Coal Measure cliffs near No. 2 Colliery, Table Head, Glace Bay. Coal seams can be seen in the cliffs: typical of the shore exposures in the Sydney coal-fields, showing wastage of cliffs.

CANADA
DEPARTMENT OF MINES
HON. P. E. BLONDIN, MINISTER; R. G. MCCONNELL, DEPUTY MINISTER.

MINES BRANCH
EUGENE HAANEL, PH.D., DIRECTOR.

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The Coal-Fields and Coal Industry of Eastern Canada

A General Survey and Description

BY

Francis W. Gray

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LETTER OF TRANSMITTAL.

DR. EUGENE HAANEL,
Director Mines Branch,
Department of Mines,
Ottawa.

SIR,—

I beg to submit, herewith, the following report on the Coal-fields and Coal Industry of Eastern Canada.

I have the honour to be,
Sir,
Your obedient servant,
(*Signed*) **Francis W. Gray.**

Sydney, N.S.
July 24, 1916.

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THE COAL-FIELDS AND COAL INDUSTRY OF EASTERN CANADA.

THE COAL-FIELDS AND COAL INDUSTRY OF EASTERN CANADA.

INTRODUCTORY.

Geological.

The Carboniferous area of eastern Canada, with its associated coal-fields, forms part of the northward continuation of the Appalachian Mountain range, as evidenced in the characteristic occurrence of the rock formations in elongated belts with a general northeasterly and southwesterly trend. This is seen in the general configuration of Nova Scotia; in the indentation of the Bay of Fundy; in the parallel valleys and hill ranges characteristic of the Province; in the narrow and picturesque Bras d'Or lakes; and in the fiordlike arms of the sea that penetrate far inland—alike in Cape Breton island and in Newfoundland.

The Carboniferous and Permo-Carboniferous rocks extend from the vicinity of Fredericton in New Brunswick; across the upper reaches of the Bay of Fundy; and along the seaward slopes of the western shore of the mainland of Nova Scotia, into Cape Breton island, where they dip under the sea, and re-appear on the other side of the Cabot strait, in a narrow strip of disturbed strata that is prolonged for a distance of eighty miles along the western shore of Newfoundland. Whether the Carboniferous rocks are continuous under the Cabot straits is, of course, not known, but there is sufficient evidence for presuming the coal seams to persist at least as far seawards as they can be mined.

Carboniferous and Permo-Carboniferous rocks cover Prince Edward Island, and are found on the Magdalen islands in the middle of the Gulf of St. Lawrence, from which it may be deduced that strata of Carboniferous age underlie a large portion of the waters of the Gulf.

The Carboniferous area is all within the Maritime Provinces, and is contained within a parallelogram measuring roughly 300 by 200 miles, having at its four corners the mouth of Chaleur bay in the west; Fredericton, New Brunswick, in the south; Arichat, Cape Breton, in the east; and the head of St. George's bay, Newfoundland, in the north.

This parallelogram may be regarded as defining, very approximately, the shores of the pre-Carboniferous continent bordering the sea in which the Carboniferous sediments were laid down. With the aid of a geological map it is not difficult to trace the outline of this ancient shore; and from the soundings given on the Admiralty chart of the Gulf of St. Lawrence, some idea may be gathered of the course of the pre-Carboniferous uplands.

Alone among the coal deposits of Canada, the seams of Nova Scotia and New Brunswick belong to the Carboniferous, and are classed as true Coal Measure deposits. The basal rocks of the Carboniferous resemble the Millstone Grits of the European Coal Measures, and are doubtfully supposed to be of the same geological age.

Historical.

The first printed mention of the existence of coal in Nova Scotia was made by Nicholas Denys, in a work published in Paris in 1672. The presence of thick coal seams in the cliffs that lie between the Little Bras d'Or entrance and the Mira river is the most striking feature of this portion of the coast of Cape Breton; and it is rather surprising that earlier mention has not been made of the presence of coal seams.

Mr. Richard Brown—to whose writings all subsequent historians of the coal industry of Nova Scotia are indebted—says that from the discovery of the island of Cape Breton by Sebastian Cabot in 1498, to the year 1672—a period of nearly 200 years:—

> Although numerous voyages were made to the coast by intelligent enterprising navigators, there is no mention whatever, in any of their narratives, of the existence of the coal seams, which, being plainly visible in the cliffs of almost every bay and headland, could not possibly have escaped observation.

During the French occupation, coal appears to have been obtained in small quantities from outcrops of the seams along the cliffs; and during the building of the fortress of Louisburg, around 1720, coal was dug to supply the needs of the workmen. After the final conquest of Louisburg in 1758, applications were made to the English Government, by English officers and others, for grants of the coal areas, but these were not entertained, and in 1766, the Privy Council absolutely forbade the mining of coal in Cape Breton, refusing to consider any applications having this purpose in view. Notwithstanding the advice of the Governor of Nova Scotia to lease the mines, the Government persisted in its very mistaken policy. Naturally a great deal of illicit mining took place, and it was found necessary in order to enforce the orders from England, to send troops to the coal-fields to prevent the mining of coal. The action of the authorities must have seemed cruelly foolish and inexplicable to those colonists who every spring saw the coal that the winter's frosts had loosened drop into the sea with the first thaws of spring, to be washed completely away by the first storm.

In 1784, Cape Breton was made a separate province, and the Privy Council reserved to the Crown all coal, together with other valuable minerals. Leases to mine coal were granted by the Crown on a royalty basis; but the industry did not flourish, partly because of the primitive methods of mining, and—to quote again from Mr. Brown, because the Government

> . . . persisted in granting only short leases, at exorbitant rates of royalty.

Coal mining operations, on a comprehensive and systematic plan, date from the year 1825, when a Company known as the General Mining Association took over a lease

> . . . of all the mines and minerals of the Province of Nova Scotia, which George IV., by an act of the royal prerogative, had granted to his brother the Duke of York.

The Duke of York, having become deeply in debt to his jewellers, was, to quote Haliburton:—

> . . . saved from their importunities by the liberality of the British Government, which generously made them a present of our mines and minerals, the lease of which issued to the Duke, and was by him assigned to them.

Indefensible as this action of the English Government appears to-day, the acquisition of these most valuable mineral rights led to the immediate development of the coal-fields, on a scale larger than had been previously attempted.

The General Mining Association does not appear to have at first contemplated the mining of coal. An erroneous idea of the extent and value of the copper ores of Nova Scotia seems to have existed at this time, and it was not until detailed explorations by the engineers of the Association had shown that the chief mineral wealth of Nova Scotia was to be found in coal deposits, and not in copper ores, that the attention of the Association was devoted to the development of the coal-fields.

Between its formation and the year 1846, the General Mining Association expended £300,000 in opening mines, and developing the coal industry. The lease to the Duke of York did not include the mines already demised and working, but by purchase the Association eventually obtained possession of all the mines and minerals of the Crown in Nova Scotia. The operations of the Association were concentrated in the Sydney and Pictou fields, and the production of coal increased from 21,000 tons in 1828, to 294,000 tons in 1858.

The monopoly of the General Mining Association was a source of great irritation to the people of Nova Scotia, and the events leading to what was then known as "the breaking of the Duke of York's lease" form one of the most interesting chapters of the development of responsible government in Nova Scotia. After a fight extending over many years, the General Mining Association, in 1857, surrendered its claim to all the mines and minerals of the Province, and was given an exclusive right to all the coal seams in certain specified areas situated in the Sydney, Pictou, and Cumberland fields: coinciding more or less exactly with the areas owned by the Acadia Coal Company at the Albion Mines; the areas operated by the Dominion Coal Company at Springhill Mines; and the areas operated in the Sydney coal-field by the Dominion Coal Company and the Nova Scotia Steel & Coal Company.

It speaks well for the knowledge of the mining engineers of the General Mining Association that, with all the added knowledge gained by the prospecting activities of the fifty years which have since elapsed, the areas chosen by the General Mining Association are still the most valuable in the Province.

With the year 1858, a new phase of the coal industry commenced. By the settlement of the long-standing dispute,

> . . . the Province was freed from the monopoly of coal, which the Association had enjoyed for thirty years; secured in the control and possession of all the other mines and minerals—now open to the enterprise of its people—and relieved from the constant discussion of an irritating subject, which had long disturbed the harmony of the Assembly, affected the peace and welfare of the country, and threatened to lead to a painful and injurious embroilment with the British Government.
> (*vide* Brown).

The reservation of the minerals of the Province by the lease to the Duke of York proved, in the long run, to be of great benefit to the people of Nova

Scotia, as the surrender of the Duke's reserved mines and minerals led to the vesting of all the mineral rights in the Government of the Province of Nova Scotia, thereby providing the Province with a source of revenue from mineral royalties; in striking contrast to Great Britain, the United States, and some portions of Canada, where royalties have been unwisely allowed to accrue to the benefit of private individuals.

After 1858, a number of independent companies began mining operations. The production gradually increased, with occasional temporary declines, due to changes in the fiscal relations of the United States and the British provinces.

The coal and steel industries in Nova Scotia, as elsewhere, have always been closely allied, and it is significant that the first really substantial gain in the annual coal yield of the Province becomes noticeable in the years 1880 to 1882, or coincident with the formation of the Nova Scotia Steel Company, and the commencement of steel manufacture near New Glasgow.

In 1893, a number of adjoining coal properties in the Glace Bay basin of the Sydney coal-field, operated by competing companies, were amalgamated to form the Dominion Coal Company. The Nova Scotia Legislature granted a ninety-nine years lease of the amalgamated areas to this Company, in consideration of an undertaking by the Company to pay a royalty of 12½ cents per ton—the usual royalty to other companies at this time being 10 cents per ton, and, further, to pay a minimum annual royalty not less in amount than the total royalty monies collected from all the independent companies operating the consolidated areas in the year preceding amalgamation. This last named provision has not proven difficult of fulfilment.

In 1893, the output of the Province was 1,485,924 tons, and until 1900 but a small increase was recorded. In 1900, however, the influence of steel manufacture once more asserted itself, and a most notable increase in production commenced. By the formation of the Dominion Iron & Steel Company, and the acquisition by the Nova Scotia Steel Company of the areas of the General Mining Association at Sydney Mines—both events occurring in 1900—a local market was provided for coal to be used in the smelting of iron-ore imported from the unique and valuable deposit of red oolitic hematite, owned by these two companies, at Wabana, Newfoundland.

The provincial production in 1900 had risen to 3,000,000 tons, and reached its present maximum in 1913, when for the 12 months ending 30th September, the tonnage raised, by counties, was as under:—

County	*Coal output (long tons).*
Cumberland	621,864
Pictou	703,583
Inverness	284,274
Cape Breton	5,594,192
	7,203,913 tons.

The progress of the coal industry can be followed from the following table, abstracted from the Nova Scotia mines reports, and covering the sales of coal. Unfortunately, no reliable figures exist of the actual production tonnages.

Sales of Nova Scotia Coal from 1785 to 1915.

Years.	Tons (long).
1785–1790	14,349
1791–1800	51,048
1801–1810	70,452
1811–1820	91,527
1821–1830	140,820
1831–1840	839,981
1841–1850	1,533,798
1851–1860	2,399,829
1861–1870	4,927,339
1871–1880	7,377,426
1881–1890	13,910,136
1891–1900	20,552,536
1901–1910	45,898,410
1911–1920 (estimated)	61,000,000
1911–1915 (actual)	30,135,295

An interesting feature of the increase in coal sales is that the succeeding decades from 1830 to 1910 show a geometrical progression increasing at a rate of 78 per cent per decade. On page 8 is shown a plotting of the curve of the actual recorded sales, and the mathematical curve closely approximating. The equation of this curve and the plotted diagram have been most kindly furnished by Mr. J. W. McLeod.

The continuation of the rate of progression shown by the record of the past eighty years would indicate a probable sales tonnage for the decade ending 1920 of 61,000,000 tons, but it is not to be anticipated the current decade will show the same rate of tonnage increase as the decades preceding.

The war which commenced in 1914, and the resultant disorganization, first of trade conditions, and afterwards of the labour supply by reason of the needs of the Army, has caused a lessened rate of production that will in all probability persist over several years to come.

Such a rate of increase as is shown by the foregoing table cannot, of course, continue indefinitely, and it seems probable, for many reasons, that the large output of the year 1913 will not again be materially exceeded within the current decade, and that for several years to come at least, the coal production of Nova Scotia will not be greater than seven million tons per annum.

A calculation of the unexpired five years of the current ten years period, allowing for the effect of the war conditions, and the present capacity of the existing mines for output, would indicate a probable tonnage of 61,000,000 tons for the ten years ending 1920, and this estimated figure has been included in the foregoing table merely for purposes of comparison with previous records.

The revenues of the Province of Nova Scotia are in large part derived from the royalties on coal, which, in the fiscal year 1913, realized $799,200. On January 1, 1913, the general coal royalty—that is, other than the royalties paid by the Dominion Coal Company on coal extracted from that Company's areas as especially enacted—was raised from 10 cents per ton to 12½ cents per ton, so that all coal now mined in Nova Scotia pays royalty at the rate of 12½ cents per ton. The royalty payment is calculated on the coal sold, and exemptions are made by the law to cover coal used at the collieries and the coal sold at reduced rates to the colliery workmen. Allowance is also made for refuse taken from the coal in the process of cleaning and preparation for the market.

Economic.

The geographical position of the Nova Scotian coal-field gives it an exceptional economic value, further enhanced by the political frontiers of North America.

Nova Scotia has the only coal deposits on the entire Atlantic sea-board of North and South America.

In Canada, there are no coal deposits between the Grand Lake coal-field in New Brunswick and Alberta; a distance of over 2,000 miles; while the nearest coal-fields in the United States—regarding the Pictou coal-field as the centre of the Nova Scotia deposits—are 800 miles away.

The production of the New Brunswick collieries has increased quite rapidly within the past few years, and in 1915 reached 122,422 tons. The output of New Brunswick is, however, not likely to increase beyond the quantity required for local needs, as the deposit is a strictly limited one, and the thinness of the single seam available will not permit of future large production.

The output of the mainland collieries of Nova Scotia is almost entirely absorbed by domestic, factory, and railway use, in the Maritime Provinces; but about one-third of the Cape Breton production is customarily sent to Montreal and points along the St. Lawrence river.

The distribution of the produce of the Nova Scotian collieries may be gathered from the following table, given in the Nova Scotia Mines Report for the year ending September 30, 1913. This year is selected, as showing not only the largest tonnages in the history of the industry, but as showing, also, more normal conditions than those which have obtained since the commencement of the war.

Sales Distribution of the Coal Production of Nova Scotia.

Year ending September 30, 1913

Destination	Counties in which the coal was mined				Total
	Cape Breton	Pictou	Cumberland	Inverness	
	Tons	Tons	Tons	Tons	Tons
Nova Scotia	1,844,202	478,571	132,326	143,945	2,599,043
New Brunswick and Prince Edward Island	336,501	98,445	277,083	30,695	742,725
St. Lawrence	2,071,515	19,348	38,475	63,919	2,193,257
Newfoundland and St. Pierre de Miquelon	217,195	.....	.....	.....	217,195
United States	407,604	.....	56,610	3,877	468,091
Bunker coal, etc	241,852	1,662	4,903	9,982	258,399
	5,118,869	598,026	509,397	252,418	6,478,710

A perusal of the foregoing table will show that the major part of the coal used outside the Province of Nova Scotia is exported from Cape Breton island; which includes the counties of Cape Breton and Inverness. The coal sent from Cape Breton island during the fiscal year 1913, to points outside the Province, totalled 3,383,140 tons, against exportations from the mainland collieries of 496,526 tons.

The coal consumed in the various processes and operations connected with the manufacture of steel in Nova Scotia, during 1913, absorbed 60 per cent of the total coal consumption of the Province, showing how important a factor steel manufacture is in relation to the coal industry.

At the present time (1916), the percentage of the coal production used in the steel industry is still greater, owing to the demand for steel for war requirements.

The production of the individual coal companies operating in Nova Scotia for the fiscal years 1913 and 1915, was as under. The year 1913 is given because of the high production realized in that year, and 1915, for comparison as to present conditions.

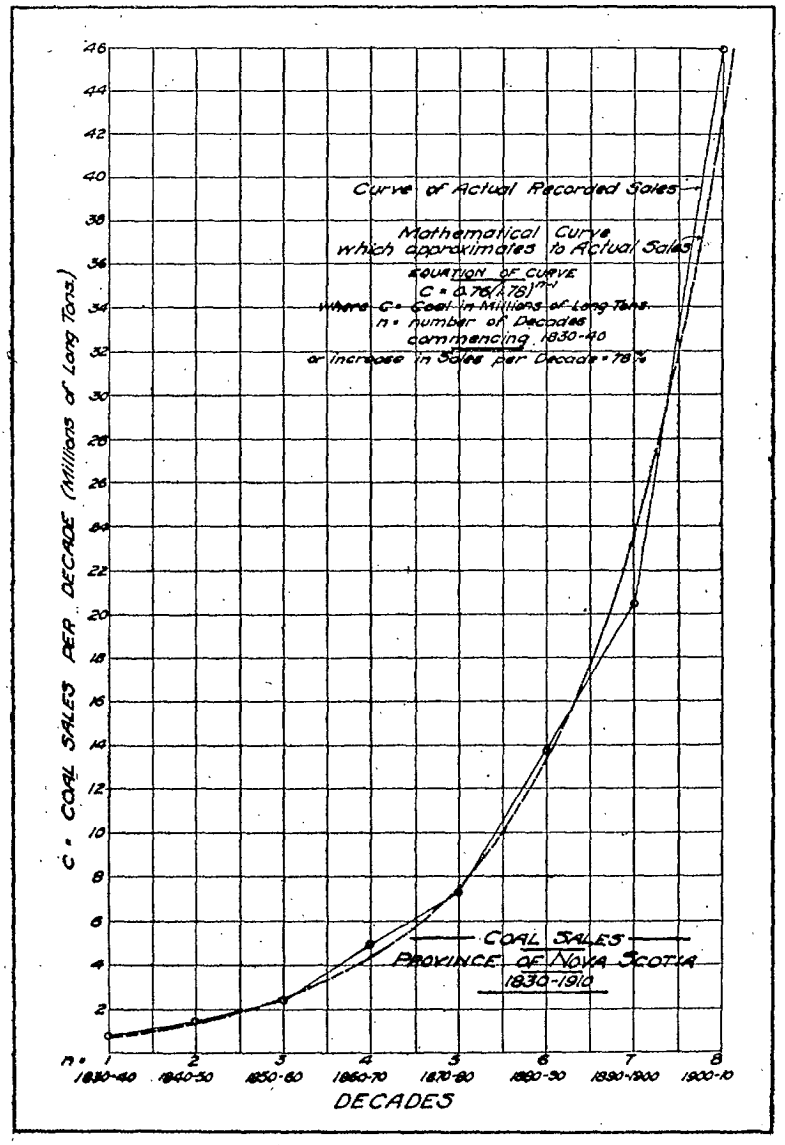


Fig. 1—Actual recorded sales.

Production of the Coal Companies of Nova Scotia

	Fiscal Years 1913 Long tons	1915 Long tons
Dominion Coal Company	5,111,546	4,728,359
Nova Scotia Steel & Coal Co	811,434	576,381
Acadia Coal Company	509,376	324,479
Inverness Railway & Coal Co	284,274	233,259
Intercolonial Coal Mining Co	194,207	189,818
Maritime Coal Ry. & Power Co	169,891	160,483
Minudie Coal Company	63,327	82,056
Colonial Mining Company	57,707	57,208
Sydney Coal Company	5,437	5,375
Various small companies	2,714	22,054
	7,203,913	6,379,463

There is keen competition in the Montreal market between the coal sent from Nova Scotia and coal imported from the United States. The Canadian product is protected by an import tariff of 53 cents per ton of 2,000 lbs. on bituminous round coal, and 14 cents per ton of 2,000 lbs. on slack coal. Anthracite is admitted duty free.

