5	72.5	1.9	7.2	13,060								
					3			45.7	54.3		.4	6.3	83.0	2.1	8.2	14,950								
Do	do		¼-inch by 0 (AC)	T	1	Cf	4.4	35.7	42.1	17.8	.3					11,510	2,230	2,310	2,460				B97311	
					2			37.3	44.1	18.6	.3					12,040								
Do	do		¼-inch by 0 (W)	T	1	Cf	8.0	36.5	46.5	9.0	.3					12,530	2,240	2,330	2,700				B68861	
					2			39.7	50.5	9.8	.4					13,620								
Do	do		3/16-inch by 0 (W)	T	1	Cf	4.9	37.0	46.2	11.9	.3					12,410	2,310	2,360	2,570				D41276	
					2			38.9	48.5	12.6	.3					13,050								
Roslyn Cascade No. 1	do		Run-of-mine	D	1		3.1	36.4	47.4	13.1	.5					12,430							57	75
				3	2			37.6	48.9	13.5	.5					12,830								
Do	do		3-inch lump	D	1		3.0	37.8	48.0	11.2	.5					12,730							58	
				2	2			39.0	49.5	11.5	.5					13,120								
Do	do		2-inch lump	D	1		3.3	36.6	45.2	14.9	.4					11,960							59	
				22	2			37.8	46.8	15.4	.4					12,370								
Do	do		do	D	1		3.9	36.6	44.7	14.8	.4					11,890							60	
				28	2			38.1	46.5	15.4	.4					12,370								
Do	do		do	D	1		3.1	36.7	40.4	19.8	.3					11,130							61	
				1	2			37.9	41.7	20.4	.3					11,480								
Do	do		3- by 1⅝-inch	D	1		4.4	37.4	45.9	12.3	.6					12,180							62	
				3	2			39.1	48.0	12.9	.6					12,740								
Do	do		3- by 1-inch	D	1		2.6	39.3	47.1	11.0	.5					12,880							63	
				4	2			40.3	48.4	11.3	.5					13,220								
Do	do		1⅝-inch by 0	D	1		4.2	37.0	47.3	11.5	.4					12,540		2,690 (2)					64	
				12	2			38.6	49.4	12.0	.4					13,090								
Do	do		¾-inch by 0	D	1		4.1	35.7	46.0	14.2	.5					12,070		2,660 (1)					65	
				12	2			37.2	48.0	14.8	.5					12,590								
Wright	Roslyn No. 8		¾-inch lump	T	1	Cf	4.3	28.6	38.6	28.5	.4					10,050	2,780	2,840	2,910+				B97620	75
					2			29.9	40.3	29.8	.4					10,500								
Do	do		¾-inch by 0	T	1	Cf	5.2	31.4	44.5	18.9	.4	5.3	63.6	1.4	10.4	11,500	2,730	2,790	2,910+				B97621	
					2			33.1	47.0	19.9	.4	5.0	67.1	1.5	6.1	12,130								
Roslyn:																								
Roslyn Nos. 3 and 9	Roslyn		4-inch lump	D	1		4.3	38.3	45.1	12.3	.3					12,340							66	76
				1	2			40.0	47.1	12.9	.3					12,890								
Do	do		12- by 4-inch	D	1		5.2	37.0	45.4	12.4	.4					12,170							67	
				1	2			39.0	47.9	13.1	.4					12,830								
Do	do		8- by 1⅝-inch	D	1		4.2	38.3	45.0	12.5	.4					12,310							68	
				32	2			40.0	46.9	13.1	.4					12,850								
Do	do		do	D	1		3.5	38.3	45.3	12.9	1.2					12,310							69	
				7	2			39.7	46.9	13.4	1.2					12,760								
Do	do		do	D	1		3.6	38.8	45.3	12.3	.3					12,440							70	
				1	2			40.3	46.9	12.8	.3					12,910								
Do	do		6- by 1⅝-inch	D	1		3.5	38.2	46.0	12.3	.3					12,450							71	
				17	2			39.6	47.7	12.7	.3					12,900								
Do	do		do	D	1		3.5	38.9	46.3	11.3	.4					12,570							72	
				30	2			40.3	48.0	11.7	.4					13,030								
Do	do		do	D	1		3.5	38.7	46.5	11.3	.4					12,650							73	
				9	2			40.1	48.2	11.7	.4					13,110								
Do	do		4- by 1⅝-inch	D	1		2.9	39.3	46.3	11.5	.3					12,750							74	
				1	2			40.5	47.7	11.8	.3					13,130								
Do	do		do	D	1		3.0	38.7	46.3	12.0	.4					12,520							75	
				2	2			39.9	47.7	12.4	.4					12,910								
Do	do		do	D	1		2.8	39.4	47.5	10.3	.4					12,830							76	
				1	2			40.5	48.9	10.6	.4					13,210								
Do	do		do	D	1		3.7	38.7	45.4	12.2	.4					12,430							77	
				1	2			40.2	47.1	12.7	.4					12,910								

[1] See Explanation of Symbols (p. 28).
[2] M, mine sample; T, tipple sample; D, delivered coal.
[3] The bold-faced figure indicates the number of deliveries averaged.
[4] 1, Sample as received; 2, dried at 105° C.; 3, moisture- and ash-free.
[5] Volatile matter by modified method.

TABLE 22.—*Analyses of mine, tipple, and delivered samples*—Continued

County, town, and mine	Bed	Rank [1]	Size or other description [1]	Kind of sample [2 3]	Condition [4]	Agglomerating index [1]	Proximate, percent				Ultimate, percent					Calorific value, B. t. u.	Fusibility of ash			Mineral-matter-free basis [1]			Laboratory No. or index No.	Reference, page in this report
							Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen		Initial deformation temperature, °F.	Softening temperature, °F.[3]	Fluid temperature, °F.	Fixed carbon, dry basis, percent	Calorific value			
																					B. t. u., dry basis	B. t. u., moist basis		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
KITTITAS COUNTY—Continued																								
Roslyn—Continued																								
Roslyn Nos. 3 and 9	Roslyn		3½- by 1¼-inch	D	1		2.6	39.8	46.9	10.7	0.4					12,920							78	76
				2	2			40.9	48.1	11.0	.4					13,260								
Do	do		1⅝- by ¼-inch	D	1		3.5	39.2	46.1	11.2	.3					12,620		2,350					79	
				1	2			40.6	47.8	11.6	.3					13,080		1						
Do	do		1- by 3/16-inch	D	1		4.0	37.8	46.6	11.6	.4					12,510							80	
				1	2			39.4	48.5	12.1	.4					13,040								
Do	do		¾- by ¼-inch	D	1		3.3	39.9	44.5	12.3	.4					12,540							81	
				1	2			41.3	46.0	12.7	.4					12,970								
Do	do		do	D	1		3.1	38.5	47.1	11.3	.4					12,740							82	
				1	2			39.7	48.6	11.7	.4					13,150								
Do	do		¾- by 3/16-inch	D	1		3.4	38.2	46.2	12.2	.4					12,480		2,380					83	
				3	2			39.5	47.9	12.6	.4					12,920		2						
Do	do		do	D	1		7.3	36.5	44.1	12.1	.5					11,870		2,350					84	
				42	2			39.4	47.5	13.1	.5					12,800		27						
Do	do		do	D	1		3.7	37.4	45.5	13.4	.4					12,190							85	
				1	2			38.8	47.3	13.9	.4					12,670								
Do	do		do	D	1		5.7	36.2	45.7	12.4	.3					12,140							86	
				1	2			38.4	48.4	13.2	.3					12,870								
Do	do		4-inch by 0	D	1		4.6	38.4	45.6	11.4	.4					12,480							87	
				2	2			40.3	47.7	12.0	.4					13,080								
Do	do		do	D	1		12.3	34.6	41.6	11.5	.4					10,940							88	
				1	2			39.4	47.5	13.1	.4					12,470								
Do	do		1⅝-inch by 0	D	1		3.7	37.6	45.8	12.9	.4					12,360		2,360					89	
				2	2			39.0	47.6	13.4	.4					12,830		1						
Do	do		do	D	1		7.9	36.1	43.4	12.6	.4					11,710		2,340					90	
				45	2			39.2	47.1	13.7	.4					12,710		29						
Do	do		do	D	1		3.9	38.2	45.8	12.1	.4					12,570		2,340					91	
				17	2			39.8	47.6	12.6	.4					13,080		6						
Do	do		do	D	1		4.7	37.8	45.2	12.3	.3					12,380		2,350					92	
				2	2			39.7	47.4	12.9	.3					12,990		7						
Do	do		do	D	1		4.0	37.8	46.5	11.7	.3					12,610		2,300					93	
				9	2			39.4	48.4	12.2	.3					13,140		4						
Do	do		do	D	1		5.0	37.3	44.5	13.2	.4					12,030		2,580					94	
				17	2			39.3	46.8	13.9	.4					12,660		5						
Do	do		1-inch by 0	D	1		5.5	36.9	45.5	12.1	.4					12,150							95	
				1	2			39.0	48.2	12.8	.4					12,850								
Do	do		do	D	1		3.3	38.5	45.2	13.0	.4					12,330							96	
				1	2			39.8	46.8	13.4	.4					12,750								
Roslyn No. 5	do	Hvab		M	1	Cf	4.5	37.6	45.6	12.3	.4					12,280	2,340	2,400	2,490	55.5	14,950	14,170	B56536	57
					2			39.4	47.8	12.8	.4					12,860								
					3			45.2	54.8		.4					14,750								
Do	do	Hvab	3-inch lump	T	1	Cf	4.1	39.0	44.8	12.1	.5					12,260	2,190	2,260	2,470	54.1	14,820	14,120	B97090	77
					2			40.7	46.7	12.6	.5					12,770								
Do	do		3- by 1⅝-inch (W)	T	1	Cf	4.5	37.9	44.3	13.3	.5					12,030	2,200	2,230	2,500				B97091	
					2			39.7	46.4	13.9	.5					12,600								

Do	do		1⅝- by ¾-inch (W)	T	1	Cf	5.4	37.0	43.4	14.2	0.4					11,830	2,190	2,360	2,590				B97092	
					2			39.1	45.9	15.0	.4					12,510								
Do	do		¾- by ¼-inch (W)	T	1	Cf	7.2	37.2	44.5	11.1	.4	5.8	66.2	1.6	14.9	12,000	2,190	2,420	2,550				B97093	
					2			40.1	47.9	12.0	.4	5.4	71.4	1.7	9.1	12,930								
					3			45.6	54.4		.5	6.2	81.1	1.9	10.3	14,690								
Do	do		3-inch by 0	T	1	Cp	5.4	34.0	35.7	24.9	.4					10,010	2,150	2,230	2,400				B97096	
					2			35.9	37.8	26.3	.4					10,580								
Do	do		1⅝-inch by 0 (W)	T	1	Cf	6.3	35.7	41.1	16.9	.5					11,190	2,230	2,310	2,480				B97094	
					2			38.1	43.9	18.0	.5					11,940								
Do	do		¼-inch by 0 (AC)	T	1	Cp	6.3	33.9	39.0	20.8	.3					10,470	2,260	2,310	2,470				B97095	
					2			36.2	41.6	22.2	.4					11,170								
Roslyn No. 9	do		Run-of-mine (crushed to 3-inch).	T	1	Cf	4.7	34.6	37.2	23.5	.3					10,370	2,150	2,210	2,400	53.3	14,850	13,910	B97198	77
					2			36.3	39.1	24.6	.3					10,890								
Do	do		3-inch lump	T	1	Cf	3.4	38.6	45.1	12.9	.4					12,340	2,200	2,260	2,370	54.6	14,940	14,350	B97192	
					2			40.0	46.7	13.3	.4					12,780								
Do	do		3- by 1⅝-inch (W)	T	1	Cf	3.7	38.7	44.9	12.7	.4					12,380	2,240	2,300	2,430				B97193	
					2			40.2	46.6	13.2	.4					12,850								
Do	do		1⅝- by ¾-inch (W)	T	1	Cf	4.8	37.7	44.3	13.2	.4					12,180	2,190	2,270	2,360				B97194	
					2			39.6	46.5	13.9	.4					12,800								
Do	do		¾- by ¼-inch (W)	T	1	Cf	6.5	37.7	45.3	10.5	.4	5.8	68.1	1.7	13.5	12,330	2,160	2,260	2,450				B97195	
					2			40.3	48.5	11.2	.4	5.4	72.8	1.8	8.4	13,190								
					3			45.4	54.6		.4	6.1	82.0	2.0	9.5	14,850								
Do	do		¾- by 3/16-inch	T	1	Cf	3.4	39.1	46.7	10.8	.4	5.6	70.2	1.8	11.2	12,730	2,310	2,360	2,520				D41274	
					2			40.5	48.3	11.2	.4	5.4	72.7	1.8	8.5	13,190								
					3			45.7	54.3		.5	6.1	81.8	2.1	9.5	14,860								
Do	do		1⅝-inch by 0 (W and AC).	T	1	Cf	6.6	35.5	41.6	16.3	.4					11,380	2,180	2,300	2,470				B97196	
					2			38.0	44.6	17.4	.4					12,180								
Do	do		1⅝-inch by 0 (W)	T	1	Cf	7.2	37.0	43.4	12.4	.3	5.8	66.0	1.6	13.9	11,850	2,260	2,330	2,540				C97935	
					2			39.9	46.8	13.3	.3	5.3	71.1	1.8	8.2	12,770								
					3			46.0	54.0		.4	6.2	82.0	2.0	9.4	14,740								
Do	do		¼-inch by 0 (AC)	T	1	Cf	5.3	34.7	40.5	19.5	.4					10,870	2,180	2,320	2,420				B97197	
					2			36.7	42.7	20.6	.4					11,480								
LEWIS COUNTY																								
Centralia:																								
Belle slope	Smith	Subb		M	1	NAa	21.8	33.8	34.5	9.9	.6					8,890	2,330	2,410	2,580	50.2	13,190	9,960	[5] C23747	58
Do	do	Subb		M	1	NAa	23.4	32.9	33.1	10.6	.4					8,510	2,410	2,450	2,650	50.9	13,100	9,620	[5] C23748	
Do	do	Subb	Composite of C23747 and C23748.	M	1	NAa	22.6	33.6	33.6	10.2	.5	6.3	49.7	.9	32.4	8,660				50.7	13,060	9,740	[5] C23749	
					2			43.4	43.4	13.2	.7	4.9	64.2	1.1	15.9	11,190								
					3			50.0	50.0		.7	5.6	74.0	1.3	18.4	12,890								
Black Badger	Tono No. 1 (?)			M	1	NAa	19.4	35.3	35.8	9.5	1.3	6.0	51.3	1.0	30.9	8,950	2,360	2,420	2,540				[5] D30894	58
					2			43.8	44.4	11.8	1.6	4.8	63.7	1.2	16.9	11,100								
					3			49.7	50.3		1.8	5.4	72.2	1.4	19.2	12,580								
Black Prince			1- by ⅛-inch	D **5**	1		24.4	33.4	34.9	7.3	.5					8,680							97	77
					2			44.2	46.1	9.7	.6					11,480								
Do			do	D **4**	1		25.2	33.0	34.6	7.2	.4					8,600							98	
					2			44.1	46.3	9.6	.6					11,500								
Columbia	Mendota No. 3	Subb		M	1	NAa	21.7	31.1	33.8	13.4	1.2	6.1	47.8	.8	30.7	8,450	2,310	2,360	2,570	53.2	13,280	9,890	[5] D3092	58
					2			39.7	43.2	17.1	1.5	4.7	61.0	1.0	14.7	10,800								
					3			47.9	52.1		1.9	5.7	73.6	1.3	17.5	13,030								
Columbia (Smith)	Big Dirty	Subc		M	1	NAa	25.9	30.5	33.5	10.1	.9	6.4	47.4	.9	34.3	8,320	2,180	2,300	2,460	53.3	13,200	9,340	[5] C1418	59
					2			41.1	45.3	13.6	1.2	4.8	63.9	1.2	15.3	11,220								
					3			47.6	52.4		1.3	5.5	74.0	1.4	17.8	12,990								
Creno prospect	Little Dirty (?)	Subc		M	1	NAa	24.2	32.0	32.6	11.2	.9	6.3	47.3	.9	33.4	8,310	2,130	2,260	2,340	51.4	13,080	9,460	[5] D30868	59
					2			42.1	43.1	14.8	1.1	4.7	62.4	1.2	15.8	10,950								
					3			49.5	50.5		1.3	5.5	73.2	1.4	18.6	12,860								
Golden Glow			3-inch lump	T	1	NAb	31.4	33.3	29.7	5.6	.7	6.9	45.8	.8	40.2	7,970	2,420	2,460	2,510	47.6	12,770	8,480	[5] B93899	77
					2			48.6	43.2	8.2	1.0	5.0	66.7	1.2	17.9	11,620								
					3			52.9	47.1		1.1	5.4	72.6	1.3	19.6	12,660								
Do			3- by 1¼-inch	T	1	NAa	31.0	33.0	29.3	6.7	.7					7,890	2,310	2,350	2,400	47.6	12,800	8,500	[5] B93900	
					2			47.8	42.5	9.7	1.0					11,420								
Do			1¼- by ⅜-inch	T	1	NAa	31.2	32.5	28.7	7.6	.6					7,660	2,050	2,090	2,140				B93901	
					2			47.2	41.8	11.0	.9					11,120								
Do			⅜-inch by 0	T	1	NAa	32.0	31.1	26.0	10.9	.7					7,110	2,150	2,220	2,450				B93902	
					2			45.7	38.2	16.1	1.0					10,450								
Kostick No. 1 prospect.	Lower Thompson			M	1	NAa	26.1	31.0	30.9	12.0	1.5	6.3	44.4	.8	35.0	7,810	2,260	2,360	2,450				[5] D30866	60
					2			41.9	41.9	16.2	2.0	4.6	60.0	1.1	16.1	10,560								
					3			50.1	49.9		2.4	5.5	71.6	1.4	19.1	12,600								
Kostick No. 2 prospect.	Smith			M	1	NAa	26.0	32.5	33.5	8.0	1.1	6.5	48.4	.9	35.1	8,440	2,180	2,260	2,420				[5] D30867	60
					2			44.0	45.2	10.8	1.5	4.9	65.4	1.2	16.2	11,410								
					3			49.3	50.7		1.7	5.5	73.3	1.3	18.2	12,790								

[1] See Explanation of Symbols (p. 28).
[2] M, mine sample; T, tipple sample; D, delivered coal.
[3] The bold-faced figure indicates the number of deliveries averaged.
[4] 1, Sample as received; 2, dried at 105° C.; 3, moisture- and ash-free.
[5] Volatile matter by modified method.

TABLE 22.—*Analyses of mine, tipple, and delivered samples*—Continued

County, town, and mine	Bed	Rank [1]	Size or other description [1]	Kind of sample [2]	Condition [4]	Agglomerating index [1]	Proximate, percent				Ultimate, percent					Calorific value, B. t. u.	Fusibility of ash			Mineral-matter-free basis [1]			Laboratory No. or index No.	Reference, page in this report
							Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen		Initial deformation temperature, °F.	Softening temperature, °F.[3]	Fluid temperature, °F.	Fixed carbon, dry basis, percent	Calorific value			
																					B. t. u., dry basis	B. t. u., moist basis		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
LEWIS COUNTY—Con.																								
Centralia—Continued																								
Larabee prospect	Upper Thompson			M	1	NAa	25.1	30.2	31.2	13.5	1.0	6.0	42.6	.6	36.3	7,370	2,620	2,700	2,780				[5] D33783	60
					2			40.3	41.7	18.0	1.4	4.3	56.8	.8	18.7	9,840								
					3			49.2	50.8		1.7	5.2	69.3	1.0	22.8	12,000								
Lincoln		Lig		M	1	NAa	32.2	31.6	28.6	7.6	.7	6.9	42.8	.8	41.2	7,440	2,060	2,180	2,460	48.1	12,510	8,100	[5] C1419	60
					2			46.6	42.2	11.2	1.1	4.9	63.2	1.1	18.5	10,970								
					3			52.5	47.5		1.2	5.6	71.2	1.3	20.7	12,360								
Martin	Tono No. 1 or Foron	Subc		M	1	NAa	28.7	32.3	30.9	8.1	.9	6.6	45.6	.8	38.0	7,910	1,970	2,210	2,310	49.6	12,680	8,670	[5] D8255	61
					2			45.3	43.3	11.4	1.3	4.8	64.0	1.1	17.4	11,090								
					3			51.2	48.8		1.5	5.5	72.2	1.3	19.5	12,520								
Monarch (new)	do	Subc		M	1	NAa	24.8	34.1	32.3	8.8	.6	6.4	47.5	.9	35.8	8,260	2,050	2,130	2,310	49.3	12,590	9,130	[5] D3090	61
					2			45.4	42.9	11.7	.8	4.9	63.2	1.1	18.3	10,990								
					3			51.4	48.6		1.0	5.6	71.6	1.3	20.5	12,450								
Do	do	Subc	Run-of-mine	T	1	NAa	28.0	33.2	27.1	11.7	1.0					7,610	2,100	2,230	2,310	45.7	12,850	8,710	[5] B93106	77
					2			46.1	37.7	16.2	1.5					10,570								
Do	do	Subc	3-inch lump	T	1	NAa	29.7	32.4	30.4	7.5	.8	6.8	45.3	.8	38.8	7,890	2,040	2,090	2,160	49.1	12,710	8,580	[5] B93105	
					2			46.1	43.3	10.6	1.2	4.9	64.5	1.2	17.6	11,220								
					3			51.5	48.5		1.3	5.5	72.1	1.3	19.8	12,550								
Do	do		1¾- by 1-inch (W)	T	1	NAa	29.3	31.5	29.1	10.1	1.0					7,700	2,090	2,190	2,270				[5] B93107	
					2			44.6	41.1	14.3	1.4					10,900								
Do	do		1- by ⅜-inch (W)	T	1	NAa	30.7	33.0	27.0	9.3	.9					7,600	2,070	2,130	2,200				[5] B93108	
					2			47.6	39.0	13.4	1.3					10,950								
Do	do		1- by ⅛-inch	D	1		25.9	32.7	33.0	8.4	.6					8,220							99	
					4			44.1	44.6	11.3	.8					11,090								
Do	do		¾- by 3/16-inch	D	1		28.9	30.7	31.3	9.1	.6					7,930							100	
					35			43.2	44.0	12.8	.9					11,160								
Do	do		1-inch by 0	D	1		28.1	32.1	29.7	10.1	.9					7,770							101	
					11			44.6	41.3	14.1	1.2					10,810								
Do	do		do	D	1		27.9	32.2	30.0	9.9	.7					7,830							102	
					11			44.7	41.5	13.8	1.0					10,860								
Do	do		do	D	1		29.0	32.5	29.5	9.0	.5					7,720							103	
					4			45.8	41.5	12.7	.7					10,870								
Do	do		do	D	1		29.6	31.6	28.9	9.9	.6					7,550							104	
					5			44.9	41.0	14.1	.9					10,730								
Do	do		do	D	1		30.6	32.0	28.0	9.4	.9					7,540							105	
					4			46.1	40.3	13.6	1.3					10,870								
Do	do		1-inch by 0 (W)	D	1		29.2	32.8	28.6	9.4	1.0					7,690							106	
					4			46.3	40.4	13.3	1.4					10,860								
Do	do		do	D	1		28.4	32.6	30.2	8.8	.6					7,780							107	
					4			45.5	42.2	12.3	.8					10,870								
Do	do		¾-inch by 0	D	1		29.3	31.3	30.4	9.0	.7					7,890							108	
					28			44.3	43.0	12.7	1.0					11,160								
Do	do		⅜-inch by 0 (W)	T	1	NAa	33.4	31.1	26.5	9.0	1.0					7,310	2,020	2,080	2,170				[5] B93109	
					2			46.7	39.7	13.6	1.5					10,970								
Monarch prospect	Upper Thompson	Subc		M	1	NAa	25.8	34.6	30.4	9.2	.4	6.6	46.6	.8	36.4	8,090	2,310	2,360	2,470	47.3	12,600	8,980	[5] D3091	61
					2			46.7	41.0	12.3	.6	5.0	62.8	1.1	18.2	10,910								
					3			53.3	46.7		.7	5.7	71.6	1.2	20.8	12,440								