Although United States coal must be carried long distances before it can be sold in Montreal, the cost of transportation is lessened by the opportunity the exportation of coal from Pennsylvania to Canada gives for utilizing the cars that carry iron ore from the Michigan and Lake Superior iron ranges to the great steel works of Pittsburgh and its vicinity. Coal exported from the United States over the Canadian border provides an outward freight for cars that would otherwise be hauled northwards empty, and enables an extremely low freight rate to be quoted for the long rail haul from the United States coal regions to the shores of the Great Lakes. From such points as Cleveland and Ashtabula the transportation of coal to Montreal can be cheaply effected by water. The bituminous coal-fields of Pennsylvania and West Virginia present ideal conditions for cheap extraction, and possibly nowhere in the world, where markets are available, can coal be mined at such little cost. The cost of mining coal in Nova Scotia must always be considerably greater than the cost in the United States fields with which the Canadian product comes into competition.

These considerations explain the necessity for the protective duties imposed on bituminous coal imported into Canada.

Up to 1913 the United States imposed a duty of 67 cents per ton of 2,000 lbs. on round coal, and 15 cents per ton on slack or culm coal from Canada, but since 1913 Canadian coal has been admitted into the United States, duty free. As the coal production of the United States now exceeds 600,000,000 tons yearly, and is annually increasing at a very rapid rate, and as the importation of Nova Scotian coal into the United States has not exceeded half a million tons per annum during the past ten years, it must be conceded the competition of Nova Scotia coal in the United States is not a factor of importance to the American coal operators. As a compensating factor, the importation of United States coal into Canada was in 1914,

14,721,057 tons, and in 1915, 12,465,902 tons. The normal importation of United States coal will average 15,000,000 tons annually.

The total estimated coal reserve of Nova Scotia, according to the recently published calculation of the Geological Survey, represents 9,719 million tons of coal, out of a total reserve for Canada of 1,234,269 million tons, or less than one per cent.

Compared with the enormous reserves of Alberta, Saskatchewan, and British Columbia, the reserves of Nova Scotia are meagre, but the excellent quality of the Nova Scotia deposits, their remoteness from other coal-fields, their accessibility, combined with their nearness to the sea-board and to important centres of population, will, for many years to come, retain Nova Scotia in its hitherto unchallenged position as the chief coal-producing province of the Dominion, although, eventually, it may be anticipated that Alberta will overtake Nova Scotia.

The combined production of Nova Scotia and New Brunswick, compared with the total Canadian coal output for the past three years, was as follows:—

	1913	1914	1915
Nova Scotia	7,980,073*	7,370,924	7,429,888
New Brunswick	70,311	98,049	122,422
	8,050,384	7,468,973	7,552,310
Total Canadian output	15,012,178	13,637,529	13,209,371
Percentage of production from eastern Canada	53%	55%	57%

* Short tons.

The foregoing table would seem to indicate a steady increase in the percentage of Canadian coal production to the credit of the Maritime Provinces; but this tendency is merely temporary, and has been occasioned by the trade depression in western Canada, and the relatively prosperous condition of eastern Canada when compared with the west, since the commencement of the war. When normal conditions again prevail in western Canada, an opposite tendency will manifest itself.

The main outlet for Nova Scotian coal, and more particularly for the production of Cape Breton island, is the St. Lawrence market. As this trade has been developed and rendered possible by inexpensive water-freights, the coal is, of course, exclusively water borne. The St. Lawrence river is usually closed to navigation by ice from the end of November until the beginning of May. Of late years it has been found possible to lengthen the open season by the use of ice-breaking steamers, and there is no doubt that much can be achieved in this direction. These experiments have been temporarily interfered with by the sending of all the ice-breakers that could be spared to do similar work in the approaches to the port of Archangel.

These limiting climatic conditions make it necessary to send coal up the St. Lawrence river during the summer in quantity sufficient to cover the entire requirements of the market for the whole year. Similarly, the cessation of water shipments up the St. Lawrence during the winter; the disproportionately large shipments required during the summer; and the necessity of keeping the working organization of the mines intact during

the winter months, compel the coal companies to store large quantities of coal at the mines in the winter, notwithstanding the "balance-wheel" provided by the consumption of the steel works. Thus there has been evolved an unusual and very specialized trade, which has required a large initial capital expenditure, and necessitates the handling of enormous quantities of coal, in a minimum time, with the provision of correspondingly large financial reserves to carry the expenditure on the winter stocking operations, until payment is received for the coal delivered during the summer months.

The Dominion Coal Company and the Nova Scotia Steel & Coal Company are the largest individual coal shippers in Nova Scotia. In the summer of 1913 these two companies shipped to St. Lawrence ports about $2\frac{1}{4}$ million tons of coal, and this figure has not since been exceeded.

The steamers used in the coal carrying trade are specially built for the purpose. They have large unobstructed holds. The hatch openings are unusually large, and a sufficient number of steam operated derricks are provided to enable these to be quickly removed or replaced. Specially large provision of water ballast is made, as the return journey from Montreal has to be made with empty holds. The ordinary vessel in this trade has a cargo capacity of about 8,000 tons, but vessels of recent construction have cargo capacity of between 11,000 and 12,000 tons, and a speed of up to 12 knots.

The transportation of the large quantity of coal handled during the six months of open navigation requires a continuous procession of steamers coming and going between Sydney and Montreal throughout the whole season, and work at the loading piers and discharging plants must proceed without intermission day and night. The tonnage engaged in coal freighting in the St. Lawrence, largely exceeds all other shipping tonnage using this route. The "colliers" have been largely requisitioned by the Admiralty for war purposes, because their special construction and large carrying capacity have rendered them especially valuable for the requirements of the Admiralty, with consequent temporary derangement of the coal freighting business.

The most extensive storage yet undertaken was in the winter months of 1913–1914, when 650,000 tons of coal were "banked" by the Dominion Coal Company at their Glace Bay mines, The coal is lifted in the summer by steam shovels, re-screened and shipped. There has never yet been an actual fire in the round coal banks, although the first coal banked out must remain in the centre of the pile for over six months before it is lifted. Heating sometimes takes place, but with proper methods this can be speedily checked and dissipated. The temperature of the air at the actual time of banking is an important consideration, as generally speaking the banked coal seems to remain at about the same temperature as that which it had when placed in the bank. The bulk of the coal placed on the ground is, of course, put there in cold or freezing weather. If a thermometer is lowered down a pipe into the interior of the bank it will usually register a temperature

near to the freezing point, a fact that it is interesting to observe on a hot summer day, when the surface of the banked coal is quite warm to the hand. The coal is banked up to a height of from 40 to 46 feet, and over 300,000 tons has been stored in a continuous pile.

The cars used in taking the coal from the mines to the loading piers are mostly 50 ton steel hoppers—taking a load of about 35 long tons, and fitted with bottom doors for discharging. At the piers the coal is lowered into hoppered bins, discharging into long metal chutes, descending into the holds of the vessels loading. Coal is shipped in this manner very quickly, the loading of a 7,000 ton steamer occupying only five hours. At the discharging plants in Montreal, Quebec, Halifax, and St. John, N.B., the coal is lifted out of the holds by huge "clams" or grab-buckets, suspended from discharging towers, and is either loaded into railway cars for immediate disposal, or is stored in piles for winter distribution.

From the standpoint of the investor, the operation of coal mines in Nova Scotia in the past has not been encouraging. Some of the coal companies, during prosperous times, and in the earlier and less expensive operation of their collieries, paid regular and handsome dividends over many years.

In very few instances, however, in the history of coalmining companies in Nova Scotia has there been any likelihood of a redemption of the original capital outlay, and a very moderate interest return is all the investor has been able to hope for. The majority of the companies now operating have been compelled to undergo financial reorganization. Several companies have suffered complete financial disaster, in some cases brought about by physical conditions beyond control, and in other cases by unskilful management, or the unjustifiable optimism of promoters.

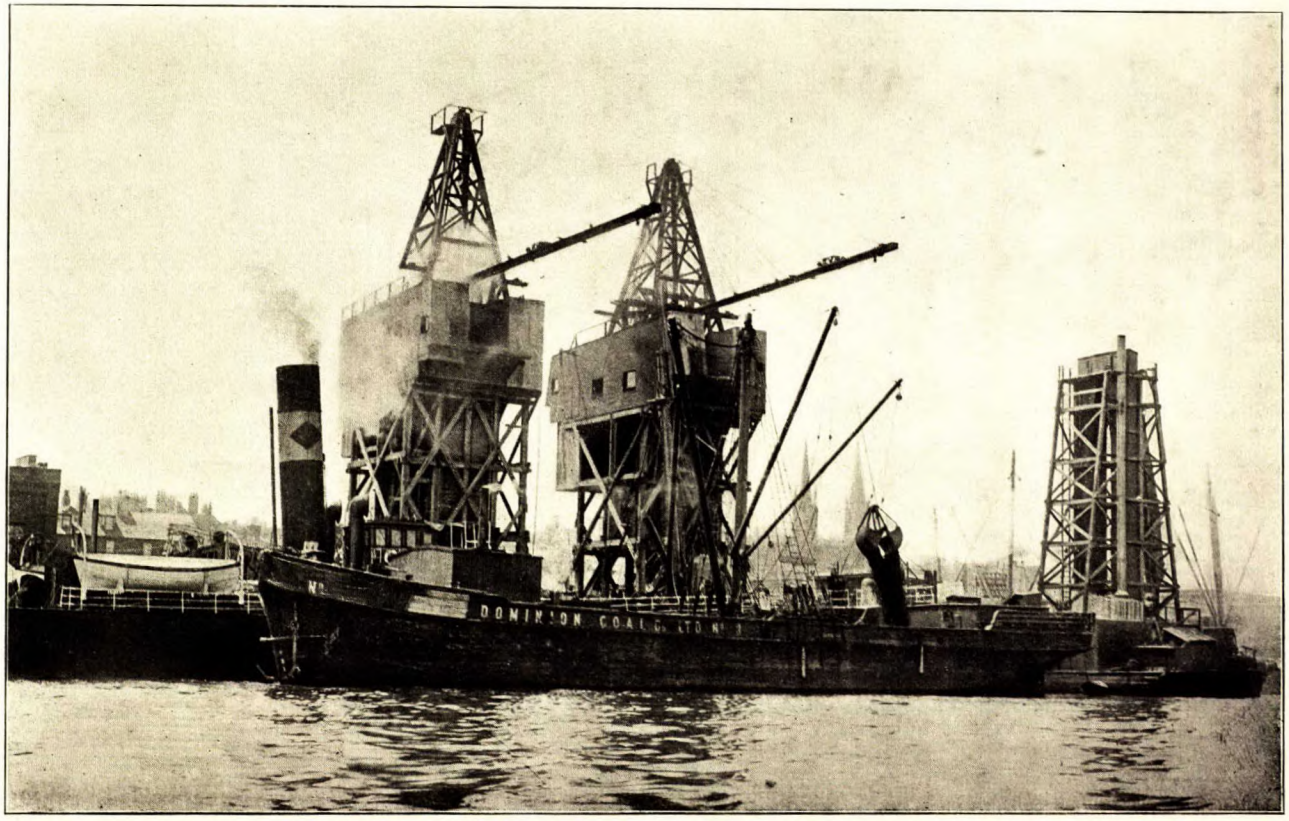
Generally speaking, however, the mines of Nova Scotia have been well managed from an engineering point of view, and the meagre financial return in the past has been due to alterations in the fiscal policies of Canada and the United States, resulting in temporary disorganization of markets, to the remoteness of the principal markets, the interference, or stoppage, of coast-wise shipments by ice in the winter, and the comparatively low selling price of coal in eastern Canada.

Within the past twenty years the price of coal has varied very little, it being one of the few commodities that has not materially increased in selling value.

It is doubtful whether the market for Nova Scotian coal has ever yielded the operators a greater price than $2.50 per ton at the pit mouth, and the average price realized, after allowing for waste and slack coal, is very much less than this figure. A comparison with normal European pit mouth selling prices will show how moderate this figure is, if due consideration is accorded to the higher cost of labour and materials in Canada.

The margin of profit has been too small to permit of the accumulation of proper reserves to provide against the troubles inseparable from mining coal, or to allow of adequate depreciation reserves for the amortization of

Winter stock pile at No. 21 Colliery, Birch Grove: Dominion Coal Company.



Coal discharging plant at Halifax: showing elevator barge for bunkering steamers, with discharging towers and barge—Dominion Coal Company. (There are three towers, but only two are shown in the picture).

capital liabilities and the depletion of coal areas. Therefore, periods of financial depression or mining accidents, have too often forced the abandonment of mining operations, and have involved investors in losses.

The formation of the Dominion Coal Company was an evolution from these conditions, and whether it be a retrograde tendency or not, the logic of events has indicated the chief hope of settled prosperity in the Nova Scotian coal trade to lie in the further development of strong corporations, with adequate financial reserves. There is no reason to anticipate anything but a long and successful career for the coal companies of the Province if these essential qualifications are given the consideration they deserve.

Whatever financial stability attaches to the coal companies of Nova Scotia to-day, is a testamentary benefit conferred by the General Mining Association; a monopoly that, with all its faults, rendered it possible to conceive mining operations on a comprehensive basis, eliminated suicidal competition in selling prices; and enabled mine workings to be laid out with the maximum of economy, with due regard to the conservation of the vast coal reserves which sporadic individual operations have tended to endanger by uncoördinated effort.

The price of coal in eastern Canada has always been dependent on the selling prices in the United States, but it is candidly admitted, to-day, that coal has in the past been mined in the United States, and sold there and in Canada, at a price actually below the cost of production, when all the factors of that cost are taken into consideration.

SUBSIDIARY INDUSTRIES.

Nova Scotia, as a province, has not reached the stage of industrial and manufacturing activity that should have accompanied a coal mining industry 100 years old; an industry that up to 1890 produced three-fourths of the coal mined in Canada, and, to-day, notwithstanding the vast coal resources of the west, is producing well over half the coal tonnage of Canada.

A perusal of the pages of Dawson, Haliburton, and other great Nova Scotians, reveals a tremendous optimism concerning the commercial possibilities of Nova Scotia; and even, to-day, it is not easy to find any flaw in the reasoning of these far-sighted men. Yet it must be confessed the potentialities of Nova Scotia have been but meagerly realized. Take away the steel industry from Nova Scotia, and what other manufacturing activity has the Province to show as a reflex of the production of 7,000,000 tons of coal annually?

In the progressive communities of New Glasgow, Truro, and Amherst, there exists the nucleus of manufactories, textile, wood-working, and leather trades, but how poorly they compare with the industries of Montreal and Toronto.

The coal mined in Nova Scotia has, for generations, gone to provide the driving power for the industries of New England, Quebec, and Ontario, and has, in large part, been followed by the youth and energy of the Province. For almost a century, Nova Scotia has been exporting the raw material that

lies at the base of all modern industry, and it is at least a legitimate subject for thought whether it would not have been possible to export manufactured articles, and to have utilized the raw material within the Province, to some extent at least, where safe and roomy harbours, and inexpensive water transportation give facilities for the assemblage of raw materials, and for the distribution of manufactured goods, in no way inferior to the other ports that border the North Atlantic coast.

What combination of physical and political causes has brought about this condition of affairs cannot here be dealt with, but no consideration of the economic aspects of the coal industry of Nova Scotia would be just which did not point out the fact that the coal districts of Nova Scotia have not evinced the manufacturing enterprise that is a commonplace feature of coal-fields situated in civilized countries, as for example, Pennsylvania, the British Midlands, Westphalia, Silesia, and Belgium.

Briefly, Nova Scotia has achieved the status of a mining camp, whereas its full stature should be that of a metropolis of industry.

CAPE BRETON ISLAND

Cape Breton island contains the most important coal-fields of eastern Canada.

The production of coal during the past three years compares with the total Canadian production, and with the production of Nova Scotia, as follows:—

	1913	1914	1915
Output of Cape Breton Island.....	6,631,677	6,055,668	6,198,080
Percentage of total Canadian production.....	44·2%	44·4%	47 %
Percentage of total Nova Scotian production..	81·5%	81·5%	83·5%

The Carboniferous deposits of Cape Breton island appear to have been deposited on the side of Pre-Cambrian hills, filling in the ancient hollows and sinuosities, and forming a fringe of Carboniferous rocks around a central boss of older formations. The newer rocks have undergone very little alteration in inclination or continuity since their deposition, except for the lateral corrugations mentioned later, and there has been no volcanic action.

The low mountain ranges of Cape Breton island, although very rugged and picturesque in their outlines, do not attain a height greater than 1,200 feet. In many places the mountain sides come down sheer to the edge of the sea, with deep water at the shore, showing that the present land surface and the adjoining submarine formations were formerly greatly elevated above the present sea-level.

The greater portion of the Carboniferous deposit is now submerged below the waters of the Atlantic and the Gulf of St. Lawrence. The formations remaining above sea-level suffered heavy denudation in the Glacial Period, and there is a constant encroachment of the sea, so that of the original vast coal deposits, there remains, to-day, but a series of detached synclinal basins, with their apices on land, dipping seaward, in fan-shaped extensions.

The erosion of the soft Carboniferous strata proceeds quite noticeably along the sea-coast. An ancient coast-line can be detected by soundings at various distances from the present coast-line, and the intervening submarine

areas have undoubtedly been encroached upon by the sea through the unceasing wave erosion of the coast.

From observations extending over thirty years, the late Mr. Richard Brown ascertained the wearing away of the cliffs in one locality to average five inches per year, an amount that later observations have established as being not less than the extent of the erosion. The shales and sandstones because of their horizontal bedding, are easily loosened by the winter frosts. In the spring, by the combined action of the thaw, and the scour of the drift ice, the faces of the cliffs are disintegrated into mounds of debris which form at the base of the cliffs, to be washed away by the first storm.

On the western side of the Island, in Inverness county, four separate coal-basins occur within a length of 45 miles along the shore. These are known respectively as the Port Hood, Mabou, Inverness, and Chimney Corner basins. They are separated, one from the other, by stretches of Lower Carboniferous rocks, and are presumably landward extensions of a coal-field now covered by the waters of the Gulf. Whether these detached basins merge into one continuous deposit under the sea is, of course, not known, but, if this should be the case, the fact would be of little economic importance, as, from the indications above water-level, the basins could not in any case merge together except at a distance too far out at sea to be workable. There is reason to believe the Chimney Corner basin is limited seaward.

The presence of Carboniferous rocks with associated thin-coal seams on the southwestern shore of St. George's bay opposite to the Port Hood coal-field on the northeastern edge of the bay is suggestive.

On the eastern side is the Sydney coal-field, because of the purity, accessibility, and wealth of its coal seams, and its proximity to good shipping harbours, probably the most valuable coal deposit in Canada.

The superficial area of the productive measures in the Sydney field is from 200 to 250 square miles. From the outcrop of the Millstone Grit at Mira bay, to the termination of the productive measures by the syenitic range of hills which forms the northern shore of the Great Bras d'Or lake, the field is about 32 miles in length, with a maximum inland width of seven miles.

The extent of the coal-field in its extension under the Atlantic can only be conjectured; but as suggested many years ago by Richard Brown, the land area is "probably the segment only of an immense basin, extending towards the coast of Newfoundland." Since Mr. Brown wrote this, the coal seams have been worked under the sea for distances up to three miles from shore, but his conjecture cannot be improved upon, and it seems probable the future possibilities of this submarine coal-field will be limited rather by the difficulties attendant upon the extraction of coal at long distances from high-water mark than by the failure of the coal seams.