Morris prospect				M	1	NAa	23.4	30.0	32.6	14.0	4.1	6.0	44.6	.7	30.6	7,990	2,050	2,130	2,420				5 B93658	62
					2			39.2	42.5	18.3	5.4	4.4	58.2	.9	12.8	10,430								
					3			47.9	52.1		6.6	5.4	71.2	1.1	15.7	12,760								
Nonpariel			3½-inch lump	T	1	NAa	28.4	31.0	33.6	7.0	.6	6.6	47.3	.8	37.7	8,210	2,140	2,190	2,330	52.6	12,840	8,880	5 B99524	77
					2			43.4	46.8	9.8	.9	4.8	66.1	1.2	17.2	11,470								
					3			48.0	52.0		1.0	5.3	73.3	1.3	19.1	12,710								
Do			3½ by 1½-inch (W)	T	1	NAa	29.0	30.7	29.9	10.4	.5					7,590	2,300	2,350	2,570				5 B99525	
					2			43.2	42.2	14.6	.8					10,680								
Do			1½- by ⅜-inch (W)	T	1	NAa	32.3	29.7	28.3	9.7	.5					7,250	2,330	2,440	2,730				5 B99526	
					2			43.8	41.9	14.3	.7					10,710								
Do			⅜-inch by 0 (W)	T	1	NAa	31.6	28.6	29.3	10.5	.6					7,360	2,370	2,450	2,580				5 B99527	
					2			41.9	42.8	15.3	.8					10,770								
Chehalis: Newaukum prospect		Subb		M	1	NAa	23.8	27.7	32.5	16.0	.8	6.1	44.4	.8	31.9	7,860	2,310	2,370	2,530	55.4	13,370	9,500	5 C64088	62
					2			36.4	42.6	21.0	1.1	4.5	58.3	1.0	14.1	10,320								
					3			46.0	54.0		1.4	5.7	73.7	1.2	18.0	13,060								
Val Myer prospect				M	1	NAa	26.0	31.2	28.9	13.9	.6	6.4	43.6	.8	34.7	7,580	2,490	2,540	2,640				5 B93644	62
					2			42.2	39.0	18.8	.8	4.7	58.9	1.0	15.8	10,250								
					3			52.0	48.0		1.0	5.8	72.6	1.3	19.3	12,620								
Morton: Atlas (Hi-Carbon)	Hi-Carbon	Hvcb		M	1	Af	7.3	35.4	36.8	20.5	1.2	5.1	55.9	1.3	16.0	10,050	2,310	2,420	2,680	52.4	14,290	12,940	C28183	62
					2			38.2	39.7	22.1	1.3	4.6	60.3	1.5	10.2	10,840								
					3			49.1	50.9		1.6	5.9	77.3	1.9	13.3	13,910								
Sunburst	No. 2(?)	Lvb		M	1	NAa	4.9	15.2	63.5	16.4	.7	3.7	68.6	1.7	8.9	11,570	2,320	2,370	2,420	82.3	14,980	14,080	B96595	63
					2			16.0	66.7	17.3	.7	3.3	72.2	1.7	4.8	12,170								
					3			19.3	80.7		.9	4.0	87.3	2.1	5.7	14,710								
Toledo: Graham Bros. & Medley Prospect.		Lig		M	1	NAa	32.5	26.6	24.7	16.2	.5	6.8	36.2	.5	39.8	6,200				49.5	7,510	12,420	5 C7246	63
					2			39.4	36.6	24.0	.7	4.1	53.7	.8	16.7	9,190								
					3			51.9	48.1		1.0	5.4	70.7	1.0	21.9	12,090								
PIERCE COUNTY																								
Carbonado: Carbonado			Run-of-mine	D	1		2.1	34.1	50.0	13.8	2.5					12,740							109	77
				7	2			34.8	51.1	14.1	2.6					13,010								
Do			do	D	1		2.0	34.1	49.2	14.7	.9					12,600							110	
				2	2			34.8	50.2	15.0	.9					12,860								
Do			do	D	1		4.2	33.7	46.3	15.8	.5					11,930							111	
				2	2			35.2	48.3	16.5	.5					12,450								
Wilkeson: Bartoy	No. 2, east dip	Hvab		M	1	Cg	5.2	27.4	53.0	14.4	.7	5.2	68.1	2.0	9.6	12,240	2,470	2,520	2,660	67.1	15,480	14,520	B53204	63
					2			28.8	56.0	15.2	.7	4.8	71.8	2.1	5.4	12,900								
					3			34.0	66.0		.8	5.7	84.7	2.5	6.3	15,220								
Do	do	Hvab		M	1	Cg	4.6	28.0	55.7	11.7	.5					12,930	2,910+			67.4	15,650	14,820	B53205	
Do	do	Hvab		M	1	Cg	4.8	27.0	54.0	14.2	.6					12,380	2,630	2,710	2,820	67.8	15,530	14,640	B53206	
Do	do	Hvab	Composite of B53204, B53205, and B53206.	M	1	Cg	4.8	27.4	54.0	13.8	.6	5.2	69.4	2.0	9.0	12,500				67.4	15,590	14,710	B53207	
					2			28.8	56.7	14.5	.6	4.9	72.9	2.1	5.0	13,130								
					3			33.7	66.3		.7	5.8	85.3	2.4	5.8	15,350								
Champion	Champion	Hvab		M	1	Cg	4.7	30.1	44.3	20.9	.8	5.0	62.6	1.5	9.2	11,320	2,520	2,650	2,750	61.1	15,600	14,650	C54014	64
					2			31.6	46.4	22.0	.8	4.7	65.8	1.6	5.1	11,880								
					3			40.5	59.5		1.0	6.0	84.3	2.0	6.7	15,220								
East Miller No. 5	No 5 (Miller), east dip		1⅝-inch lump	T	1	Cg	2.3	26.9	56.8	14.0	1.5	4.9	71.6	2.0	6.0	12,820	2,290	2,330	2,440				B95270	78
					2			27.6	58.0	14.4	1.6	4.7	73.3	2.0	4.0	13,120								
					3			32.2	67.8		1.8	5.5	85.6	2.4	4.7	15,330								
Do	do		1⅝-inch by 0	T	1	Cg	5.7	25.2	51.6	17.5	1.6					11,770	2,220	2,310	2,570				B95271	
					2			26.7	54.7	18.6	1.7					12,490								
Skookum	No. 3, west dip	Hvab		M	1	Cg	1.1	28.4	55.9	14.6	.4	4.9	72.5	2.1	5.5	12,920	2,470	2,620	2,780	67.3	15,560	15,360	C16487	64
					2			28.7	56.6	14.7	.5	4.9	73.3	2.1	4.5	13,060								
					3			33.7	66.3		.5	5.7	86.0	2.5	5.3	15,320								
Sparton	Champion	Hvab		M	1	Cf	4.1	35.9	46.0	14.0	.7	5.3	67.5	1.9	10.6	12,280	2,420	2,590	2,730	57.1	15,230	14,490	D31102	65
					2			37.4	48.0	14.6	.8	5.1	70.4	2.0	7.1	12,800								
					3			43.8	56.2		.9	6.0	82.4	2.3	8.4	14,980								
Wilkeson-Miller	No. 5 (Miller), west dip	Hvab		M	1	Cg	5.0	36.7	52.2	6.1	.7	6.0	74.7	2.2	10.3	13,660	2,340	2,460	2,690	59.2	15,480	14,650	B53925	65
					2			38.7	54.9	6.4	.7	5.8	78.7	2.3	6.1	14,380								
					3			41.3	58.7		.8	6.1	84.1	2.4	6.6	15,360								
Do	do	Hvab		M	1	Cg	3.7	36.3	53.2	6.8	1.3					13,720	2,080	2,250	2,680	60.1	15,470	14,850	B53926	
Do	do	Hvab	Composite of B53925 and B53926.	M	1	Cg	4.4	36.5	52.6	6.5	1.0	5.9	74.9	2.1	9.6	13,680				59.5	15,480	14,750	B53927	
					2			38.2	55.0	6.8	1.0	5.6	78.3	2.2	6.1	14,320								
					3			41.0	59.0		1.1	6.0	84.1	2.4	6.4	15,370								

[1] See Explanation of Symbols (p. 28).
M, mine sample; T, tipple sample; D, delivered coal.
[3] The bold-faced figure indicates the number of deliveries averaged.
[4] 1, Sample as received; 2, dried at 105° C.; 3, moisture- and ash-free.
[5] Volatile matter by modified method.

TABLE 22.—*Analyses of mine, tipple, and delivered samples*—Continued

County, town, and mine	Bed	Rank [1]	Size or other description [1]	Kind of sample [2 3]	Condition [4]	Agglomerating index [1]	Proximate, percent				Ultimate, percent					Calorific value, B. t. u.	Fusibility of ash			Mineral-matter-free basis [1]			Laboratory No. or index No.	Reference, page in this report
							Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen		Initial deformation temperature, °F.	Softening temperature, °F. [3]	Fluid temperature, °F.	Fixed carbon, dry basis, percent	Calorific value			
																					B. t. u., dry basis	B. t. u., moist basis		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
PIERCE COUNTY—Continued																								
Wilkeson—Continued																								
Wilkeson-Wingate	No. 4 (Wingate), east dip.	Mvb	2-inch lump	M	1	Cg	2.4	21.3	57.3	19.0	2.7	4.5	68.0	1.8	4.0	12,120	2,210	2,260	2,380	75.3	15,860	15,370	D26934	66
					2			21.9	58.7	19.4	2.8	4.3	69.7	1.9	1.9	12,420								
					3			27.1	72.9		3.5	5.4	86.5	2.4	2.2	15,410								
Do	do	Mvb		M	1	Cg	2.6	21.8	59.3	16.3	2.4	4.6	70.5	1.9	4.3	12,530	2,100	2,230	2,490	75.1	15,810	15,310	D26935	
					2			22.4	60.9	16.7	2.4	4.4	72.3	2.0	2.2	12,870								
					3			26.9	73.1		2.9	5.3	86.9	2.3	2.6	15,460								
Do	do	Mvb	2-inch lump	T	1	Cg	3.9	21.6	57.1	17.4	.9					12,170	2,210	2,540	2,710	74.2	15,790	15,020	B95268	78
					2			22.5	59.4	18.1	1.0					12,660								
Do	do		2-inch by 0	T	1	Cg	7.8	20.4	56.3	15.5	.8	5.0	66.9	1.7	10.1	11,840	2,400	2,740	2,890				B95269	
					2			22.1	61.1	16.8	.9	4.5	72.5	1.9	3.4	12,840								
					3			26.6	73.4		1.1	5.4	87.2	2.2	4.1	15,430								
Do	No. 4 (Wingate)		1⅝-inch by 0	D	1		4.8	25.8	51.6	17.8	2.1					11,830		2,310					112	
					10			27.1	54.2	18.7	2.2					12,430		10						
Do	do		do	D	1		5.3	25.0	52.9	16.8	2.2					11,950		2,300					113	
					14			26.4	55.9	17.7	2.3					12,620		13						
Do	do		do	D	1		7.3	23.9	52.9	15.9	2.1					11,830		2,300					114	
					16			25.8	57.0	17.2	2.3					12,760		16						
Do	do		do	D	1		5.0	24.0	54.3	16.7	2.3					12,030							115	
					1			25.3	57.1	17.6	2.4					12,660								
THURSTON COUNTY																								
Bucoda:																								
Boxer	Mendota			M	1	NAa	22.7	32.5	32.0	12.8	2.8	6.1	45.3	.8	32.2	8,060	1,990	2,090	2,310				[5]D30865	66
					2			42.1	41.3	16.6	3.6	4.6	58.6	1.0	15.6	10,430								
					3			50.5	49.5		4.3	5.5	70.3	1.2	18.7	12,500								
D. & F. No. 1			3-inch lump	T	1	NAa	15.3	34.6	33.7	16.4	4.3	5.7	49.2	.8	23.6	9,000	2,010	2,140	2,320	51.1	13,590	10,990	[5]B93558	78
					2			40.9	39.8	19.3	5.1	4.7	58.1	1.0	11.8	10,630								
					3			50.7	49.3		6.3	5.8	72.1	1.2	14.6	13,170								
Do			do	T	1	NAa	14.0	35.1	32.3	18.6	4.5					8,990	2,090	2,160	2,340	49.8	13,820	11,320	[5]C1243	
					2			40.8	37.6	21.6	5.2					10,450								
Do			3- by 1½-inch	T	1	NAa	16.0	33.8	32.1	18.1	3.6					8,690	2,060	2,170	2,320	50.6	13,620	10,840	[5]B93559	
					2			40.2	38.3	21.5	4.3					10,350								
Do			do	T	1	NAa	14.9	32.8	31.5	20.8	3.9					8,480	2,090	2,160	2,370	51.1	13,700	10,990	[5]C1244	
					2			38.5	37.1	24.4	4.6					9,960								
Do			1½-inch by O (W)	T	1	NAa	21.1	32.0	30.1	16.8	3.1					8,110	2,080	2,210	2,460				[5]B93561	
					2			40.5	38.3	21.2	3.9					10,280								
Do			do	T	1	NAa	17.5	32.9	32.2	17.4	3.1	5.8	47.5	.8	25.4	8,630	2,150	2,270	2,370				[5]C1245	
					2			39.8	39.2	21.0	3.8	4.6	57.7	.9	12.0	10,460								
					3			50.5	49.5		4.8	5.9	73.0	1.2	15.1	13,250								
Do			1½-inch by 0	T	1	NAa	18.1	31.0	31.4	19.5	3.3					8,100	2,100	2,250	2,500				[5]B93560	
					2			37.9	38.3	23.8	4.0					9,890								

D. & F. prospect	Upper Thompson			M	1	NAa	20.7	29.6	36.8	12.9	1.6	6.1	48.3	.7	30.4	8,750	2,050	2,420	2,550				[5] C96368	67
					2			37.4	46.4	16.2	2.0	4.8	61.0	.9	15.1	11,040								
					3			44.6	55.4		2.4	5.7	72.8	1.1	18.0	13,180								
Gordon prospect	Penitentiary	Subc		M	1	NAa	25.5	30.6	31.2	12.7	4.4	6.1	42.1	.6	34.1	7,530	1,920	1,970	2,080	52.3	12,530	8,720	[5] D1995	67
					2			41.1	41.8	17.1	5.9	4.3	56.6	.9	15.2	10,110								
					3			49.6	50.4		7.1	5.2	68.2	1.0	18.5	12,200								
Meeks' prospect	Big Dirty	Subc		M	1	NAa	23.3	31.2	32.5	13.0	.4	6.2	46.5	.9	33.0	8,120	2,260	2,310	2,590	51.9	12,970	9,450	[5] D1994	67
					2			40.7	42.4	16.9	.5	4.7	60.6	1.1	16.2	10,590								
					3			49.0	51.0		.6	5.7	73.0	1.4	19.3	12,750								
Penn-Bucoda	No. 4 (Bagley)		Run-of-mine (crushed to 1½-inch).	T	1	NAa	21.2	33.3	32.7	12.8	.4	6.2	48.2	.8	31.6	8,520	2,310	2,360	2,570				[5] C80364	78
					2			42.3	41.4	16.3	.5	4.9	61.2	1.0	16.1	10,800								
					3			50.5	49.5		.6	5.8	73.1	1.2	19.3	12,910								
Penn-Bucoda prospects.	Big Dirty, upper bench	Subb		M	1	NAa	23.1	34.9	34.0	8.0	.5	6.5	50.7	.9	33.4	8,850	2,310	2,370	2,580	49.9	12,980	9,690	[5] C26026	68
					2			45.3	44.3	10.4	.6	5.1	66.0	1.2	16.7	11,500								
					3			50.6	49.4		.7	5.7	73.6	1.3	18.7	12,840								
Do	Big Dirty, middle bench	Subc		M	1	NAa	23.8	33.2	32.9	10.1	.4	6.3	48.6	.9	33.7	8,380	2,260	2,330	2,510	50.4	12,850	9,410	[5] C26027	
					2			43.5	43.3	13.2	.5	4.9	63.7	1.2	16.5	10,990								
					3			50.1	49.9		.6	5.7	73.4	1.4	18.9	12,660								
Do	Big Dirty, lower bench	Subb		M	1	NAa	21.5	34.9	31.3	12.3	.4	6.3	48.9	.8	31.3	8,590	2,240	2,310	2,520	48.0	13,180	9,910	[5] C26028	
					2			44.4	39.9	15.7	.5	5.0	62.3	1.0	15.5	10,950								
					3			52.7	47.3		.6	5.9	73.8	1.2	18.5	12,980								
Do	Little Dirty	Subb		M	1	NAa	22.2	33.1	32.7	12.0	2.3	6.3	47.8	.8	30.8	8,470	2,070	2,120	2,330	50.8	13,140	9,740	[5] C26029	
					2			42.6	42.0	15.4	3.0	4.9	61.5	1.0	14.2	10,890								
					3			50.3	49.7		3.6	5.8	72.7	1.2	16.7	12,870								
Do	Smith	Subb		M	1	NAa	22.1	34.7	32.6	10.6	.4	6.4	49.3	.8	32.5	8,660	2,310	2,400	2,580	49.1	13,050	9,780	[5] C26030	
					2			44.6	41.8	13.6	.5	5.0	63.4	1.1	16.4	11,130								
					3			51.6	48.4		.6	5.8	73.4	1.2	19.0	12,890								
Tono: Tono No. 1	Tono No. 1		3-inch lump	T	1	NAa	21.7	33.2	38.4	6.7	.4	6.4	53.6	1.1	31.8	9,290	2,380	2,500	2,570	54.1	13,090	10,020	[5] B94620	78
					2			42.4	49.0	8.6	.5	5.1	68.5	1.5	15.8	11,870								
					3			46.4	53.6		.5	5.5	74.9	1.6	17.5	12,980								
Do	do		3- by 1¾-inch	T	1	NAa	23.0	31.2	35.8	10.0	.4					8,660	2,500	2,520	2,640	54.1	13,090	9,710	[5] B94621	
					2			40.5	46.5	13.0	.5					11,240								
Do	do		1¾- by ¼-inch (W)	T	1	NAa	24.6	31.0	36.0	8.4	.4					8,620	2,510	2,540	2,640				[5] B94622	
					2			41.1	47.8	11.1	.5					11,430								
Do	do		1¼- by ⅜-inch	D	1		21.2	32.9	36.5	9.4	.3					8,930							116	
				1	2			41.8	46.3	11.9	.4					11,340								
Do	do		2-inch by 0	D	1		21.2	33.0	35.4	10.4	.4					8,800							117	
				1	2			41.9	44.9	13.2	.5					11,170								
Do	do		1¾-inch by 0	T	1	NAa	23.4	30.5	34.4	11.7	.5					8,340	2,520	2,560	2,750				[5] B94623	
					2			39.7	45.0	15.3	.6					10,880								
Tono prospect	Tono No. 2			M	1	NAa	24.4	32.4	33.9	9.3	1.9	6.2	47.3	1.0	34.3	8,270	1,920	2,030	2,310				[5] D30869	69
					2			42.9	44.7	12.4	2.5	4.7	62.5	1.3	16.7	10,940								
					3			48.9	51.1		2.8	5.3	71.4	1.4	19.1	12,480								
WHATCOM COUNTY																								
Bellingham: Bellingham	Bellingham No. 1	Hvcb or Suba		M	1	NAb	7.6	36.3	39.7	16.4	.3					10,340	2,330	2,470	2,570	53.3	13,860	12,570	D8250	69
Do	do	Hvcb or Suba		M	1	NAb	6.6	36.1	39.3	18.0	.3					10,270	2,380	2,420	2,600	53.3	13,900	12,760	D8251	
Do	do	Hvcb or Suba		M	1	NAb	6.8	36.1	40.0	17.1	.3					10,260	2,470	2,500	2,620	53.6	13,740	12,590	D8252	
Do	do	Hvcb or Suba		M	1	NAb	6.5	36.9	40.0	16.6	.3					10,430	2,310	2,390	2,500	53.1	13,810	12,720	D8253	
Do	do	Hvcb or Suba	Composite of D8250, D8251, D8252, and D8253.	M	1	NAb	7.2	36.0	40.0	16.8	.3	5.1	58.3	1.2	18.3	10,340				53.7	13,860	12,640	D8254	
					2			38.8	43.1	18.1	.3	4.6	62.8	1.3	12.9	11,130								
					3			47.3	52.7		.4	5.7	76.7	1.6	15.6	13,600								
Do	do		4-inch lump	D	1		5.7	36.1	42.5	15.7	.3					10,680							118	78
				1	2			38.3	45.1	16.6	.3					11,320								
Do	do		do	D	1		6.5	36.8	41.9	14.8	.3					10,820							119	
				1	2			39.4	44.8	15.8	.3					11,570								

[1] See Explanation of Symbols (p. 28).
[2] M, mine sample; T, tipple sample; D, delivered coal.
[3] The bold-faced figure indicates the number of deliveries averaged.
[4] 1, Sample as received; 2, dried at 105° C.; 3, moisture- and ash-free.
[5] Volatile matter by modified method.

TABLE 22.—*Analyses of mine, tipple, and delivered samples*—Continued

County, town, and mine	Bed	Rank [1]	Size or other description [1]	Kind of sample [2 3]	Condition [4]	Agglomerating index [1]	Proximate, percent				Ultimate, percent					Calorific value, B. t. u.	Fusibility of ash			Mineral-matter-free basis [1]			Laboratory No. or index No.	Reference, page in this report
							Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen		Initial deformation temperature, °F.	Softening temperature, °F.[3]	Fluid temperature, °F.	Fixed carbon, dry basis, percent	Calorific value: B. t. u., dry basis	Calorific value: B. t. u., moist basis		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
WHATCOM COUNTY Continued																								
Bellingham—Continued																								
Bellingham	Bellingham No. 1	Hvcb	4-inch	T	1	NAb	8.4	34.2	39.4	18.0	.4					10,070	2,360	2,430	2,660	54.6	13,970	12,510	[5] B97697	78
					2			37.3	43.1	19.6	.4					10,990								
Do	do		2-inch lump	D	1		7.3	34.7	46.0	12.0	.3					11,080							120	
				14	2			37.4	49.7	12.9	.3					11,950								
Do	do		do	D	1		6.7	36.8	42.8	13.7	.3					10,900							121	
				9	2			39.4	45.9	14.7	.3					11,680								
Do	do		do	D	1		6.8	36.8	42.2	14.2	.3					10,790							122	
				33	2			39.5	45.3	15.2	.3					11,580								
Do	do		do	D	1		5.8	33.9	41.3	19.0	.4					10,170							123	
				1	2			36.0	43.8	20.2	.4					10,800								
Do	do		8- by 2-inch	D	1		7.1	34.6	40.7	17.6	.3					10,160							124	
				4	2			37.2	43.9	18.9	.3					10,940								
Do	do		4- by 2-inch (W)	T	1	NAb	6.4	37.5	37.5	18.6	.3					10,240	2,460	2,510	2,680				D19111	
					2			40.1	40.0	19.9	.3					10,940								
Do	do		do	T	1	NAb	7.5	35.5	40.2	16.8	.3	5.4	58.4	1.1	18.0	10,400	2,470	2,530	2,870				[5] B97698	
					2			38.3	43.5	18.2	.3	4.9	63.2	1.2	12.2	11,240								
					3			46.9	53.1		.4	6.0	77.2	1.5	14.9	13,750								
Do	do		4- by 1⅝-inch (W)	T	1	NAa	7.3	36.6	39.7	16.4	.2					10,440	2,520	2,600	2,770				E13233	
					2			39.4	42.9	17.7	.3					12,600								
Do	do	Hvcb or Suba	4- by 1¼-inch	T	1	NAb	6.7	32.7	36.6	24.0	.3					9,310	2,440	2,500	2,650	54.5	13,830	12,580	[5] B97703	
					2			35.1	39.1	25.8	.3					9,980								
Do	do		4- by 1-inch	D	1		6.8	36.3	38.8	18.1	.3					10,240							125	
				6	2			38.9	41.7	19.4	.3					10,990								
Do	do		3½- by 1-inch	D	1		7.1	34.9	40.6	17.4	.4					10,280							126	79
				14	2			37.6	43.7	18.7	.4					11,070								
Do	do		2- by 1¼-inch (W)	T	1	NAb	8.6	34.1	39.3	18.0	.3					10,010	2,540	2,600	2,880				[5] B97699	
					2			37.3	43.1	19.6	.3					10,950								
Do	do		1¼- by ⅞-inch (W)	T	1	NAb	8.8	33.9	38.6	18.7	.3					9,870	2,600	2,680	2,910				[5] B97700	
					2			37.1	42.4	20.5	.3					10,820								
Do	do		1¼- by ⅜-inch	T	1	NAb	7.2	32.5	34.3	26.0	.2					9,010	2,490	2,590	2,690				[5] B97704	
					2			35.1	36.9	28.0	.3					9,710								
Do	do		⅞- by ⅜-inch (W)	T	1	NAb	11.0	32.8	38.4	17.8	.3					9,740	2,580	2,660	2,890				[5] B97701	
					2			36.9	43.1	20.0	.3					10,950								
Do	do		1⅝-inch by 0 (W)	T	1	NAb	8.9	35.8	39.5	15.8	.4					10,360	2,550	2,630	2,720				E13234	
					2			39.3	43.4	17.3	.4					11,380								
Do	do		⅜-inch by 0	T	1	NAb	13.4	31.0	37.3	18.3	.3					9,260	2,400	2,430	2,640				[5] B97702	
					2			35.9	42.9	21.2	.3					10,700								

Glen Echo	do		4-inch lump	T	1	NAb	7.6	34.6	46.6	11.2	.4	5.3	62.8	1.0	19.3	11,090	2,220	2,290	2,460	58.1	13,820	12,630	[5] B97917	79
					2			37.5	50.4	12.1	.4	4.8	67.9	1.0	13.8	12 010								
					3			42.7	57.3		.5	5.5	77.3	1.2	15.5	13,660								
Do	do		2-inch lump	D	1		5.4	34.6	42.4	17.6	.4					10,240							127	
				1	2			36.6	44.8	18.6	.4					10,830								
Do	do		do	D	1		5.9	35.7	42.0	16.4	.4					10,500							128	
				1	2			37.9	44.7	17.4	.4					11,150								
Do	do		do	D	1		6.2	36.1	41.1	16.6	.4					10,370							129	
				1	2			38.5	43.8	17.7	.4					11,060								
Do	do		4- by 2-inch (W)	T	1	NAb	8.4	34.5	39.9	17.2	.4					10,020	2,430	2,450	2,690				[5] B97918	
					2			37.7	43.6	18.7	.4					10,930								
Do	do		2- by 1-inch (W)	T	1	NAb	9.1	33.7	37.8	19.4	.3					9,600	2,450	2,470	2,690				[5] B97919	
					2			37.1	41.6	21.3	.4					10,560								
Do	do		1-inch by 0 (W)	T	1	NAb	12.0	33.6	36.9	17.5	.4					9,450	2,490	2,520	2,760				[5] B97920	
					2			38.2	41.9	19.9	.4					10,750								

[1] See Explanation of Symbols (p. 28).
[2] M, mine sample; T, tipple sample; D, delivered coal.
[3] The bold-faced figure indicates the number of deliveries averaged.
[4] 1, Sample as received; 2, dried at 105° C.; 3, moisture- and ash-free.
[5] Volatile matter by modified method.

TABLE 23.—*Analyses of borehole core samples* [1]

Location	Bed	Core			Condition [2]	Agglomerating index [3]	Proximate, percent				Ultimate, percent					Calorific value, B. t. u.	Fusibility of ash			Laboratory No. or index No.	Reference, page in this report
		Designation	Depth From—	Depth To—			Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen		Initial deformation temperature, ° F.	Softening temperature, ° F.	Fluid temperature, ° F.		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
LEWIS COUNTY																					
Centralia:			*Ft. in.*	*Ft. in.*																	
15 miles northeast, NE¼ sec. 30, T. 15 N., R. 1 E.	Upper Thompson	G	271 9	282 9	1	NAa	16.4	31.8	32.9	18.9	1.9	5.6	47.2	0.7	25.7	8,440	2,160	2,250	2,550	[4] D41581	70
					2			38.0	39.3	22.7	2.2	4.5	56.4	.8	13.4	10,100					
					3			49.2	50.8		2.9	5.8	72.9	1.1	17.3	13,050					
½ mile north, SW¼ sec. 29, T. 15 N., R. 2 W.		DD	30 11	34 11	1	NAa	26.5	33.0	30.4	10.1	.4					8,000				[4] D59349	70
					2			44.8	41.4	13.8	.6					10,890					
					3			52.0	48.0		.7					12,630					
5 miles northeast, SW¼ sec. 30, T. 15 N., R. 1 W.	Black Bear	J	991 7	996 0	1	NAa	12.0	36.0	34.2	17.8	2.9	5.7	52.0	.9	20.7	9,600	2,180	2,260	2,500	[4] D40920	70
					2			40.9	38.9	20.2	3.2	4.9	59.1	1.0	11.6	10,910					
					3			51.2	48.8		4.1	6.2	74.1	1.2	14.4	13,670					
10 miles east, SW¼ sec. 33, T. 15 N., R. 1 W.	Big Dirty	I	145 8	185 3	1	NAa	19.2	31.5	35.0	14.3	.6	5.8	49.5	1.0	28.8	8,720	2,260	2,310	2,520	[4] D34603	70
					2			39.0	43.3	17.7	.8	4.5	61.2	1.2	14.6	10,780					
					3			47.4	52.6		1.0	5.5	74.4	1.5	17.6	13,110					
Do	Smith	I	288 2	295 7	1	NAa	18.2	31.9	35.1	14.8	.4	5.8	49.8	1.0	28.2	8,770	2,310	2,360	2,490	[4] D35247	
					2			39.0	43.0	18.0	.5	4.6	60.9	1.2	14.8	10,710					
					3			47.6	52.4		.6	5.6	74.3	1.4	18.1	13,070					
Do	Penitentiary	I	498 9	501 5	1	NAa	17.1	32.4	36.5	14.0	1.6	5.8	51.3	.8	26.5	9,140	2,080	2,130	2,420	[4] D33782	
					2			39.0	44.1	16.9	1.9	4.7	61.9	1.0	13.6	11,030					
					3			47.0	53.0		2.3	5.6	74.5	1.2	16.4	13,270					
Do	Mendota	I	625 6	635 4	1	NAa	17.8	32.3	33.2	16.7	1.3	5.8	48.8	.9	26.5	8,750	2,080	2,230	2,280	[4] D35248	
					2			39.3	40.4	20.3	1.6	4.6	59.5	1.1	12.9	10,650					
					3			49.3	50.7		2.1	5.8	74.6	1.4	16.1	13,360					
5 miles southeast, SE¼ sec. 7, T. 14 N., R. 1 W.	Tono No. 1	K	110 5	119 5	1	NAa	25.0	33.8	30.8	10.4	1.3	6.4	46.8	.9	34.2	8,160	2,060	2,150	2,340	[4] D41582	70
					2			45.0	41.1	13.9	1.7	4.9	62.4	1.3	15.8	10,890					
					3			52.3	47.7		2.0	5.7	72.5	1.5	18.3	12,650					
Do	Upper Thompson	K	525 4	532 9½	1	NAa	24.1	29.5	28.1	18.3	.6	5.9	41.4	.7	33.1	7,170	2,310	2,390	2,470	[4] D44519	
					2			38.9	37.0	24.1	.8	4.3	54.5	1.0	15.3	9,450					
					3			51.3	48.7		1.1	5.6	71.8	1.3	20.2	12,460					
Chehalis:																					
1¾ miles east, NE¼ sec. 33, T. 14 N., R. 2 W.		V	561 3	562 8	1	NAb	26.4	36.3	27.7	9.6	1.8					8,250				[4] D55878	70
					2			49.4	37.6	13.0	2.5					11,190					
					3			56.7	43.3		2.9					12,870					
Do		V	564 7	566 3	1	NAb	26.3	34.5	30.0	9.2	2.2					8,060				[4] D55879	
					2			46.8	40.8	12.4	3.0					10,930					
					3			53.5	46.5		3.5					12,480					
5½ miles northwest, SE¼ sec. 20, T. 14 N., R. 3 W.		CH-3	141 4¾	143 6	1	NAa	33.4	32.3	29.7	4.6	1.1					7,530				[4] D71167	70
					2			48.5	44.6	6.9	1.7					11,300					
					3			52.1	47.9		1.8					12,140					
Do		CH-3	433 7¼	434 10	1	NAa	31.3	29.2	27.2	12.3	.3					6,700				[4] D71168	71
					2			42.5	39.6	17.9	.5					9,750					
					3			51.8	48.2		.6					11,890					
Toledo:																					
6.6 miles east, NW¼ sec. 20, T. 11, N., R. 1 E.		CH-5	113 ⅜	115 5½	1	NAa	28.6	21.1	12.3	38.0	1.2					3,600	2,780	2,910+		[4] D72816	71
					2			29.5	17.2	53.3	1.7					5,030					
					3			63.2	36.8		3.5					10,770					
Do		CH-5	118 10¾	119 8¾	1	NAa	30.8	21.7	16.3	31.2	1.6					4,200	2,730	2,860	2,910+	[4] D72817	
					2			31.3	23.7	45.0	2.4					6,060					
					3			57.0	43.0		4.3					11,030					
Do		CH-5	128 0	130 1¼	1	NAa	27.4	22.3	13.7	36.6	.6					4,060	2,780	2,910+		[4] D72818	
					2			30.7	18.9	50.4	.9					5,590					
					3			62.0	38.0		1.8					11,280					
Do		CH-5	161 1½	162 9¼	1	NAa	32.1	23.2	20.1	24.6	.6					5,110	2,360	2,520	2,730	[4] D72819	
					2			34.1	29.6	36.3	.9					7,530					
					3			53.5	46.5		1.4					11,800					

THURSTON COUNTY																								
Bucoda:																								
2 miles east, SE¼ sec. 8, T. 15 N., R. 1 W.	Little Dirty	B	66	9	71	6	1	NAa	15.8	36.9	36.4	10.9	2.9	5.9	54.0	.9	25.4	9,680	2,050	2,150	2,180	[4] D30146	71
							2			43.8	43.2	13.0	3.5	4.9	64.1	1.1	13.4	11,490					
							3			50.3	49.7		4.0	5.7	73.7	1.3	15.3	13,210					
Do	Smith	B	128	6⅞	135	2¾	1	NAa	17.7	33.9	36.5	11.9	.9	5.9	52.5	1.0	27.8	9,150	2,310	2,360	2,490	[4] D30147	
							2			41.1	44.5	14.4	1.1	4.5	63.8	1.2	15.0	11,120					
							3			48.0	52.0		1.3	5.2	74.5	1.4	17.6	12,990					
Do	Penitentiary	B	291	5	296	1	1	NAa	15.8	36.4	33.1	14.7	2.5	6.0	51.6	.9	24.3	9,300	2,180	2,210	2,280	[4] D30148	
							2			43.2	39.3	17.5	3.0	5.0	61.3	1.0	12.2	11,050					
							3			52.3	47.7		3.6	6.0	74.3	1.2	14.9	13,390					
Do	Mendota	B	443	10⅞	446	9⅛	1	NAa	15.7	35.4	35.3	13.6	2.2	5.9	52.8	.9	24.6	9,510	1,940	2,000	2,180	[4] D30575	
							2			41.9	41.9	16.2	2.6	4.9	62.6	1.1	12.6	11,270					
							3			50.0	50.0		3.1	5.9	74.7	1.3	15.0	13,450					
2 miles south, NW¼ sec. 19, T. 15 N., R. 1 W.	Big Dirty	C–2	23	4	40	6	1	NAa	17.4	35.7	32.6	14.3	1.0	5.9	51.6	.9	26.3	9,070	2,030	2,100	2,450	[4] D36934	71
							2			43.2	39.5	17.3	1.2	4.8	62.4	1.1	13.2	10,980					
							3			52.3	47.7		1.4	5.8	75.5	1.3	16.0	13,280					
3½ miles east, NE¼ sec. 15, T. 15 N., R. 1 W.	Smith	D	349	9	362	10	1	NAa	19.1	33.8	37.2	9.9	.5	6.1	53.2	1.0	29.3	9,350	2,210	2,280	2,470	[4] D28809	71
							2			41.7	46.1	12.2	.6	4.9	65.7	1.2	15.4	11,550					
							3			47.6	52.4		.7	5.6	74.8	1.4	17.5	13,160					
Do	Mendota	D	537	8	545	10	1	NAa	14.8	37.1	36.8	11.3	2.1	6.0	55.2	.8	24.6	9,880	2,080	2,150	2,380	[4] D28810	
							2			43.5	43.2	13.3	2.4	5.1	64.8	1.0	13.4	11,590					
							3			50.1	49.9		2.8	5.9	74.7	1.1	15.5	13,370					
6 miles southeast, SW¼ sec. 24, T. 15 N., R. 1 W.	D and F	E–2	520	8	526	6	1	NAa	19.5	30.2	35.6	14.7	.6	5.8	48.2	.8	29.9	8,530	2,260	2,380	2,570	[4] D48109	71
							2			37.6	44.2	18.2	.7	4.5	59.9	1.0	15.7	10,590					
							3			45.9	54.1		.9	5.6	73.2	1.2	19.1	12,950					

[1] Samples taken by geologist of Federal Geological Survey.
[2] 1, Sample as received; 2, dried at 105° C.; 3, moisture- and ash-free.
[3] See Explanation of Symbols (p. 28).
[4] Volatile matter by modified method.

DESCRIPTION OF MINE SAMPLES

Compiled by Joseph Daniels [1]

The brief descriptions that follow have been compiled from the notes and data submitted by the men who measured the sections and collected the samples. They give some idea of the mthods used in mining and preparing the coals and supplement the information contained in table 23. The letters in parentheses following the sampler's name indicate the organization represented when the samples were taken, as follows: USBM, Bureau of Mines; USGS, Geological Survey.

Additional information about some of these mines is given in Bureau of Mines Technical Papers 491 [2] and 618.[3]

KING COUNTY

BLACK DIAMOND. FRANKLIN MINE

Analyses C21218 to C21221 (p. 29). High-volatile B bituminous coal, King County field, Green River district, from Franklin mine, a slope (truck) mine 901 feet above sea level in SE¼ sec. 7, T. 21 N., R. 7 E., 2½ miles east of Black Diamond. Coal bed, McKay; Puget formation; dip, 35° W.; strike, N.–S.; cover at points sampled, 950 to 1,400 feet. The bed was measured and sampled at three points by M. R. Geer (USBM) May 17, 1944, as described below:

Sections of coal bed in Franklin mine

Laboratory No.	C21218	C21219	C21220
	Ft. In.	*Ft. In.*	*Ft. In.*
Roof, shale.			
Coal, bone, shale (not measured)			
Shale, carbonaceous (immediate roof)			
Coal	1 1½		
Shale, carbonaceous	[1] 2¾		
Shale, carbonaceous, soft		[1] 5½	
Bony			[1] 4½
Coal	3¼		
Coal, partly bony		10½	
Shale, brown			[1] ¼

[1] Not included in sample.

Sections of coal bed in Franklin mine—Con.

Laboratory No.	C21218	C21219	C21220
	Ft. In.	*Ft. In.*	*Ft. In.*
Coal, partly bony			1 2½
Bone and shale	[1] 7		
Shale, carbonaceous, soft		[1] 1	[1] ¾
Coal, bony	[1] 8½		
Coal, partly bony		1 4	9
Shale, hard	[1] 8½		
Shale, carbonaceous, bony		[1] 11½	
Shale, brown, soft			[1] 2
Coal	4 ½		
Coal, partly bony		1 5	1 4½
Bony	[1] 3		
Shale, hard		[1] 9	[1] 7
Coal, bright, clean		4 0	3 6½
Bony		[1] 5	
Bone, hard			[1] 5½
Floor, shale, hard, smooth.			
Thickness of bed	7 11	10 3½	8 6½
Thickness in sample	5 5¼	7 7½	6 10½

[1] Not included in sample.

Sample C21218 was taken in 41 chute, 90 feet above 4 south gangway, 2,300 feet inby auxiliary slope. Sample C21219 was taken on 5 south countergangway, 100 feet inby auxiliary slope. Sample C21220 was taken at face of 5 south countergangway, 2,400 feet inby auxiliary slope.

The ultimate analysis of a composite made by combining samples C21218 to C21220 is given under laboratory No. C21221.

System of mining, chute-and-pillar. The coal is shot from the solid with permissible explosives. At the time of sampling the average daily output was 250 tons; the life of the mine was estimated to be 10 years. At the tipple plus-3-inch lump is removed by a shaker screen and picked. The minus-3-inch round-hole slack is trucked from the mine to a washing plant at Black Diamond, where it is washed by an Elmore jig and wet tables and sized on revolving screens. The sizes of washed coal produced are 3½-inch round-hole to 1-inch square-hole, 1-inch square-hole to $\frac{3}{32}$-inch square-hole, and $\frac{3}{32}$-inch square-hole to 0.

BLACK DIAMOND. FRANKLIN GEM MINE

Analysis C21380 (p. 29). High-volatile C bituminous coal, King County field, Green River district, from Franklin Gem mine, a slope (truck) mine 1,280 feet above sea level in NE¼ sec. 18, T. 21 N., R. 7 E., 2 miles east of Black Diamond. Coal bed, Gem; Puget formation; dip, 29° W.; strike, N. 24° W.; cover at point sampled, 200 feet. The bed was measured and sampled on 2 north gangway, 20 feet inby of 1 chute, by M. R. Geer (USBM) May 20, 1944.

[1] Former consultant mining engineer, Fuels-Technology Division, Region II, Bureau of Mines, Seattle, Wash.

[2] Ash, S. H., Yancey, H. F., Kiessling, O. E., Daniels, Joseph, Snyder, N. H., Plein, L. N., Fieldner, A. C., Cooper, H. M., and Osgood, F. D., Analyses of Washington Coals: Tech. Paper 491, 1931, 203 pp.

[3] Yancey, H. F., Geer, M. R., Daniels, Joseph, Snyder, N. H., Swingle, R. J., Cooper, H. M., and Abernethy, R. F., Analyses of Washington Coals, Supplement to Technical Paper 491: Tech. Paper 618, 1941, 81 pp.

Section of coal bed in Franklin Gem mine

Laboratory No.	C21380	
	Ft.	*In.*
Roof, shale.		
Bone (immediate roof)	[1] 4	0
Coal	**2**	**4½**
Bone, firm (immediate floor)	[1] 2	1
Floor, sandstone.		
Thickness of bed	8	5½
Thickness of sample	2	4½

[1] Not included in sample.

System of mining, chute-and-pillar. The coal is shot from the solid with permissible explosives. At the time of sampling the daily output was 20 tons from advance workings. The coal is sized on a shaker screen having 1-inch round holes; 2 products are made, picked lump over 1 inch and minus-1-inch coal.

BLACK DIAMOND. FRANKLIN NO. 10 MINE

Analyses D7808 and D7809 (p. 29). High-volatile B bituminous coal, King County field, Green River district, from Franklin No. 10 mine, a drift (truck) mine 670 feet above sea level in sec. 18, T. 21 N., R. 7 E., 2 miles southeast of Black Diamond. Coal bed, Franklin No. 10; Puget formation; dip, 55° SW.; strike, N. 10° W.; cover at points sampled, approximately 200 feet. The bed was measured and sampled at the face of the gangway 2,700 feet north of the portal, by Joseph Daniels (USBM) December 20, 1948.

Sections of coal bed (upper and lower benches) in Franklin No. 10 mine

Section	Upper bench		Lower bench	
Laboratory No.	D7808		D7809	
	Ft.	*In.*	*Ft.*	*In.*
Roof, shale, hard.				
Coal, bright, soft	**1**	**0**	--	--
Shale, brown, hard, variable		[1] 4	--	--
Coal, bright, soft	**2**	**0**	--	--
Shale, hard and soft bands, variable		[1] 7	--	--
Coal, bright, soft, thin shale partings	**1**	**7**	--	--
Shale, hard, brown, coaly streaks (mining band)	[1] 1	6½	--	--
Coal, bright		**11**	--	--
Sandy band, coal and shale		[1] 6		[1] 10
Coal, bright, hard		**6**		**11**
Shale, brown, hard, variable		[1] 2	--	--
Coal, bright		**9**	**1**	**0**
Shale, brown, hard		[1] 4	--	--
Coal, hard, bony bands	**1**	**2**	**1**	**0**
Floor, shale, soft, parting.				
Floor, shale, hard	--	--	--	--
Thickness of bed	11	4½	3	9
Thickness of sample	7	11	2	11

[1] Not included in sample.

The bed at the points sampled is very irregular, and the shale bands vary in thickness. D7808 is an analysis of the section exposed and D7809 of the lower part of the bed, including a 1-foot band of coal and shale. Sections of this bed and analyses also are given under Hi Heat mine at Black Diamond.

System of mining, chute-and-pillar. The coal is shot from the solid with permissible explosives. At the time of sampling the mine was producing an average of 230 tons daily; the life of the mine was estimated to be 25 years. The coal is trucked 3½ miles to a washery at Black Diamond, where the entire output is washed. All coal is crushed to pass a 3-inch screen, washed in a McNally-Norton jig, and screened to the following sizes: Nut, through 3-inch and over 1¼-inch square-hole; Steam, through 1¼-inch square-hole; Buckwheat, through 3/32-inch square-hole.

BLACK DIAMOND. GEM NO. 1 MINE

Analysis B62407 (p. 29). High-volatile C bituminous or subbituminous A coal, King County field, Green River district, from Gem No. 1 mine, a slope (truck) mine 200 feet above sea level in NW¼ sec. 27, T. 21 N., R. 6 E., 2¼ miles southwest of Black Diamond. Coal bed, unnamed; Puget formation; dip, 22° W.; strike, N.–S.; cover at point sampled, 140 feet. The bed was measured and sampled on 4 level, 160 feet north of the slope, 560 feet west and north of the portal, by M. R. Geer (USBM) April 29, 1941, as described below:

Section of coal bed in Gem No. 1 mine

Laboratory No.	B62407	
	Ft.	*In.*
Roof, sandstone.		
Bone	[1] 1	1
Coal	--	**2**
Sandstone	--	[1] 1½
Coal	**2**	**4**
Coal, sandstone streaks	--	**5**
Coal	--	**9½**
Sandstone	--	[1] 2
Coal	**1**	**0**
Bone	--	[1] 7
Floor, sandstone.		
Thickness of bed	6	7
Thickness of sample	4	8½

[1] Not included in sample.

System of mining, chute-and-pillar. The coal is shot from the solid with permissible explosives. At the time of sampling the daily production was 10 tons from advance workings, and the lifetime of the mine was estimated to be 15 years. At the washery plus-2½-inch round-hole lump is removed by a shaker screen and picked; the remainder of the coal is washed in a Forrester jig, then sized over a revolving screen into 2½-inch round-hole to ⅞-inch square-hole, ⅞-inch square-hole to ¼-inch square-hole, and minus-¼-inch square-hole sizes.

BLACK DIAMOND. GEM NO. 2 MINE

Analysis C21382 (p. 29). High-volatile C bituminous or subbituminous A coal, King County field, Green River district, from Gem No. 2 mine, a slope (truck) mine, 230 feet above sea level in SE¼ sec. 27, T. 21 N., R. 6 E., 2¼ miles southwest of Black Diamond. Coal bed, Gem; Puget formation; dip, 27° W.; strike, N. 25° W.; cover at point sampled, 120 feet. The bed was measured and sampled at the face of 1 north gangway, 500 feet north of the portal, by M. R. Geer (USBM) May 19, 1944, as described below:

Section of coal bed in Gem No. 2 mine

Laboratory No.	C21382	
	Ft.	*In.*
Roof, shale, brown.		
Bone, hard	[1] 1	8
Coal	--	**3½**
Shale, brown, hard	--	[1] ¾
Coal	**2**	**10½**
Shale, brown	--	[1] 1
Coal	**2**	**3**
Bone, hard, smooth (immediate floor)	1	----
Floor, shale, brown.		
Thickness of bed	8	2¾
Thickness of sample	5	5

[1] Not included in sample.

System of mining, chute-and-pillar. The coal is shot from the solid with permissible explosives. At the time of sampling the mine was producing 10 tons of coal daily from advance workings. The coal is sized on shaker and revolving screens having 2½-inch round holes and ¾- and ¼-inch square holes. Over 2½-inch round-hole lump is picked; the undersize is washed in a Forrester jig, producing 2½- to ¾-inch, ¾- to ¼-inch, and minus-¼-inch coal.

BLACK DIAMOND. HI HEAT MINE

Analyses C21223 to C21225 (p. 29). High-volatile B bituminous coal, King County coal field, Green River district, from Hi Heat mine, a (truck) mine 670 feet above sea level in SE¼ sec. 18, T. 21 N., R. 7 E., 2 miles southeast of Black Diamond. Coal bed, Franklin No. 10; Puget formation; dip, 46° W.; strike, N.–S.; cover at points sampled, 50 feet. The bed was measured and sampled as 2 benches at 2 points, 1 in a gangway in the lower bench and 1 in a gangway in the upper bench, by M. R. Geer (USBM) May 19, 1944, as described below:

Sections of coal bed (upper and lower benches) in Hi Heat mine

Section	Upper bench		Lower bench	
Laboratory No.	C21223		C21224	
	Ft.	*In.*	*Ft.*	*In.*
Roof, sandstone.				
Shale, brown, hard (immediate roof).	[1] 1	0	-------	
Shale, carbonaceous, soft	--	[1] 4	-------	
Bony	--	[1] 3	-------	
Coal	--	**5**	-------	
Bone, hard	--	[1] 1	-------	
Coal	**1**	**0**	-------	
Shale, brown	--	[1] 1½	-------	
Coal	**1**	**3**	-------	
Bone, hard (immediate floor)	--[1]	11	-------	
Immediate roof	------		[1] 7	0
Coal	------		--	**10**
Shale, concretion	------		--	[1] 2
Coal	------		**1**	**0**
Bone, soft	------		--	[1] 4
Coal	------		--	**10**
Immediate floor, shale and bone, carbonaceous	------		**7**	**0**
Thickness of bed	5	4½	17	2
Thickness of sample	2	8	2	8

[1] Not included in sample.

A drift was driven north 100 feet in the lower bench of bed, and the gangways were driven separately in lower and upper benches. Sample C21223 was taken at the face of upper-bench gangway 270 feet north of portal. Sample C21224 was taken at the face of lower-bench gangway 220 feet north of portal. The ultimate analysis of a composite made by combining samples C21223 and C21224 is given under laboratory No. C21225.

System of mining, chute-and-pillar. The coal is shot from the solid with stumping powder. The mine is new and at the time of sampling was producing 5 tons daily from advance workings. Coal was screened to produce plus-1-inch, through 1-inch and over ⅜-inch, and through ⅜-inch sizes.

BLACK DIAMOND. J. & P. MINE

Analysis C21222 (p. 30). High-volatile C bituminous or subbituminous A coal, King County field, Green River district, from J. & P. mine, a drift (truck) mine approximately 400 feet above sea level in SE¼ sec. 26, T. 21 N., R. 6 E., 2 miles south of Black Diamond. Coal bed, Kummer No. 1; Puget formation; dip, 48° E.; strike, N. 20° E.; cover at point sampled, 100 feet. The bed was measured and sampled at the face of the water-level gangway 300 feet south of the portal by M. R. Geer (USBM) May 18, 1944, as described below:

Section of coal bed in J. & P. mine

Laboratory No.	C21222	
	Ft.	*In.*
Roof, sandstone.		
Bone (immediate roof)	-------	
Coal	**3**	**1½**
Shale, brown, soft	--	[1] 1
Coal	--	**5½**
Clay, soft	--	[1] 1½
Coal	**1**	**2½**
Bone (immediate floor)	--	[1] 8
Floor, shale, sandy.		
Thickness of bed	5	8
Thickness of sample	4	9½

[1] Not included in sample.

System of mining, chute-and-pillar. The coal is shot from the solid with permissible explosives. At the time of sampling the mine was in the development state, and coal was screened on a stationary punched plate having 1¼-inch round-hole openings.

BLACK DIAMOND. KUMMER MINE

Analysis C40881 (p. 30). Subbituminous B coal, King County field, Green River district, from Kummer mine, a slope (truck) mine 600 feet above sea level in NE¼ sec. 26, T. 21 N., R. 6 E., 2 miles south of Black Diamond. Coal bed, Kummer No. 4; Puget formation; dip, 48° E.; strike, N.–S.; cover at point sampled, 150 feet. The bed was measured and sampled at 2 crosscuts, 50 feet north of the slope, by M. R. Geer (USBM) May 11, 1945, as described below:

Section of coal bed in Kummer mine

Laboratory No	C40881	
	Ft.	*In.*
Roof, shale, sandy.		
Coal	**1**	**2**
Shale, sandy	--	[1] 3/4
Coal	--	**4½**
Sandstone	--	[1] ½
Coal	**1**	**3**
Sandstone	--	[1] ¼
Coal	--	**3½**
Shale, sandy	--	[1] ½
Coal, bony streak	**1**	**0**
Clay, soft, sandy	--	[1] 3
Coal	--	**8**
Shale	--	[1] 3/8
Coal	--	**8½**
Floor, shale, underlain by 10 feet 6 inches of coal, bone, and shale and floor clay.		
Thickness of bench	5	10 7/8
Thickness of sample	5	5½

[1] Not included in sample.

System of mining, chute-and-pillar. The coal is shot from the solid with permissible explosives. When sampled, the mine was in the development stage, and the entire output came from advance workings. The coal was screened over 1-inch square-hole and through ½-inch square-hole screens.

This is not the Kummer mine described in Technical Paper 618, page 49.

CUMBERLAND. DURHAM MINE

Analysis C22079 (p. 30). High-volatile A bituminous coal, King County field, Green River district, from Durham mine, a water-level gangway mine 1,525 feet above sea level in NE ¼ sec. 2, T. 21 N., R. 7 E., 4½ miles northeast of Cumberland on the Chicago, Milwaukee, St. Paul & Pacific Railroad. Coal bed, Durham No. 2; Puget formation; dip, 32° E., strike, N. 15° W.; cover at point sampled, 150 feet. The bed was measured and sampled in the top countergangway, 30 feet inby 39 chute, 2,400 feet southeast of the portal, by M. R. Geer (USBM) June 2, 1944, as described below:

Section of coal bed in Durham mine

Laboratory No	C22079	
	Ft.	*In.*
Roof, shale.		
Bone, coal, shale	[1] 8	0
Coal	--	**6½**
Bone and shale	--	[1] 4½
Coal	--	**11¾**
Bone	--	[1] 2½
Coal, bony	--	**4**
Bone	--	[1] 2
Coal	--	**3½**
Shale, carbonaceous, soft	--	[1] 1½
Bony	--	[1] 2
Coal	--	**5½**
Bony	--	[1] 1½
Coal	--	**8½**
Bone	--	[1] 2

[1] Not included in sample.

Section of coal bed in Durham mine—Con.

Laboratory No	C22079	
	Ft.	*In.*
Coal	--	**10**
Bony	--	[1] 5
Coal	--	**4**
Bony	--	[1] 1½
Coal	--	**4½**
Bony	--	[1] 7
Shale, gray (immediate floor)	--	[1] 3
Floor, 7 feet of carbonaceous shale, underlain by main sandstone footwall.		
Thickness of bed	7	6¾
Thickness of sample	4	10¼

[1] Not included in sample.

System of mining, chute-and-pillar. The coal is shot from the solid with permissible explosives. At the time of sampling the mine was producing 40 to 50 tons of coal daily from advance workings; its life was estimated to be 15 years. At the tipple all coal is crushed to pass a 3½ inch screen, cleaned in a Forrester jig, and sold as washed 3½-inch to 0 coal.

CUMBERLAND. HYDE MINE

Analysis C21558 (p. 30). High-volatile B bituminous coal, King County field, Green River district, from Hyde mine, a slope (truck) mine approximately 840 feet above sea level in SW ¼ sec. 29, T. 21 N., R. 7 E., 1 mile southwest of Cumberland. Coal bed, McKay; Puget formation; dip, 42° S.; strike, E.–W.; cover at point sampled, 50 feet. The bed was measured and sampled on a slope at 1 crosscut, 75 feet south of the portal, by M. R. Geer (USBM) May 22, 1944, as described below:

Section of coal bed in Hyde mine

Laboratory No	C21558	
	Ft.	*In.*
Roof, shale, hard.		
Bone, coal streaks	[1] 1	9
Coal, partly bony	--	**4½**
Shale	--	[1] ½
Coal	--	**1½**
Shale	--	[1] ¾
Coal	--	**8½**
Shale, soft	--	[1] ¼
Bone, coal streaks	[1] 1	6½
Shale, brown, hard	--	[1] 2
Coal	**2**	**2**
Coal, bony	--	[1] 2
Floor, shale, hard, smooth.		
Thickness of bed	7	1½
Thickness of sample	3	4½

[1] Not included in sample.