The main basin of the Sydney field is separated into subordinate basins by folds, or corrugations, running parallel to each other, and coinciding with arms of the sea, chief among these being the commodious harbour of Sydney. As in the case of the Inverness field, it is not known whether the subordinate basins are interrupted in their seaward extension, and there

are some grounds for surmising that the extent of the dislocation occasioned by the folds may in one or two instances be less pronounced as the coal seams dip seawards. This, however, can only be determined by future mining operations.

The four subordinate basins, beginning from the southeast, are known as the Morien basin; the Glace Bay basin; the Lingan-Victoria basin; and the Sydney Mines, or Bras d'Or basin. The correlation of the seams throughout the subordinate basins is fairly well understood, but it is not established with absolute certainty. So far, this matter of correlation has been more of academic interest than of commercial importance, as the physical characteristics and quality of the coal seams change considerably even in the same subordinate basin.

The field offers good scope for the study of the fossil horizons, as some of the measures adjoining the coal seams are rich in distinctive fossils; and there can be little doubt that a systematic study of the fossils, particularly of the fauna in the several divisions of the main coal-field, would definitely establish the correlation of the seams and thereby decide a matter that in the past has been a fruitful source of controversy.

The most profitable section of the productive Measures is found in the Lingan-Victoria basin, which contains the higher seams that in the basins to the eastward have been eroded or have their outcrops under the sea.

The following ideal section is given as typical of the field, but must not be taken as referring to any particular location. It is a characteristic of the Sydney coal-field that while the coal seams themselves are very persistent in their horizons, the separating strata are apt to change in thickness. In one or two instances the coal seams are divided by the gradual thickening of an included dirt band, from a few inches to many feet. Sometimes, the seams come together again, the included dirt band being lens-shaped. In other instances the seams become permanently divided.

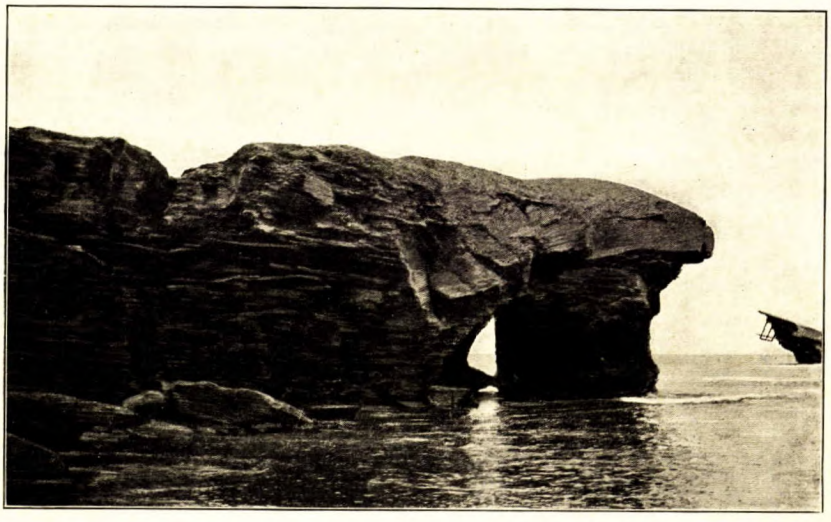
Typical Ideal Section of Productive Coal Measures in the Lingan-Victoria Basin of the Sydney Coal-field.

Local Name of Seam		Thickness of Measures Feet Inches	Total Depth Feet
Carr seam	3′—0″	3—0	
Strata		170—0	
McNeill seam	3′—5″	3—5	176
Strata		341—0	
Barachois seam	6′—0″	6—0	523
Strata		55—0	
Dunphy seam	3′—0″	3—0	581
Strata		306—0	
Victoria seam	7′—0″	7—0	894
Strata		257—0	
Fairy House seam	3′—5″	3—5	1,154
Strata		66—0	
Northern Head seam	5′—0″	5—0	1,225
Strata		113—0	
Lingan seam	8′—0″	8—0	1,346
Strata		134—0	
Emery seam	2′—8″	2—8	1,483
Strata		1,000—0?	
Mullins seam	6′—0″	6—0	2,489

PLATE IV

Sandstone spur near Table Head, Glace Bay: photographed in 1900.

PLATE V



Sandstone spur near Table Head, Glace Bay: photographed about eight years later—showing effect of erosion. At the present time the cliff is perforated with two holes.

Up to the present time, mining operations in the Sydney coal-field have been chiefly confined to the thicker and more accessible seams, but as these have been worked more or less continuously for sixty years, the land areas are becoming exhausted, and the extraction of the thinner seams, and workings in the submarine areas are becoming general.

An ideal section of the measures taken at the shaft of the Hub colliery of the Dominion Coal Company, in the centre of the Glace Bay basin, and close to the shore, would show at least seven workable seams, giving an aggregate thickness of 39 feet of coal in the comparatively shallow depth of 1,300 feet. It will be noticed that the individual seams are all separated one from the other by sufficient thicknesses of intervening strata to enable each seam to be mined without danger of interfering with the workings in other seams, provided that proper precautions are taken. This section is presumably the same as that which underlies the vast submarine areas of the Glace Bay basin.

The section of the Lingan-Victoria Measures—given in detail in the foregoing table—shows a similar wealth of workable seams, all of which, presumably continue into the submarine tract adjoining. Substantially the same section should be met with in the submarine portion of the Sydney Mines basin, although nothing is definitely known of the position or the nature of the disturbance that underlies the waters of Sydney harbour, and separates the Lingan-Victoria tract from the seams worked at Sydney Mines. In the Morien basin, fewer seams are contained in the submarine tract, as the erosion has here been more extensive, but the more important seams are all present.

Coal seams are found in Richmond county, Cape Breton, but they are of uncertain occurrence, and of inferior quality. Coal has, in the past, been mined intermittently, but without profitable results. The occurrence is not commercially important, except perhaps for local use.

Inland from the settlement of Big Pond on the East Bay of the Bras d'Or lake, and in the valley of Salmon river, a tributary of the Mira river, there is a detached synclinal basin of Carboniferous measures, evidently an outlier of the Sydney coal-field that has escaped erosion, containing small seams. At some future date it might pay to work this basin on a small scale to supply local needs, but at the present time the venture would not be profitable.

The presence of a strip of Carboniferous rocks along the shore of East bay, near Irish Cover, dipping under the lake suggests the possibility of coal under the Bras d'Or lake, which may some day prove worth detailed investigation.

Extensive mining operations in the Sydney coal-field have hitherto been confined to three, or at the outside, four seams in the several subordinate basins. There are a number of other seams as yet unworked. The seams are thinner than those hitherto mined, and of inferior quality by reason of dirt bands. Values, however, are usually comparative, and it is only because of the existence of the thicker and cleaner seams that the

smaller seams have up to now been disregarded. Seams much inferior in quality, and much thinner than the unworked seams of the Sydney field, are to-day being profitably mined and marketed in other parts of the world. When the time arrives, as it has already arrived in other coal-fields, that economic conditions permit of the mining of these smaller and virgin seams, they will be utilized.

OPERATING COAL COMPANIES

Following is a brief description of the operating coal companies in Cape Breton island:—

Dominion Coal Company.

This Company controls the whole of the land area of the Glace Bay and Lingan-Victoria basins, together with the adjacent submarine areas, which are for all practical purposes unlimited. It controls also the greater part of the land and submarine areas in the Morien basin, some extremely valuable submarine areas in the Sydney Mines basin, and has, in addition, a number of detached areas scattered throughout the Island of Cape Breton in advantageous positions. In addition to the Cape Breton properties, this Company controls and operates the Springhill Mines in Cumberland county, on the mainland of Nova Scotia; and the areas of the Cumberland Railway & Coal Company in the Morien basin, Cape Breton.

The Dominion Coal Company occupies a preponderating position among Canadian coal operators, producing in 1915, 42% of the coal output of Canada, and 75% of the output of Nova Scotia.

The Company has in full operation 17 collieries: 15 in Cape Breton, and 2 at Springhill. The production of the individual collieries in 1915, was as follows:—

	Colliery		Tons	Name of Seam
Glace Bay basin	1.	(Dominion)	493,949	Phalen.
	2.		784,345	"
	3.		36,770*	"
	4.	(Caledonia)	356,513	"
	5.	(Reserve)	146,542	"
	6.		273,692	"
	7.	(Hub)	199,122	Hub.
	8.	(International)	*	Harbour.
	9.		392,374	"
	10.	(Reserve)	154,567	Emery.
	11.		109,319	"
Lingan-Victoria basin	12.		370,930	Victoria.
	14.		413,374	"
	15.		288,536	Lingan.
	16.		304,423	"
	17.			Victoria.
Morien basin	21.	(Birch Grove)	93,683	Birch Grove.
	22.	" "	190,840	" "
Springhill mines	2.		266,533	
	3.		134,258	
			5,009,770	

* Denotes mines exhausted.

Glace Bay harbour: showing Dominion Coal Company's coal loading pier for schooner trade, also a portion of the stock of pit props.

No. 17 Colliery is the Old Victoria mine, which was closed down in 1897, and unwatered and rehabilitated in 1913. This mine was not working in 1916, owing to the shortage of miners, but it is sufficiently developed to produce up to 800 tons per day, whenever conditions will permit of its operation.

No. 3 Colliery was worked out and closed down in 1915. This mine was opened in 1899, and in its lifetime produced approximately four million tons of coal.

No. 8 Colliery was worked out and abandoned in 1914. The mine was opened in 1863, and in its long lifetime produced 5,400,000 tons of coal.

The most valuable seam in the Glace Bay basin is the Phalen seam, which, for this reason, has been most extensively worked. The land area is largely exhausted, one of the land mines, No. 3, as previously mentioned, having been closed down, and another, No. 5, is approaching exhaustion. The whole land area of the Phalen seam is underlaid by the Emery seam at a depth of about 160 feet. The workings of No. 10 Colliery on the Emery seam are situated beneath those of No. 5 Colliery mining the Phalen seam, and those of No. 11 Colliery are extracting the Emery seam where it lies under the exhausted Phalen workings of No. 3 Colliery. In both cases the plant and houses erected in connexion with the Phalen seam are being utilized for the Emery seam, and the same procedure is possible, and will no doubt eventually be followed in the case of Mines Nos. 1, 2, 4, and 6, now operating on the Phalen seam, whenever the time for this shall arive.

Underneath the Emery seam there are known to be at least three workable seams of good quality, none of which have been more than touched by crop openings, so that the potentialities of the land area are very great. In the submarine tracts all the seams are present, and have been so little worked that they may be properly regarded as virgin areas, with the possible exception of the workings on the Hub seam, the topmost seam of the series.

The output capacity of the mines now being operated by the Dominion Coal Company, on single shift, and exclusive of the Springhill Collieries, and allowing for the usual winter conditions is $5\frac{1}{4}$ million tons per year. This tonnage can of course be increased to any desired quantity by the development of new collieries.

The Dominion Coal Company owns and operates the Sydney & Louisburg railway in Cape Breton, and the Cumberland railway in Cape Breton county. It has extensive machine shops, locomotive repair shops, foundries, coalwasher, etc. It owns a chain of retail stores for the sale of goods to workmen, and has found it necessary to provide very extensive housing accommodation for its workpeople.

In addition to the property at the mines and the loading ports of Sydney, Louisburg, Glace Bay, and Morien, the Company owns extensive modern discharging plants at Montreal, Three Rivers, Quebec, Halifax, and St. John, N.B.

The geographical position of the mines, the climatic conditions, and other special features of the industry already explained, have combined to make the Dominion Coal Company almost as much a transportation company as a coal mining concern, and a larger expenditure has been necessary on transportation facilities than is usual in coal mining operations.

The Dominion Coal Company is a main subsidiary of the Dominion Steel Corporation, hence a large portion of the output of the mines is used in the works of the Dominion Iron & Steel Company at Sydney, where 650 by-product coke ovens are usually in full operation.

The employees number over 13,000 persons; and, approximately, 12,000 persons—workmen of the Company and their families—are housed at the mines, in dwellings erected and owned by the Company.

Nova Scotia Steel and Coal Company.

This Company controls the major part of the land areas in the Sydney Mines, or Bras d'Or basin, and a portion of the adjacent submarine areas, together with some outlying submarine leases in the Lingan-Victoria and the Glace Bay basins.

The Nova Scotia Steel & Coal Company is the direct successor of the General Mining Association, and some of the original erections of this pioneer Company are still to be seen at Sydney Mines.

The Company owns five operating collieries, producing between 800,000 and 900,000 tons annually.

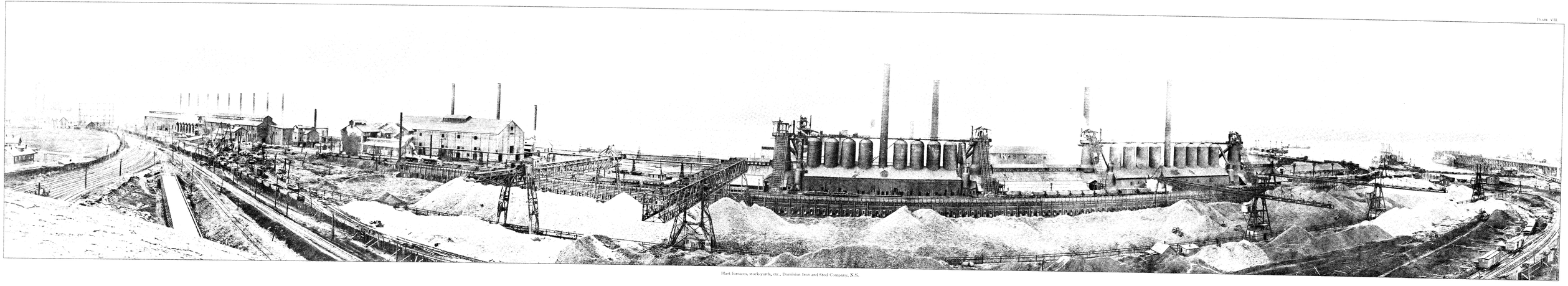
The production of the individual collieries in 1915 was as follows:—

Mine	Tons raised	Seam
Princess	156,185	Main Seam
Florence	180,350	" "
Scotia	127,602	" "
Queen	97,785	" "
Lloyds	50,001	Lloyds Seam
	611,923 tons	

The Company owns and operates its own railway. Like all other Cape Breton coal companies, it has incurred large expenditure on housing accommodation for its workmen.

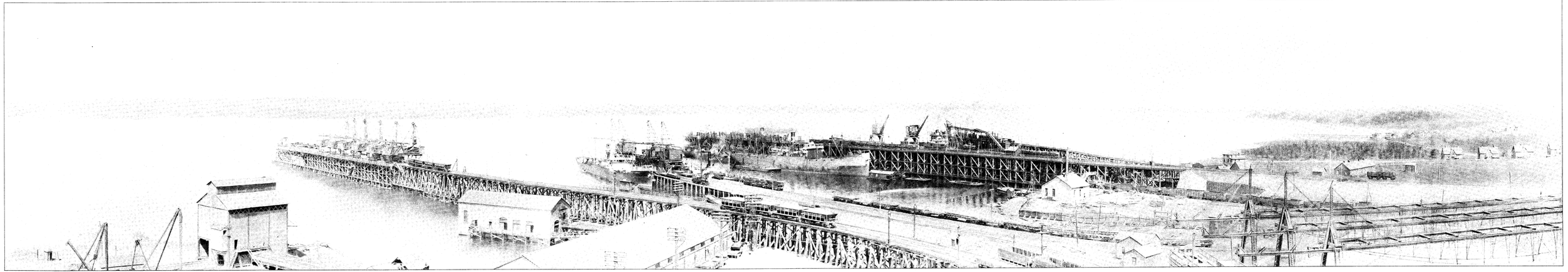
The loading piers are situated at North Sydney, and the Company has modern discharging plants at Quebec and Montreal. The employees at the mines number about 2,200 persons, of whom, approximately, 600 persons—workmen of the Company, and their families—are housed in dwellings at the mines owned by the Company. A large proportion of the workmen of this Company own their own houses, in which they have been assisted by money loans at moderate interest from the Company.

As in the case of the Dominion Collieries, a large proportion of the Nova Scotia Company's output is used in the steel works at Sydney Mines, and at the works at Trenton, near New Glasgow—both the property of this Company.



Blast furnaces, stock-yards, etc., Dominion Iron and Steel Company, N.S.

Typical colliery village, showing workmen's dwellings, at No. 17 Colliery, Dominion Coal Company, Sydney, N.S.



Loading piers of Dominion Steel Corporation, at Sydney harbour, N.S.

Inverness Railway and Coal Company.

This Company is controlled by the Canadian Northern Railway Company, and operates a coal property, chiefly submarine, near the town of Inverness, in Inverness county. The only seam worked at present is one seven feet thick, with a dip varying from 15 to 50 degrees. It is proposed, eventually, to win the overlying thirteen-foot seam.

The Company owns and operates the Inverness railway, running from Inverness to the shipping piers at Port Hastings, on the Strait of Canso, a distance of 56 miles, and connecting with the Canadian Government railway at Point Tupper, a distance from Inverness of 62 miles. The employees number about 800 persons, and the Company owns dwellings accommodating 1,500 persons.

In addition to the three main companies mentioned, two small companies are working on the outcrop of the Sydney Mines basin, namely the Sydney Coal Company and the Colonial Coal Company. The production of these companies will not exceed 50,000 tons per year.

In Inverness county the slope mines of the Port Hood & Richmond Company, and the Mabou Coal Company, have been flooded by water from the sea, and are not now working.

The Cape Breton Coal, Iron, & Railway Company controls a land area, containing the lower seams, situated on the fringe of the Morien basin, near the crop of the barren measures. This Company, promoted by English capital, has been unfortunate financially, and the mine is not in operation at the present time.

NOVA SCOTIA MAINLAND

There are two principal coal-fields on the mainland of Nova Scotia, namely, the Cumberland and the Pictou fields.

CUMBERLAND FIELD.

This field is evidently a continuation of the Carboniferous Measures of New Brunswick, but containing the higher and productive beds which, in New Brunswick, are not present. It is bounded on the west by Chignecto bay, the northwestern arm of the Bay of Fundy.

Areas in which the Coal Measures are exposed, and from which coal is being produced, are the Joggins area on the north, and the Springhill area on the south; separated by the Athol fault. It is thought the Joggins area represents the northern limb of a syncline, the Springhill area being the continuation of the Measures of the northern area, brought upwards by a deformation of the syncline.

The Cumberland field is very involved, and much faulted, and because of the presence of formations younger than the Carboniferous, it affords more possibilities of concealed coal-fields than any other part of Nova Scotia.

The tract of country bordered by Chignecto bay on the west, having the Joggins mines at one extremity and the mouth of Apple river at the other, bounded by the Cobequid hills on the east, running from Apple river to

Halfway river, thence to the Springhill mines and back to Joggins mines, is blanketed by newer formations. These may be unconformably laid on the lower and barren Measures of the Lower Carboniferous; but the researches of the late Hugh Fletcher, of the Geological Survey, lead to the inference of a concealed extension of the Coal Measures containing the horizon of the Joggins main seam, in which case the bounds of the Cumberland coal-field would be very largely extended, although the coal seams, if present, may lie at a great depth. Systematic diamond-drill boring should disclose the facts.[1]

The Maritime Coal Railway & Power Company is the principal operator in the Joggins Field. The output of this Company in 1916 will be about 200,000 tons, and about 500 men are employed.

The Minudie Coal Company operate slope mines near River Hebert. The output in 1915 was 86,000 tons and about 300 men are normally employed.

The Joggins main seam, averaging six feet in thickness, is the most important one in this district, although there are several other seams.

There are a number of unimportant small collieries in this field, most of which are not now worked. Coal mining in the district has not proved altogether profitable, and in several cases large sums of money have been spent on colliery equipment without much justification. Like most districts in which thin-coal seams are numerous, a good many prospects have been opened up in the unwarranted hope that the seams would increase in thickness, and much money has been thereby wasted.