System of mining, chute-and-pillar. The coal is shot from the solid with stumping powder. At the time of sampling the slope was being sunk, and the daily output of the mine was 10 tons. Only run-of-mine coal was being produced, but a preparation plant was contemplated.

ENUMCLAW. GREEN RIVER MINE

Analysis C21381 (p. 30). High-volatile C bituminous or subbituminous A coal, King County field, Green River district, from Green River mine, a slope (truck) mine 730 feet above sea level in SE¼ sec. 36, T. 21 N., R. 6 E., 3½ miles north of Enumclaw. Coal bed, Kummer No. 4(?), Puget formation; dip, 27° W.; strike, N.–S.; cover at point sampled, 175 feet. The bed was measured and sampled on the slope at 2 crosscut below 1 gangway, by M. R. Geer (USBM) May 20, 1944, as described below:

Section of coal bed in Green River mine

Laboratory No	C21381	
	Ft.	*In.*
Roof, not exposed.		
Bone (immediate roof)		
Clay, bone streaks	--	[1] 7
Coal, bony	--	[1] **9**
Clay, soft	--	[1] 5
Coal	--	**10**
Shale, soft	--	⅛
Coal	**2**	**2**
Clay, soft	--	[1] 2½
Coal, partly bony	--	**3**
Bone	--	[1] 1
Coal	--	**2½**
Clay	--	[1] 1
Coal	--	**3**
Clay, sandy	--	[1] ½
Coal	--	**7½**
Shale, soft	--	⅛
Coal	--	**5**
Shale	--	[1] ¼
Coal, partly bony	--	**4½**
Clay and bone streaks	--	[1] 6½
Clay, soft	--	[1] 2½
Coal, partly bony	--	**9**
Clay, sandy	--	[1] 1½
Coal, partly bony	--	**9**
Clay, soft	--	[1] 3
Coal, bony	--	[1] **2**
Bone (immediate floor)		
Floor, not exposed.		
Thickness of exposed section	10	1½
Thickness of sample	6	7¾

[1] Not included in sample.

System of mining, chute-and-pillar. The coal is shot from the solid with permissible explosives. At the time of sampling the mine was a new operation. Lump, over 2½-inch hole, and washed coal, through 2½-inch over 1½-inch, through 1½-inch over ¼-inch, and through ¼-inch sizes were produced. In 1946 a washery equipped with a Forrester jig and trommels yielded the following products: Picked lump over 3¼-inch round-hole, and the following washed sizes—Egg, through 3¼-inch round-hole over 1¾-inch square-hole; stoker, through 1¾-inch square-hole over ¼-inch square-hole; and Buckwheat, through ¼-inch sqaure-hole.

ISSAQUAH. HARRIS NO. 2 MINE

Analysis B75318 (p. 31). Subbituminous A or high-volatile C bituminous coal, King County field, Newcastle-Issaquah district, from Harris No. 2 mine, a drift (truck) mine 400 feet above sea level in NW¼ sec. 32, T. 24 N., R. 6 E., 3 miles west of Issaquah. Coal bed, Jones; Puget formation; dip, 30° N.; strike, S. 65° E.; cover at point sampled, 100 feet. The bed was measured and sampled in 3 chute, 10 feet above the water-level gangway, by M. R. Geer (USBM) April 3, 1942, as described below:

Section of coal bed in Harris No. 2 mine

Laboratory No	B75318	
	Ft.	*In.*
Roof, not exposed.		
Shale, light brown, soft (immediate roof)	--	[1] 1½
Coal, bright	**2**	**1**
Shale, dark, soft	--	[1] 1
Coal, bone, and shale streaks	**1**	**3**
Bony (immediate floor)	[1] 1	3
Floor, not exposed.		
Total thickness exposed	3	6½
Thickness of sample	3	4

[1] Not included in sample.

System of mining, chute-and-pillar. The coal is shot from the solid with stumping powder. When sampled, the mine was in the development stage. This mine is a new operation in the Jones bed; the old Harris No. 1 mine was in the Dolly Varden bed.

ISSAQUAH. LAHEE MINE

Analysis D19163 (p. 31). Subbituminous A or high-volatile C bituminous coal, King County field, Newcastle-Issaquah district, from Lahee mine, a drift (truck) mine approximately 250 feet above sea level in N½ sec. 32, T. 24 N., R. 6 E., 3 miles west of Issaquah. Coal bed, Dolly Varden; Puget formation; dip, 40° NE.; strike, N. 70° W.; cover at point sampled, approximately 600 feet. The bed was measured and sampled at the face of the water-level drift, 1,875 feet west of the portal, by Joseph Daniels (USBM) May 18, 1949, as described below:

Section of coal bed in Lahee mine

Laboratory No	D19163	
	Ft.	*In.*
Roof, shale, sandy, soft, rough.		
Shale, soft, with coaly streaks	--	[1] 3
Coal, bright, with thin, hard shale partings 4 inches and 6 inches from top	**1**	**2**
Shale, brown, hard	--	[1] ¾
Shale, gray, soft	--	[1] ¾
Coal, bright, hard	**1**	**1**
Bone and hard shale	--	[1] 1
Shale, gray, soft	--	[1] 5½
Coal, bright, hard	--	**8**
Bone	--	1
Bottom, shale, sandy [2]	[1] 2	8
Coal and bone, variable	[1] **1**	**0**
Bone	--	[1] 2
Shale, gray, soft		
Thickness of bed	7	9
Thickness of sample	2	11

[1] Not included in sample.
[2] The upper 3 feet 11 inches is considered the workable section of the bed; below this is 3 feet 10 inches of formation that may or may not be a part of the Dolly Varden bed.

System of mining, chute-and-pillar. The coal is shot from the solid with permissible explosives. The property is being reopened after several years of idleness. Run-of-mine coal is trucked to Renton for

preparation; over 3-inch round-hole lump is picked, and the 3-inch undersize is washed in a Forrester jig and shipped as Egg, stoker, and Buckwheat.

ISSAQUAH. QUEEN NO. 1 MINE

Analysis D18545 (p. 31). Subbituminous A coal, King County field, Newcastle-Issaquah district, from Queen No. 1 mine, a drift (truck) mine 320 feet above sea level in NE¼ sec. 31, T. 24 N., R. 6 E., 3 miles west of Issaquah. Coal bed, Muldoon; Puget formation; dip, 45° NE.; strike, N. 70° W.; cover at point sampled, approximately 800 feet. The bed was measured and sampled in 57 chute, 50 feet above water level, 4,000 feet northeast of portal, by Joseph Daniels (USBM) May 12, 1949, as described below.

Section of coal bed in Queen No. 1 mine

Laboratory No	D18545	
	Ft.	*In.*
Roof, shale, sandy, hard.		
Shale, soft	--	[1]2
Coal, bright, hard	--	**11**
Shale parting, gray	--	¼
Coal and bone, mixed	--	**3**
Coal, bright, hard	**1**	**4**
Shale, brown, hard	--	[1]1
Coal, hard	--	**10**
Shale, brown	--	[1]1
Coal, bright, hard	--	**9**
Coal, bone, shale	--	**6**
Coal, bright, hard	**1**	**5**
Shales, black, hard, shelly	[1]1	0
Floor, sandstone, hard, smooth, shaly.		
Thickness of bed	7	4¼
Thickness of sample	6	¼

[1] Not included in sample.

The Muldoon underlies the May Creek bed. System of mining, chute-and-pillar. The coal is shot from the solid with permissible explosives. The average daily output was 150 tons; the total production of the mine in 1948 was 34,052 tons. The lifetime of the mine was estimated to be 50 years. At the tipple the coal is sized on 3½-inch round-hole, 1-inch square-hole, and 3/16-inch square-hole screens. Over 3½ shaker-screen lump is picked; the undersize is washed in a single-cell Elmore jig and screened on vibrator screens to Egg-Nut, Pea, and Buckwheat sizes.

PALMER. ELK NO. 3 MINE

Analyses B61445 and D1342 to D1344 (p. 31). High-volatile B bituminous coal, King County field, Green River district, from Elk No. 3 mine, a drift mine (inside slope) 933 feet above sea level in SE ¼ sec. 34, T. 22 N., R. 7 E., 2 miles north of Palmer on the Northern Pacific Railroad. Coal beds, Dutch and "A" or Victory; Puget formation; dip, 45° NE.; strike, N. 65° W.; cover at points sampled, Dutch bed 150 and 325 feet and "A" bed 225 and 285 feet. The beds were measured and sampled by M. R. Geer (USBM) March 7, 1941, and by Joseph Daniels (USBM) September 14, 1948, as described below:

Sections of coal beds in Elk No. 3 mine

Bed	Dutch			
Laboratory No	B61445		D1342	
	Ft.	*In.*	*Ft.*	*In.*
Roof, shale, hard.				
Bony (roof coal)	[1]1	0		
Shale, soft	--	[1]¼	--	[1]9
Bone			--	[1]3
Coal, bright	**2**	**2**	--	**11**
Coal, bony	**1**	**1**	--	**5**
Coal and bone			**1**	**9**
Bony	--	[1]10		
Shale, hard	--	[1]¾	--	[1]2
Coal			--	[1]**2**
Shale, brown, firm			--	[1]1½
Bone	--	[1]1		
Coal	--	**2½**	**1**	**5**
Shale	--	[1]1	[1]2	11
Coal, bright	--	**6**		
Coal, bony	--	**2**		
Shale, soft	--	[1]½		
Bony	[1]1	4	[1]1	2
Floor, shale, hard, smooth.[2]				
Thickness of bed[3]	7	7	10	½
Thickness of sample	4	1½	4	6

Bed	"A" or Victory			
Bench	Upper		Lower	
Laboratory No.	D1344		D1343	
	Ft.	*In.*	*Ft.*	*In.*
Roof, shale, firm.				
Shale, bony	--	[1]3½		
Bone and coal	--	[1]4		
Clay, white, variable	--	[1]5		
Coal, soft	**1**	**0**		
Clay, yellow, variable	--	[1]3		
Coal	**2**	**0**		
Shale, brown, hard	--	[1]6		
Coal, bony	**1**	**6**		
Shale, hard, brown[4]			--	[1]6
Coal			--	[1]**6**
Shale, hard, brown			--	[1]3
Shale, hard, black			--	[1]2
Shale, hard, brown			--	[1]3
Coal, occasional shale partings			**5**	**0**
Coal and bone			--	**3**
Floor, shale, hard, smooth.				
Thickness of bench	6	3½	6	11
Thickness of sample	4	6	5	3

[1] Not included in sample.
[2] Not exposed in B61445.
[3] Thickness exposed in B61445.
[4] Floor of upper bench and roof of lower bench.

Sample B61445 was taken in a rock tunnel driven from "A" or Victory bed 20 feet into the footwall of the Dutch bed, 700 feet from the portal on the water-

level gangway. Sample D1342 was taken in the Dutch bed, first-level sump of the inside slope. Sample D1343 was taken in the lower bench of the "A" or Victory bed in a chute 100 feet northeast of the slope and 25 feet above the slope-level gangway. Sample D1344 was taken higher in the same chute in the upper bench of the "A" bed.

System of mining, chute-and-pillar. The coal is shot from the solid with permissible explosives. The coal beds being worked are the Dutch, Big Elk, Little Elk, and "A" or Victory; the Big Elk output is obtained from stripping operations. Over 3-inch round-hole lump is picked, and the undersize is washed on a Forrester jig.

RAVENSDALE. DANVILLE NO. 1 MINE

Analyses B51279 to B51281 (p. 32). Subbituminous A or high-volatile C bituminous coal, King County field, Green River district, from Danville No. 1 mine, a slope mine 690 feet above sea level in SW¼ sec. 24, T. 22 N., R. 6 E., 2 miles northwest of Ravensdale on the Pacific Coast Railroad. Coal bed, Frazier; Puget formation; dip, 85° NW.; strike, N. 40° E.; cover at points sampled, 470 and 250 feet. The bed was measured and sampled at two points by M. R. Geer (USBM) and J. H. Delaney (USBM) April 4, 1940, as described below:

Sections of coal bed in Danville No. 1 mine

Laboratory No.	B51279		B51280	
	Ft.	*In.*	*Ft.*	*In.*
Roof, sandstone, hard.				
Coal, hard	**2**	**4**	--	--
Bone	--	--	[1] 1	3
Coal, soft	--	--	--	**11½**
Shale and coal (mining)	--	[1] 2½	--	[1] ¾
Coal, hard	**2**	**4½**	--	--
Coal, soft	--	--	**1**	**½**
Shale, carbonaceous	--	[1] 1½	--	--
Shale and coal (mining)	--	--	--	[1] ½
Coal, hard	**1**	**9**	--	--
Coal	--	--	**1**	**11**
Shale	--	1	--	--
Shale and coal (mining)	--	--	--	[1] ¾
Coal, hard	**1**	**8**	**2**	**0**
Bony	--	[1] 9	--	[1] 9
Floor, shale, carbonaceous, 14 feet to sandstone main footwall.				
Total thickness of bed	9	3½	8	1
Thickness of sample	8	1½	5	11

[1] Not included in sample.

Sample B51279 was taken at the face of 2 north gangway 700 feet from inside slope. Sample B51280 was taken at 1 countergangway at the hoist station of the inside slope.

The ultimate analysis of a composite made by combining samples B51279 and B51280 is given under laboratory No. B51281.

The mine is about 1,000 feet north of the old Danville mine described in Technical Paper 491 (pp. 127–128) and is still largely in the development stage.

System of mining, chute-and-pillar. The coal is shot from the solid with permissible explosives. The average daily output was 200 tons, all from advance workings; the life of the mine was estimated to be 20 years. At the tipple the coal was screened and picked over a 2¾-inch bar screen to produce lump; the undersize was washed in a Forrester jig and screened over revolving screens into 2¾ to 1-inch, 1-inch to ⅜-inch, ⅜-inch to 5/32-inch, and through 5/32-inch sizes.

RAVENSDALE. DANVILLE NO. 2 MINE

Analyses C22080, D90541, D21493, D42878, D56374 (p. 32). Subbituminous A or high-volatile C bituminous coal, King County field, Green River district, from Danville No. 2 mine, a slope (truck) mine 530 feet above sea level in SE¼ sec. 24, T. 22 N., R. 6 E., 2 miles northeast of Ravensdale on the Pacific Coast Railroad. This mine is newer than the Danville No. 1, which earlier operated on the Frazier bed. Coal beds, Eight-Foot, Landsburg No. 1, and Six-Foot; Puget formation; dips, vertical to 75° NW.; strike, N.–S. to S. 35° W.; cover at points sampled, 500 to 710 feet.

The Eight-Foot bed was measured and sampled by M. R. Geer (USBM) June 24, 1944, and August 23, 1952; the Landsburg No. 1 bed, by Joseph Daniels (USBM) June 24, 1949, by M. R. Geer (USBM), and C. L. Allyn (USBM) May 10, 1950; and the Six-Foot bed, by M. R. Geer (USBM) December 14, 1950, as described below:

Sections of Eight-Foot bed in Danville No. 2 mine

Laboratory No.	C22080		D90541	
	Ft.	*In.*	*Ft.*	*In.*
Roof,[1] shale, firm.				
Bone, hard	--	[2] 4	--	[2] 2
Coal	--	**3**	**1**	**9¾**
Shale, soft	--	--	--	[2] 1
Shale, brown, hard	--	[2] ½	--	--
Coal	--	**11**	**2**	**4½**
Shale, hard	--	--	--	[2] 1
Bone, hard	--	[2] ¾	--	--
Coal	--	--	--	**1¾**
Do	**3**	**0**	--	--
Shale, carbonaceous, soft	--	--	--	[2] 5
Bone and shale	--	[2] 3	--	--
Coal	--	--	**7¼**	**0**
Do	**1**	**4**	--	--
Shale, gray	--	--	--	[2] ½
Shale, brown, hard	--	[2] ⅛	--	--
Coal	--	--	**2**	**4**
Do	--	**11**	--	--
Shale, carbonaceous, soft	1	0	--	[2] 4¾
Coal, bony	--	--	--	**10**
Floor, shale, hard, smooth.				
Thickness of bed	8	1⅜	9	3½
Thickness of sample	6	5	8	1¼

[1] Sample D90541: Roof, shale, sandy, hard.
[2] Not included in sample.

Sample C22080 was taken at the face of 1-level south gangway 50 feet inby 41 chute, 3,700 feet southwest of the slope bottom, in SE¼NW¼ sec. 25. Sample D90541 was taken at the face of 1-level south gangway, 35 feet north of rock tunnel, 245 feet on bearing S. 75° E. from 2-slope bottom, in NW¼SW¼ sec. 25, T. 22 N., R. 6 E., in new slope workings.

Sections of Landsburg No. 1 bed in Danville No. 2 mine

Bench		Lower bench,
Laboratory No	D21493	D42878
	Ft. In.	Ft. In.
Roof, shale, brown, soft.		
Coal	[1] **11**	
Shale, brown	[1] 2	
Coal	[1] **11**	
Shale, brown	[1] 1¼	
Coal	[1] **1 7**	
Coal, soft, foliated	[1] **2 4**	
Coal, with shale bands	[1] **2 0**	
Coal, blocky, bright	**2 10**	
Shale, carbonaceous (immediate roof)	[1] 2	[1] 2
Coal		**1 0**
Coal, bright, hard	**3 2**	
Shale, brown, coaly band	[1] 8	
Shale, carbonaceous, soft		[1] 8
Coal	**10**	
Coal, bony, and shale		[1] **3¼**
Shale, brown, coaly streak	[1] 6	
Shale and bone		[1] 1½
Coal with shale band	**1 0**	
Coal		**3**
Shale, gray, hard	[1] 3	
Shale, brown		[1] ½
Coal	**11**	**9¼**
Shale, soft, banded	[1] 8	
Shale, brown		[1] ¼
Coal	**1 11**	
Shale, brown, soft	[1] 1	
Coal	**2 0**	**3 1**
Shale, carbonaceous		[1] 5
Shale, black, soft	[1] 9	
Floor, shale, sandy, hard, smooth.		
Thickness of bench	12 11	6 9¾
Thickness of sample	9 10	5 1¼

[1] Not included in sample.

Sample D21493 was taken at the face of 2-level gangway southwest of slope, 1,200 feet inby fault, in the lower section of the bed between a hard, sandy, shale footwall and a carbonaceous-shale parting, a total measured thickness of 12 feet 11 inches. Above this lower section of the bed the upper part is revealed in a doghole driven at right angles to the gangway and exposing a section 10 feet 10¼ inches thick.

Sample D42878 was taken at face of counter 65 feet inby 33 chute, 2 level, 4,000 feet southwest of portal, in SE¼NW¼ sec. 25, T. 22 N., R. 6 E.

Section of Six-Foot bed in Danville No. 2 mine

Laboratory No	D56374	
	Ft.	In.
Roof, shale.		
Coal	**2**	**9**
Bone and shale		[1] 4
Coal	**2**	**2**
Bone		[1] 2
Shale		[1] 1
Coal (immediate floor) [2]		**7**
Thickness of bench	6	1
Thickness of sample	5	6

[1] Not included in sample.
[2] This mining section is underlain by 21 feet of shale, bone and clay.

Sample D56374 was taken at face of a doghole 20 feet northeast of rock tunnel, 2 level, in SW¼SE¼ sec. 24, T. 22 N., R. 6 E.

System of mining, chute-and-pillar. The coal is shot from the solid with permissible explosives.

Formerly, the coal was passed over shaker and trommel screens and washed in a Forrester jig to produce Egg-Nut, Pea, and Buckwheat sizes. At present the raw coal is trucked to a washery at Black Diamond for preparation, where sizes smaller than 4-inch are washed in a Baum-type jig. Lump coarser than 4-inch is handpicked, crushed, and washed with 4-inch slack. Vibrating and revolving screens produce 4- to 1½-inch, 1½- to ⅜-inch, and ⅜-inch to 0 primary sizes.

RAVENSDALE. MCKAY MINE

Analyses C95581 and C96786 (p. 33). High-volatile C bituminous or subbituminous A coal, King County coalfield, Green River district, from McKay mine, a slope mine 810 feet above sea level in sec. 1, T. 21 N., R. 6 E., ¾ mile southeast of Ravensdale on the Northern Pacific Railroad. Coal bed, McKay; Puget formation; dip, 47° S. 57° W.; strike N. 33° W.; cover at points sampled, 1,300 feet. The bed was measured and sampled by H. F. Yancey (USBM) May 26, 1948, and M. R. Geer (USBM) June 14, 1948, as described below:

Sections of coal bed (upper and lower benches) in McKay mine

Section	A	B
Bench	Upper	Lower
Laboratory No	[1] C96786	[2] C95581
	Ft. In.	Ft. In.
Roof, shale.		
Coal, bony	[3] 6½	
Shale, brown	[3] 1	
Coal	[3] 4½	
Shale, carbonaceous	[3] 1	
Coal	**2**	
Shale, carbonaceous	[3] 2	
Coal	**2 10**	
Bone and shale	[3] 1 11	
Shale	1 0	
Roof, bone, coal and shale		[3] 8 0
Coal, bright (bottom bench)	[3] **4 9**	**4 9**
Floor, shale, soft, smooth.		
Thickness of bed	11 11	4 9
Thickness of sample	3 0	4 9

[1] Upper bench. [2] Lower bench. [3] Not included in sample.

Sample C95581 was taken 300 feet north of bottom of inside slope along 5 level north, 11 chute, inby rib, 8 feet above gangway, of the lower bench. Sample C96786 was taken at the pump station 5 level north, 200 feet north of bottom of inside slope.

System of mining, chute-and-pillar. The coal is shot from the solid with permissible explosives. At the washery lump coal over 3½-inch round-hole size is picked, and the undersize is washed on an Elmore jig and Deister tables. The washed sizes produced are 3½- by 1-inch, 1- by ⅜-inch, and ⅜-inch by 0.

RENTON. COAL CREEK PROSPECT

Analysis D65685 (p. 34). High-volatile C bituminous or subbituminous A coal, King County field, Newcastle-Issaquah district, from Coal Creek prospect, a slope (truck) mine 608 feet above sea level in SE¼ sec. 26, T. 24 N., R. 5 E., 10 miles northeast of Renton. Coal bed, No. 3½; Puget formation; dip, 38° N.; strike, N. 70° W. The bed was measured and sampled at face of water-level gangway, 800 feet west of portal,

by M. R. Geer (USBM) June 1, 1951, as described below:

Section of coal bed in Coal Creek prospect

Laboratory No	D65685	
	Ft.	*In.*
Coal	--	**5½**
Clay		[1] ¼
Coal	--	**1¾**
Clay	--	[1] ¼
Coal	--	**1**
Clay	--	⅛
Coal	--	**6½**
Clay	--	[1] ¾
Coal	--	**5½**
Clay	--	[1] 1½
Bone	--	[1] 2¾
Clay	--	[1] 2
Coal	--	**4½**
Clay	--	[1] 4
Coal	--	**5**
Clay	--	[1] ½
Coal	**1**	**0**
Shale	--	[1] 1
Coal	--	**3**
Thickness of bed	4	9⅞
Thickness of sample	3	8¾

[1] Not included in sample.

System of mining, chute-and-pillar. Coal is shot from the solid. The mine is new, and the daily production from advance workings is 30 tons. The coal is trucked to a washery at Newcastle.

RENTON. IVAN JONES PROSPECT

Analysis B78372 (p. 34). Subbituminous A or high-volatile C bituminous coal, King County field, Renton-Cedar Mountain district, from a prospect 500 feet above sea level in NW¼ sec. 25, T. 23 N., R. 5 E., 5 miles southeast of Renton. Coal bed, unnamed; Puget formation; dip, 30° S; strike, N. 75° E.; cover at point sampled, 200 feet. The bed was measured and sampled at face of a slope 25 feet south of the portal by M. R. Geer (USBM) May 29, 1942.

Section of coal bed in Ivan Jones prospect

Laboratory No	B78372	
	Ft.	*In.*
Roof, shale, soft.		
Bone, soft	[1] 1	----
Coal	--	**8**
Bone, soft	--	[1] 6
Coal, firm, bright	**1**	**4**
Bone, soft	--	[1] 6
Coal	--	**7**
Bone and shale	--	[1] 2
Coal	--	**6**
Floor, shale, hard.		
Thickness of bed	5	3
Thickness of sample	3	1

[1] Not included in sample.

At the time of sampling the property was in the prospect stage; it is 500 feet east of the old Cavanaugh mine, and the bed is probably No. 2 of the Cavanaugh mine.

RENTON. NEWCASTLE MINE

Analysis D18546 (p. 34). Subbituminous A coal, King County field, Newcastle-Issaquah district, from Newcastle mine, a slope (truck) mine 785 feet above sea level in SE¼ sec. 27, T. 24 N., R. 5 E., 9 miles northeast of Renton at old town of Newcastle. Coal bed, Jones; Puget formation; dip, 35° N.; strike, S. 70° E.; cover at point sampled, approximately 250 feet. The bed was measured and sampled 1,300 feet southeast of slope on 1 level, in chute 24½, 110 feet above gangway, by Joseph Daniels (USBM) May 13, 1949, as described below:

Section of coal bed in Newcastle mine

Laboratory No	D18546	
	Ft.	*In.*
Roof, shale, sandy, firm.		
Coal, bright, firm	--	**11**
Shale, brown, hard, with coal streaks	--	[1] 9
Shale, gray, hard, variable	--	[1] 2
Shale, black, with coal streaks	--	[1] 10
Shale, gray, soft	--	[1] 3
Coal, bright, soft	--	**8**
Shale, brown, soft	--	[1] 2
Coal, bright, soft	**3**	**4**
Shale, brown, hard	--	[1] 2
Floor, shale, sandy, hard, smooth.		
Thickness of bed	7	3
Thickness of sample	4	11

[1] Not included in sample.

System of mining, chute-and-pillar. The coal is shot from the solid with permissible explosives. The average daily production was 100 tons; the life of the mine was estimated to be 10 years. At the tipple the coal is passed over 4-inch round-hole, shaker screens and picked to produce lump; the undersize is washed in an Elmore jig and screened to produce 4- by 1-inch round-hole Egg-Nut, 1-inch round-hole by ¼-inch square-hole stoker, and minus-¼-inch.