The Springhill area is controlled by the Dominion Coal Company, which took over the operations of the Cumberland Coal & Railway Company in 1911. The Springhill Mines are amongst the oldest in Nova Scotia. The areas now worked were acquired from the General Mining Association in 1872 by the Springhill Mining Company, and coal was first produced by this Company in 1873. Mining operations have been continuously prosecuted here since that time. Two slopes are now working, extracting coal from three seams. The workings are extensive, as would naturally be the case in mines of such long development.

The seams are highly inclined, in some places approaching the vertical. The section disclosed by the workings is as follows:—

	Coal	Measures
North seam	13′—0″	13′—0″
Measures		105′—0″
Coal	5′—0″	5′—0″
Measures		130′—0″
Coal	2′—4″	2′—4″
Measures		185′—0″
Main seam	11′—0″	11′—0″
Measures		80′—0″
Back seam	11′—0″	11′—0″
Measures		100′—0″
Coal	4′—0″	4′—0″
Measures		176′—0″
Coal	2′—0″	2′—9″

[1] A borehole near Newville, at Halfway River lake, on the railway from Springhill to Parrsboro' encountered coal at a depth of 2,350 feet, said to have been nine feet thick. The boring was discontinued at a depth of 2,359 feet. (See Trans. N. S. Inst. Sci., Vol. xi, part 3, 1904–1905. Presidential speech by H. S. Poole.)

At least two of the seams, other than the three now being worked, should be mineable at some future date.

The Springhill seams are gaseous, and like the Pictou seams, are subject to spontaneous combustion in the wastes. No explosives are used in these collieries.

The Springhill collieries are situated on an elevation 600 feet above sea-level, and are farther inland than any of the other Nova Scotian coal mines. The output in 1915 was 400,000 tons. The number of employees is normally 1,400 men, including the workmen employed on the Cumberland railway. This railway runs from Springhill to Parrsboro, on Minas basin, where the Company has a loading pier, and facilities for loading coal into vessels.

This Company also controls extensive timber areas, from which pit timber is obtained. About 750 persons are housed in the Company's dwellings.

In the highly inclined and troubled seams of the Springhill area, the choice of sites for new winnings is a more difficult and also more hazardous matter than is the case in the Glace Bay areas controlled by the Dominion Coal Company; but there is no doubt the Springhill areas will permit of new winnings, either by working the untouched seams to the existing slopes and bankheads, or by entirely new collieries. The heavy capital expenditure that would be entailed by the development of new collieries in this area could only be justified by a heavy demand for coal at a good selling price.

PICTOU COAL-FIELD.

The known workable extent of the Pictou coal-field is comprised within an area 11 miles long, by $2\frac{1}{2}$ miles wide.

The field is usually divided into three main districts; namely, the Westville, Albion, and Vale divisions. The Westville area lies at the western extremity, and is shown on the Geological Survey maps as being separated from the Albion area, in the centre of the field, by a fault, variously estimated at from 1,600 to 2,600 feet.

The Vale area occupies the eastern end of the field, and is separated from the Albion area by a faulted and apparently barren territory.

The whole of the productive area has an extremely complicated and variable structure, and although the seams found in the three main divisions possess certain resemblances, no definite correlation has, as yet, been found possible.

Sir W. E. Logan, in 1869, described the structure of the Pictou coal-field as having "a very complicated character." Later explorations have served to confirm and to emphasize this early opinion.

The number and thickness of the coal seams; the great thickness of associated carbonaceous and oily shales; the gaseous and fiery nature of both the coal and the shale beds, combined with the variable and faulted nature of the strata, all occurring in a small superficial area, mark out the Pictou coal-field as one of the most interesting carboniferous deposits known.

The exact relation of the Westville measures to the Albion measures is, as yet, a matter of conjecture. The four known coal seams of the Westville area dip in, approximately, the same direction and at about the same inclination as the seams in the Albion area. The surface measurement between the roughly parallel crops of the two series of coal seams averages about two miles, diminished to one mile where the crops come nearest together.

The existence and size of the McCulloch fault seems to have been presumed from surface indications, and from a belief that the Main or Ford seam of the Albion area was identical with the Main or Acadia seam of the Westville area, worked at the Drummond and the Acadia Collieries. No proof of the identity of these two seams has been given beyond the similarity of the carbonaceous shales immediately overlying them. A great depth of barren shales overlies the Main seam in the Albion area, (see section on page 26), including one small coal seam found at from 330 to 350 feet above the seam, and no coal seams have been discovered in similar shales overlying the Drummond and Acadia workings; a fact that seems to strengthen the supposition that the Main (Albion) seam and the Acadia (Westville) seam are the same. It does not anywhere appear, however, that the measures overlying the Acadia seam have ever been *thoroughly* explored by borings, and until this has been done, the non-existence of coal seams overlying the Acadia seam, between the outcrop of this seam and the assumed line of the McCulloch fault, cannot be said to have been definitely established.

The workings of the Acadia colliery were carried to a point that approached within 700 feet of horizontal distance to workings in the Cage Pit seam in the Albion area. The difference in elevation did not permit of correlation between the Acadia (Westville) seam and the Main (Albion) seam, if a fault of 2,600 feet displacement were presumed to exist, while the horizontal distance certainly seems very small to include a fault of such magnitude, which, if it exists at all, must have a very flat hade.

The assumed position of the McCulloch fault on Mr. H. S. Poole's map of 1893 was shown one-fourth mile to the eastward of the position assumed on Logan's map of 1869. The map, as revised by Mr. Poole in 1903, showed the fault moved still farther eastward by one-eighth mile, and since that date the workings of the Drummond mine have proved the coal seams to be uninterrupted, except by minor down-throw faults, to a point that lies eastward of the assumed surface position of the fault in 1893, by a further one-fourth mile.

If the McCulloch fault exists as a reverse fault, the Westville Measures being thrown down and the Albion Measures thrown upwards, it would be quite possible that the Westville seams could continue eastward some distance beyond the surface trace of the fault, the hade of which is of course quite unknown.

The workings of the Drummond and Acadia collieries were, unfortunately, both interrupted at a point sufficiently advanced to the westward

to throw grave doubt on the existence of the McCulloch fault, but in neither case can it be said that the existence of the fault has been disproved.

Access to the lower portion of the Drummond workings on the Acadia seam is now precluded by the underground fire that occurred in 1915. At some future date the remaining coal in the deep workings may be won by drifting upwards from the underlying seam, but this, in the natural course of events, may be twenty or thirty years hence, so that the proving of the McCulloch fault, by underground workings, is not an immediate possibility. It might be proven by boring in the direction of the Acadia seam from the workings in the McGregor seam on the Albion side.

The existence, or non-existence, of the McCulloch fault, has, however, a most important bearing on the future of the Pictou coal-field. If the Albion and Westville areas were originally a continuous deposit, subsequently fractured by the McCulloch fault, then, whether the Main or Acadia seams be correlated or not, presumably the Albion series are repeated in the Westville block. Presuming that the McCulloch fault exists, a borehole suitably placed in the Westville area should disclose the presence of additional seams there.

If the McCulloch fault does not exist, then presumably the Westville series continues conformably beneath the Albion series; an assumption that would place the Acadia seam at a depth of 10,000 feet at the Allan shafts in the Albion area. The importance that would attach to the presence of seams *above* the Acadia seam, is thus very great.

Valuable information should be obtainable by boring on the Westville block. A borehole just inside the crop of the Acadia seam, and another over the lowest workings in the Drummond mine would give a complete section of the strata column overlying and underlying the Acadia seam, and would render material assistance in the correlation of the seams in the two main divisions.

The following section of the Albion Measures is condensed from Logan & Hartley's Report of 1869, and for comparison, is given the section below the McGregor seam, as determined by recent diamond-drill borings carried out by the Acadia Coal Company, of which particulars have been supplied through the courtesy of Mr. F. E. Notebaert, the Chief Mining Engineer of the Acadia Coal Company.

It will be noted that Mr. Hartley's section contains sixteen coal seams, if the concealed seams below the McGregor be included. The recent boring has disclosed nine seams below the McGregor, or sixteen seams in all.

Considering the early date of Mr. Hartley's section, and that the particulars given of the seams lying below the Stellar or Oil-Coal were gathered from surface observation of the coal outcrops, it will be seen that the more exact information available to-day from diamond drill records bears eloquent testimony to the careful and painstaking work of the early geological workers in this field.

Section of the Productive Measures in the Albion Area.

(Condensed from Hartley's Section, 1867–9)

	Coal	Measures
Three-and-a-half foot seam	3′—6″	3′—6″
Measures		1,128′—7″
Main seam	34′—7″	34′—7″
Measures		148′—1″
Deep seam	22′–11″	22′–11″
Measures		106′—8″
Third seam	5′—7″	5′—7″
Measures		113′—0″
Purvis seam	2′—8″	2′—8″
Measures		130′—0″
Fleming seam	3′—3″	3′—3″
Measures		4′—3″
McGregor seam	11′—7″	11′—7″
Measures, said to contain an impure coal seam of considerable thickness		186′—0″
Measures		25′—7″
Stellar seam (or Oil-coal)	5′—0″	5′—0″
Measures		15′—2″
Coal—seam "A"	11′—0″	11′—0″
Measures		110′—6″
Coal—seam "B"	2′—0″	2′—0″
Measures		75′—0″
Coal—seam "C"	10′—0″	10′—0″
Measures		58′—0″
Coal—seam "D"	0′—6″	0′—6″
Measures		35′—0″
Coal—seam "E"	0′—7″	0′—6″
Measures		39′—0″
Coal—seam "F"	4′—0″	4′—0″
Measures		9′—0″
Coal—seam "G"	2′—0″	2′—0″
Measures, chiefly fireclays and sandstones, with some small coal seams		150′—0″
	119′—1″	2,452′—11″

Section of the Productive Measures in the Albion Area.

(Per Hartley, 1869, and Notebaert, 1916)

Totals of Hartley's 1869 Section to the floor of	Coal	Measures
the McGregor seam	84′—1″	1,714′—8″
Section as disclosed by diamond-drill cores below the McGregor seam:—		
Measures		45′—0″
Coal	21′—9″	21′—9″
Measures		14′—4″
Coal	3′—6″	3′—6″
Measures		127′—8″
Stellar seam (or Oil-coal)	5′—0″	5′—0″
Measures		31′–10″
Coal	6′—6″	6′—6″
Measures		169′—9″
Coal and shale mixed (not good)	29′—9″	29′—9″
Measures		47′—6″
Coal and shale mixed	4′–11″	4′–11″
Measures		74′—8″
Coal (good seam)	20′—4″	20′—4″
Measures		190′—4″
Coal (coarse)	3′—2″	3′—2″
Measures		9′—9″
Coal (good)	9′—8″	9′—8″
Measures, hard grey shale		251′—0″
	188′—9″	2,781′—1″

In giving the section shown on page 26, Mr. Hartley wrote:—

No single section or column can be given which will fairly represent the measures of the entire coalfield, as very considerable changes occur in the character and size of the coal seams, and changes of a remarkable character are seen throughout the field in the rocks.

Mining operations, in depth, have corroborated the exact truth of this observation.

As is the case in many coal-fields, the coal seam horizons seem fairly persistent, although the thickness of the individual seams, and the intervening strata, vary very considerably within comparatively small distances. A study of the palæontological evidence to be found in the roofs and pavements of the coal seams, and microscopic examination of coal sections from the several seams, would doubtless throw much light on the problem of correlating the seams in the three divisions of the Pictou coal-field.

The district north of the known limits of the Pictou field, in the direction of New Glasgow, is overlain by the New Glasgow Conglomerate and Permian rocks; but explorations have so far tended to confirm the opinion of the Geological Survey, namely, that the Permian in this district overlies unconformably either Millstone Grit or Devonian Measures.

The Vale area contains a series of coal seams bent into a synclinal basin, along a northeasterly axis, measuring about three miles across from crop to crop of the lowest seam. This series of seams is believed to be a higher series than those contained in the Albion area, the thickness of strata intervening being estimated at about 1,600 feet, containing beds of oil-shale, but no coal seams, so far as is known. The territory between the East river and the outcrop of the lowest seam in the Vale synclinal basin, measures roughly, two miles. All the higher series of seams have been eroded in this territory, and, moreover, the barren area is faulted and disturbed in a manner not thoroughly understood, except that the dip of the strata changes from a direction towards the axis of the Vale syncline to a dip towards another syncline that runs east and west through the Allan shafts, and is roughly parallel with Fraser's mountain.

A typical section of the Vale seams is as follows—but, as in the other areas of the Pictou field, the seams and the intervening strata show great variations.

	Coal	Measures
Captain seam	3′—0″	3′—0″
Measures		22′—8″
Millrace seam	3′—0″	3′—0″
Measures		63′—6″
George MacKay seam	3′—9″	3′—9″
Measures		607′—0″
Six-foot seam	6′—0″	6′—0″
Measures		700′—0″
McBean seam	8′—0″	8′—0″
Measures		37′—0″
Coal	2′—0″	2′—0″
Measures, containing cannel seams and oil-shales		

Coal was first discovered in the Pictou field in 1798, when prospecting was carried on along the banks of the East river, and small quantities were mined from the outcrop of the main seam, the coal being lightered

down the East river for shipment to Halifax and other points along the coast. Coal mining operations on a large scale were commenced by the General Mining Association in 1827, in the vicinity of the present town of Stellarton, and were continued by this Company until 1874, when the property was sold to the Halifax Company, Limited.

In 1854 coal was uncovered near Westville and mining operations were commenced by the Black Diamond Company. In 1868 the Acadia Colliery and the Drummond Colliery commenced.

In 1872, the Vale Coal & Iron Manufacturing Company began operations on what is now known as the Vale area, near the present village of Thorburn.

In 1886 the Acadia, Vale, and Halifax Companies were amalgamated to form the Acadia Coal Company, which thus came into possession of areas and collieries in all three divisions of the Pictou field. In the following year the Acadia Coal Company acquired the Black Diamond properties. Since this time there have been but two operating coal companies in the Pictou field, namely, the Acadia Coal Company, and the International Coal Mining Company operating the Drummond Colliery at Westville.[1]

The Acadia Coal Company at the present time is working its areas in the Albion district only.

The Albion mine has two main slopes, drawing coal from workings in six seams, and reference to the section of the Albion measures (see page 26), will show the number of untouched seams that can, if desired, be made tributary to these slopes.

The Allan shaft mine draws coal from workings on the Cage Pit and the Ford seams. The Allan shafts were sunk in what appears to be the deepest part of the coal basin. There are two shafts, the deepest in eastern Canada, one 962 feet and the other 1,440 feet deep. The Cage Pit seam is, on an average, 15 feet thick at this point, and the Ford seam measures up to 40 feet in thickness, and in some places very considerably more. The Ford seam in this locality is most variable, both in thickness and inclination, the ground being very troubled. Because of the faulted character of the seam, it has proved costly to work, and has necessitated costly stone drifting. Recently, the management have carried out extensive prospecting by diamond drill borings of small diameter, and valuable information has been obtained in this way, at comparatively small expense.

The Vale colliery, in the eastern division, and the Acadia colliery, in the western division—both owned by the Acadia Coal Company—are closed down, because of the exhaustion of the profitably workable coal, and the unremunerative nature of the mining operations. The future of these mines, and the working of the other seams contained in the areas in which they are situated, is dependent on the selling price of coal and the local demand.

Belgian capital was several years ago invested in the Acadia Coal Company, and large capital expenditure has been incurred in proving and developing the property.

[1] Particulars of the early history of coal-mining in the Pictou field have been kindly supplied by Mr George Gray, the Assistant General Manager of the Acadia Coal Company.

A complete electrification of the colliery plants in the Albion district has been carried out. The modern steel bankheads at the Allan shaft mine and at the Albion slopes are among the best in Nova Scotia.

The output in 1913 was 536,000 tons, and has not since been exceeded. An underground fire in the Albion slopes in 1913, and an explosion, followed by a fire, in the Allan shaft mines, at the end of 1914, seriously interfered with production. The output in 1916 will be about 400,000 tons. The employees number between 800 and 1,000 men.

The Intercolonial Coal Mining Company operates the Drummond colliery, the only producing colliery at present in the Westville division. Up to the close of 1915 the workings of the Main or Acadia seam produced the major portion of this Company's output, but a series of serious underground fires rendered it necessary to close off the lower workings and necessitated the abandonment of the whole of the workings in this seam. Mining is now being carried on in the Second seam, and, as mentioned elsewhere, a seam of fireclay underlying the Third seam is also worked. The output of this Company in 1916 will be about 150,000 tons. The workmen number between 500 and 600 persons.

NEW BRUNSWICK.

Although the existence of coal in New Brunswick has been known since the earliest settlements, it is only since 1911 that any organized attempt has been made to work the deposit on a large scale. The Province is sparsely settled, and the immense forest which provides its chief industry has yielded a plentiful supply of fuel. These conditions, combined with the difficulties of transport, have militated against the utilization of the coal deposits. The Canadian Government railway; the Canadian Pacific railway, and the Grand Trunk Transcontinental railway now traverse New Brunswick; the last-named road going directly through the Grand Lake coal-field. A demand for railway coal has, therefore, been created, that will provide a limited but profitable market. In fact, the railways themselves because of the remoteness of the railway centres of New Brunswick from other sources of coal supply have encouraged the mining of coal to supply their local needs, and thereby save expensive freight charges on coal brought from Nova Scotia.

The Carboniferous rocks are exposed over large tracts in New Brunswick, but they consist, mostly, of the lowest and barren strata, the productive beds being represented only by a thickness of 200 feet of measures corresponding to the lower productive measures of Nova Scotia. Small seams and traces of coal are found in many places scattered all over the Province, but the only really valuable coal occurrence is in the Grand Lake field, situated 70 miles north of St. John, and lying midway between Fredericton and Moncton. The area underlain by coal is estimated by the Geological Survey at 112 square miles. Only one seam of value is found

which varies from 18 inches to 30 inches in thickness, and lies almost flat, or with a very slight inclination, at a depth of not more than fifty feet from the surface. The coal is of fairly good quality and clean.

In places the coal has been worked "open-cast," and in other places by openings driven into the seam where exposed in the banks of a river.

Systematic operations are now being carried on at Minto (Sunbury county) by the Minto Coal Company. The Canadian Pacific railway has built a branch line from Fredericton to Minto, and has acquired the road from Minto to Norton formerly owned by the New Brunswick government, connecting with the Canadian Government railway at Norton Junction. The Transcontinental railway also connects at Chipman Junction, so that the coal-field is now linked up with the three main railway systems of the Maritime Provinces.

The method of mining adopted by the Minto Coal Company is interesting. A number of shafts are sunk, to each of which a territory of eight acres is allotted. The levels are driven to the boundary, and the coal worked back to the shaft, which is abandoned after the area is exhausted. An output of from 350 to 500 tons daily is obtained from these shafts. The Minto Company had an output of 81,000 short tons in 1915, and expects to produce 120,000 tons in 1916. The bulk of the coal mined is taken by the railways, there being a long term contract arrangement between the Minto Coal Company and the Canadian Pacific railway for the supply of coal.

The Company employs 250 men, and has houses accommodating all its workmen and their families.

The contents of the Grand Lake coal-field are estimated by Mr. Dowling at 138,000,000 tons, giving, with the addition of 13,000,000 tons for the areas at Dunsinane and Beersville, a total, for the Province, of 151,000,000 tons.

Although from the nature of the deposit the production must always be limited, both in the rate of output and in actual resources, there can be no doubt that properly exploited the coal-field will prove of great local importance and be a considerable asset to the railways and the Province generally.

It is well that responsible people are behind the present enterprise, for, in the past, the New Brunswick coal-fields have been improperly exploited in connexion with fraudulent flotations of so-called "coal companies," to the great injury of credulous investors, and the detriment of the good name of the Province.

PRINCE EDWARD ISLAND.

The whole of Prince Edward Island, with negligible exceptions, is overlain by rocks of the Permo-Carboniferous formation, uniformly reddish in colour. At the request of the Provincial Government the Dominion Geological Survey, in 1908, put down a series of boreholes in order to test the possibility of coal being found at workable depths. The holes were bored

on the crest of anticlines which cross over from New Brunswick and the Nova Scotia mainland, it being assumed that the Permian cover might be thinner at these points than elsewhere in the island. A churn drill was used, boring up to an 18-inch hole. Difficulties were experienced in the work of boring, due to heavy flows of both fresh and salt water, whenever certain well-defined sandstone beds were encountered. The majority of the holes did not get beyond the red beds of the Permo-Carboniferous; but in a bore near Miminegash, at the extreme western end of the island, the depth of the red beds was only 950 feet, the remainder of the bore, to a total depth of 1,660 feet, being in the lower grey beds of the Permo-Carboniferous. Arrangements were being made to obtain a core drill to continue the bore, but, unfortunately, before this was secured the hole caved in, burying the tools, and was lost.

The following is quoted from the Report of Progress of the Geological Survey for 1909:—

> Consequently, the Carboniferous has not been tested. But though the question of the extension of the coal basins from Cape Breton and Nova Scotia is still unsettled, it has now only an academic interest, so far as Prince Edward Island is concerned, since the work done has demonstrated that no coal occurs within commercial reach of the surface. The bore-holes average nearly 2,000 feet in depth, and have not reached the Carboniferous, which would have to be penetrat ed several hundred feet before the Coal Measures would be encountered. The unstable nature of the rocks, and their saturated condition, would make sinking and maintaining a shaft a very difficult and expensive engineering feat.

It is unfortunate that the results of this exploration should have been so inconclusive. The depth to the Carboniferous is apparently not prohibitive, while the experience gained in sinking through water-logged strata in other parts of the world would lead to the conclusion that, although it would doubtless be most expensive, it would be quite feasible to sink and maintain a shaft through the strata met with in the Prince Edward Island borings.

It may be, that the Permian rocks are laid down unconformably on strata older than the productive Coal Measures of the Carboniferous, and that the coal seams are not present, as is apparently the case in other parts of the Maritime Provinces; but the question cannot be regarded as conclusively settled until deeper borings have failed to reveal the presence of coal seams.

In any case, even if the presence of workable coal seams were to be demonstrated, they could hardly be profitably mined under present economic conditions in competition with the easily accessible coal deposits of Cape Breton.

GENERAL.

Submarine Mining.

Coal has been mined under the sea for many years in Cape Breton, and, in the future, the bulk of the coal output of this island will have to come from submarine territory. In fact, the time is not far distant when the percentage of submarine coal will exceed that of the coal taken from the land areas, taking the Province as a whole.

The workings of No. 1 Colliery of the Nova Scotia Steel & Coal Company at Sydney Mines are the most extensive under-sea workings, occupying an area of 3 square miles under the entrance to Sydney harbour. The face of the deeps, in 1916, was about $1\frac{3}{4}$ mile distant from the shoreline, and the workings are being further extended through an area leased from the Dominion Coal Company, which will provide the Nova Scotia Company with an immediate extension of its submarine workings, and with access to its own areas lying farther out to sea; distant $3\frac{1}{2}$ miles from the shore.

In the Lingan-Victoria basin, a limited area only of the coal seams is under the land, the bulk of the deposit being submarine. Five collieries are now working on submarine coal here, and others are projected.

In the Glace Bay basin the land area is practically worked out, that is, as far as the three upper seams—the Hub, Harbour, and Phalen—are concerned. There are, at present, six mines with workings in submarine territory.

In the Morien basin the bulk of the deposit is submarine; but it is not now being worked. In Inverness county, as elsewhere stated, the basins are mainly submarine, although there are some land areas that have not yet been developed.

The most notable submarine area is the seaward extension of the Sydney coal-field. So far as can be surmised from the geological indications on land, there is no reason to anticipate any abrupt termination of the coal seams, or any limit to their accessibility, except those imposed by the difficulties attending the extraction of coal at a point remote from the source of ventilation and mechanical power, among which problems not the least will be the expeditious transportation of the workmen to and from their work. The balance of probability is for the uninterrupted continuance of submarine coal seams beyond the physical limits of extraction, but, nevertheless, the exact conditions can only be established by exploration.

In calculations that have been made as to the available tonnage in these submarine areas, it has been usual to assume three miles from shore as the limit of extraction, but it seems reasonable to assume, from experience in other submarine coal-fields, notably the Cumberland coal-field on the west coast of England, that it will be found possible to mine coal up to a distance of between five and six miles from shore. How much farther seaward mining can be prosecuted, only time and actual experiment can demonstrate. An important factor will be the inclination of the coal seams, but so far as the Sydney submarine area is in question, the seams here dip so gently that the actual horizontal distance to be traversed will set limits to extraction before the depth of the cover, or burden of the superincumbent strata becomes too great. One limitation will be the cost of mining, and it may be the first limiting factor to make itself felt.

Many interesting problems suggest themselves as likely to arise as the extraction of the submarine areas proceeds, but the mining of the more remote areas will scarcely come within the lifetime of the present generation, whose obvious duty it will be to so prosecute the work of extraction as not to imperil the accessibility of the remaining submarine coal.

The provisions of the Coal Mines Regulation Act of Nova Scotia, relating to submarine mining, are tentative, and recognize the impossibility of making rigid rules where so much has yet to be learned from actual experience. The Act gives great discretionary powers to the Commissioner of Mines, and provides that before work is commenced in any submarine area the plans must be approved by the Inspector of Mines. Every new lift or level in a submarine mine is defined as being a new winning, requiring the sanction of the Inspector of Mines. No submarine coal is allowed to be wrought under a less cover than 180 feet of solid measures; but submarine passageways may be driven to win coal under not less than 100 feet of solid measures. When there is less than 500 feet of solid cover, submarine workings must be laid off in panels of not more than half one square mile in area; surrounded by barriers of coal not less than 90 feet thick, and pierced by not more than four passageways having a sectional area not greater than nine feet in width, and six feet in height.

The present law has not attempted to deal with the extraction of pillars in submarine territory, or to regulate the method of extraction where the solid cover exceeds 500 feet, except in making this conditional on the approval of the Inspector of Mines. The size of pillars to be left in submarine workings now proceeding or projected has in all cases been the subject of an agreement between the Inspector of Mines and the owners of the mines affected. There is reason to believe that future practice in submarine areas may permit the complete extraction of the coal without leaving any supporting pillars. It may also be found possible to use with advantage the method of "flushing" now largely adopted in European and in some United States collieries, by which the space left by the extraction of the coal is filled by sand or similar material "flushed" into the waste by admixture with water, and led into the workings by a specially constructed piping system from the surface.

The complete extraction of the coal permits of a more even settling down of the superincumbent measures, and lessens the danger of a break in the measures which might let in the sea-water.

If it is found necessary to leave permanent pillars in submarine workings, this will entail the complete loss of the coal contained in the pillars, and it will also bring into operation the limitation of extraction by the increased cost of mining at an earlier date than if it is found possible to dispense with permanent pillars, as the existence of a large area of permanently abandoned workings supported by pillars increases all mining costs, particularly that of ventilation, and adds an element of danger that is not present where the abandoned waste is completely filled, either by complete subsidence of the roof, or by some method of stowing.

If the system of mining in panels, now prescribed by the law, is followed, considerable care will have to be bestowed on the projections of the submarine workings, so as to avoid the exact superimposition or crossing of panel barriers in a higher seam upon the panel barriers in a lower seam; for presumably, if a solid block of coal surrounded by an extracted area in a lower

seam were exactly superimposed by a similar block also surrounded by an extracted area in a higher seam, or higher seams, the result would be a "hump" or inequality in the sea bottom, with a tendency to break the strata and let in the sea.

There is a marked difference between the conditions attending submarine mining on the western and eastern sides of Cape Breton island. On the western side, in the Inverness coal-field, the strata are much fractured, and the coal seams dip steeply. In the Sydney coal-field the seams are but slightly inclined, and the strata overlying and intervening between the coal seams consist of strong sandstones and impermeable marls and shales. Faults are rare, and the sea bottom is usually rock, without great thicknesses of sand or sand pockets. A great part of this submarine coal-field is territory that has been gradually encroached upon by the sea, not by subsidence of the measures, but by erosion of modern date—geologically speaking. As the land area of the productive measures is remarkably free from faults or evidences of recent earth movements there seems no reason to anticipate the existence of faults in the area that has been encroached upon by the sea.

Two mines in Inverness county have been flooded by water from the sea. The Mabou mine was flooded in January, 1909, and the Port Hood mine in June, 1911.

At the point in the slope of the Mabou mine where the sea entered there was only 110 feet between the roof of the slope and the sea bottom.

In the Port Hood mine the water entered at a point where pillars were being drawn in the lowest level, supposed to be covered by 942 feet of solid measures. The inrush is estimated to have amounted to 3,000 gallons a minute in the initial stages, and the flow at the Mabou mine is thought to have been about 700 gallons per minute.

A Commission was appointed by the Nova Scotia Legislature to inquire into the causes leading to these inundations.

Concerning the Mabou incident, the Commissioners consider it was an error of judgment to have entered the seam under the comparatively thin cover, having in view the nature of the overlying strata.

Regarding Port Hood colliery, the Commissioners advise that in future "every reasonable means should be employed to ascertain the depth, nature and condition of the overlying strata before pillars are extracted in any submarine area."

The inundation of the Mabou mine was quite evidently the result of poor judgment, but the Port Hood inundation was of a sudden and unexpected nature, and while subsequent investigation showed peculiarities in the overlying strata that partly account for the inrush, it has never been shown that the break could have been guarded against.

While the actual physical conditions that led to this inundation are a matter of conjecture, and can probably never be exactly determined, it does not seem reasonable to suppose that the water from the sea entered through a vertical, or approximately vertical fracture in the roof of the seam

communicating directly with the ocean. The connexion with the sea is undoubted, because the water is certainly sea-water, and there was noticed a small daily rise and fall of the water corresponding in time to the tides, showing that the point of entrance of the water was near the shore, where the fluctuations of the tide would manifest their influence.

The pumping equipment of the mine had a maximum capacity of 110 gallons per minute, and was, of course, entirely inadequate to deal with an inrush of water of any magnitude. There was no reserve lodgment for water, and under these circumstances it cannot be said the inundation was an uncontrollable one. Much larger streams of water are being daily controlled in other Cape Breton collieries than seems to have entered at Port Hood.

The occurrence has served as a warning, and the necessity for emergency pumps and adequate lodgments in submarine areas was emphasized by this incident.

As there are no landmarks at sea, it will be necessary, when two or more seams are being worked in the same submarine area, to superimpose the plan of the workings of one seam upon those of the others, in order to gauge their relationship to each other, for where a number of seams are so shown, the result is very confusing. One method that could be used would be to paint a skeleton plan of the workings in each seam on plate glass, each seam being painted in a different colour, the plate glass sheets being placed one above another in natural order. This method has been successfully used to show intricate workings in faulted ground in the German coalfields. The German engineers went a little further, however, and made their model to exact scale, both horizontally and vertically, showing the dip of the seams and the fault lines, so that the completed model represented in miniature a transparent cube of the earth's crust containing the mine workings.

The surveying and plotting in the submarine areas will have to be very accurately done, and subjected to most rigid checking, as there will be no opportunity for such useful checks as are made possible in land areas by shafts and boreholes.

As the method of extraction in submarine areas is subject to the approval of the Inspector of Mines, and as the Government is the lessor of the coal seams, the responsibility for the accuracy of the mine plans will necessarily be a joint one, and will not rest entirely on the coal operators.

Preparation, Washing, and Coking of Coal, and the Recovery of By-products.

The preparation of coal for the market at the Nova Scotia collieries has not yet reached the elaborate scale noticeable at European coal mines, because, hitherto,the coal has been mined from clean thick seams; but as the inferior and thinner seams come to be worked, more attention to the matter of preparation, and the rejection of impurities from the coal, will be required.

All the bankheads at the more recently developed collieries are equipped with shaking screens and picking belts. Coal is sold either as "run of mine," that is, without removal of the slack, or as "screened coal," the slack being taken out. The slack coal, made in the mining, amounts to between 25% and 30% of the runmine, and in some cases runs very much higher.

Slack coal for coke making has been washed for many years, and latterly, a little has been washed for the general market. The Dominion Steel Company has a washery on the Campbell "bumping table" principle, with a washing capacity of 100 tons per hour, which prepares coal for the coke ovens.

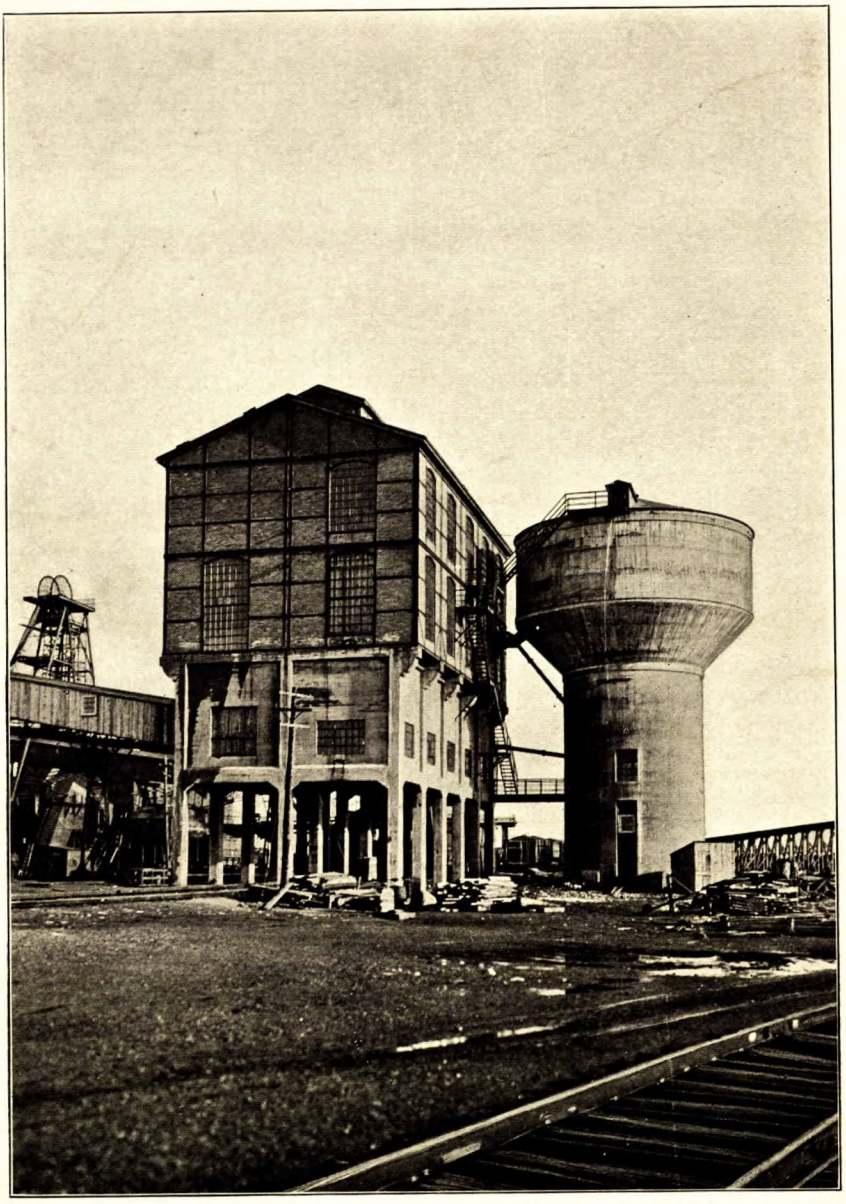
The Dominion Coal Company, in 1912, erected a "Baum" washer, having a capacity of 120 tons per hour; and three years later the Nova Scotia Steel & Coal Company installed a washer of the same type, but of smaller capacity. The "Baum" washer is of the "jig" type, the principal feature being, that the impulse to the washing-water in the jigs is given by compressed air. A feature of this washer is the recovery of all the fine coal, and economy in the use of washing water. The Inverness Coal & Railway Company has a small Jeffrey washer.

Several installations for briquetting slack coal have from time to time been put down. The Colonial Coal Company, one of the small companies operating in the Sydney field, successfully manufactured "ovoid" briquettes from slack coal, that found a ready sale, but the plant was destroyed by fire, and has not been rebuilt.

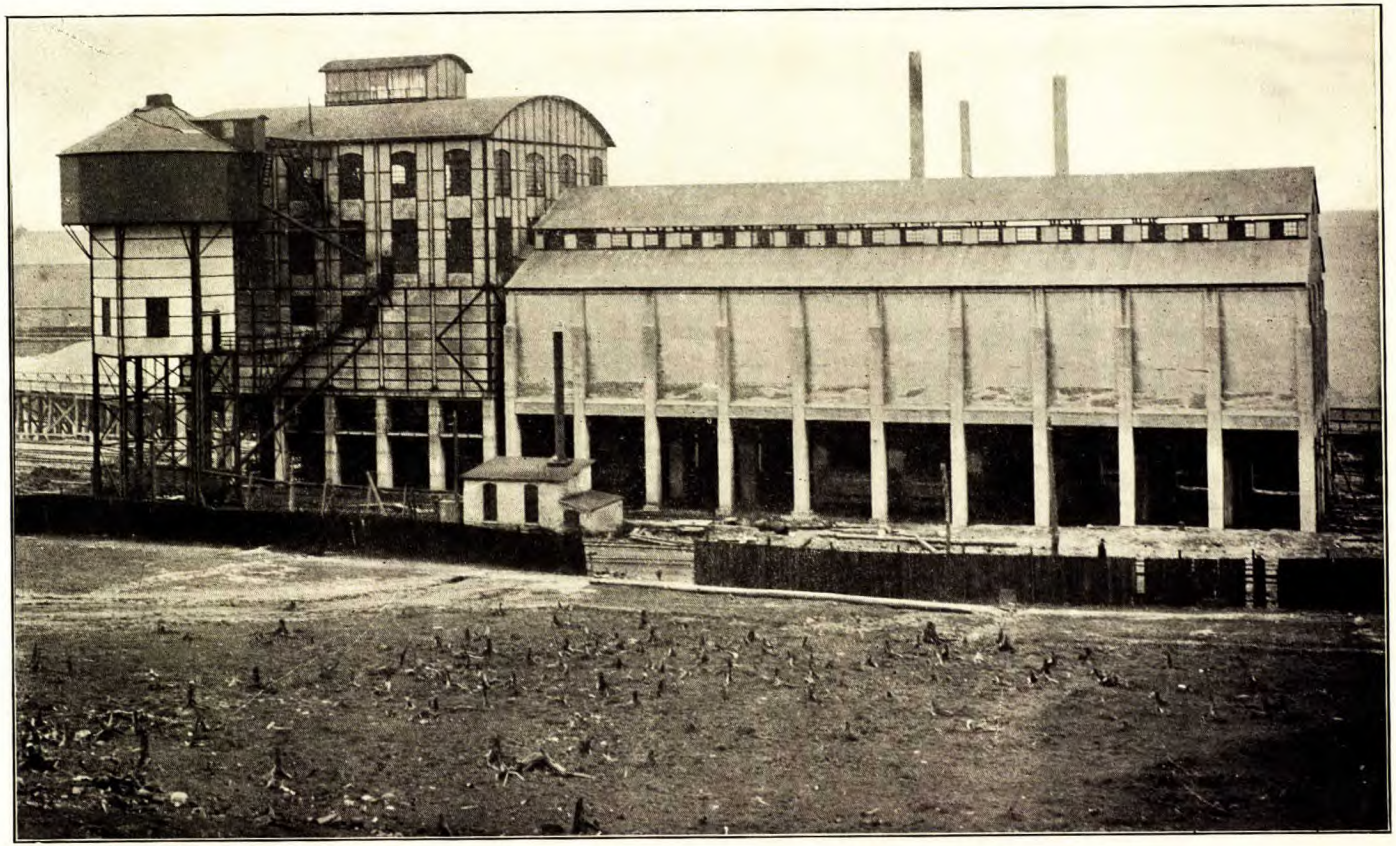
The analysis of the coals of Nova Scotia varies within comparatively narrow limits, and all the coals come within the bituminous class. As a rule, the purest coals are more fragile than those of lower grade. Some of the coals having a slightly higher percentage of volatile constitutents are well suited for gas-making purposes, while others with a higher percentage of fixed carbon, are preferred for steam-raising purposes, but there is a great similarity between the seams in the same district.