RENTON. TALBOT MINE

Analysis C21559 (p. 35). Subbituminous A or high-volatile C bituminous coal, King County coalfield, Renton-Cedar Mountain district, from Talbot mine, a shaft (truck) mine 319 feet above sea level in SW¼ sec. 29, T. 23 N., R. 5 E., 2½ miles south of Renton. Coal bed, Springbrook; Puget formation; dip, 55° S.; strike, E.–W.; cover at point sampled, 370 feet. The bed was measured and sampled at face of 1 east gangway, 15 feet inby chute, 1,250 feet east of shaft bottom, by M. R. Geer (USBM) on May 22, 1944, as described below:

Section of middle bench of coal bed in Talbot mine

Laboratory No.	C21559	
	Ft.	*In.*
Roof, not exposed.		
Shale (immediate roof)		
Bone	--	[1] 6
Coal, partly bony	**1**	**3**
Shale, brown	--	[1] 2
Coal	**1**	**7**
Shale, brown	--	[1] 1
Coal	**1**	**4½**
Clay, soft	--	[1] 3
Coal	--	**11**
Clay, brown, soft	--	[1] 1½
Coal	**4**	**7**
Bone	--	[1] 4
Clay, soft	--	[1] 2
Shale (immediate floor)	--	----
Floor, not exposed.		
Thickness of bed exposed	11	4
Thickness of sample	9	8½

[1] Not included in sample.

The section measured is the middle bench of the bed; the total bed is approximately 50 feet thick.

System of mining, chute-and-pillar. The coal is shot from the solid with permissible explosives. At the tipple the coal is passed over shaker screens having 3½-inch round holes, and the lump is picked; the undersize is washed in a Forrester jig and sized on revolving screens into through 3½-inch round-hole and over 1-inch square-hole Egg; through 1-inch and over ⅛-inch square-hole stoker; and through ⅛-inch square-hole slack.

KITTITAS COUNTY

RONALD. ROSLYN NO 3 MINE

Analysis B56460 (p. 36). High-volatile A bituminous coal, Roslyn-Cle Elum field, Roslyn district, from Roslyn No. 3 mine, a slope mine 2,570 feet above sea level in SW¼ sec. 7, T. 20 N., R. 15 E., at Ronald on the Northern Pacific Railroad. Coal bed, Roslyn (No. 5); Roslyn formation; cover at point sampled, 560 feet. The bed was sampled on the timber incline at the face of Pioneer entry at barrier along west line, sec. 19, T. 20 N., R. 15 E., by H. F. Yancey (USBM) September 26, 1940, as described below:

Section of coal bed in Roslyn No. 3 mine

Laboratory No.	B56460	
	Ft.	*In.*
Roof, shale, smooth.		
Shale (immediate roof)	--	[1] 7
Coal, bony	--	[1] **3½**
Coal	--	**9¾**
Shale	--	⅛
Coal	--	**8¼**
Shale, hard	--	[1] 1
Coal	--	**7**
Shale, hard	--	3½
Coal	--	**2¾**
Shale	--	⅛
Coal	**1**	**6**
Shale	--	½
Coal	--	**2**
Shale, coal streaks	--	[1] 2½
Floor, shale, sandy, rough.		
Thickness of bed	4	11
Thickness of sample	4	3½

[1] Not included in sample.

System of mining, room-and-pillar. Some of the coal is undercut or sheared with machines, shot with permissible explosive, and loaded with shaking conveyors; recently some was mined with continuous miners. At the tipple virtually all of the coal is crushed to pass a 3½-inch screen and shipped by rail to a central cleaning plant, where it is washed in jigs and tables. The smaller sizes are dried in both centrifugal and heat driers. Sizes prepared are: 3½- to 1⅝-inch, 1⅝- to ¾-inch, ¾- to ¼-inch, ¼-inch to 0, and combinations.

ROSLYN. ROSLYN NO. 5 MINE

Analysis B56536 (p. 38). High-volatile A bituminous coal, Roslyn-Cle Elum field, Roslyn district, from Roslyn No. 5 mine, a slope mine 2,176 feet above sea level in sec. 21, T. 20 N., R. 15 E., 1¼ miles southeast of Roslyn on the Northern Pacific Railroad. Coal bed, Roslyn (No. 5); Roslyn formation; cover at point sampled, 645 feet. The bed was measured and sampled on 1 south entry, 160 feet east of the west line, sec. 28, T. 20 N., R. 15 E., by H. F. Yancey (USBM) September 26, 1940, as described below:

Section of coal bed in Roslyn No. 5 mine

Laboratory No.	B56536
	Ft. In.
Roof, shale, rough.	
Shale (immediate roof)	-- 8
Shale, coal streaks	-- [1] 2
Coal	**1 4**
Shale	-- 1/4
Coal	-- **5**
Shale	-- 1/4
Coal	-- **8 1/2**
Clay, coal streaks	-- [1] 4 3/4
Coal	**1 10 1/2**
Shale, coal streaks	-- 2 1/2
Floor, shale, hard, rough.	
Thickness of bed	5 1 3/4
Thickness of sample	4 7

[1] Not included in sample.

System of mining and preparation same as that described for Roslyn No. 3 mine.

LEWIS COUNTY

CENTRALIA. BELLE SLOPE MINE

Analyses C23747 to C23749 (p. 39). Subbituminous B coal, Southwestern field, Centralia-Chehalis district, from the Belle Slope mine, a slope and drift (truck) mine 256 feet above sea level in SE1/4 sec. 34, T. 15 N., R. 1 W., 9 miles northeast of Centralia. Coal bed, Smith; Skookumchuck formation; dip, 14° NE.; strike, S. 50° E.; cover at points sampled, 100 to 225 feet. The bed was measured and sampled at 2 points by H. F. Yancey (USBM) and M. R. Geer (USBM) July 7, 1944, as described below:

Sections of coal bed in Belle Slope mine

Laboratory No.	C23747		C23748	
	Ft.	In.	Ft.	In.
Roof, shale.				
Coal, bony	[1] 3	6	[1] 3	6
Sandstone	--	[1] 8	--	[1] 8
Coal (immediate roof)	[1] 2	6	[1] 2	6
Coal	3	0	2	2
Shale, brown	--	[1] 1/4	--	[1] 3/4
Coal	1	5 1/2	--	9
Shale, brown	--	[1] 3/8	--	1/4
Coal	--	2	--	1 3/4
Shale	--	[1] 1/4	--	[1] 1/4
Coal	--	2 1/4	--	1 3/4
Shale	--	[1] 1/4	--	[1] 1/4
Coal	1	6	--	2 3/4
Shale	--	----	--	[1] 1/4
Coal	--	----	--	4
Shale	--	----	--	[1] 3/8
Coal	--	----	--	5
Shale	--	----	--	[1] 3/8
Coal	--	----	--	1 3/4
Shale	--	----	--	[1] 1/4
Coal	--	----	--	2 1/4
Shale	--	----	--	[1] 1/4
Coal	--	----	--	1
Shale	--	----	--	[1] 1/2
Coal	--	----	1	2 1/2
Floor, shale, sandy.				
Thickness of bed	13	7/8	12	9 1/4
Thickness of sample	6	3 3/4	5	9 3/4

[1] Not included in sample.

Sample C23747 was taken 100 feet south of the slope on rib of 1 south entry at a vertical depth from surface of 225 feet. Sample C23748 was taken 350 feet west of the portal on back entry of water-level drift at a vertical depth of 100 feet from the surface. Of the series now known and exposed on the property, this bed is the third from the top.

The ultimate analysis of a composite made by combining samples C23747 and C23748 is given under laboratory No. C23749.

This mine was opened in 1943 by driving a water-level gangway and a slope from the outcrop.

System of mining, room-and-pillar. The coal is undercut with shortwall machines and shot with black powder. Shaker screens with 1 5/8-inch openings have been installed at the tipple to size the coal.

CENTRALIA. BLACK BADGER MINE

Analysis D30894 (p. 39). Weathered coal, Southwestern field, Tenino-Mendota district, from Black Badger mine, a drift (truck) mine 175 feet above sea level in NW1/4NW1/4 sec. 6, T. 14 N., R. 1 W., 4 1/2 miles northeast of Centralia. Coal bed Tono No. 1 (?); Skookumchuck formation; dip, 10° SE. to SW. (variable); strike, NE. to NW. (variable); cover at point sampled, 15 feet. The bed was measured and sampled (weathered sample) 25 feet northeast of the portal in main entry by M. R. Geer (USBM) and W. A. Olds (USBM) November 15, 1949, as described below:

Section of coal bed in Black Badger mine

Laboratory No.	D30894
	Ft. In.
Roof, sandstone:	
Clay (immediate roof)	-- [1] 3/4
Coal	-- **4**
Clay, sandy	-- [1] 1/4
Coal	-- **6**
Bone	-- [1] 1
Coal	-- **10**
Bone	-- [1] 1
Coal	**1 0**
Shale and bone	-- [1] 1
Coal	-- **7 1/2**
Bone and shale	-- [1] 1
Coal	**1 1**
Shale, coal streaks	-- [1] 10 1/2
Coal	-- **3 1/2**
Shale	-- [1] 1/4
Coal	-- **4 1/2**
Shale	-- [1] 1/2
Coal	-- **11 1/2**
Bone	-- [1] 7
Floor, sandstone:	
Thickness of bed	7 11 1/4
Thickness of sample	6 0

[1] Not included in sample.

This mine has not reported production since 1940; the system of mining at that time was room-and-pillar. The coal was shot from the solid.

CENTRALIA. COLUMBIA MINE

Analysis D3092 (p. 39). Subbituminous B coal, Southwestern field, Tenino-Mendota district, from Columbia mine, a slope (truck) mine 300 feet above sea level in E1/2NW1/4, sec. 10, T. 14 N., R. 1 W., 8 miles east of Centralia. Coal bed, Mendota No. 3; Skookumchuck formation; dip, 3°–4° SW.; strike, N.

55° W.; cover at point sampled, approximately 200 feet. The bed was measured and sampled at face of 25 room, 1 level east, 1,000 feet southeast of the slope bottom, near boundary of property, by Joseph Daniels (USBM) October 10, 1948, as described below:

Section of coal bed in Columbia mine

Laboratory No	D3092	
	Ft.	*In.*
Roof, sandstone, soft.		
Coal, bright	--	8
Shale parting	--	[1] ½
Coal, bright, hard	--	11
Shale, hard	--	[1] ½
Coal, firm	--	11
Coal, banded	--	4
Coal	1	2
Shale, hard	--	[1] ½
Coal	1	0
Shale, hard	--	[1] 2¾
Coal, thin shale bottom	--	2
Coal, thin parting at bottom	1	0
Coal	1	3
Shale, hard	--	[1] ½
Coal	1	0
Shale, hard	--	[1] ½
Coal, variable	--	5
Floor, not determined.		
Thickness of bed	9	3¼
Thickness of sample	8	10

[1] Not included in sample.

At the place of sampling a roll is present in the bottom of the bed, and the true thickness and the nature of the floor could not be determined.

System of mining, room-and-pillar. The coal is undercut by machine and shot with permissible explosives. At the time of sampling the daily production was 50 tons. At the tipple the coal is passed over a 3-inch round-hole shaker screen. The oversize is shipped as lump coal. The undersize is washed in a Forrester jig and sized on a trommel screen to produce the following sizes: Range, through 3-inch round-hole and over 1½-inch square-hole; stoker, through 1½-inch and over ¾-inch square-hole; Buckwheat, through ¾-inch and over ⅛-inch square-hole.

The bed is believed to be the same as that formerly mined at the Mendota mine, designated as No. 3, described in Technical Paper 491 (p. 170). The presence of cannel coal in this mine and at Mendota tends to confirm the correlation. The property also has been known as the Smith No. 3 mine.

CENTRALIA. COLUMBIA (SMITH) MINE

Analysis C1418 (p. 39). Subbituminous C coal, Southwestern field, Tenino-Mendota district, from Columbia (Smith) mine, a drift 490 feet above sea level in sec. 10, T. 14 N., R. 1 W., approximately 8 miles east of Centralia. Coal bed, Big Dirty; Skookumchuck formation; dip 2° W., strike N.-S.; cover at point sampled, 45 feet. The bed was measured and sampled on rib of main entry, 150 feet northwest of the opening, by Herbert Fowler (USBM) May 27, 1943, as described below:

Section of coal bed in Columbia (Smith) mine

Laboratory No	C1418	
	Ft.	*In.*
Roof, shale, sandy.		
Coal, roof	[1] 1	0
Coal	--	9½
Clay	--	[1] ½
Coal	1	1½
Shale, soft	--	[1] ½
Coal	--	7
Shale, soft	--	[1] ½
Coal	2	0
Floor, fire clay.		
Thickness of bed	5	7½
Thickness of sample	4	6

[1] Not included in sample.

The bed is 1 of 3 seams on the Columbia mine property, also known as the Smith mine, and is indicated on old maps as the Jumbo or Gumbo bed. Stratigraphically, the Jumbo bed lies 150 feet above the Smith bed, which in turn, lies 150 feet above the Mendota bed, the lowest bed worked at the Columbia mine.

CENTRALIA. CRENO PROSPECT

Analysis D30868 (p. 39). Subbituminous C coal, Southwestern field, Tenino-Mendota district, from Creno prospect (upper bed) 340 feet above sea level in SE¼NE¼, sec. 9, T. 14 N., R. 1 W., 7¼ miles east of Centralia. Coal bed, Little Dirty (?); Skookumchuck formation; dip, 5°–7° S. 70° E.; strike, N. 20° E.; cover at point sampled, 20 feet. The bed was measured and sampled at the face of a prospect drift, 50 feet southeast of the portal, by M. R. Geer (USBM) and W. A. Olds (USBM) November 11, 1944, as described below:

Section of coal bed in Creno prospect

Laboratory No	D30868	
	Ft.	*In.*
Roof, sandstone.		
Coal	--	7½
Shale, sandy	--	[1] 1
Coal	1	0
Shale, sandy	--	[1] ½
Coal	--	3½
Shale	--	[1] ¼
Coal	1	½
Shale	--	⅛
Coal	--	3
Shale	--	⅛
Coal	--	10
Shale	--	[1] ¼
Coal	--	5½
Floor, clay, underlain by sandstone.		
Thickness of bed	4	8¼
Thickness of sample	4	6¼

[1] Not included in sample.

The bed sampled lies about 40 feet above a second bed, which was not sampled, and 75 to 100 feet above the Mendota bed formerly mined at Kopiah.

CENTRALIA. KOSTICK NO. 1 PROSPECT

Analysis D30866 (p. 39). Weathered coal, Southwestern field, Tenino-Mendota district, from Kostick No. 1 prospect, a prospect 250 feet above sea level in NW¼SE¼ sec. 9, T. 14 N., R. 1 W., 6½ miles east of Centralia. Coal bed, Lower Thompson; Skookumchuck formation; dip, 26° S. 30° W.; strike, S. 60° E. The bed was measured and sampled (weathered sample) in a prospect trench at the surface by M. R. Geer (USBM) and W. A. Olds (USBM) November 15, 1949, as described below:

Section of coal bed in Kostick No. 1 prospect

Laboratory No.	D30866	
Roof, sandstone.	*Ft.*	*In.*
Coal	--	**4½**
Sandstone	--	2¾
Coal	--	**1½**
Shale, sandy	--	¾
Coal	--	**3½**
Shale	--	1
Coal	--	**5½**
Shale	--	½
Coal	**1**	**2½**
Shale	--	2½
Bone	--	2¼
Shale	--	¼
Coal	--	**6½**
Sandstone	--	**7**
Coal	--	**4½**
Shale	--	1¾
Coal	**1**	**0**
Shale, sandy	--	1¾
Coal	**1**	**0**
Bone and shale, carbonaceous	1	6
Floor, shale.		
Thickness of bed	8	7
Thickness of sample	4	10½

CENTRALIA. KOSTICK NO. 2 PROSPECT

Analysis D30867 (p. 39). Weathered coal, Southwestern field, Tenino-Mendota district, from Kostick No. 2 prospect, a prospect 490 feet above sea level in NE¼SW¼ sec. 9, T. 14 N., R. 1 W., 6½ miles east of Centralia. Coal bed, Smith; Skookumchuck formation; dip, 58° N. 35° E.; strike, S. 55° E. The bed was measured and sampled (weathered sample) in a prospect trench at the surface by M. R. Geer (USBM) and W. A. Olds (USBM), November 11, 1949, as described below:

Section of coal bed in Kostick No. 2 prospect

Laboratory No.	D30867	
Roof, sandstone.	*Ft.*	*In.*
Carbonaceous material. Thickness over	[1] 5	10
Sandstone	--	[1] 1
Coal	--	**9**
Bone and shale	--	[1] 1
Coal	**2**	**2**
Shale	--	[1] ¼
Coal	--	**9**
Shale and bone	--	[1] 2½
Coal	--	**11**
Floor, sandstone.		
Thickness of bed sampled	4	11¾
Thickness of sample	4	7

[1] Not included in sample.

CENTRALIA. LARABEE PROSPECT

Analysis D33783 (p. 40). Coal, Southwestern field, Tenino-Mendota district, from Larabee prospect, approximately 600 feet above sea level in NW¼ sec. 32, T. 15 N., R. 1 E., 14 miles northeast of Centralia. Coal bed, Upper Thompson; Skookumchuck formation; dip, 7° SE.; strike, N. 70° E. The outcrop was measured and sampled at one point by P. D. Snavely, Jr. (USGS), December 29, 1949, as described below:

Section of coal bed in Larabee prospect

Laboratory No.	D33783	
Roof, sandstone.	*Ft.*	*In.*
Bone	--	[1] 4½
Clay	--	[1] 1¾
Bone	--	[1] 3
Coal	--	**2**
Bone	--	[1] 4½
Tuff, sandy	--	[1] 1¼
Coal, bright	--	**6½**
Siltstone	--	[1] 1¾
Coal	--	**4**
Bone	--	[1] 1½
Coal, bright	--	**10**
Sandstone	--	[1] ¾
Coal	--	**7**
Coal, bony	--	**6½**
Siltstone	--	[1] 3½
Coal, bony	**1**	**0**
Siltstone	[1] 1	7
Coal	**1**	**0**
Siltstone	--	[1] 3½
Coal, bony	--	**4**
Siltstone	--	[1] 2
Coal	--	**5**
Coal, bony	--	**3**
Bone	--	[1] 1
Siltstone	--	[1] 7
Coal	**2**	**0**
Base, not exposed.		
Thickness of bed	12	7
Thickness of sample	8	0

[1] Not included in sample.

CENTRALIA. LINCOLN MINE

Analysis C1419 (p. 40). Lignite, Lewis County field, Centralia-Chehalis district, from mine formerly called Lincoln, a slope (truck) mine in NE¼SE¼ sec. 20, T. 14 N., R. 2 W., 2½ miles south of Centralia. Coal bed, unnamed; Skookumchuck formation; strike, NW.; cover at point sampled, 28 feet. The bed was measured and sampled at face of 1 room off slope entry, 110 feet north of entry opening, by Herbert Fowler (USBM) May 27, 1943, as described below:

Section of coal bed in Lincoln mine

Laboratory No.	C1419	
Roof, shale, hard.	*Ft.*	*In.*
Coal, roof	[1] **1**	**0**
Coal	**6**	**0**
Floor, fire clay, hard.		
Total thickness of bed	**7**	**0**
Thickness of sample	6	0

[1] Not included in sample.

The sample was taken at the only available place in the abandoned mine, which was last operated by the Lincoln Coal Mine Co. The property appears to have been worked from 1933 to 1942, first under the name of Lincoln and in 1942 as Midway mine.

CENTRALIA. MARTIN MINE

Analysis D8255 (p. 40). Subbituminous C coal, Southwestern field, Centralia-Chehalis district, from Martin mine, a rock tunnel and slope (truck) mine 317 feet above sea level in SW¼ sec. 29, T. 15 N., R. 2 W., 2 miles north of Centralia. Coal bed, Tono No. 1 or Foron; Skookumchuck formation; dip, 20° SW. (variable); strike, N. 65° W.; cover at point sampled, 500 feet. The bed was measured and sampled on 2 level west, 850 feet west of slope, on high side of counter 50 feet above gangway, by Joseph Daniels (USBM) December 22, 1948, as described below:

Section of coal bed in Martin mine

Laboratory No.	D8255	
	Ft.	*In.*
Roof, shale, soft.		
Shale, brown, soft	--	[1] 6
Coal	--	**5**
Shale, soft	--	[1] ½
Coal	[1] **1**	**6**
Shale, gray, soft	--	[1] 1
Coal, firm, hard	**1**	**0**
Shale, gray, soft	--	[1] 1
Coal, bright, soft	--	**5**
Clay, brown, soft	--	[1] 1
Coal, hard, firm	**1**	**1**
Shale, brown, soft	--	[1] ½
Coal, firm, hard	--	**11½**
Shale, brown, soft	--	[1] ½
Coal, firm, hard	--	**11½**
Shale, brown, soft	--	[1] ½
Coal, firm, hard	--	**11½**
Floor, shale, sandy, hard.		
Thickness of bed	8	9½
Thickness of sample	5	11½

[1] Not included in sample.

System of mining, chute-and-pillar. The coal is shot from the solid with permissible explosives. At the time of sampling the daily output was 50 tons; the life of the mine is estimated to be 25 years. At the tipple the coal is picked on a chute and passed over a 3½-inch round-hole shaker screen to produce lump and undersize; the undersize is washed in a Forrester jig and sized on vibrator screens. The washed coals produced are: Range, through 3½-inch and over 2½-inch round-hole; Nut-Pea, through 2½-inch round-hole and over 1½-inch square-hole; stoker, through 1½-inch and over ½-inch square-hole; Buckwheat, through ½-inch square-hole.

Three seams are exposed in the rock tunnel to the slope on the Foron bed; in descending order they are the 30-Inch bed, the 38-Inch bed, and the Nonpareil or Big bed. The Foron bed at the Martin mine is the same as that formerly worked at the Ford's Prairie mine in NW¼ sec. 30, T. 15 N., R. 2 W., and in the Peoples Coal Co. mine in the SE¼ sec. 29, T. 15 N., R. 2 W., immediately adjacent to the Martin mine.

CENTRALIA. MONARCH MINE (NEW)

Analysis D3090 (p. 40). Subbituminous C coal, Southwestern field, Centralia-Chehalis district, from Monarch mine (new), a slope mine 488 feet above sea level in sec. 30, T. 15 N., R. 2 W., 5 miles north of Centralia on the Northern Pacific Railroad, the Chicago, Milwaukee, & St. Paul Railway, and the Pacific Railroad. Coal bed, Tono No. 1 or Foron (local name, Monarch No. 1); Skookumchuck formation; dip, 18°–20° SW.; strike, N. 35°–40° W.; cover at point sampled 350 to 375 feet. The bed was measured and sampled on 3 level from 6 plane, 1,100 feet southeast of plane at face of gangway, approximately 250 feet from the east quarter corner of sec. 30, by Joseph Daniels (USBM) October 9, 1948, as described below:

Section of coal bed in Monarch mine (new)

Laboratory No.	D3090	
	Ft.	*In.*
Roof, shale, soft.		
Sandstone, soft, wet	---	---
Shale, sandy	---	---
Coal	[1] **2**	**4**
Sand, soft	--	[1] 1½
Coal, blocky, hard	**1**	**1**
Shale, sandy	--	[1] 1½
Coal, blocky	**1**	**5½**
Shale, brown, variable		[1] 1
Coal, blocky		**10**
Do	**1**	**6½**
Shale, gray, variable	--	[1] 1
Coal, firm	--	**5**
Floor, shale, hard, smooth.		
Thickness of bed	7	11
Thickness of sample	5	4

[1] Not included in sample.

The top bench of coal, which is 2 feet 4 inches thick, is usually left in place and supported by timbers in driving gangways and chutes because the overlying sandstone disintegrates and falls into the mine workings. In some retreating operations this top coal is recovered.

System of mining, chute-and-pillar. The coal is shot from the solid with permissible explosives. At the time of sampling the daily output was 150 tons, and the life of the mine was estimated to be 5 years. At the tipple the coal passes over a shaker screen having 3-inch and 1¾-inch round holes. The oversize lump is picked on the screen; range size through 3-inch and over 1¾-inch is shipped; and the undersize is sent to a Forrester jig. The washed product is sized on a trommel having 1¾-inch and ⅜-inch square holes, which yields some range size, through 1¾ and over ⅜-inch stoker, and through ⅜-inch and over ⅛-inch (square-hole vibrator screen) Buckwheat; the minus-⅛-inch is rejected.

The mine is operating the property formerly known as Ford's Prairie mine, described in Technical Paper 491 (p. 158).

CENTRALIA. MONARCH PROSPECT

Analysis D3091 (p. 40). Subbituminous C coal, Southwestern field, Centralia-Chehalis district, from a prospect opening 380 feet above sea level in sec. 30, T. 15 N., R. 2 W., about ¾ mile from the tipple of the Monarch mine on the road from Plant No. 6. Coal bed, Upper Thompson; Shookumchuck formation; dip, 20°–25° SW.; strike, N. 30°–35° W.; cover at point sampled, 100 feet. The bed was measured and sampled at the face of a prospect drift 150 feet west of the open-

ing by Joseph Daniels (USBM) October 9, 1948, as described below:

Section of coal bed in Monarch prospect

Laboratory No.	D3091
	Ft. In.
Roof, not visible.	
Coal	1 6
Sand, soft	-- [1] 1
Coal	-- 2
Shale, sandy	-- [1] 1½
Coal	1 5
Shale and coal, variable	-- [1] 2
Coal	-- 10½
Shale, sandy	-- [1] 2
Coal	-- 10
Shale and coaly streak	-- [1] 3
Coal	1 10
Shale, hard, variable	-- [1] 1
Coal	-- 5
Shale, hard	-- [1] 1
Coal	-- 3
Shale, hard	-- [1] 1
Coal	-- 9
Floor, shale, hard, smooth.	
Thickness of bed	9 0
Thickness of sample	8 ½

[1] Not included in sample.

This bed underlies the Tono No. 1 or Foran at approximately 170 feet stratigraphic interval and may be the equivalent of the locally named Nonpariel bed.

CENTRALIA. MORRIS PROSPECT

Analysis B93658 (p. 41). Coal, Southwestern field, Tenino-Mendota district, from Morris prospect approximately 350 feet above sea level in N½ sec. 2, T. 14 N., R. 1 W., northeast of Columbia mine, 8 miles east of Centralia. Coal bed, unnamed; Skookumchuck formation; dip, 5° (approximately); strike, SW.; cover at point sampled, 20 feet. The bed was measured at the face of a drift, 20 feet from the portal, by Herbert Fowler (USBM) January 15, 1943, as described below:

Section of coal bed in Morris prospect

Laboratory No.	B93658
	Ft. In.
Roof, sandstone, hard.	
Coal	3 2
Shale	-- [1] 1
Coal	1 0
Shale	-- [1] ½
Coal	1 8½
Shale	-- [1] ¾
Coal	2 ½
Floor, sandstone, hard.	
Thickness of bed	8 1¼
Thickness of sample	7 11

[1] Not included in sample.

CHEHALIS. NEWAUKUM PROSPECT

Analysis C64088 (p. 41). Subbituminous B coal, Southwestern field, Chehalis-Centralia district, from a prospect shaft in NW¼NE¼ sec. 24, T. 14 N., R. 1 W., 11 miles east of Chehalis. Coal bed, unnamed; Skookumchuck formation; dip, 0°–5° SW.; strike, SE.–NW. The bed was measured and sampled at the surface by M. R. Geer (USBM) October 16, 1946, as described below:

Section of coal bed in Newaukum prospect

Laboratory No.	C64088
	Ft. In.
Roof, gravel.	
Coal	1 1½
Clay, brown	-- ⅛
Coal	1 4
Clay, brown	-- [1] 1
Coal	5 1
Clay, brown	-- [1] 1
Coal	1 2
Clay, brown	-- [1] 1½
Coal	1 8
Floor, fire clay.	
Thickness of bed	10 8⅛
Thickness of sample	10 4⅝

[1] Not included in sample.

CHEHALIS. VAL MYER PROSPECT

Analysis B93644 (p. 41). Coal, Southwestern field, Cinnabar district, from a prospect approximately 900 feet above sea level in sec. 10, T. 13 N., R. 1 E., 15 miles southeast of Chehalis and 5 miles northeast of Onalaska on Alpha Prairie. Coal bed, unnamed; Puget formation; dip, 16°; strike, N. 58° W. The bed was measured and sampled at the surface by Herbert Fowler (USBM) January 13, 1943, as described below:

Section of coal bed in Val Myer prospect

Laboratory No.	B93644
	Ft. In.
Roof, variable.	
Coal, roof	-- [1] 5
Coal	1 9
Shale, soft	-- [1] ¾
Coal	-- 3½
Smut or mud, soft	-- [1] 1¾
Coal	2 9
Shale, hard	[1] 1⅝
Coal	1 1
Shale, hard	[1] 1½
Coal	4½
Floor, fire clay, soft.	
Thickness of bed	7 1⅝
Thickness of sample	6 3

[1] Not included in sample.

This bed is probably the one mentioned in Bulletin 19, Washington Geological Survey, The Coal Fields of Southwestern Washington, by H. E. Culver (pp. 105 and 106), as appearing in sec. 10, T. 13 N., R. 1 E., in 2 small creeks just above their junction in the SE¼NE¼.

MORTON. ATLAS (HI-CARBON) MINE

Analysis C28183 (p. 41). High-volatile C bituminous coal, Southwestern field, Mineral Lake district, from Atlas (Hi-Carbon) mine, a drift (truck) mine 1,150 feet above sea level in sec. 12, T. 12 N., R. 4 E., 2 miles southeast of Morton. Coal bed, Hi-Carbon;

Puget formation; dip, 22° SW.; strike, N. 45° W.; cover at point sampled, 200 feet. The bed was measured and sampled in 1 right entry off old slope on high rib, 60 feet inby slope air course, by M. R. Geer (USBM) October 16, 1944, as described below:

Section of coal bed in Atlas mine

Laboratory No.	C28183	
	Ft.	*In.*
Roof, sandstone, rough.		
Bone (immediate roof)	--	[1] 8
Bone and coal	--	[1] 4
Coal	1	**5**
Shale, hard	--	[1] 2
Coal	--	**11**
Shale, carbonaceous, soft	--	[1] 5
Coal	**1**	**0**
Shale, carbonaceous, soft	--	[1] 5
Coal	--	**5**
Shale, hard	--	[1] 1½
Coal	**1**	**5**
Shale, carbonaceous, soft	[1] 1	4
Floor, sandstone.		
Thickness of bed	8	6½
Thickness of sample	5	2

[1] Not included in sample.

System of mining, room-and-pillar. The coal is shot from the solid with nonpermissible explosives. At the time of sampling the mine was being reopened and produced 10 tons daily, all from advance workings. Only run-of-mine coal was being shipped. This mine was formerly known as Hi-Carbon mine.

MORTON. SUNBURST MINE

Analysis B96595 (p. 41). Low-volatile bituminous coal, Southwestern field, Mineral Lake district, from Sunburst mine, a drift (truck) mine approximately 1,100 feet above sea level in sec. 12, T. 14 N., R. 4 E., 3 miles west of Mineral and 13 miles north of Morton by road. Coal bed No. 2?; Puget formation; dip, 45°; strike, S.–W.; cover at point sampled, 125 feet. The bed was measured and sampled on rib of air course 300 feet southwest of the entry by Herbert Fowler (USBM) February 26, 1943, as described below:

Section of coal bed in Sunburst mine

Laboratory No.	B96595	
	Ft.	*In.*
Roof, sandstone.		
Shale	--	[1] 6
Tarlike residue, soft	--	[1] ¼
Coal, bright	**3**	**0**
Floor, shale, hard.		
Thickness of section	3	¼
Thickness of sample	3	0

[1] Not included in sample.

TOLEDO. GRAHAM BROS. & MEDLEY PROSPECT

Analysis C7246 (p. 41). Lignite, Southwestern field, Kelso-Castle Rock district, from a prospect shaft 494 feet above sea level in SW¼ sec. 15, T. 11 N., R. 1 E., 9 miles east of Toledo. Coal bed, unnamed; Puget formation; dip, 7° W.; strike, N.–S.; cover at point sampled, 10 feet. The bed was measured and sampled by H. F. Yancey (USBM) in a prospect shaft 3,500 feet west and 1,100 feet north of the southeast corner of sec. 15; September 10, 1943, as described below:

Section of coal bed, Graham Bros. & Medley prospect

Laboratory No.	C7246	
	Ft.	*In.*
Roof, clay, soft.		
Coal	[1] **1**	**3½**
Do.	**4**	**2½**
Coal, soft	--	[1] **3**
Coal	**1**	**0**
Shale, sandy	--	[1] 1
Coal	--	**6½**
Clay, sandy	--	[1] 4½
Coal	--	**8**
Clay, sandy	--	[1] 2½
Coal	--	**11¼**
Shale, sandy	--	[1] ¾
Coal	**1**	**10¾**
Do.	**2**	**8½**
Clay	--	[1] ½
Coal	--	**1½**
Clay	--	[1] 1
Coal	--	**7¾**
Clay	--	[1] 1¼
Coal	--	**½**
Clay	--	[1] 1
Coal	--	**6**
Clay	--	[1] 2½
Coal	--	**7**
Shale, sandy	--	[1] 1
Coal	**2**	**6**
Clay	--	[1] 2
Coal	**1**	**11**
Clay	--	[1] 3¼
Coal	**4**	**0**
Clay		[1] ¼
Coal		**10¾**
Clay		[1] ½
Coal	**1**	**2½**
Floor, clay, hard.		
Thickness of bed	27	9
Thickness of sample	24	4½

[1] Not included in sample.

Eight benches of the bed were sampled on the wall of the prospect shaft.

An additional sample weighing 9 tons was cut from the bed in the prospect shaft. This was screened through a 1½-inch round-hole screen at the Seattle Station, and the undersize was washed in a jig. Analyses of coal from washing tests are reported in Report of Investigations 3795, Preparation Tests of Lignite From a Deposit Near Toledo, Lewis County, Wash., by H. F. Yancey and M. R. Geer, published in 1945.

More data are given in Technical Paper 699, Exploration, Reserves, Bed Characteristics, and Strip-Mining Possibilities of a Lignite Deposit near Toledo, Lewis County, Wash., by Albert L. Toenges, Louis A. Turnbull, and Willard A. Cole, published in 1947.

PIERCE COUNTY

WILKESON. BARTOY MINE

Analyses B53204 to B53207 (p. 41). High-volatile A bituminous coal, Pierce County field, Wilkeson-Carbonado district, from Bartoy mine, a drift mine 870 feet above sea level in SW¼ sec. 27, T. 19 N., R. 6 E., at

Wilkeson. Coal bed, No. 2, east dip; Puget formation; dip, 53° E.; strike, S. 31° E.; cover at point sampled, 100 to 140 feet. The bed was measured and sampled at three points by M. R. Geer (USBM) and A. Centenero (USBM) May 14 and 15, 1940, as described below:

Sections of coal bed, east dip, in Bartoy mine

Section	A		B		C	
Laboratory No.	B53204		B53205		B53206	
	Ft.	*In.*	*Ft.*	*In.*	*Ft.*	*In.*
Roof, sandstone.						
Shale, carbonaceous, and bone	--	[1]4	2	6	[1]1	0
Coal, soft	--	**11**	--------		--------	
Shale, pyritic	--	[1]1	--------		--------	
Coal, soft	**2**	**6**	--------		--------	
Coal, firm	**1**	**8**	--------		--------	
Shale, carbonaceous	--	[1]2	--------		--------	
Coal	--------		--	**5**	--	**3½**
Bone	--------		--	[1]2	--	[1]1½
Coal	--------		--	**10½**	--	**10½**
Shale	--------		--	[1]1	--	[1]1
Coal, bright	--------		--	**3**	--------	
Shale	--------		--	[1]1	--------	
Coal, bright	--------		--	**6**	--	**8**
Shale	--------		--	[1]1½	--	[1]1
Coal, bright	--------		**2**	**2**	**1**	**7**
Shale, carbonaceous	--------		--	[1]2	--	[1]2
Floor, shale, sandy, hard.						
Total thickness of bed exposed	5	8	7	4	4	10½
Thickness of sample	5	1	4	2½	3	5

[1] Not included in sample.

Sample B53204 was taken in 7 chute, 15 feet above drift; sample B53205, in 5 chute, 1 crosscut above counter; and sample B53206, in 4 chute at counter.

The ultimate analysis of a composite made by combining samples B53204 to B53206 is given under laboratory No. B53207.

The bed is reported as disturbed by folding and faulting and varies considerably both in thickness and character. At the only point in the mine where the entire bed was exposed it measured 8 feet 7½ inches between the main walls. An unmeasured thickness of carbonaceous shale and bone, the immediate roof, lies between all of the sections sampled and the main sandstone roof.

System of mining, chute-and-pillar. The coal is shot from the solid with permissible explosives. At the time of sampling the mine was in the development stage and produced 15 tons daily; the life of the mine was estimated to be 10 years. The coal was screened on a 1½-inch bar screen, the oversize was hand-picked, and the undersize was cleaned in a tub washer. A small amount of washed coal was coked in beehive ovens at Wilkeson.

A large sample for a carbonization test was collected near the point at which sample B53204 was taken, washed at the Seattle station, and shipped to Pittsburgh. Analysis of the delivered washed coal is given under laboratory No. 54199.

Carbonizing properties and petrographic composition of this coal are described in Technical Paper 649, Carbonizing Properties and Petrographic Composition of No. 2 Bed Coal From Bartoy Mine and No. 5 Bed Coal From Wilkeson-Miller Mine, Wilkeson, Pierce County, Wash., by J. D. Davis, D. A. Reynolds, G. C. Sprunk, C. R. Holmes, and J. T. McCartney, published in 1942.

WILKESON. CHAMPION MINE

Analysis C54014 (p. 41). High-volatile A bituminous coal, Pierce County field, Wilkeson-Carbonado district, from Champion mine, a slope (truck) mine 900 feet above sea level in SE¼ sec. 22, T. 19 N., R. 6 E., 2 miles northeast of Wilkeson. Coal bed, Champion; Puget formation; dip, 58° N. 70° E.; strike, N. 20° W.; cover at point sampled, 300 feet. The bed was measured and sampled at the return air course, 25 feet above 2 slope entry, by M. R. Geer (USBM), February 1, 1946, as described below:

Section of coal bed in Champion mine

Laboratory No.	C54014	
	Ft.	*In.*
Roof, shale, brown.		
Coal, friable	**1**	**4**
Clay, bone streaks	--	[1]10
Coal, bony	--	**5**
Clay, brown	--	[1]2
Coal, friable	**1**	**2**
Clay, brown	--	[1]2
Coal, firm	**1**	**8**
Clay, brown (immediate footwall)	[1]1	0
Floor, sandstone.		
Thickness of bed	6	9
Thickness of sample	4	7

[1] Not included in sample.

System of mining, chute-and-pillar. The coal is shot from the solid with permissible explosives. At the time of sampling the mine was new, producing 10 tons per day from development work. The coal was screened on a 1¼-inch bar screen, the oversize was hand-picked, and the undersize was cleaned in a Robinson tub washer.

WILKESON. SKOOKUM MINE

Analysis C16487 (p. 41). High-volatile A bituminous coal, Pierce County field, Wilkeson-Carbonado district, from Skookum mine, a slope mine 860 feet above sea level in SW¼ sec. 27, T. 19 N., R. 6 E., at Wilkeson. Coal bed, No. 3, west dip; Puget formation; dip, 80° W.; strike, N.–S.; cover at point sampled, 900 feet. The bed was measured and sampled at the face of 3 south gangway, 130 feet inby 2 coal-angle chute, 1,400 feet inby slope bottom, by M. R. Geer (USBM) February 29, 1944, as described below:

Section of coal bed, west dip, in Skookum mine

Laboratory No.	C16487
	Ft. *In.*
Roof, shale, hard.	
Bone, coal streaks	[1] 1 8
Coal, bright, friable	-- **1½**
Shale, brown, hard	-- [1] ½
Coal, bright, friable	**1 4**
Shale, brown, hard	-- [1] 5½
Coal, bright, friable	**1 5**
Bone	-- [1] 1½
Coal, bright, friable	**1 4**
Bone	-- [1] 1
Coal, bright	-- **3**
Bone	-- [1] 1
Coal, bright, friable	-- **8**
Coal, bony, hard	**1 9**
Shale, brown, hard	-- [1] 9
Shale, carbonaceous, bone, soft, slickensided	[1] 9 9
Floor, sandstone, hard.	
Thickness of bed	19 10
Thickness of sample	6 10½

[1] Not included in sample.

System of mining, chute-and-pillar. The coal is undercut with machines and shot with permissible explosives. At the time of sampling the mine was in the development stage and produced 255 tons daily, all from advance workings. The entire output was passed over a Bradford breaker and vibrating screens and then washed on Vissac jigs and tables. Sizes of washed coal produced were 1- by ¼-inch and 1-inch by 0.

WILKESON. SPARTON MINE

Analysis D31102 (p. 41). High-volatile A bituminous coal, Pierce County field, Wilkeson-Carbonado district, from Sparton mine, a slope (truck) mine approximately 700 feet above sea level in SE¼ sec. 15, T. 19 N., R. 6 E., 3 miles north of Wilkeson. Coal bed, Champion; Puget formation; dip, 63° NE.; strike, S. 25° E.; cover at point sampled, 400 feet. The bed was measured and sampled at the face of 1-level gangway, 80 feet southeast of slope bottom, by M. R. Geer (USBM) November 21, 1949, as described below:

Section of coal bed in Sparton mine

Laboratory No.	D31102
	Ft. *In.*
Roof, sandstone.	
Bone (immediate roof)	-- [1] 6
Coal	**1** **½**
Bone	-- [1] ½
Clay	-- [1] 3½
Bone	-- [1] 1½
Clay	-- [1] 1
Coal	-- **5**
Shale, brown	-- [1] 2
Coal	**2** **1½**
Shale, sandy	[1] ¾
Coal	**1** **3½**
Bone (immediate floor)	-- [1] 1½
Clay	-- [1] 5
Coal	-- [1] **5**
Sandstone	-- [1] 2
Bone and shale, carbonaceous	-- [1] 7½
Floor, shale, carbonaceous.	
Thickness of bed	7 10¾
Thickness of sample	4 10½

[1] Not included in sample.

System of mining, chute-and-pillar. The coal is shot from the solid with permissible explosives. At the time of sampling the mine was new, and only a small amount of coal from advance workings was being produced. The coal is passed over a 1½-inch bar screen and picked, and the undersize is washed in a Forrester jig.

WILKESON. WILKESON-MILLER MINE

Analyses B53925 to B53927 (p. 41). High-volatile A bituminous coal, Pierce County field, Wilkeson-Carbonado district, from Wilkeson-Miller mine, a drift mine 890 feet above sea level in SE¼, sec. 28, T. 19 N., R. 6 E., at Wilkeson on the Northern Pacific Railroad. Coal bed, No. 5 (Miller), west dip, Puget formation; dip, 65° W.; strike, S. 24° W.; cover at points sampled, 195 to 215 feet. The bed was measured and sampled at 2 points by M. R. Geer (USBM) and A. Centenero (USBM) June 17, 1940, as described below:

Sections of coal bed, west dip, in Wilkeson-Miller mine

Section Laboratory No	A B53925		B B53926	
	Ft.	*In.*	*Ft.*	*In.*
Roof, sandstone, hard, rolly.				
Coal, firm	--	4	--	3
Shale, brown, soft	--	[1] 3/4	--	[1] 3/4
Coal, firm	3	6	4	2
Floor, bone, firm, 20 in. thick.				
Thickness of bed	3	10 3/4	4	5 3/4
Thickness of sample	3	10	4	5

[1] Not included in sample.

Sample B53925 was taken at the face of lower drift, 450 feet south of portal. Sample B53926 was taken in 1 chute at counter, lower drift, 425 feet south of portal.

The ultimate analysis of a composite made by combining samples B53925 and B53926 is given under laboratory No. B53927.

System of mining, chute-and-pillar. The coal is shot from the solid with permissible explosives. At the time of sampling the drift opening was under development. Coal was screened over a 1¼-inch bar screen and the oversize picked.

A large sample for a carbonization test was collected near the point at which sample B53925 was taken, washed at the Seattle Station, and shipped to Pittsburgh. Analysis of the delivered washed coal is given under laboratory No. B55065.

Carbonizing properties and petrographic composition of this coal are described in Technical Paper 649, Carbonizing Properties and Petrographic Composition of No. 2 Bed Coal From Bartoy Mine and No. 5 Bed Coal From Wilkeson-Miller Mine, Wilkeson, Pierce County, Wash., by J. D. Davis, D. A. Reynolds, G. C. Sprunk, C. R. Holmes, and J. T. McCartney, 1942.

WILKESON. WILKESON-WINGATE MINE

Analyses D26934 and D26935 (p. 42). Medium-volatile bituminous coal, Pierce County field, Wilkeson-Carbonado district, from Wilkeson-Wingate mine, a drift mine 850 feet above sea level in SW¼ sec. 27, T. 19 N., R. 6 E., at Wilkeson on the Northern Pacific Railroad. Coal bed, No. 4 (Wingate), east dip; Puget formation; dip, 59° NE.; strike, S. 25° E.; cover at point sampled, approximately 400 feet. The bed was measured and sampled at 2 points near the face of 2-level gangway, approximately 2,500 feet southeast of slope bottom in SE¼ sec. 27, by Joseph Daniels (USBM) September 8, 1949, as described below:

Sections of coal bed, east dip, in Wilkeson-Wingate mine

Section Laboratory No	A D26934		B D26935	
	Ft.	*In.*	*Ft.*	*In.*
Roof, sandstone.				
Coal, hard	--	**10½**	**1**	**4½**
Shale, carbonaceous, soft	--	[1] 3	---	---
Shale, carbonaceous, soft, variable thickness	---	---	1½ to 2	
Coal, soft		**7**	---	---
Shale, carbonaceous, soft		[1] 5	---	---
Coal, soft	**1**	**3**	---	---
Coal, hard	---	---	**1**	**3**
Floor, shale, sandy, hard.				
Thickness of bed	3	4½	2	9½
Thickness of sample	2	8½	2	7½

[1] Not included in sample.

Sample D26934 was taken at face of the 2-level gangway, 2,500 feet southeast of slope bottom. Sample D26935 was taken in 41½ chute, 25 feet above gangway, inside rib, approximately 2,400 feet southeast of slope bottom on 2 level.

System of mining, chute-and-pillar. The coal is shot from the solid with permissible explosives. At the tipple the coal is picked on a 1⅝-inch bar screen as lump, and the coal passing the screen is washed in a Forrester jig and sold as steam coal. The coal is friable, and little lump is produced. Some lump coal is mixed with the washed 1⅝-inch product of the jig and sold as run-of-mine.

THURSTON COUNTY

BUCODA. BOXER MINE

Analysis D30865 (p. 42). Weathered coal, Southwestern field, Tenino-Mendota district, from Boxer mine, a slope (truck) mine 340 feet above sea level in NE¼ sec. 14, T. 15 N., R. 2 W., 1½ miles southwest of Bucoda. Coal bed, Mendota; Skookumchuck formation; dip, 10° S.; 30° E.; strike, S. 60° W.; cover at point sampled, 10 feet. The bed was measured and sampled on the southeast rib of slope 15 feet inby the portal by M. R. Geer (USBM) and W. A. Olds (USBM) November 14, 1949, as described below:

Section of coal bed in Boxer mine

Laboratory No	D30865	
	Ft.	*In.*
Roof, shale.		
Coal (immediate roof)		
Coal	--	**3**
Clay	--	[1] 3
Coal	--	**4**
Clay	--	[1] 2½
Coal	**2**	**6**
Clay, blue	--	[1] 5
Coal	--	**3**
Bone	--	[1] 1
Coal	--	**11**
Clay	--	[1] 5½
Coal, bony	--	**4**
Bone	--	[1] 5½
Coal	--	**6**
Remainder of bed not measurable		
Floor, sandstone.		
Thickness of bed visible	6	11½
Thickness of sample	5	1

[1] Not included in sample.

At the time of sampling the mine was inactive. Production had been reported from November 1939 to June 1943.

BUCODA. D. & F. PROSPECT

Analysis C96368 (p. 43). Coal, Southwestern field, Tenino-Mendota district, from an outcrop approximately 250 feet above sea level in sec. 18, T. 15 N., R. 1 E., 8 miles east of Bucoda. Coal bed, Upper Thompson; Skookumchuck formation; dip, 30° W.; strike, N.–S. The bed was measured and coal sampled by M. R. Geer (USBM) June 8, 1949, as described below:

Section of coal bed in D. & F. prospect

Laboratory No	C96368	
	Ft.	*In.*
Roof, sandstone.		
Coal, soft	--	**10½**
Clay, soft	--	[1] 1
Coal, hard	**1**	**2½**
Clay, soft	--	[1] 1¼
Coal, hard	--	**6**
Shale, hard	--	[1] ¾
Coal, hard	**3**	**0**
Clay, soft	--	[1] 1½
Coal, hard	**2**	**6**
Clay, sandy	--	[1] 2
Coal	**1**	**9**
Clay	--	[1] 1
Coal	--	[1] **10½**
Clay	--	[1] 4
Coal	**2**	**1**
Floor, sandstone.		
Thickness of bed	13	9
Thickness of sample	12	9½

[1] Not included in sample.

The sample was taken on the surface outcrop of a bed underlying that worked in the D. & F. mine several hundred yards north of the prospect. Weathered coal was removed before the sample was cut; the coal face was wet from surface water.

BUCODA. GORDON PROSPECT

Analysis D1995 (p. 43). Subbituminous C coal, Southwestern field, Tenino-Mendota district, from Gordon prospect, 325 feet above sea level in NW¼ sec. 13, T. 15 N., R. 2 W., ½ mile southwest of Bucoda. Coal bed, Penitentiary; Skookumchuck formation; dip, 7° SE., strike, N. 60° E. The outcrop was measured and sampled by E. Wolf (USGS) October 7, 1948, as described below:

Section of coal bed in Gordon prospect

Laboratory No	D1995	
	Ft.	*In.*
Roof, sandstone.		
Bone (immediate roof)	1	0
Shale, carbonaceous	--	[1] 4
Clay, silty	--	[1] 3
Bone	--	1
Coal, bony	--	**2**
Coal, tuffaceous, bony	--	**2**
Coal	--	**10**
Coal, bony	--	**2**
Bone	--	6
Coal	--	**6**
Bone	--	2
Shale, carbonaceous, bony	[1] 1	0
Thickness of bed	4	2
Thickness of sample	2	7

[1] Not included in sample.

BUCODA. MEEKS' PROSPECT

Analysis D1994 (p. 43). Subbituminous C coal, Southwestern field, Tenino-Mendota district, from Meek's prospect 375 feet above sea level in SW¼ sec. 18, T. 15 N., R. 1 W., 1¼ miles southeast of Bucoda. Coal bed, Big Dirty; Skookumchuck formation; dip, 9° SE.; strike N. 50° E. The outcrop was measured and sampled by E. Wolf (USGS) September 7, 1948, as described below:

Section of coal bed in Meeks' prospect

Laboratory No	D1994	
	Ft.	*In.*
Siltstone, carbonaceous	--	[1] 5
Coal, bony and coal	--	**9**
Siltstone, carbonaceous, tuffaceous	--	[1] 3½
Coal	**1**	**11**
Siltstone	--	[1] 1½
Coal	--	**9½**
Siltstone	--	[1] 1¼
Coal	**2**	**3½**
Siltstone	--	[1] 1½
Coal	--	8
Siltstone	--	[1] 3½
Coal	--	**6½**
Siltstone, tuffaceous	[1] 1	3½
Coal	**1**	**1½**
Siltstone	--	[1] 2
Coal	**1**	**0**
Siltstone, tuffaceous, carbonaceous	--	[1] 4½
Coal	--	8
Siltstone	--	[1] 3+
Thickness of bed	13	1¼
Thickness of sample	9	8

[1] Not included in sample.

BUCODA. PENN-BUCODA PROSPECTS

Analyses C26026 to C26030 (p. 43). Subbituminous B and C coals, Southwestern field, Tenino-Mendota district, from prospects at elevations of 350 to 400 feet above sea level in NW¼ sec. 18, T. 15 N., R. 1 W., 1 mile southeast of Bucoda. Coal beds, Big Dirty (upper, middle, and lower benches), Little Dirty, and Smith; Skookumchuck formation; dip, 5° E.; strike, N.–S. All samples were taken near the surface under cover of 0 to 25 feet. The beds were measured and sampled by M. R. Geer (USBM) August 29–30, 1944, as described below:

Sections of Big Dirty bed, Penn-Bucoda prospects

Bench	Upper
Laboratory No	C26026
	Ft. *In.*
Roof, sandstone.	
Coal, 3 shale partings	[1] 3 0
Coal, bright, hard	2 11
Shale	-- 1¾
Coal	-- 1½
Shale	-- ⅛
Coal	-- 7
Coal and clay	-- [1] 5
Coal	-- 1
Coal under this section reported to be 11 feet	-- --
Floor, not exposed.	
Thickness of bed exposed	7 2⅜
Thickness of sample	3 8⅝

Bench	Middle
Laboratory No	C26027
	Ft. *In.*
Roof, not exposed.	
Coal and shale, weathered	[1] 3 0
Clay	-- [1] 4½
Coal	1 5½
Shale	-- ⅛
Coal	-- 1
Shale	-- ⅛
Coal	-- 8
Shale	-- [1] ½
Coal	-- 9
Clay	-- [1] 3
Coal	1 1
Clay	-- [1] 3
Coal	2 0
Clay	-- [1] 1
Coal	-- 6
Floor, not exposed.	
Thickness of bed exposed	10 6¾
Thickness of sample	6 6¾

Section of Big Dirty bed, Penn-Bucoda prospects—Continued

Bench	Lower
Laboratory No	C26028
	Ft. *In.*
Roof, not exposed.	
Clay	[1] 1 4
Coal	-- 11
Clay	-- [1] 2
Coal	1 2
Clay	-- [1] 9
Coal	4 4
Coal, bottom; 3 feet of coal reported to be below this section.	
Floor, not exposed.	
Thickness of bed exposed	8 8
Thickness of sample	6 5

[1] Not included in sample.