Comparing the different coal-fields, the Pictou seams are characterized by a high ash and low sulphur content. In the Cumberland area, some coals of remarkable purity are found in the Springhill seams, but the seams in the Joggins district have a comparatively inferior analysis. The Inverness coals are comparatively high in sulphur and ash content, and resemble the coals from the Joggins district. The best general analysis is shown by the seams in the Sydney coal-field. While, however, these comparative differences exist between the coals of the various coal-fields, a study of the table of analyses given on page 38, will show the general similarity of all Nova Scotian coals.

All the Sydney coals are suitable for coke making, and yield a good percentage of by-products. Some of the Pictou coals make an excellent coke, but not all the seams in this district yield a coking coal. Judging by the high percentage of nitrogen shown in the analysis of the Pictou coals, they should be valuable for use in any way that allows the recovery of the by-products. The Springhill coals do not yield a commercially strong coke,



"Baum" coal washing plant of the Nova Scotia Steel and Coal Company, at Sydney Mines: showing washery and concrete settling tank.



"Baum" coal washing plant of the Dominion Coal Company, Sydney, N.S.: showing washery, and concrete storage pockets holding 8,000 tons of washed coal, also concrete settling tank.

Blast furnaces and coke ovens of the Nova Scotia Steel and Coal Company, Sydney Mines.

and the seams that are at present mined in the Joggins and Inverness districts are unsuitable for coke-making.

Coke is manufactured in by-product ovens at the works of the Dominion Iron & Steel Company and the Nova Scotia Steel & Coal Company. The by-products recovered are sulphate of ammonia, tar, and latterly, benzol. The waste gases are used in the open-hearth furnaces, in re-heating furnaces, and in the various processes of steel-making, and for steam-raising. The ovens of the Dominion Iron & Steel Company yield from eight to nine gallons of tar per ton of coal carbonized. The tar is taken by the Dominion Tar & Chemical Company, which has a plant immediately adjoining the coke ovens, and is there fractionally distilled for the manufacture of light oils, carbolic acid, creosote oil, disinfecting fluid, protective paints, pitch, and other tar products.

In 1915, the Dominion Iron & Steel Company commenced the recovery of benzol, and the distillation of toluol, at the request of the military authorities. The toluol is shipped to the Province of Quebec for nitration and the manufacture of the high explosive tri-nitro-toluol. Previous to 1915 the benzol had not been recovered.

It is also possible that the recovery of the carbolic acid for the manufacture of picric acid may be undertaken at Sydney; and in view of the large amount of explosives that are used in Cape Breton in mining coal, and in mining iron ore and limestone for the steel works, both in Cape Breton and in Newfoundland, there would seem to be an opening for the local manufacture of explosives.

It may be of interest to note that the Dominion Iron & Steel Company makes sulphuric acid, which is used in the manufacture of sulphate of ammonia, and in one or two processes connected with the manufacture of steel wire.

Surprisingly little use has been made of coal gas for illuminating and heating purposes in Nova Scotia. In the whole of the Sydney coal-field, for example, there is no gasworks, although the advantages of gas for heating and cooking, are undoubted; especially where economy of fuel and freedom from smoke is desired. With the exception of the by-product coke ovens used in the manufacture of coke for steel-making purposes, and two municipal gas works, the whole of the bituminous coal used in Nova Scotia is burned without any attempt at recovery of the by-products. The use of coke as a fuel is also unusual, and coke, made from bituminous slack coal, could in many instances be advantageously substituted for imported anthracite coal.

The manufacture of coke on a small scale nearer the larger centres of population would provide a clean fuel, and if combined with a modern plant for the recovery of the by-products, and the complete utilization of the gases, would not only provide a profitable market for slack coal, but would substitute a Canadian product for anthracite now imported from the United States.

There are very few soft coal regions where so little use has been made of coal gas and coke as is the case in Nova Scotia, notwithstanding that Nova Scotian coals are particularly suitable for gas manufacture, and are "fat" coals, yielding a larger percentage of by-products than any Canadian coals. The gas works of the Halifax Electric Tramway Company in Halifax, and the Yarmouth Fuel Gas Company, are the only gas works in the Province of Nova Scotia.

Very full details concerning the analysis of Nova Scotian coals, and of coking and washing tests, by-product recovery, boiler trials, etc., will be found in the Report on the "Coals of Canada," issued by the Mines Branch of the Department of Mines, Ottawa. (See Bibliography).

A summary of the averages of analyses of samples of coal taken from the several coal-fields of eastern Canada, extracted from the abovementioned publication, is given below.

Table of Average Analyses of Coal Samples taken from Collieries operating in the several Coal-fields of the Maritime Provinces.

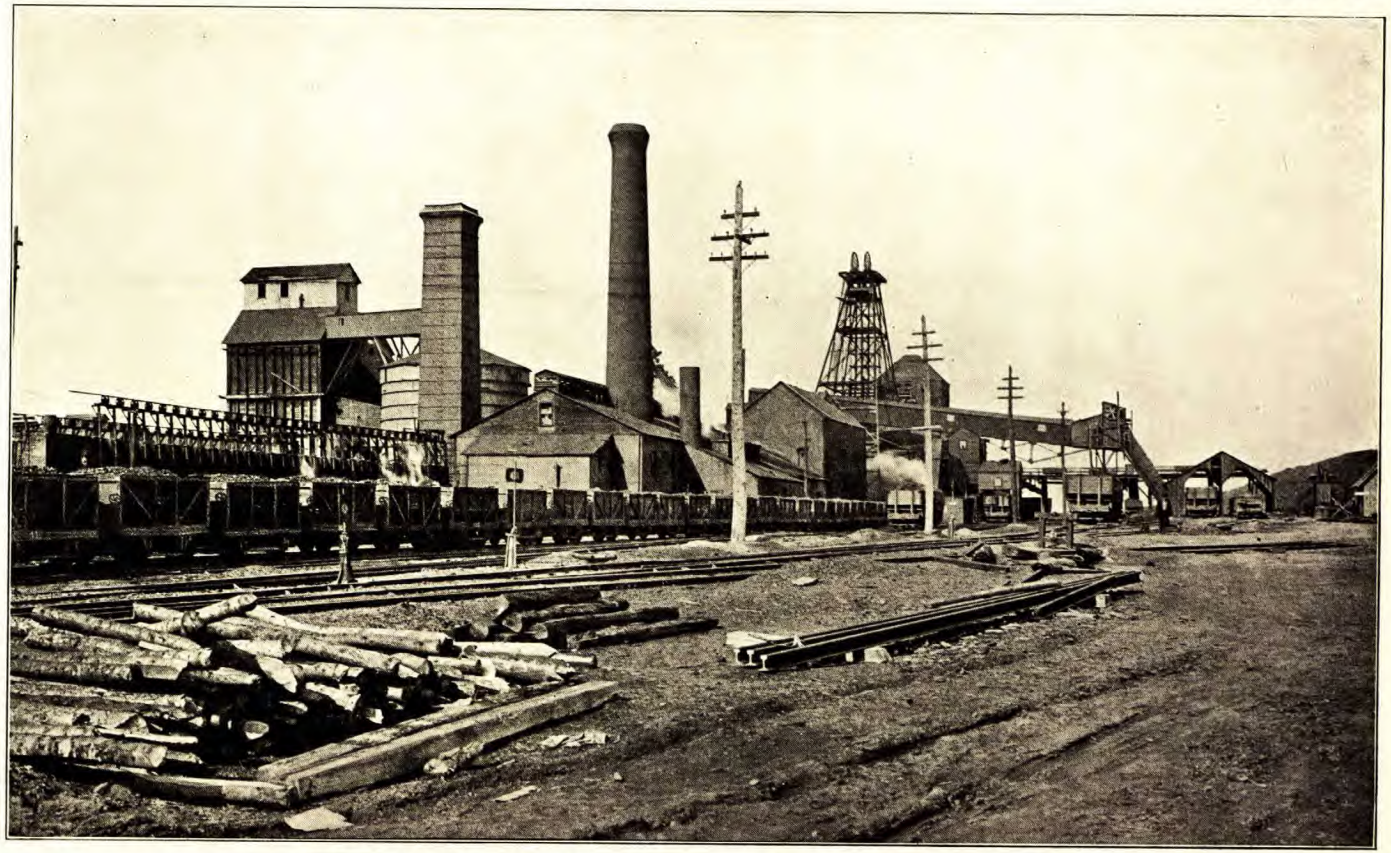
	Sydney, Cape Breton	Inverness Co., Cape Breton	Pictou Co.	Springhill, Cumberland Co.	Joggins, Cumberland Co.	Grand Lake. New Brunswick
Number of seam samples included in average	9	2	6	3	3	1
Moisture in coal.	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Total moisture	3·7	7·0	2·4	2·6	2·9	1·13
Moisture left after air-drying	2·6	5·3	1·7	2·1	2·2	0·09
Proximate analysis of dry coal.						
Fixed carbon	56·3	49·0	57·5	59·0	46·4	53·4
Volatile matter	36·4	38·5	29·6	33·0	37·8	32·2
Ash	7·3	12·5	12·9	8·0	15·8	14·4
Ultimate analysis of dry coal.						
Carbon	75·8	65·4	73·0	76·6	64·8	70·3
Hydrogen	5·1	4·5	4·5	4·9	4·4	4·6
Sulphur	2·9	6·9	1·2	1·5	6·2	5·8
Nitrogen	1·4	0·9	1·9	1·6	1·2	0·6
Oxygen	7·5	9·8	6·5	7·4	7·6	4·3
Calorific power in British Thermal Units	13,660	11,960	12,970	13,520	11,869	12,890

It may be noted that the figures given in this table by no means represent the best analyses of Nova Scotian coals. They may be taken as a very moderately stated average, and as conservative figures.

Methods of Working.

The coal seams of Nova Scotia vary considerably in inclination and thickness, and naturally, the methods of mining vary accordingly.

Nos. 2 and 9 Collieries of the Dominion Coal Company: two coal seams are worked at this mine to contiguous shafts.



"Princess" Colliery of the Nova Scotia Steel and Coal Company, Sydney Mines.

Joggins mine: Maritime Coal, Railway, and Power Company, Cumberland county.

In the Sydney coal-field the seams are surprisingly free from faults and interruptions, and maintain a uniform dip over large areas; a condition, which, combined with the regular cleavage of the coal, makes it possible to project mine workings ahead with considerable certainty that it will be possible to adhere to the plan laid down.

The majority of the collieries have been opened from the outcrop by slopes, in which both trip haulages and endless haulages are used. There are not any really deep shafts in the Sydney field. The deepest shaft is that of No. 2 Colliery of the Dominion Coal Company, which is 800 feet to the Phalen seam. The shafts are usually of the square or oblong timbered type, and it is usual to divide a shaft into compartments by wooden partitions. The Princess pit at Sydney Mines was sunk through strata that permitted heavy leakage of sea water, and it was necessary to use cast iron tubbing, but with this exception it cannot be said that any of the shafts in the Sydney field call for special mention. At most of the shaft collieries there is one shaft reserved for the raising and lowering of men and mine materials. With one or two exceptions access to the workings of shaft collieries is also possible through slopes on the same seam. The winning of the submarine areas will require shafts of greater diameter and more elaborate construction than those sunk up to the present time.

In Inverness county, and on the mainland of Nova Scotia, all the collieries in operation are slope mines, with the exception of the Allan shafts of the Acadia Coal Company, which, as mentioned elsewhere, are the deepest sinkings in eastern Canada.

The pillar and room method of extraction has been most generally adopted throughout the Province. In the earlier days of mining, no particular attention was paid to the size or strength of the pillars left to support the roof; and, as the seams were largely attacked along the outcrops, the mining operations of the present day have suffered from extensive crushes, and from the influx of surface water in large quantities, conditions which need not have occurred.

The longwall method of working has been adopted at various times and in various places, but it has never met with much favour at the hands of the local miners, who have been accustomed to pillar-and-stall work in dry and thick seams. As, however, the thinner seams come to be worked, the introduction of longwall methods is inevitable. The Dominion Coal Company has for several years worked the Emery seam on a longwall face. This seam averages 4 ft. 0 ins. to 4 ft. 6 ins. in thickness, and has a roof well adapted for longwall extraction. The coal is undercut by an ordinary disc-cutter driven by compressed air.

In other parts of Nova Scotia various modifications of the longwall method have been used successfully to meet special circumstances. At the Joggins colliery a modified longwall method is used, the coal being undercut by a "Pickquick" rotary-bar cutter, electrically driven.

In Inverness county, and in some of the newer mines opened by the Dominion Coal Company in the Lingan-Victoria field, the inclination of

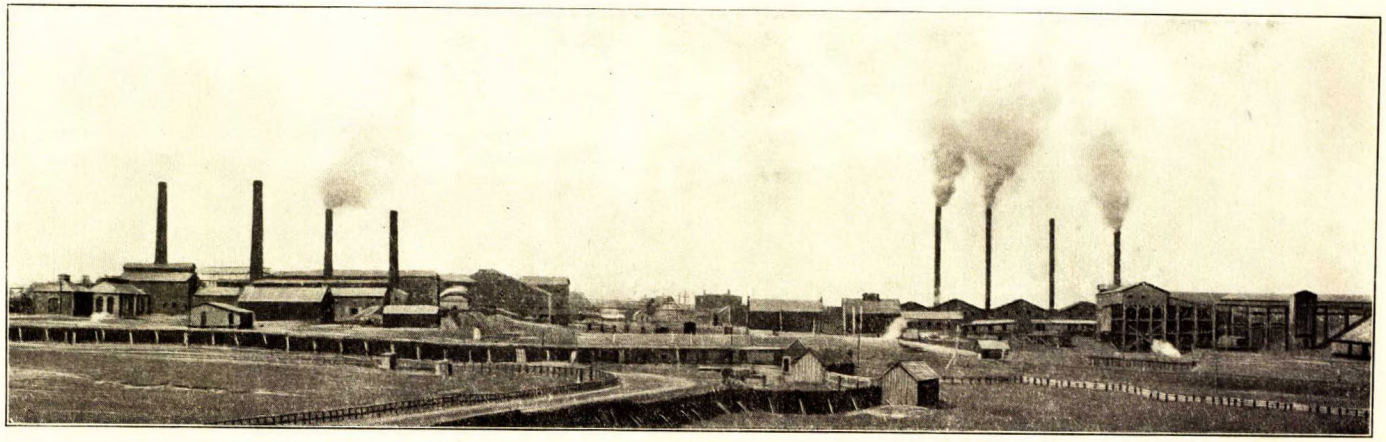
the seam varies from 15 to 35 per cent, and the ordinary arrangements of the pillar and room system are modified to meet these conditions. The coal is fed down to the main levels by a system of "balances," or, an adaptation of a gravity haulage, in which the weight of the loaded tub running downhill is utilized to pull the empty tub uphill. The equipment of these "balances" consists of a brake drum on which the rope is wound; a cage or tram to receive the pit tubs on a horizontal level; and a weighted tram to counter balance the loaded tub and pull up the empty tub. The cage, carrying the pit tub, is received at the foot of the balance into a pit in a siding off the haulage level, the floor of the cage being at the same elevation as the rails of the haulage level.

At the Springhill mines, where the inclination of the seams approaches and sometimes exceeds the vertical, the coal is lowered from the face down wooden chutes lined with sheet iron, and is dropped into cars in the levels below. No explosives are used, and sometimes the coal will come away so easily as to run for days without mining. Mining under these conditions of inclination is naturally much more difficult and more expensive than in seams of ordinary inclination. In those portions of the workings where the inclination will permit, the ordinary system of balances is, of course, used.

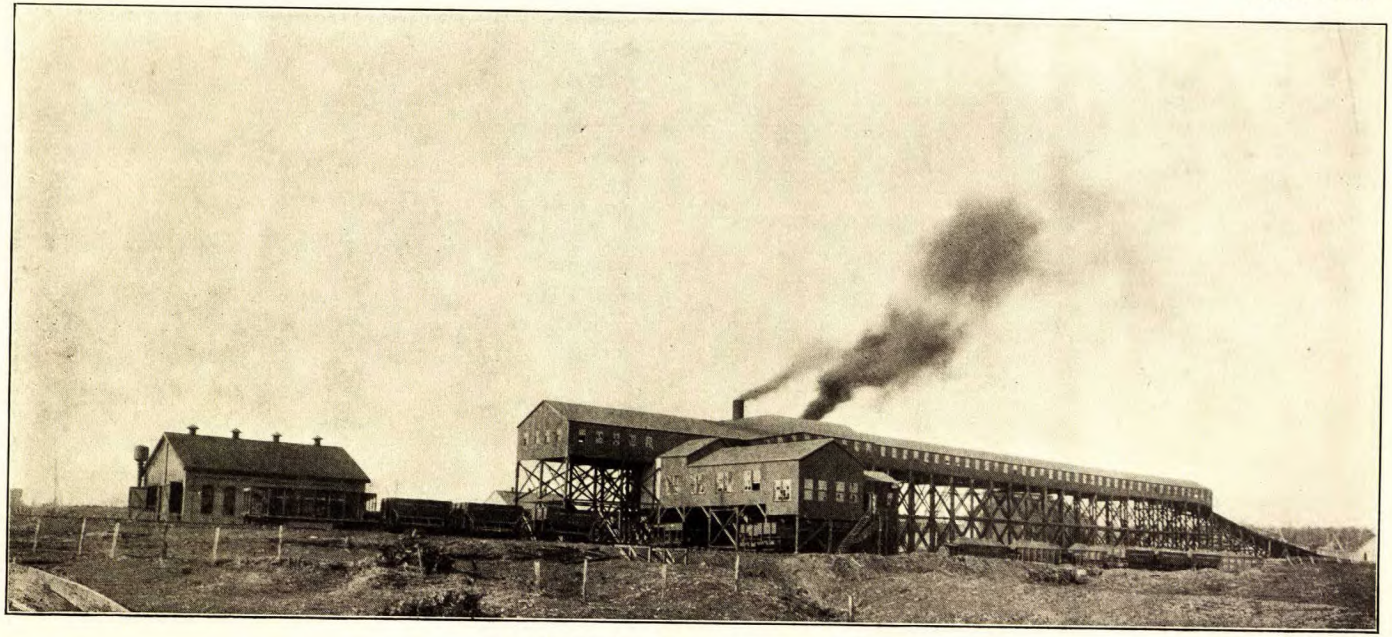
The coal in the development work and rooms is undercut by air-driven percussive pick machines, or so-called "punchers." Coal cutters of the radial post type are coming into general use. These machines consist essentially of a percussive cutter of rock-drill type mounted on a column, fitted with a worm-gearing which enables the machines to cut either vertically or horizontally, as desired. The radial machines do not impose as great a strain on the men operating them as do the "puncher" machines, moreover, they can be worked by comparatively unskilled men, whereas the successful operation of a puncher machine is a very specialized class of work. In some cases the coal is sheared on the side, or in the centre of the working face. A large amount of coal is still cut by hand, but the tendency is towards the elimination of the hand-pick miner. Pillar coal is mined by hand, except in the case of very large pillars, which are sometimes "split" by the use of machines.

Up to within very recent years the blasting of coal was accomplished by loose black powder, fired by squibs, but this practice has very properly been abandoned. In the damp mines compressed powder, or "pellets" are used. The charge is fired by an ordinary squib, sometimes ignited by a wire heated by contact with the safety lamp flame, and inserted through a small hole specially bored in the lamp glass. The use of squibs is with good reason coming to be regarded with disfavour, and powder fuses fired by electric batteries are being introduced. In the dry and dusty mines, or in mines where gas occurs, so-called "safety" or "permitted" explosives are used, as "Excellite" or "Monobel." These explosives are, of course, fired by a fulminate of mercury detonator, and electric battery.

The quantity of explosive used varies with the nature of the seam, but from 4 to 7 tons of coal produced per pound of powder used, may be taken

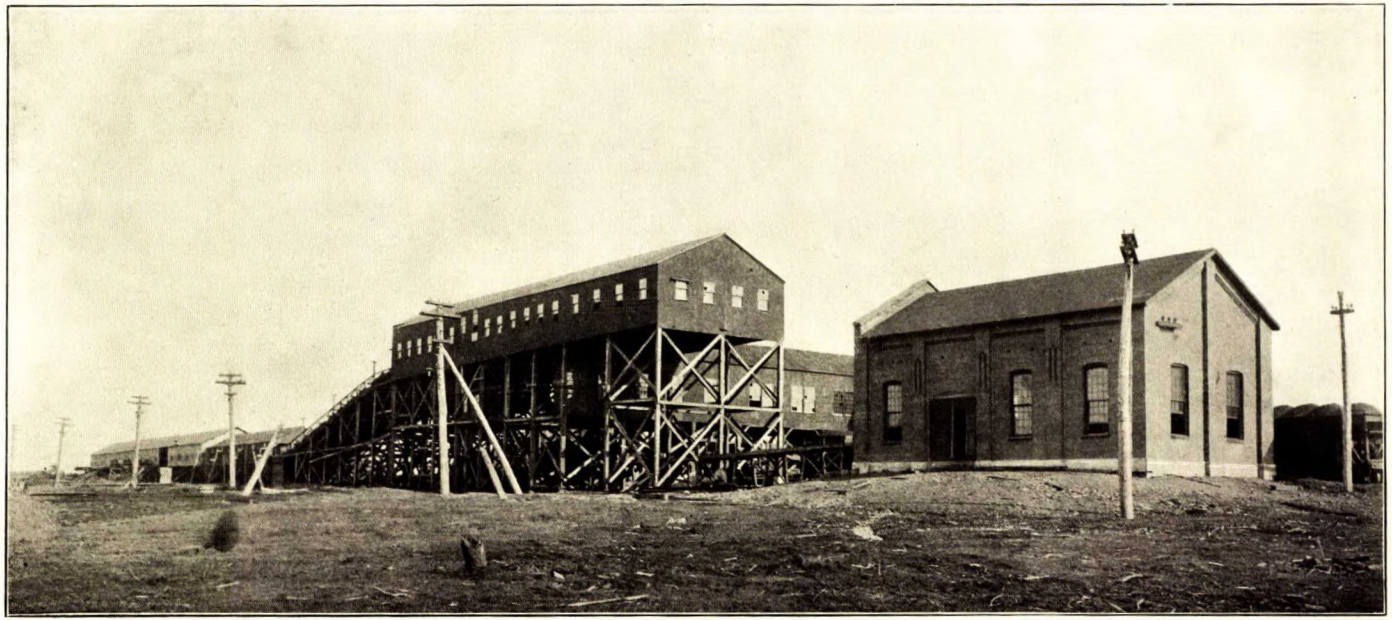


The Springhill mines of the Dominion Coal Company.



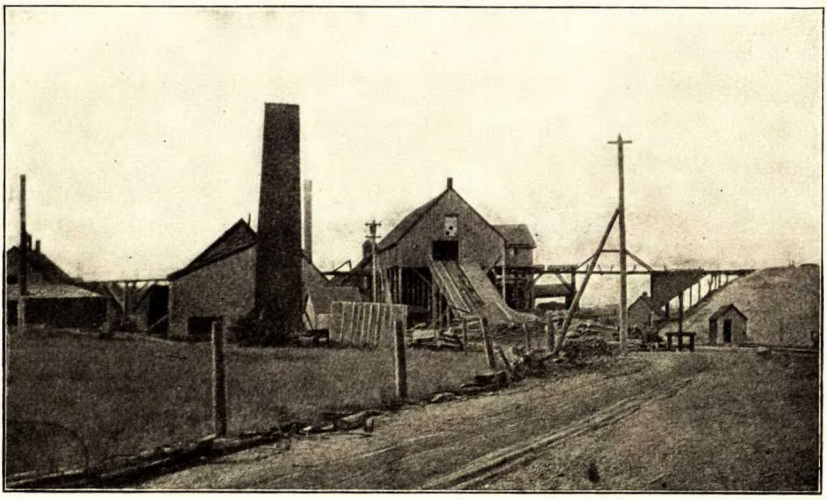
No. 12 Colliery: Dominion Coal Company.

No. 4 (Caledonia) Colliery: Dominion Coal Company.



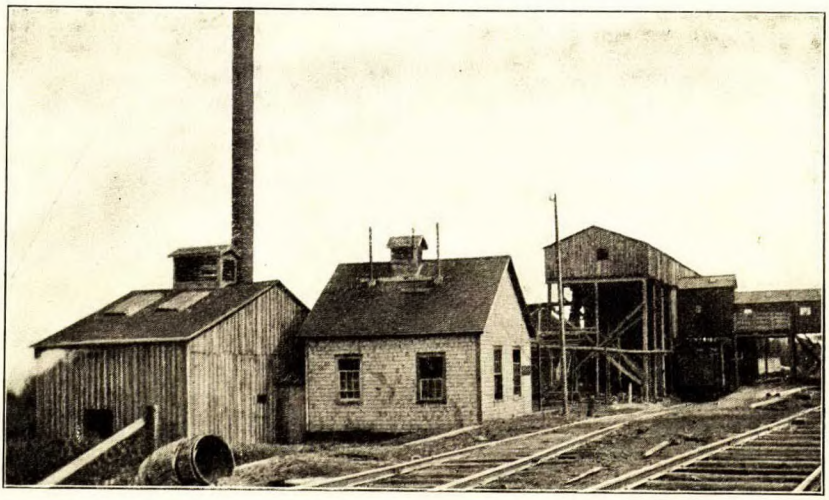
No. 14 Colliery, Dominion Coal Company: showing electric hoisting engine house at rear of bankhead.

PLATE XX

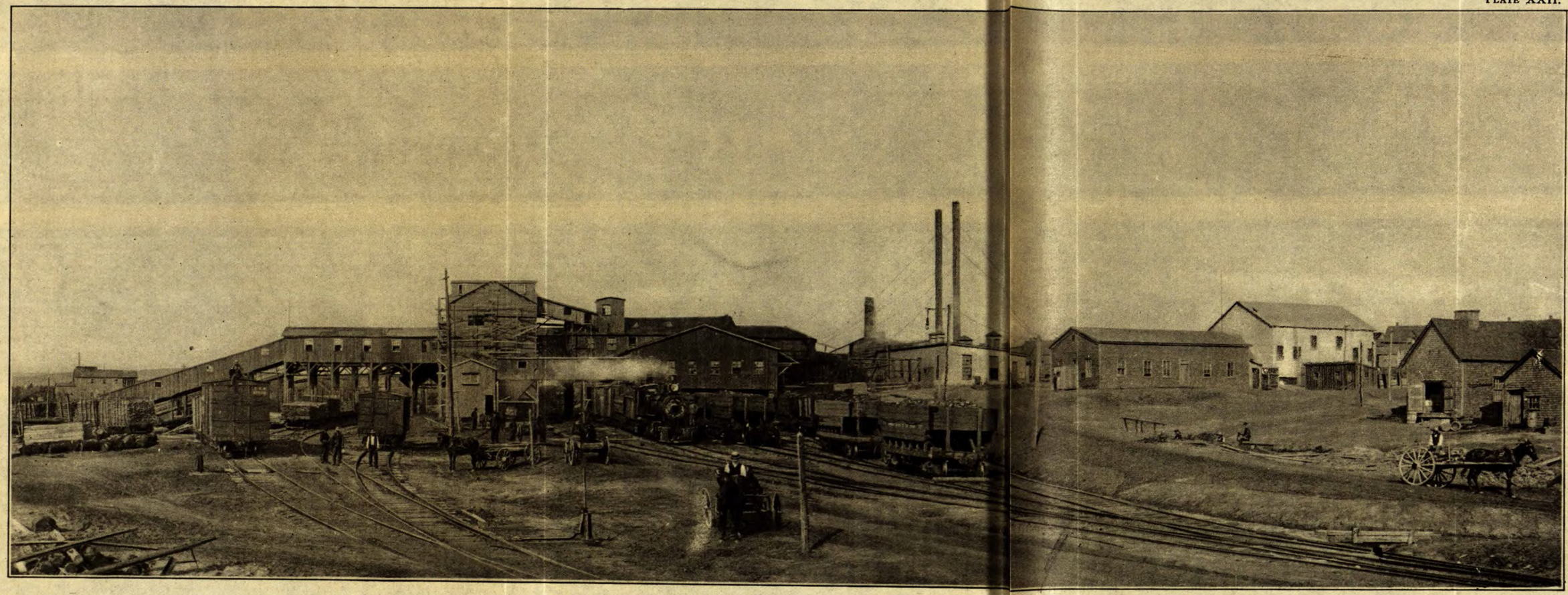


No. 1 slope of the Minudie Coal Company, River Hebert, N.S.

PLATE XXI



No. 2 slope of the Minudie Coal Company, River Hebert, N.S.



Bankhead and colliery buildings: Inverness Railway and Coal Company, Inverness, Cape Breton, N.S.

as usual practice. Generally speaking, the tendency is to lessen the amount of powder used. Apart from the greater danger associated with a too free use of explosives, the coal is shattered, and an undue quantity of slack coal is created.

The yield of coal in proportion to the number of men employed is relatively high in Nova Scotia. The production per man employed, including all classes above and below ground, will average 2½ tons a day.

Horses are used underground in large numbers, but the tendency is now to avoid their use as much as possible, and to substitute mechanical haulage. The horses used average from 4 feet 8 inches to 5 feet 2 inches in height, and cost between $180 and $200 each. Mules are not used in Nova Scotia mines. The price of pit horses has doubled within ten years, and suitable animals are very difficult to obtain. For many reasons it may be expected that mechanical haulage will eventually supersede the use of horses underground.

In Nos. 2 and 9 collieries of the Dominion Coal Company, compressed air locomotives are used for haulage in and out along the main roads leading to the pit bottom. The main haulages are mostly operated by engines working on the surface, chiefly steam-driven, but in several recent installations, electrically operated. The auxiliary haulages underground are in one or two instances electrically operated, but are mostly driven by compressed air.

The hoisting equipment at the shaft collieries presents some unusual features. At several of the shaft mines in the Glace Bay district the loaded pit tubs are brought to bank on a "dumping cage." The pit tub rests on a pivoted platform, and as the cage approaches the bank, the platform is pressed by a spring against a curved termination to the shaft guides, thereby deflecting the platform, tilting the tub and dumping the contents through an end-door into an automatic weigh-tank, from which, after being weighed, the coal passes on to the screens. The pit tubs do not leave the shaft. At other mines the pit tubs are run out on to the flatsheets in the usual way.

At No. 2 Colliery of the Dominion Coal Company, the loaded tubs are weighed in the pit bottom, after which the coal is emptied by rotary tipplers into large inclined storage shoots excavated in the mine floor. From the shoots the coal is shot downwards into a hopper tank suspended from the hoisting rope, which in passing downwards automatically opens the door of the loaded storage shoot, and is filled with coal. When hoisted to the surface, the tank automatically discharges itself on to the screen. Normally, about 6 tons of coal is hoisted in the tank. The tank and framework together weigh 10 tons, so that the minimum loaded dead weight on the hoisting rope is between 16 and 18 tons. The entire operation is automatic, the best performance obtained reaching 57 hoists in an hour. So far as known this is a unique colliery hoisting arrangement.

Colliery Plant and Motive Powers.

The machinery at the Nova Scotian collieries is modern and powerful, and considering the comparative isolation of the coal-field, the mining

engineers of the Province have succeeded in following closely the most recent and approved developments in colliery equipment.

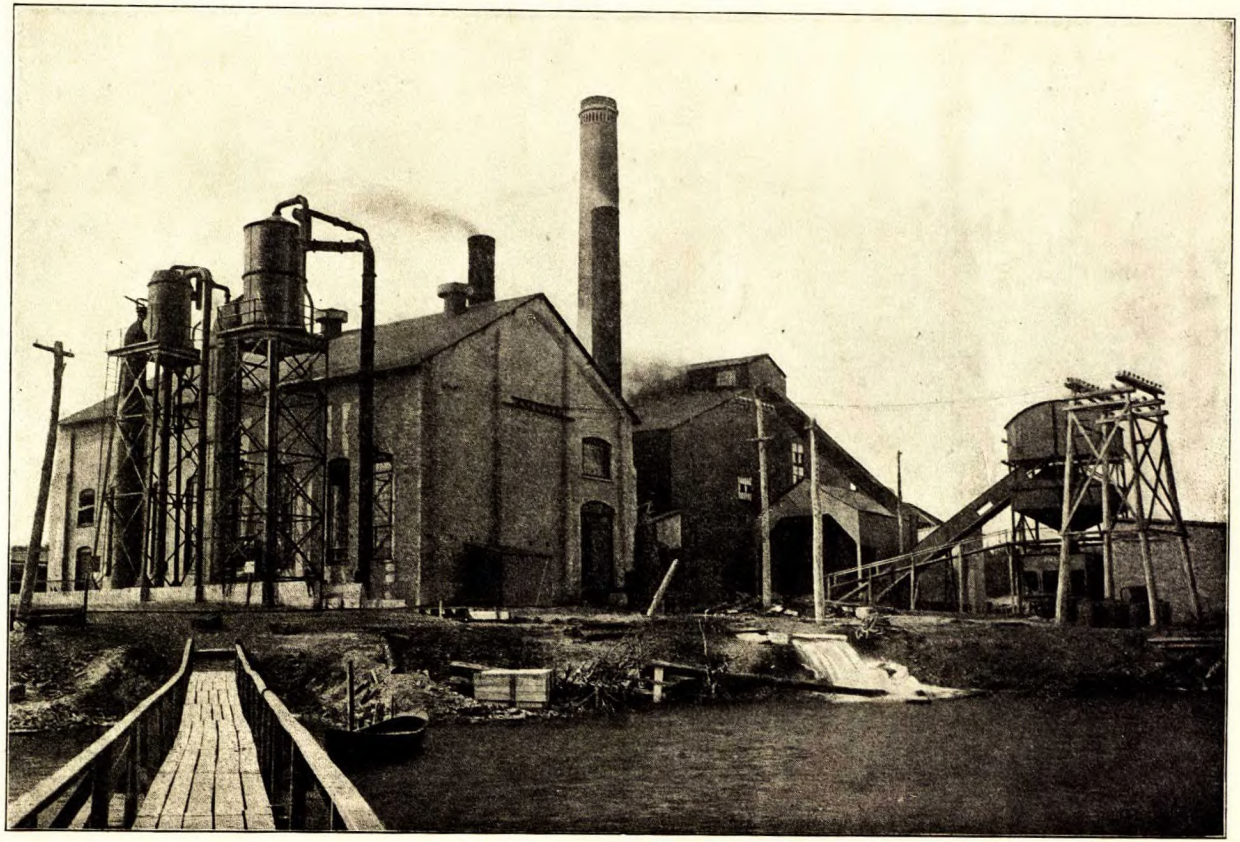
Water tube boilers of the Babcock type, are generally used, accompanied in most instances by arrangements for forced draft, and automatic stokers, designed to utilize slack coals and refuse. Chain grate stokers are also used considerably. The Dominion Coal Company has a battery of three Bettington boilers, fired by pulverized coal dust, and especially designed for using inferior fuels. Practically all the combustible matter in the fuel is consumed, and the residue is an irreducible vitreous slag. This battery of boilers was the first of the type to be erected in America. The Nova Scotia Steel Company, at its No. 1 Colliery, has a battery of Babcock & Wilcox boilers, three of the boilers being fired by waste coke-oven gases, and three others by a mixture of slack and coke breeze. These installations are mentioned, because they are typical of the tendency towards economy and the elimination of waste that has been a marked characteristic of recent mining practice in Nova Scotia. A number of exhaust steam turbines have been installed, and no doubt further economies will be effected in this direction. Several live-steam turbines are also in use for the generation of electric power, and a large turbo-compressor unit is shortly to be installed at Springhill mines for the generation of compressed air.

As in other mining districts, electricity is displacing steam as a motive power. At the newer collieries of the Dominion Coal Company and at several of the mines of the Acadia Coal Company and the Nova Scotia Steel Company, no steam is used, except for heating the buildings in the winter.

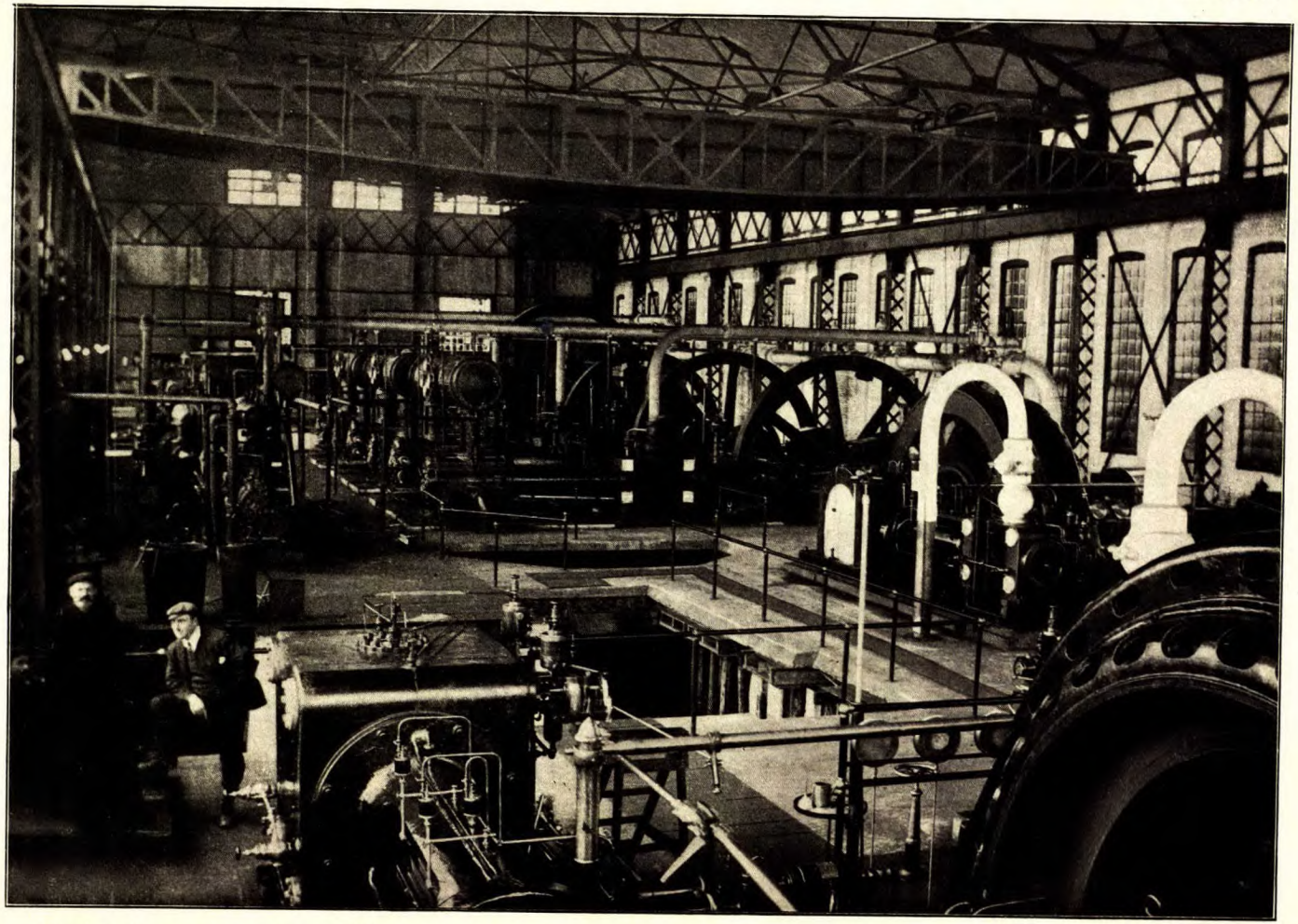
Nova Scotia—particularly in Cape Breton—is subject to sleet storms in the spring, causing the phenomenon known as a "silver thaw." Ice to a considerable thickness is deposited on all overhead wires, sometimes breaking down both poles and wire; but despite this drawback, it has been found possible to transmit high-voltage currents for long distances with little or no interruption, provided the outside construction is properly designed to cope with the occasional severity of these local sleet storms. One of the Dominion Coal Company's generating stations has, for several years past, distributed electric current to collieries having a radius of twelve miles.