Section of Little Dirty bed, Penn-Bucoda prospects

Laboratory No	C26029
	Ft. *In.*
Roof, shale.	
Coal	-- 1½
Shale	-- [1] ⅜
Coal	-- 6
Bone	-- [1] 3
Coal	1 5
Shale, sandy	-- [1] 1
Coal	1 7½
Clay	-- [1] 1
Coal	-- 1
Clay	-- [1] 1
Coal	-- 8
Floor, shale.	
Thickness of bed	4 11⅜
Thickness of sample	4 5

[1] Not included in sample.

Section of Smith bed, Penn-Bucoda prospects

Laboratory No	D26030
	Ft. *In.*
Roof, clay.	
Coal, weathered	[1] 1 6
Clay, soft	-- [1] 6
Coal	5 5
Shale, hard	-- ¼
Coal	-- 3
Shale, hard	-- ¼
Coal	-- 3
Main floor said to be 1 foot lower.	
Floor, not exposed.	
Thickness of bed exposed	7 11½
Thickness of sample	5 11½

[1] Not included in sample.

The following samples were taken in the Big Dirty bed: Sample C26026, upper bench, taken at the face of a 40-foot drift on the outcrop at an approximate elevation of 250 feet, under 20 feet of cover; sample C26027, middle bench, taken at the face of a 15-foot drift on the outcrop at an approximate elevation of 390 feet, under 10 feet of cover; sample C26028, lower bench, taken in a trench on the outcrop at an approximate elevation of 400 feet, under 6 feet of cover. Sample C26029, Little Dirty, was taken at the face of a 20-foot drift on the outcrop at an approximate elevation of 500 feet, under 25 feet of cover. Sample C26030, Smith bed, was taken at the outcrop exposed by trench at an approximate elevation of 470 feet. The entire thickness was not exposed. These prospects were later developed in 1946 by strip operations known as the Penn-Bucoda mine.

A tipple was installed to prepare this coal. It was equipped with a stationary bar screen set over a breaker, followed by a double-deck vibrator screen having 1½-inch and ⅜-inch square holes. The material picked on the bar screen was then crushed in the breaker to pass 1½-inch by 0 size.

BUCODA. TONO PROSPECT

Analysis D30869 (p. 43). Weathered coal, Southwestern field, Tenino-Mendota district, from an outcrop 320 feet above sea level in NE¼ sec. 20, T. 15 N., R. 1 W., 2½ miles southeast of Bucoda near the town of Tono. Coal bed, Tono No. 2; Skookumchuck formation; dip, 5°–10° E.; strike, N.–S. The bed was measured and sampled by M. R. Geer (USBM) and W. A. Olds (USBM) November 14, 1949, as described below:

Section of coal bed in Tono prospect

Laboratory No.	D30869	
	Ft.	*In.*
Roof, shale.		
Coal	**2**	**1**
Bone	--	[1] 6
Coal	**2**	**9**
Floor, sandstone.		
Thickness of bed	5	4
Thickness of sample	4	10

[1] Not included in sample.

This bed is 30 to 40 feet below Tono No. 1 seam and evidently had been mined at some time in the past from Tono No. 1 mine.

WHATCOM COUNTY

BELLINGHAM. BELLINGHAM MINE

Analyses D8250 to D8254 (p. 43). High-volatile C bituminous or subbituminous A coals, Northwestern field, Bellingham district, from Bellingham mine, a slope mine 94 feet above sea level in sec. 13, T. 38 N., R. 2 E., in Bellingham on the Great Northern Railroad. Coal bed, Bellingham No. 1; Puget formation; dip, 10° to 8° SW.; strike, S. 28° E.; cover at points sampled, 910 to 1,100 feet. The bed was measured and sampled at four points by Joseph Daniels (USBM) December 27, 28, 1949, as described below:

Sections of coal bed in Bellingham mine

Section	A		B		C		D	
Laboratory No.	D8250		D8251		D8252		D8253	
	Ft.	*In.*	*Ft.*	*In.*	*Ft.*	*In.*	*Ft.*	*In.*
Roof, shale, soft.								
Coal and shale	--	[1] 10	--	[1] 10	--	[1] 10	--	[1] 10
Shale, brown, hard	--	[1] 3	--	[1] 4	--	[1] 6	--	[1] 4
Coal, bright, hard	5	4	1	0	5	8	5	3
Shale, brown, sandy	--	----	--	[1] 1½	--	----	--	---
Coal, bright, hard	--	----	4	0	--	----	--	---
Shale, brown, hard	--	[1] 2	--	[1] 2	--	[1] 3	--	[1] 3
Coal, bright, firm	--	----	1	7½	1	7	1	5
Coal, hard, bony bottom	1	9	--	----	--	----	--	---
Shale, brown, hard	--	[1] 4	--	[1] 3	--	[1] 4	--	---
Coal, bony	1	5	1	2	1	0	--	---
Floor, shale, sandy, smooth.								
Thickness of bed	10	1	9	6	9	2	8	1
Thickness of sample	8	6	7	9½	8	3	6	8

[1] Not included in sample.

Sample D8250 was taken on 9 north level, 2 incline, 1 left entry, 4 room, 250 feet from entry, left rib, in a synclinal-fold area near the western boundary of the property. Sample D8251 was taken on 9 north level, 7 block, 8 room, 280 feet from level, right rib, also in the synclinal-fold area where the bed dips only 3° to 4°. Sample D8252 was taken on 10 south level, 2,500 feet southeast of slope, low side of rib. Sample D8253 was taken on 10 north level, 2,400 feet northwest of slope, high side of rib; this section does not include the lowest band of bony coal.

The ultimate analysis of a composite made by combining samples D8250 to D8253 is given under laboratory No. D8254.

System of mining, room-and-pillar. Since these samples were taken the mining operations have been mechanized, and a new washing plant has been installed. In one section of the mine the coal is undercut with machines, shot with permissible explosives, and loaded by shaker conveyors; in the other a continuous miner is used. The daily output of about 400 to 500 tons of washed coal is passed over shaker screens with 4-inch round holes to produce picked lump and undersize. The undersize is sent to the new washing plant, where the 4- to 3/16-inch size is cleaned in a drum-type heavy-medium unit and the minus-3/16-inch on tables. The following sizes of washed coal are produced: Egg, through 4- and over 2-inch round-hole; Nut, through 2- and over 1⅛-inch round-hole; No. 1 Pea, through 1⅛-inch round-hole and over ⅝-inch square-hole; stoker, through ⅝-inch square-hole and over 5/16-inch square-hole; Buckwheat, through 5/16-inch square-hole.

DESCRIPTION OF BOREHOLE CORE SAMPLES

By Joseph Daniels [1]

The brief descriptions that follow have been compiled from information supplied by Parke D. Snavely, Jr., of the Federal Geological Survey, who took the samples. They supplement the information in table 23.

LEWIS COUNTY

CENTRALIA. USGS BOREHOLE G

Analysis D41581 (p. 46). Coal, Southwestern field, Centralia-Chehalis district, from a drill core hole in NE¼ sec. 30, T. 15 N., R. 1 E., 15 miles northeast of Centralia; collar elevation of hole, approximately 675 feet. Coal bed, Upper Thompson; Skookumchuck formation; dip, 7° to 8° NW.; strike, approximately N. 30° E. The core was logged from 272 feet 5 inches to 282 feet 9 inches; core received for analysis, 81 inches of which 55 inches of bone, siltstone, and claystone were rejected and 26½ inches of coal was included in the sample. The sample was collected by Parke D. Snavely, Jr. (USGS) April 19, 1950.

CENTRALIA. USGS BOREHOLE DD

Analysis D59349 (p. 46). Coal, Southwestern field, Centralia-Chehalis district, from a drill core hole in SW¼ sec. 29, T. 15 N., R. 2 W., ½ mile north of Centralia; collar elevation of hole, approximately 305 feet. Coal bed, Little Dirty(?); Skookumchuck formation; dip, 36°; strike, approximately N. 60° W. Core amounting to 31½ inches was lost in the interval from 30 feet 11 inches to 34 feet 11 inches. The sample was collected by Parke D. Snavely, Jr. (USGS) January 29, 1951.

CENTRALIA. USGS BOREHOLE J

Analysis D40920 (p. 46). Coal, Southwestern field, Centralia-Chehalis district, from a drill core hole, collar elevation approximately 230 feet, in SW¼ sec. 30, T. 15 N., R. 1 W., 5 miles northeast of Centralia. Coal bed, Black Bear; Skookumchuck formation; dip, 2° to 4° NE.; strike, approximately N. 70° W. The core was logged from 991 feet 7 inches to 996 feet 0 inch; core received for analysis, 34 inches of which 15 inches of sandstone and tuff were rejected and 19 inches of coal was included in the sample. The sample was collected by Parke D. Snavely, Jr. (USGS) February 23, 1950.

CENTRALIA. USGS BOREHOLE I

Analysis D34603 (p. 46). Coal, Southwestern field, Centralia-Chehalis district, from a drill core hole in SW¼ sec. 33, T. 15 N., R. 1 W., 10 miles east of Centralia; collar elevation of hole, 303 feet. Coal bed, Big Dirty; Skookumchuck formation; dip, approximately 10° NE.; strike, N. 70° W. The core was logged from 145 feet to 185 feet 3 inches; core received for analysis, 36 feet 4 inches of which 12 feet 2 inches of bone was rejected and 24 feet 2 inches of coal included in the sample.

Analysis D35247 (p. 46). Coal bed, Smith; dip, approximately 8° NE.; strike, N. 70° W. The core was logged from 288 feet 2 inches to 295 feet 7 inches; core received for analysis, 62 inches of which 2½ inches of sandstone was rejected and 59½ inches of coal included in the sample.

Analysis D33782 (p. 46). Coal bed, Penitentiary; dip, approximately 8° NE.; strike, N. 70° W. The core was logged from 498 feet 9 inches to 501 feet 5 inches; core received for analysis, 2 feet 8 inches of which 2¾ inches of siltstone was rejected and 2 feet 4½ inches of brecciated coal included in the sample.

Analysis D35248 (p. 46). Coal bed, Mendota; dip, approximately 8°; strike, approximately N. 70° W. The core was logged from 625 feet 6 inches to 635 feet 4 inches; core received for analysis, 92½ inches of which 41½ inches of bone, claystone, and shale were rejected and 51 inches of coal was included in the sample. The samples were collected by Parke D. Snavely, Jr. (USGS) November and December 1949.

CENTRALIA. USGS BOREHOLE K

Analysis D41582 (p. 46). Coal, Southwestern field, Centralia-Chehalis district, from a drill core hole in SE¼ sec. 7, T. 14 N., R. 1 W., 5 miles southeast of Centralia; collar elevation of hole, approximately 300 feet. Coal bed, Tono No. 1; Skookumchuck formation; dip, 13° SW.; strike, approximately N. 45° W. The core was logged from 110 feet 5 inches to 119 feet 8 inches; core received for analysis, 82½ inches of which 18 inches of bone, siltstone, and claystone were rejected and 64½ inches of coal was included in the sample.

Analysis D44519 (p. 46). Coal bed, Upper Thompson, dip, 13° SW.; strike, approximately N. 45° W. The core was logged from 525 feet 4 inches to 539 feet 9½ inches; core received for analysis, 64 inches of which 20 inches of bone, shale, and siltstone were rejected and 44 inches of coal was included in the sample. The samples were collected by Parke D. Snavely, Jr. (USGS) April and May 1950.

CHEHALIS. USGS BOREHOLE V

Analysis D55878 (p. 46). Coal, Southwestern field, Centralia-Chehalis district, from a drill core hole in NE¼ sec. 33, T. 14 N., R. 2 W., 1¾ miles east of Chehalis; collar elevation of hole, approximately 205 feet. Coal bed, unnamed; Skookumchuck formation. The core was logged from 561 feet 3 inches to 562 feet 8 inches; 17 inches of coal was included in the sample.

Analysis D55879 (p. 46). The core was logged from 564 feet 7 inches to 566 feet 3 inches of which 5 inches was lost in coring and 15 inches of coal was included in the sample. The samples were collected by Parke D. Snavely, Jr. (USGS) August 2, 1950.

CHEHALIS. USGS BOREHOLE CH-3

Analysis D71167 (p. 46). Coal, Southwestern field, Centralia-Chehalis district, from a drill core hole

[1] Former consultant mining engineer, Fuels-Technology Division, Region II, Bureau of Mines, Seattle, Wash.

in SE¼ sec. 20, T. 14 N., R. 3 W., 5½ miles northwest of Chehalis; collar elevation of hole, approximately 755 feet. Coal bed, unnamed; Skookumchuck formation. The core was logged from 141 feet 4¾ inches to 143 feet 6 inches; 25¼ inches of coal was included in the sample.

Analysis D71168 (p. 46). Coal bed, unnamed. The core was logged from 443 feet 7¼ inches to 434 feet 10 inches; the sample contained 14¾ inches of coal. The samples were collected by Parke D. Snavely, Jr. (USGS) September 1951.

TOLEDO. USGS BOREHOLE CH-5

Analysis D72816 (p. 46). Coal, Southwestern field, Kelso-Castle Rock district, from a drill core hole in NW¼ sec. 20, T. 11 N., R. 1 E., 6.6 miles east of Toledo; collar elevation of hole, approximately 300 feet. Coal bed, unnamed; dip, 7° S.; strike, E.–W. The core was logged from 113 feet ⅜ inches to 115 feet 5½ inches; the sample contained 19⅞ inches of coal after 1¼ inches was rejected.

Analysis D72817 (p. 46). Coal bed, unnamed. The core was logged from 118 feet 10¾ inches to 119 feet 8¾ inches; the sample contained 10 inches of coal.

Analysis D72818 (p. 46). Coal bed, unnamed. The core was logged from 128 feet to 130 feet 1¼ inches; the sample contained 25¼ inches of coal.

Analysis D72819 (p. 46). Coal bed, unnamed. The core was logged from 161 feet 1½ inches to 162 feet 9¼ inches; the sample contained 19¾ inches of coal. The samples were collected by Parke D. Snavely, Jr. (USGS) October 14, 1951.

THURSTON COUNTY

BUCODA. USGS BOREHOLE B

Analysis D30146 (p. 47). Coal, Southwestern field, Tenino-Mendota district, from a drill core hole in SE¼ sec. 8, T. 15 N., R. 1 W., 2 miles east of Bucoda; collar elevation of hole, 284 feet. Coal bed, Little Dirty; Skookumchuck formation; dip, 5° SE.; strike, unknown. The core was logged from 69 feet 1⅛ inches to 71 feet 3 inches; core received for analysis, 25⅞ inches of which ⅞ inch of siltstone was rejected and 25 inches of coal included in sample.

Analysis D30147 (p. 47). Coal bed, Smith; dip, 5° to 10° SE. The core was logged from 128 feet 6⅞ inches to 135 feet 2¾ inches; core received for analysis, 56¼ inches of which ¼ inch of siltstone was rejected and 56 inches of coal included in sample.

Analysis D30148 (p. 47). Coal bed, Penitentiary; dip, 5° to 10°. The core was logged from 291 feet 5 inches to 295 feet 6¾ inches; core received for analysis, 47¾ inches of which 5 inches of siltstone and bone were rejected, and 42¾ inches of coal was included in sample.

Analysis D30575 (p. 47). Coal bed, Mendota. The core was logged from 443 feet 10⅞ inches to 446 feet 9⅛ inches; core received for analysis, 32 inches of which 5 inches of siltstone was rejected and 27 inches of coal included in the sample. All samples were collected by Parke D. Snavely, Jr. (USGS) during September and October 1949.

BUCODA. USGS BOREHOLE C-2

Analysis D36934 (p. 47). Coal, Southwestern field, Tenino-Mendota district, from a drill core hole in NW¼ sec. 19, T. 15 N., R. 1 W., 2 miles south of Bucoda; collar elevation of hole, approximately 250 feet. Coal bed, Big Dirty; Skookumchuck formation; dip, 5° to 7° SE.; strike, approximately N. 45° E. The core was logged from 23 feet 4 inches to 40 feet 6 inches; core received for analysis, 30 inches of which 4 inches of shale and bone were rejected and 26 inches of coal was included in sample. The sample was collected by Parke D. Snavely, Jr. (USGS) January 11, 1950.

BUCODA. USGS BOREHOLE D

Analysis D28809 (p. 47). Coal, Southwestern field, Tenino-Mendota district, from drill core hole in NE¼ sec. 15, T. 15 N., R. 1 W., 3½ miles east of Bucoda; collar elevation of hole, 475 feet. Coal bed, Smith; Skookumchuck formation; dip, 10°. The core was logged from 349 feet 9 inches to 362 feet 10 inches; core received for analysis, 58 inches of which ½ inch of siltstone was rejected and 57½ inches of coal included in sample.

Analysis D28810 (p. 47). Coal bed, Mendota. The core was logged from 537 feet 8 inches to 545 feet 10 inches; core received for analysis, 94 inches of which 21 inches of bone and tuff were rejected and 73 inches of coal was included in sample. The samples were collected by Parke D. Snavely, Jr. (USGS) August 1949.

BUCODA. USGS BOREHOLE E-2

Analysis D48109 (p. 47). Coal, Southwestern field, Tenino-Mendota district, from drill core hole in SW¼ sec. 24, T. 15 N., R. 1 W., 6 miles southeast of Bucoda; collar elevation of hole, 580 feet. Coal beds, D and F; Skookumchuck, formation; dip, 0° to 8°; strike, N. 40° W. The core was logged from 520 feet 8 inches to 526 feet 6 inches; core received for analysis, 56½ inches of which 21 inches of bone, shale, and tuff were rejected and 25½ inches of coal was included in sample. The sample was collected by Parke D. Snavely, Jr. (USGS) June 1950.

DESCRIPTION OF TIPPLE AND DELIVERED SAMPLES

By S. J. Aresco [1] and F. E. Hartner [2]

EXPLANATION OF TABLE OF DESCRIPTION

The data in table 24 were taken from notes made by the persons who took the samples and supplement the description given in table 22 (p. 29).

The tipple samples were taken by engineers of the Bureau of Mines at the mine tipple as the coal was loaded for shipment. These samples represent as nearly as possible the quality of the coal as shipped. They are designated in column 3 as tipple; individual analyses are given for them.

The delivered samples were collected systematically throughout all deliveries to Government installations by representatives of the Government departments under directions supplied by the Bureau. Yearly averages are given for these samples.

When a single year is given in the column under date of delivery, the Government fiscal year is meant. For example, 1951 refers to the fiscal year begun July 1, 1950, and ended June 30, 1951.

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[2] Clerk, Analysis Section, Branch of Bituminous Coal, Division of Solid Fuels Technology, Region V, Bureau of Mines, Pittsburgh, Pa.

TABLE 24.—*Description of tipple and delivered samples*

County, town, and mine	Approximate tons delivered	Place of delivery	Date of delivery	Laboratory or index No.	Reference, page in this report
1	2	3	4	5	6
KING COUNTY					
Black Diamond:					
Franklin	30	Tipple	Apr. 6–7, 1943	B99032	29
Do	40	do	do	B99034	
Do	75	do	do	B99035	
Do	150	do	do	B99033	
Do	18	do	June 9, 1941	B63744	
Do	40	do	Apr. 6–7, 1943	B99036	
Franklin Gem	5	do	Mar. 31, 1943	B98791	29
Do	5	do	do	B98792	
Landsburg	2, 203	Fort Lewis, Wash	1953	1	29
Do	13, 295	McChord Air Force Base, Wash.	1952	2	
Do	7, 063	do	1953	3	
Do	146	Air Force Base, Blaine, Wash.	1954	4	
Palmer Nos. 10 and 12	125	Tipple	June 23, 1949	D21490	30
Do	5, 860	Fort Lawton and Fort Lewis, Wash.	1950	5	
Do	225	Tipple	July 15–16, 1952	D90362	
Do	125	do	June 23, 1949	D21491	
Cumberland:					
National	8	do	Apr. 26, 1943	B99848	30
Olson No. 1	216	McChord Air Force Base, Wash.	1948	6	30
Enumclaw: Green River	15	Tipple	July 18, 1946	C60717	31
Issaquah:					
Grand Ridge	8	War Department, Seattle, Wash.	1944	7	31
Do	8	do	1944	8	
Issaquah	30	Tipple	Feb. 20, 1943	B96353	31
Queen No. 1	30	do	Apr. 17, 1941	B62575	31
Do	40	do	Mar. 1–2, 1943	B96671	
Do	100	do	do	B96672	
Do	33	Fort Lawton and Boeing Field, Wash.	1944	9	
Do	168	do	1945	10	

TABLE 24.—*Description of tipple and delivered samples*—Continued

County, town, and mine	Approximate tons delivered	Place of delivery	Date of delivery	Laboratory or index No.	Reference, page in this report
1	2	3	4	5	6
KING COUNTY—continued					
Issaquah—Continued					
Queen No. 1		Tipple	Mar. 8, 1941	B61222	31
Do	100	do	Mar. 1–2, 1943	B96673	
Do	125	do	do	B96675	
Do	30	do	do	B96674	
Palmer:					
Elk No. 3	20	do	Feb. 15–16, 1943	B96020	31
Do	30	do	do	B96021	
Do	50	do	do	B96019	
Do	5	do	do	B96016	
Do	15	do	do	B96017	
Do	40	do	do	B96018	
Do		do	Mar. 7, 1941	B61370	32
Ravensdale:					
Anderson No. 7	24	Auburn Holding and Reassignment Depot, Wash.	1946	11	32
Do	44	do	1945	12	
Do	60	do	1946	13	
Do	16	Boeing Field, Seattle, Wash.	1945	14	
Do	9	do	1946	15	
Danville Nos. 1 and 2	3	Tipple	Apr. 27, 1943	B99772	32
Do	40	do	do	B99773	
Do	25	do	Apr. 8, 1940	B51603	
Do	15	do	Apr. 27, 1943	B99774	
Do	15	do	do	B99775	
Do	50	do	Apr. 24–25, 1951	D65014	
Do	250	do	July 15–16, 1952	D90363	
McKay	15	do	Feb. 10–11, 1943	B95540	33
Do	101	Fort Lawton, Wash.	1941	16	
Do	60	Tipple	Feb. 10–11, 1943	B95541	
Do	4, 409	Fort Lewis and McChord Air Force Base, Wash.	1940	17	
Do	5, 319	Fort Lewis, Wash.	1941	18	
Do	1, 387	do	1941	19	
Do	6, 627	Fort Lewis and Paine Field, Wash.	1942	20	
Do	5	Tipple	Feb. 10–11, 1943	B95542	
Do	3, 950	McChord Air Force Base, Wash.	1941	21	
Do	14, 976	Fort Lewis, Wash.	1942	22	
Do	200	Tipple	Feb. 10–11, 1943	B95543	
Do	582	Fort Lewis, Wash.	1944	23	
Do	538	do	1945	24	
Do	44	Fort Stevens, Oreg.	1941	25	
Do	270	Tipple	Feb. 10–11, 1943	B95545	
Do	2, 499	Veterans' Administration, Roseburg, Oreg.	1940	26	
Do	50	Tipple	Feb. 10–11, 1943	B95544	
McKay strip	50	do	Sept. 8, 1950	D50537	33
Do	250	do	do	D50538	
Ravensdale strip	80	do	May 8, 1953	E14606	33
Do	12, 401	Fort Lewis, Wash.	1949	27	
Do	170	Tipple	May 8, 1953	E14266	
Do	150	do	Mar. 26, 1953	E10304	
Ravensdale No. 4 strip	200	do	Dec. 30, 1952	E1657	31
Do	200	do	Feb. 11, 1954	E37813	
Do	50	do	do	E37814	

TABLE 24.—*Description of tipple and delivered samples*—Continued

County, town, and mine	Approximate tons delivered	Place of delivery	Date of delivery	Laboratory or index No.	Reference, page in this report
1	2	3	4	5	6
KING COUNTY—continued					
Renton:					
New Black Diamond	2, 825	Fort Lewis, Wash	1942	28	34
Do	318	Fort Greely, Alaska	1942	29	
Do	2, 689	Tacoma Indian Sanatorium, Washington.	1940	30	
Newcastle	50	Tipple	Feb. 22–23, 1943	B96407	34
Do	20	do	do	B96403	
Do	40	do	do	B96404	
Do	30	do	do	B96405	
Do	25	do	do	B96406	
Do	382	Seattle Port of Embarkation, Wash.	1943	31	
Do	3, 493	do	1943	32	
Do	50	McChord Air Force Base, Wash.	1951	33	
Do	125	Naval Air Station, Whidbey Island, Wash.	1943	34	
Do	2, 675	Tacoma Indian Sanatorium and Fish and Wildlife Service, Washington.	1941	35	
Newcastle (Coal Creek).		Tipple	Mar. 7, 1941	B61223	34
Do		do	Mar. 17, 1941	B61684	
Do	200	do	Feb. 24–25, 1943	B96402	35
Do	30	do	do	B96398	
Do	9, 279	Fort Lewis, Wash	1942	36	
Do	63	do	1944	37	
Do	147	Fort Lawton and Paine Field, Wash.	1945	38	
Do	250	Tipple	Feb. 24–25, 1943	B96399	
Do	275	do	do	B96400	
Do	100	do	do	B96401	
New Lake Young	1, 613	Tacoma Indian Sanatorium, Washington.	1942	39	35
Springbrook No. 3.	50	Tipple	Feb. 18, 1943	B96087	
Do	10	do	do	B96083	35
Do	20	do	do	B96084	
Do	20	do	do	B96085	
Do	15	do	do	B96086	
Talbot	10	do	May 21, 1943	C1143	35
Do	10	do	do	C1144	
Do	10	do	do	C1145	
Do	15	do	do	C1146	
KITTITAS COUNTY					
Ronald:					
Jonesville No. 4	40	Tipple	Mar. 15, 1943	B97524	35
Ronald No. 2	500	do	Mar. 11, 1943	B97304	35
Do	25	do	do	B97299	
Do	125	do	do	B97300	
Do	160	do	do	B97301	
Do	475	do	do	B97302	
Do	190	do	do	B97303	
Ronald No. 4	263	Post-Office Department, Washington.	1945	40	35
Do	25	Tipple	Mar. 12–13, 1943	B97622	
Do	495	Post-Office Department, Washington.	1945	41	

TABLE 24.—*Description of tipple and delivered samples*—Continued

County, town, and mine	Approximate tons delivered	Place of delivery	Date of delivery	Laboratory or index No.	Reference, page in this report
1	2	3	4	5	6
KITTITAS COUNTY—continued					
Ronald—Continued					
Ronald No. 4	152	Post-Office Departments, Oregon and Washington.	1946	42	35
Do	25	Tipple	May 16, 1941	B63151	36
Do	1,182	War Department, Washington	1945	43	
Do	155	do	1946	44	
Do	40	Tipple	Mar. 12–13, 1943	B97623	
Do	250	Naval Supply Depot, Tacoma, Wash.	1949	45	
Do	40	Tipple	Mar. 12–13, 1943	B97624	
Do	104	Fish and Wildlife Service, Leavenworth and North Bend, Wash.	1946	46	
Do	168	Post-Office Department, Washington, and Fish and Wildlife Service, Leavenworth, Wash.	1947	47	
Do	214	Post-Office Departments, Oregon and Washington.	1946	48	
Do	15	Army Air Field, Ellensburg, Wash.	1944	49	
Do	59	Spokane Air Force Base, Wash.	1947	50	
Do	226	Geiger Field, Wash	1945	51	
Do	107	Department of Agriculture, Crewport, Wash.	1947	52	
Do	100	Tipple	Mar. 12–13, 1943	B97625	
Do	164	Spokane Air Force Base, Wash.	1944	53	
Do	887	do	1945	54	
Do	172	do	1946	55	
Do	1,100	Naval Supply Depot, Spokane, Wash.	1947	56	
Roslyn No. 3	500	Tipple	Mar. 8–10, 1943	B97306	36
Do	20	do	do	B97305	
Do	75	do	do	B97307	37
Do	70	do	do	B97308	
Do	140	do	do	B97309	
Do	84	do	Apr. 10, 1950	D41275	
Do	370	do	Mar. 8–10, 1943	B97310	
Do	296	do	Apr. 10, 1950	D41273	
Do	300	do	July 15, 1948	C97934	
Do	160	do	Mar. 8–10, 1943	B97311	
Do	36	do	Nov. 27, 1941	B68861	
Do	151	do	Apr. 10, 1950	D41276	
Roslyn Cascade No. 1	124	Post-Office Departments, Idaho and Washington.	1941	57	37
Do	1,105	Fort George Wright, Wash	1941	58	
Do	4,207	Fort Stevens, Oreg., and Fort George Wright, Wash.	1940	59	
Do	4,898	do	1941	60	
Do	329	McChord Field, Wash	1942	61	
Do	879	do	1940	62	
Do	3,496	Fort Lewis, Wash	1941	63	
Do	2,712	Veterans' Administration, Roseburg, Oreg.	1941	64	
Do	2,860	do	1942	65	
Wright	5	Tipple	Mar. 16, 1943	B97620	37
Do	10	do	do	B97621	

TABLE 24.—*Description of tipple and delivered samples*—Continued

County, town, and mine	Approximate tons delivered	Place of delivery	Date of delivery	Laboratory or index No.	Reference, page in this report
1	2	3	4	5	6
KITTITAS COUNTY—continued					
Roslyn:					
Roslyn Nos. 3 and 9	45	Post-Office Department, Washington.	1951	66	37
Do	50	Colville Indian Agency, Wash.	1951	67	
Do	19, 356	Fort Lewis, Wash.	1949	68	
Do	2, 577	Fort Lewis and Moses Lake Air Force Base, Wash.	1950	69	
Do	50	Fort Lewis, Wash.	1951	70	
Do	6, 302	Fort Lewis and Larson Air Force Base, Wash.	1951	71	
Do	17, 431	Air Force and War Department, Washington.	1952	72	
Do	3, 940	Fort Lewis and Fort Lawton, Wash.	1954	73	
Do	150	Moses Lake Air Force Base, Wash.	1948	74	
Do	99	Post-Office Department, Washington.	1950	75	
Do	36	Post-Office Department, Prosser, Wash.	1953	76	
Do	35	Post-Office Department, Washington.	1954	77	
Do	1, 998	Fort Lewis, Wash.	1949	78	38
Do	700	Larson Air Force Base, Wash.	1954	79	
Do	61	Post-Office Department, Ellensburg, Wash.	1954	80	
Do	50	do	1948	81	
Do	93	Post-Office Department, Washington.	1952	82	
Do	198	Fort Lewis and Post-Office Department, Wash.	1951	83	
Do	21, 681	Fort Lewis, McChord Field, and Post-Office Department, Wash.	1949	84	
Do	53	Post-Office Department, Anacortes, Wash.	1950	85	
Do	42	Post-Office Department, Ellensburg, Wash.	1953	86	
Do	139	Post-Office Department, Okanogan and Wenatchee, Wash.	1948	87	
Do	45	Post-Office Department, Wash.	1949	88	
Do	798	Naval Supply Depots, Seattle and Tacoma, Wash., and Naval Air Station, Whidbey Island, Wash.	1948	89	
Do	21, 026	Naval Ammunition Depot and Fort Lewis, Wash.	1949	90	
Do	6, 709	McChord Air Force Base, Wash., and Naval Air Station, Whidbey Island, Wash.	1950	91	
Do	10, 021	McChord Air Force Base, Wash.	1951	92	
Do	1, 945	Atomic Energy Commission, Wash.	1953	93	
Do	14, 772	McChord Air Force Base, Wash.	1954	94	
Do	58	Public Buildings Administration, Blaine, Wash.	1951	95	
Do	54	Post-Office Department, Yakima, Wash.	1954	96	

TABLE 24.—*Description of tipple and delivered samples*—Continued

County, town, and mine	Approximate tons delivered	Place of delivery	Date of delivery	Laboratory or index No.	Reference, page in this report
1	2	3	4	5	6
KITTITAS COUNTY—continued					
Rosslyn—Continued					
Roslyn No. 5	25	Tipple	Mar. 5–6, 1943	B97090	38
Do	75	do	do	B97091	
Do	70	do	do	B97092	39
Do	110	do	do	B97093	
Do	450	do	do	B97096	
Do	340	do	do	B97094	
Do	150	do	do	B97095	
Roslyn No. 9	500	do	Mar. 4–9, 1943	B97198	39
Do	30	do	do	B97192	
Do	75	do	do	B97193	
Do	90	do	do	B97194	
Do	140	do	do	B97195	
Do	77	do	Apr. 10, 1950	D41274	
Do	400	do	Mar. 4–9, 1943	B97196	
Do	300	do	July 15, 1948	C97935	
Do	150	do	Mar. 4–9, 1943	B97197	
LEWIS COUNTY					
Centralia:					
Black Prince	3, 456	Veterans' Administration, American Lake, Wash.	1952	97	39
Do	1, 724	do	1953	98	
Golden Glow	3	Tipple	Jan. 18, 1943	B93899	39
Do	2	do	do	B93900	
Do	1	do	do	B93901	
Do	1	do	do	B93902	
Monarch (new)	20	do	Jan. 7–8, 1943	B93106	40
Do	15	do	do	B93105	
Do	15	do	do	B93107	
Do	20	do	do	B93108	
Do	1, 839	Veterans' Administration, American Lake, Wash.	1954	99	
Do	6, 086	do	1940	100	
Do	7, 619	do	1943	101	
Do	7, 802	do	1944	102	
Do	3, 629	do	1945	103	
Do	4, 750	do	1948	104	
Do	3, 850	do	1949	105	
Do	1, 004	do	1950	106	
Do	1, 958	do	1951	107	
Do	6, 550	do	1941	108	
Do	10	Tipple	Jan. 7–8, 1943	B93109	
Nonpariel	10	do	Apr. 17–19, 1943	B99524	41
Do	20	do	do	B99525	
Do	50	do	do	B99526	
Do	10	do	do	B99527	
PIERCE COUNTY					
Carbonado:					
Carbonado	375	Post-Office Departments, California, Oregon, and Washington.	1940	109	41
Do	147	Post-Office Department, Oregon.	1941	110	
Do	95	Post-Office Department, Washington.	1949	111	

TABLE 24.—*Description of tipple and delivered sample*—Continued

County, town, and mine	Approximate tons delivered	Place of delivery	Date of delivery	Laboratory or index No.	Reference, page in this report
1	2	3	4	5	6
PIERCE COUNTY—con.					
Wilkeson:					
East Miller No. 5	3	Tipple	Feb. 5, 1943	B95270	41
Do	30	do	do	B95271	
Wilkeson-Wingate	5	do	Feb. 8, 1943	B95268	42
Do	55	do	do	B95269	
Do	1,066	McChord Field, Wash	1945	112	
Do	1,757	do	1946	113	
Do	4,255	do	1947	114	
Do	500	Veterans' Administration, Vancouver, Wash.	1948	115	
THURSTON COUNTY					
Bucoda:					
D. & F. No. 1	10	Tipple	Jan. 11–12, 1942	B93558	42
Do	10	do	May 24, 1943	C1243	
Do	15	do	Jan. 11–12, 1942	B93559	
Do	10	do	May 24, 1943	C1244	
Do	10	do	Jan. 11–12, 1942	B93561	
Do	15	do	May 24, 1943	C1245	
Do	10	do	Jan. 11–12, 1942	B93560	
Penn-Bucoda	150	do	Aug. 15, 1947	C80364	43
Tono:					
Tono No. 1	60	do	Jan. 29–30, 1943	B94620	43
Do	75	do	do	B94621	
Do	70	do	do	B94622	
Do	250	Naval Air Station, Skelton, Wash.	1945	116	
Do	250	do	1945	117	
Do	70	Tipple	Jan. 29–30, 1943	B94623	
WHATCOM COUNTY					
Bellingham:					
Bellingham	49	Border Station, Blaine, Wash.	1949	118	43
Do	41	do	1943	119	
Do	125	Tipple	Mar. 17, 1943	B97697	44
Do	4,416	Forts Lawton and Worden, Wash., and Border Station, Blaine, Wash.	1940	120	
Do	3,341	Forts Casey, Flagler, Lawton, and Worden, Wash., and Treasury Department, Blaine, Wash.	1941	121	
Do	16,213	Border Station, Blaine, Wash.; Forts Casey, Lawton, and Worden, Wash.; and Seattle Q. M. Depot, Yakutat, Alaska.	1942	122	
Do	50	Border Station, Blaine, Wash.	1948	123	
Do	2,011	Fort Worden, Wash	1951	124	
Do	45	Tipple	May 20, 1949	D19111	
Do	45	do	Mar. 17, 1943	B97698	
Do	100	do	Apr. 27, 1953	E13233	
Do	135	do	Mar. 17, 1943	B97703	
Do	4,047	Forts Greely and Raymond, Alaska.	1942	125	

TABLE 24—*Description of tipple and delivered samples*—Continued

County, town, and mine	Approximate tons delivered	Place of delivery	Date of delivery	Laboratory or index No.	Reference, page in this report
1	2	3	4	5	6
WHATCOM COUNTY—con.					
Bellingham—Continued					
Bellingham	8,765	Forts Casey, Flagler, Lawton, and Worden, Wash.	1943	126	44
Do	80	Tipple	Mar. 17, 1943	B97699	
Do	65	do	do	B97700	
Do	135	do	do	B97704	
Do	65	do	do	B97701	
Do	200	do	Apr. 27, 1953	E13234	
Do	120	do	Mar. 17, 1943	B97702	
Glen Echo	10	do	Mar. 18, 1943	B97917	45
Do	26	Border Station, Blaine, Wash.	1944	127	
Do	50	do	1945	128	
Do	45	do	1946	129	
Do	5	Tipple	Mar. 18, 1943	B97918	
Do	5	do	do	B97919	
Do	10	do	do	B97920	

TRUE SPECIFIC GRAVITIES OF WASHINGTON COALS

By R. F. Abernethy [1] and F. E. Hartner [2]

Table 25 gives the true specific gravities of a number of mine and tipple samples of Washington coals determined by the standard method.[3] The specific gravity is given for the dry coal, and for convenience of comparison the dry-ash value also is given. The proximate and ultimate analyses of these coals are given in table 22 (p. 29).

[1] Chief, Analysis Section, Branch of Bituminous Coal, Division of Solids Fuels Technology, Region V, Bureau of Mines, Pittsburgh, Pa.
[2] Clerk, Analysis Section, Branch of Bituminous Coal, Division of Solid Fuels Technology, Region V, Bureau of Mines, Pittsburgh, Pa.
[3] Fieldner, A. C., and Selvig, W. A., Methods of Analyzing Coal and Coke: Bureau of Mines Bull. 492, 1951, 51 pp.

TABLE 25.—*True specific gravities of Washington coals*

County and town	Mine	Bed	Kind of sample [1]	Size of sample	Dry ash	Specific gravity	Laboratory No.
1	2	3	4	5	6	7	8
KING COUNTY							
Black Diamond	Franklin	McKay	M		4.6	1.30	C21218
Do	do	do	M		9.1	1.34	C21219
Do	do	do	M		9.3	1.34	C21220
Do	do	do	T	3-inch lump	4.5	1.31	B99032
Do	do	do	T	3-inch by 0	18.1	1.43	B99033
Do	Franklin Gem	Gem	M		11.6	1.40	C21380
Do	do	do	T	1-inch lump	11.7	1.41	B98791
Do	do	do	T	1-inch by 0	12.5	1.43	B98792
Do	Gem No. 1		M		20.0	1.51	B62407
Do	Gem No. 2	Gem	M		18.5	1.43	C21382
Do	Hi Heat	Franklin No. 10, upper bench.	M		18.2	1.42	C21223
Do	do	Franklin No. 10, lower bench.	M		12.6	1.31	C21224
Do	J. & P	Kummer No. 1	M		14.6	1.46	C21222
Do	Kummer	Kummer No. 4	M		19.3	1.53	C40881
Cumberland	Durham	Durham No. 2	M		18.1	1.41	C22079
Do	Hyde	McKay	M		14.5	1.37	C21558
Do	National	No. 1	T	Run-of-mine	19.0	1.42	B99848
Enumclaw	Green River	Kummer No. 4(?)	M		21.4	1.51	C21381
Issaquah	Harris No. 2	Jones	M		17.2	1.46	B75318
Do	Issaquah	Lower Bagley	T	Run-of-mine	20.5	1.52	B96353
Do	Lahee	Dolly Varden	M		16.2	1.44	D19163
Do	Queen No. 1	Muldoon	M		21.0	1.51	D18545
Do	do	Lower Bagley and May Creek.	T	3-inch lump	10.5	1.42	B62575
Do	do	Lower Bagley, Upper Bagley, and Muldoon.	T	do	17.2	1.48	B96671
Do	do	do	T	3-inch by 0	23.2	1.53	B96675
Palmer	Elk No. 3	Dutch	M		33.9	1.56	D1342
Do	do	"A" or Victory, upper bench.	M		22.8	1.44	D1344
Do	do	"A" or Victory, lower bench.	M		20.3	1.43	D1343
Do	do	Big Elk	T	Run-of-mine	40.9	1.68	B96020
Do	do	Victory	T	do	29.9	1.55	B96021
Do	do	Victory and Big Elk.	T	do	36.5	1.63	B96019
Do	do	do	T	4-inch lump	15.8	1.40	B96016

M, mine sample; T, tipple sample.

TABLE 25.—*True specific gravities of Washington coals*—Continued

County and town	Mine	Bed	Kind of sample [1]	Size of sample	Dry ash	Specific gravity	Laboratory No.
1	2	3	4	5	6	7	8
KING COUNTY—con.							
Ravensdale	Danville No. 1	Frazier	M		10.6	1.45	B51279
Do	do	do	M		10.1	1.44	B51280
Do	do	do	T	3½-inch lump	16.0	1.46	B99772
Do	Danville No. 2	Eight-Foot	M		13.5	1.41	C22080
Do	do	Landsburg No. 1	M		15.2	1.43	D21493
Do	do	Landsburg No. 1, lower bench.	M		7.4	1.37	D42878
Do	McKay	McKay, upper bench	M		6.0	1.37	C96786
Do	do	McKay	T	3½-inch lump	4.7	1.36	B95540
Do	do	do	T	3½-inch by 0	11.7	1.42	B95545
Renton	Ivan Jones prospect		M		6.7	1.36	B78372
Do	Newcastle	Jones	M		10.9	1.39	D18546
Do	do	Bagley and May Creek.	T	Run-of-mine	23.0	1.53	B96407
Do	do	do	T	3½-inch lump	17.9	1.47	B96403
Do	Newcastle (Coal Creek).	Bagley	T	Run-of-mine	24.6	1.53	B96402
Do	do	do	T	3½-inch lump	11.8	1.44	B96398
Do	Springbrook No. 3	Springbrook No. 2, upper bench.	T	Run-of-mine	26.6	1.59	B96087
Do	do	do	T	3-inch lump	15.8	1.48	B96083
Do	Talbot	Springbrook, middle bench.	M		12.3	1.43	C21559
Do	do	Springbrook, upper bench.	T	3½-inch lump	15.4	1.47	C1143
KITTITAS COUNTY							
Ronald	Jonesville No. 4	Wright (Roslyn No. 6).	T	Run-of-mine	23.4	1.46	B97524
Do	Ronald No. 2	Big (Roslyn No. 1)	T	Run-of-mine (crushed to 2½-inch).	22.4	1.46	B97304
Do	do	do	T	¼-inch by 0 (air cleaned).	16.3	1.40	B97303
Do	Roslyn No. 3	Roslyn (No. 5)	T	Run-of-mine (crushed to 3-inch).	23.1	1.46	B97306
Do	do	do	T	3-inch lump	13.8	1.37	B97305
Do	do	do	T	¼-inch by 0 (air cleaned).	18.6	1.42	B97311
Do	Wright	Roslyn No. 8	T	¾-inch lump	29.8	1.51	B97620
Do	do	do	T	¾-inch by 0	19.9	1.42	B97621
Roslyn	Roslyn No. 5	Roslyn	T	3-inch lump	12.6	1.38	B97090
Do	do	do	T	3-inch by 0	26.3	1.51	B97096
Do	do	do	T	¼-inch by 0 (air cleaned).	22.2	1.47	B97095
Do	Roslyn No. 9	do	T	Run-of-mine (crushed to 3-inch).	24.6	1.49	B97198
Do	do	do	T	¼-inch by 0 (air cleaned).	20.6	1.45	B97197

[1] M, mine sample; T, tipple sample.

TABLE 25.—*True specific gravities of Washington coals*—Continued

County and town	Mine	Bed	Kind of sample [1]	Size of sample	Dry ash	Specific gravity	Laboratory No.
1	2	3	4	5	6	7	8
LEWIS COUNTY							
Centralia	Belle Slope	Smith	M		12.6	1.48	C23747
Do	do	do	M		13.9	1.49	C23748
Do	Black Badger	Tono No. 1 (?)	M		11.8	1.49	D30894
Do	Columbia	Mendota No. 3	M		17.1	1.51	D3092
Do	Columbia (Smith)	Big Dirty	M		13.6	1.50	C1418
Do	Creno prospect	Little Dirty (?)	M		14.8	1.49	D30868
Do	Golden Glow		T	3-inch lump	8.2	1.50	B93899
Do	do		T	3- by 1¼-inch	9.7	1.49	B93900
Do	do		T	1¼- by ⅜-inch	11.0	1.51	B93901
Do	do		T	⅜-inch by 0	16.1	1.56	B93902
Do	Kostick No. 1 prospect.	Lower Thompson	M		16.2	1.52	D30866
Do	Kostick No. 2 prospect.	Smith	M		10.8	1.47	D30867
Do	Lincoln		M		11.2	1.50	C1419
Do	Martin	Tono No. 1 or Foron.	M		11.4	1.48	D8255
Do	Monarch (new)	do	M		11.7	1.49	D3090
Do	do	do	T	Run-of-mine	16.2	1.55	B93106
Do	do	do	T	3-inch lump	10.6	1.51	B93105
Do	Monarch prospect	Upper Thompson	M		12.3	1.49	D3091
Do	Morris prospect		M		18.3	1.62	B93658
Do	Nonpariel		T	3½-inch lump	9.8	1.49	B99524
Chehalis	Newaukum prospect		M		21.0	1.53	C64088
Do	Val Myer prospect		M		18.8	1.54	B93644
Morton	Atlas (Hi-Carbon)	Hi-Carbon	M		22.1	1.49	C28183
Do	Sunburst	No. 2 (?)	M		17.3	1.52	B96595
PIERCE COUNTY							
Wilkeson	Bartoy	No. 2, east dip	M		15.2	1.39	B53204
Do	do	do	M		12.3	1.35	B53205
Do	do	do	M		14.9	1.38	B53206
Do	Champion	Champion	M		22.0	1.44	C54014
Do	East Miller No. 5	No. 5 (Miller), east dip.	T	1⅝-inch lump	14.4	1.40	B95270
Do	do	do	T	1⅝-inch by 0	18.6	1.42	B95271
Do	Skookum	No. 3, west dip	M		14.7	1.38	C16487
Do	Sparton	Champion	M		14.6	1.38	D31102
Do	Wilkeson-Miller	No. 5 (Miller), west dip.	M		6.4	1.29	B53925
Do	do	do	M		7.1	1.31	B53926
Do	Wilkeson-Wingate	No. 4 (Wingate), east dip.	T	2-inch lump	18.1	1.43	B95268
Do	do	do	T	2-inch by 0	16.8	1.42	B95269

[1] M, mine sample; T, tipple sample.

TABLE 25.—*True specific gravities of Washington coals*—Continued

County and town	Mine	Bed	Kind of sample [1]	Size of sample	Dry ash	Specific gravity	Laboratory No.
1	2	3	4	5	6	7	8
THURSTON COUNTY							
Bucoda	Boxer	Mendota	M		16. 6	1. 53	D30865
Do	D. & F. No. 1		T	3-inch lump	19. 3	1. 55	B93558
Do	do		T	do	21. 6	1. 55	C1243
Do	do		T	3- by 1½-inch	21. 5	1. 57	B93559
Do	do		T	3- by 1½-inch	24. 4	1. 59	C1244
Do	do		T	1½-inch by 0	23. 8	1. 60	B93560
Do	D. & F. prospect		M		16. 2	1. 51	C96368
Do	Gordon prospect	Penitentiary	M		17. 1	1. 59	D1995
Do	Meeks' prospect	Big Dirty	M		16. 9	1. 50	D1994
Do	Penn-Bucoda prospects.	Big Dirty, upper bench.	M		10. 4	1. 46	C26026
Do	do	Big Dirty, middle bench.	M		13. 2	1. 49	C26027
Do	do	Big Dirty, lower bench.	M		15. 7	1. 48	C26028
Do	do	Little Dirty	M		15. 4	1. 51	C26029
Do	do	Smith	M		13. 6	1. 48	C26030
Tono	Tono No. 1	Tono No. 1	T	3-inch lump	8. 6	1. 46	B94620
Do	do	do	T	3- by 1¾-inch	13. 0	1. 49	B94621
Do	do	do	T	1¾-inch by 0	15. 3	1. 52	B94623
Do	Tono prospect	Tono No. 2	M		12. 4	1. 48	D30869
WHATCOM COUNTY							
Bellingham	Bellingham	Bellingham No. 1	M		17. 7	1. 47	D8250
Do	do	do	M		19. 3	1. 48	D8251
Do	do	do	M		18. 4	1. 48	D8252
Do	do	do	M		17. 8	1. 47	D8253
Do	do	do	T	4-inch lump	19. 6	1. 49	B97697
Do	do	do	T	4- by 1¼-inch	25. 8	1. 56	B97703
Do	do	do	T	1¼- by ⅜-inch	28. 0	1. 58	B97704
Do	do	do	T	⅜-inch by 0	21. 2	1. 52	B97702
Do	Glen Echo	do	T	4-inch lump	12. 1	1. 47	B97917

[1] M, mine sample; T, tipple sample.

SULFUR FORMS IN WASHINGTON COALS

By R. F. Abernethy [1] and F. E. Hartner [2]

The sulfur in coal has been found to exist in three principal forms: Sulfate, pyritic, and organic.[3] These forms will give the fuel technologist most of the desired information concerning the sulfur occurring in Washington coals. Proximate and ultimate analyses will be found in table 22 (p. 29).

Table 26 gives the values obtained by the standard method [4] for the sulfate, pyritic, organic, and total sulfur.

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[2] Clerk, Analysis Section, Branch of Bituminous Coal, Division of Solid Fuels Technology, Region V, Bureau of Mines, Pittsburgh, Pa.

[3] Powell, A. R., The Analysis of Sulfur Forms in Coal: Bureau of Mines Tech. Paper 254, 1921, 21 pp.

[4] Fieldner, A. C., and Selvig, W. A., Methods of Analyzing Coal and Coke: Bureau of Mines Bull. 492, 1951, 51 pp.

TABLE 26.—*Sulfur forms in Washington coals*

County and town	Mine	Bed	Sulfur, as-received condition				Laboratory No.
			Sulfate	Pyritic	Organic	Total	
1	2	3	4	5	6	7	8
KING COUNTY							
Black Diamond	Franklin	McKay	0.00	0.09	0.38	0.47	B99032
Do	Franklin Gem	Gem	.00	.06	.50	.56	B98791
Cumberland	National	No. 1	.00	.06	.42	.48	B99848
Enumclaw	Green River	Kummer No. 4(?)	.01	.17	.04	.22	C60717
Issaquah	Issaquah	Lower Bagley	.00	.06	.30	.36	B96353
Do	Queen No. 1	Lower Bagley, Upper Bagley, and Muldoon.	.00	.18	.31	.49	B96674
Palmer	Elk No. 3	Victory and Big Elk	.00	.11	.49	.60	B96016
Ravensdale	Danville No. 1	Frazier	.00	.33	.57	.90	B99774
Do	McKay	McKay	.01	.28	.38	.67	B95540
Renton	Newcastle	Bagley and May Creek	.00	.06	.36	.42	B96406
Do	Newcastle (Coal Creek)	Bagley	.00	.07	.32	.39	B96398
Do	Springbrook No. 3	Springbrook No. 2, upper bench.	.00	.10	.31	.41	B96085
Do	Talbot	Springbrook, upper bench	.01	.26	.43	.70	C1145
KITTITAS COUNTY							
Ronald	Jonesville No. 4	Wright (Roslyn No. 6)	.00	.09	.27	.36	B97524
Do	Ronald No. 2	Big (Roslyn No. 1)	.00	.06	.22	.28	B97301
Do	Ronald No. 4	Roslyn No. 6	.00	.08	.36	.44	B97624
Do	Roslyn No. 3	Roslyn (No. 5)	.00	.07	.27	.34	B97309
Do	do	do	.01	.04	.31	.36	D41273
Do	Wright	Roslyn No. 8	.00	.06	.34	.40	B97621
Roslyn	Roslyn No. 5	Roslyn	.00	.09	.30	.39	B97093
Do	Roslyn No. 9	do	.00	.07	.31	.38	B97195
LEWIS COUNTY							
Centralia	Golden Glow		.01	.14	.53	.68	B93899
Do	Monarch (new)	Tono No. 1 or Foron	.01	.12	.70	.83	B93105
Do	Nonpariel		.00	.08	.55	.63	B99524
PIERCE COUNTY							
Carbonado	East Miller No. 5	No. 5 (Miller), east dip	.00	1.00	.52	1.52	B95270
Do	Wilkeson-Wingate	No. 4 (Wingate), east dip	.00	.27	.57	.84	B95269
THURSTON COUNTY							
Bucoda	D. & F. No. 1		.05	1.79	2.48	4.32	B93558
Do	do		.04	2.07	1.01	3.12	C1245
Do	Penn-Bucoda	No. 4 (Bagley)	.01	.11	.28	.40	C80364
Tono	Tono No. 1	Tono No. 1	.00	.04	.33	.37	B94620
WHATCOM COUNTY							
Bellingham	Glen Echo	Bellingham No. 1	.00	.07	.33	.40	B97917

INDEX

D

E

F

O