As an underground motive power, compressed air has been chiefly favoured in Nova Scotia, but recently, electricity has been largely introduced for driving underground pumps and haulages; and to a limited extent, electric coal cutters have been used at the coal face. No underground electric trolley-haulages are in use.

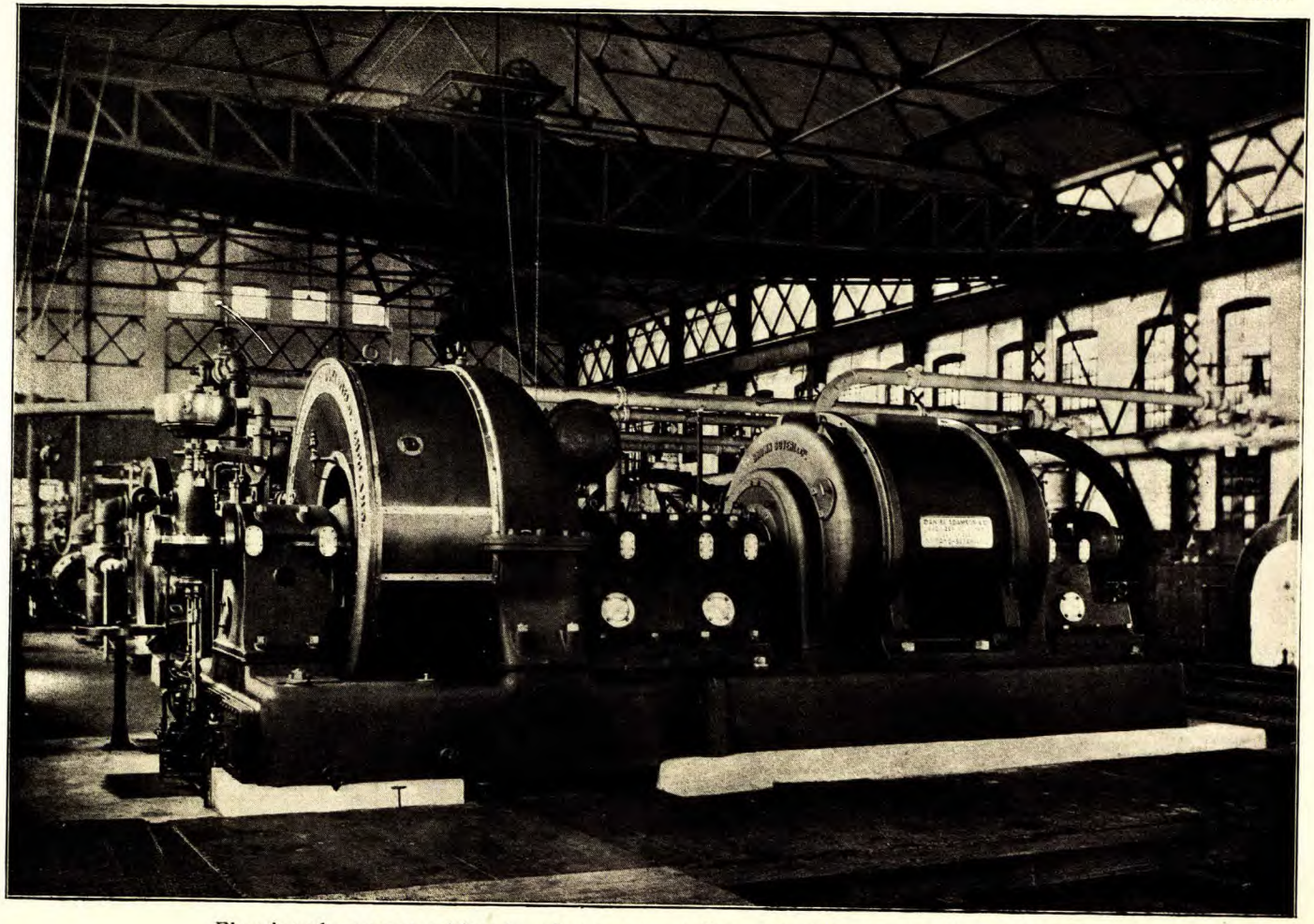
The development of electricity as applied to coal-mining in Nova Scotia is so recent that up to 1915 no regulations concerning the use of electricity were contained in the Coal Mines Regulation Act. In 1912, the Nova Scotia Government appointed a Commission to formulate suitable regulations, and these were made law in 1915. The regulations are very complete, following largely the recently adopted British electrical rules for coal mines. They cover not only the use and transmission of all electrical



Waterford Lake electric power plant, Dominion Coal Company: serving the Lingan-Victoria group of collieries.



Interior of power house, No. 2 Colliery of the Dominion Coal Company, at Glace Bay, N.S.: showing air compressors and electric generators. (The unoccupied space in the centre of the floor is now occupied by the turbo-generator set shown on Plate XXV.)



Electric turbo-generator driven by exhaust-steam turbine. Dominion No. 2 Colliery, Glace Bay.

power underground, but also the minor uses of electricity in the mines in connexion with shot-firing, telephones, signalling wires, and electric relighters for safety lamps. If properly enforced, the regulations prescribed by law should fully safeguard the future use of electricity in the coal mines of Nova Scotia.

The great submarine coal-field of Cape Breton offers a wide field for the use of electric power. The problem of the extraction of coal at great distances from the point of entrance of fresh air and power supply is largely that of the transmission of power, and electricity offers the only possible solution in the light of our present knowledge. There are very real dangers connected with the use of electricity at the coal face, but modern improvements in flame-proof motors lead to the hope that, under the spur of necessity, a satisfactory solution will be forthcoming. If, however, objections to the use of electricity at the face are sustained in future practice, it is quite possible to install air compressors, operated by electric power, safely enclosed, and suitably housed at some distance from the coal face, and to convey compressed air in the usual way for the operation of coal-cutters and small haulages at the actual working face.

When the workings of a submarine colliery reach under the sea for a long distance, say exceeding three miles, then the haulage problem will approximate to that of a railway system, with its feeder lines, marshalling sidings, and the main line. The main haulage entries will have to be constructed on a scale not hitherto attempted, with a view to rapid and continuous operations and the movement of large tonnages of coal. The subsidiary haulages will have to be separately operated, and the motive-power for their operation will have to be brought long distances. In the same way, the main ventilating currents will require to be carried onwards by auxiliary fans located "inbye." For many reasons the use of horses for underground haulage in remote submarine workings will be inadvisable, and mechanical appliances will require to be used in haulage, with as complete an exclusion of the labour of men and horses as may be found to be possible.

For all these various operations electricity promises the only possible motive power, except as modified by the local generation of compressed air, as already mentioned.

It may further be surmised that the illumination of the submarine workings will be exclusively by electric light. As is now common practice, the main roads will be lighted by the ordinary incandescent lighting circuit but it may be anticipated these circuits will be carried much farther "inbye" than is now the case. The oil-safety-lamp may be expected to be entirely superseded by the portable electric miners' lamp, except as the oil flame light may be necessary for gas testing. Apart from the greater safety of the miners' electric lamp, the absence of the products of combustion, and the lessened drain on the oxygen in the air, will be greatly in favour of the electric lamp, when the submarine workings become so extended as to require auxiliary ventilation.

Mine Explosions and Fires.

The Cape Breton seams, while not by any means free from gas, do not give off an excessive quantity. The seams, hitherto, have been largely worked from the outcrops at shallow depths; the workings are characterized by comparatively low temperatures, and gob fires are unknown.

Between 1878 and the present time, there have been four minor explosions in Cape Breton collieries, but there has not occurred any mine accident in this field, involving, at one time, the death of more than twelve men.

On four occasions serious underground fires have occurred in Cape Breton. In two instances it was necessary to flood the workings by letting in the sea, necessitating a long period of idleness and heavy expenditure in pumping out the water after the fire was extinguished.

The Hub seam at its outcrop along the shore at Glace bay was set on fire in 1752, and was consumed along the crop of the seam for a distance of nearly one mile. The locality is still known as the "Burnt Mines," the shales adjoining the seam showing evident traces of fire.

The seams on the mainland of Nova Scotia show exactly opposite characteristics to the seams in Cape Breton island. Few coal-fields have been so troubled by mine fires, explosions, and the constant presence of gas as the Pictou field. One of the seams in this field is said by Indian tradition to have been on fire before the coming of the white man, and according to the late Dr. Gilpin, "Pictou" is the Indian word for explosion, and may be connected with the exudation of gas from the Main seam that has been so noticeable a phenomena of this locality.

The following remarks on the Pictou coal-field made by Mr. R. Smith, before a Select Committee of the House of Commons, in 1835, are of interest:—

> The ebullition of fire damp at the East River was similar to that of a steam boiler, with the same kind of rapidity, so that putting flame to it on a calm day it would spread over the river, like what is commonly termed 'setting the Thames on fire'; it often reminded me of that saying. It is very common for the women to go to the river with the washing they have to perform for their families and dig a hole about ten inches deep by the river-side. This they then fill with pebbles, and put a candle to it; by this means they have plenty of boiling water. I mention this to show how highly charged the coal was with gas. When we first reached the seam at a depth of 180 feet, the gas roared as the miner struck the coal with his pick; it would often go off like the report of a pistol. The noise which the gas and water made in issuing from the coal was like a hundred thousand snakes hissing at each other.

Three explosions involving serious loss of life have taken place in the Pictou field, and at Springhill mines. In 1891, an explosion occurred causing the death of 125 men.

Safety lamps are now used in every important coal mine in Nova Scotia, although it is only within the last decade that the use of safety-lamps has become so extended. The N. S. Coal Mines Regulation Act requires the use of a locked safety lamp wherever the presence of inflammable gas is reported. At many of the collieries a type of lamp is in use that is locked magnetically, and cannot be opened except by the use of an unlocking device kept on the surface. These lamps can be lit after locking by an electric

ignition device, and electric re-lighters are provided underground at convenient places to re-light lamps that may have gone out underground.

The occurrence of mine explosions was not surprising under the conditions that attended early mining in Nova Scotia—conditions that were not peculiar to Nova Scotia alone, but were to be found in Great Britain also, at that time. One notable explosion, that caused the death of 55 men, arose out of a combination of naked lights, furnace ventilation, black powder, and the presence of gas. It is probable that defective ventilation, and a diminished percentage of oxygen in the mine air may have acted as a deterrent of mine explosions under these conditions.

The mainland collieries are subject to gob fires, arising from spontaneous combustion in the wastes. Some of the causes predisposing to this tendency are probably the steep inclination of the seams and their extraordinary thickness: preventing complete extraction of the coal, and rendering it difficult to avoid sliding movements of the strata, and crushing of the coal. The constant presence of gas, and the generally inflammable and bituminous nature of the adjoining shales, combined with the unusually large quantity of timber supports needed in the thick seams, and the other conditions mentioned, have given rise to a series of mine fires that have been a most serious drawback to the profitable operation of the Pictou and Cumberland fields.

The late Dr. Gilpin, when Deputy Commissioner of Mines for Nova Scotia, in 1894, contributed to the Institution of Mining Engineers a comprehensive account of explosions in Nova Scotian coal mines. A chronological summary, condensed from this paper, and supplemented by the addition of particulars of later date, will be found as an appendix to these present notes. (See page 61).

A study of the causes of the mine explosions and fires listed in the appendix will disclose that significantly many of them originated from the use of explosives, either from "blown-out" shots, or the ignition of gas feeders by the explosive used. Open lights were responsible for other explosions and fires.

One violent explosion was brought about by the drawing of pillars in a lower seam which let down burning material from an upper seam that had been on fire for many years.

A curious and well authenticated case was an explosion in an abandoned colliery, caused by the ignition of accumulated gas in the mine workings by a lightning flash which travelled down the mine shaft.

Adequate ventilation, the prohibition of open lights in the presence of gas, the substitution of "permissible" explosives and electric detonators for loose or compressed gunpowder, are conditions now to be found in the majority of Nova Scotian collieries. The future will in all probability see the introduction of still more conservative methods in the use of explosives, and it may be found possible in some instances to avoid altogether the use of explosives in the extraction of the coal, or, at least, to considerably lessen the quantity employed. It may also be anticipated that the use

of naked lights in coal mines will in time be entirely prohibited, whether gas has been reported or not.

As the mine workings descend into deeper and warmer strata, the coal dust problem will become more serious than it has been in the shallow, cool, and usually damp workings of the areas in which the first mine winnings were situated.

Dr. Gilpin's conclusion with regard to the influence of coal-dust was, that:—

. . . No explosion in Nova Scotia can be attributed to coal-dust alone, but a number of them have had their area and their destructiveness to life materially increased by coal dust.

This opinion was expressed in 1894, when the explosive properties of coal-dust were not so freely admitted as is the case to-day. The large currents of fresh air that modern mine ventilation affords, passing rapidly through the workings, have emphasized the coal-dust problem, and in districts where the winter temperature of the outer air descends to zero or below, these ample ventilating currents extract great quantities of moisture in their passage through the workings, and thereby increase the dust danger. Owing to the wide difference between the winter and summer temperatures, there is a wide range in the percentage of moisture in the mine air; the divergence being probably more marked at the mainland collieries, where, because of their more inland position, and in the case of Springhill mines, the greater elevation, the winter temperatures are lower, and the moisture in the outer air is less than is usually the case in Cape Breton island.

Since about 1907, many of the coal companies have provided oxygen breathing apparatus to assist in the fighting of mine fires, and in recovery operations after mine explosions.

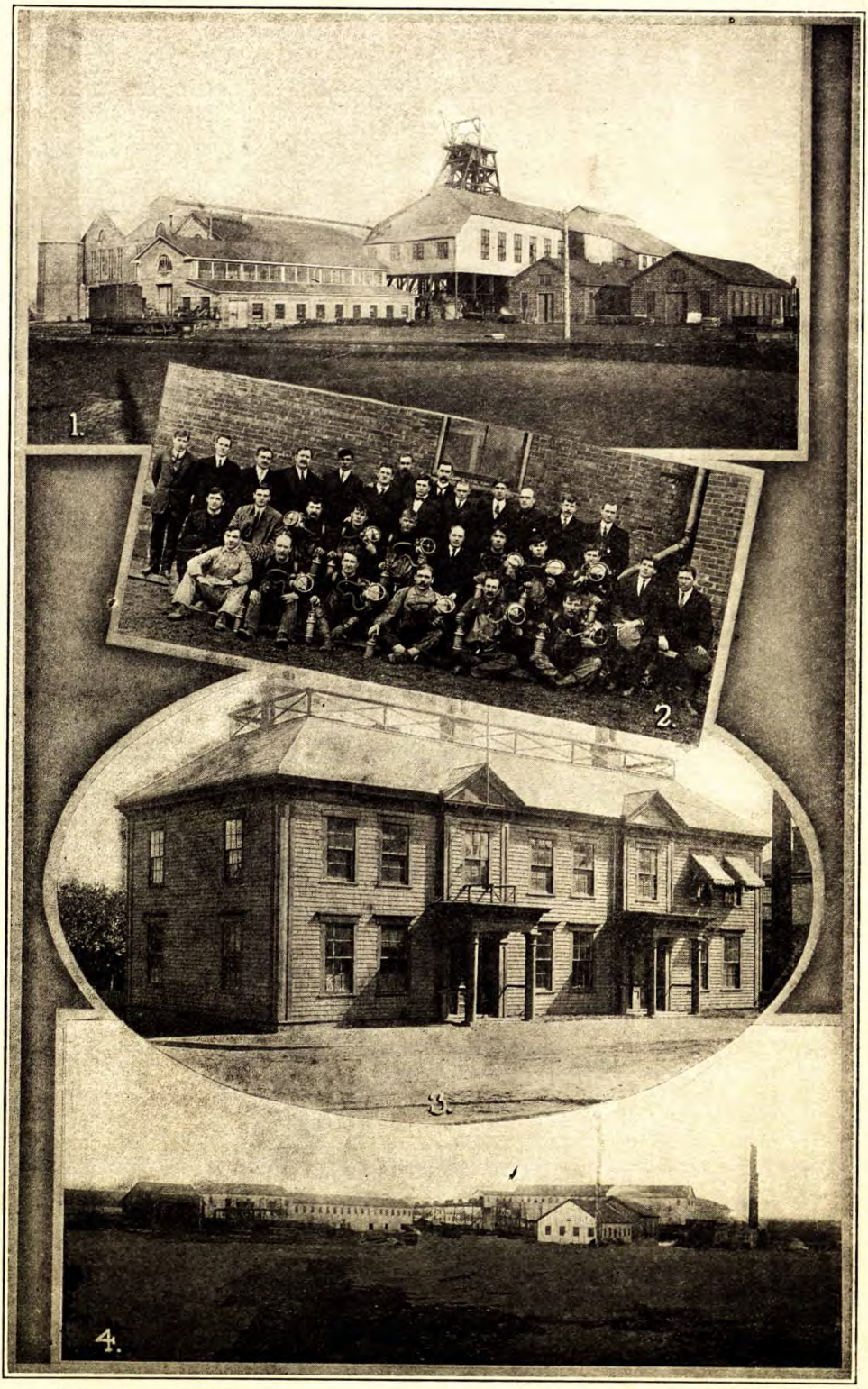
The Dominion Coal Company, the Nova Scotia Steel and Coal Company, and the Acadia Coal Company, have well-equipped stations where these apparatus are stored, and where men receive instruction in their use.

In a number of instances the use of these devices by trained men has given valuable assistance in extinguishing or sealing off mine fires, and in recovering such areas afterwards.

Probably the severest test to which breathing apparatus has been subjected in Nova Scotia was the fighting of a mine fire at the Albion mines in June, 1913. This fire was fought by hose and water at close quarters, a helmeted man playing with hose on the fire itself, and other men behind relieving him at short intervals. On several occasions the flames came back on the men, and at one time it was necessary to carry out a fall of burning material in buckets. The fire was eventually extinguished—actually put out—and not smothered by walling off as has generally been necessary. A sentence from the Deputy Inspector's Report is worth quoting:—

. . . I do consider it was one of the most plucky and gallant fire fights in the history of mining.[1]

[1] *Note.*—Deputy Inspector Blackwood, who made this report, was afterwards killed by "after-damp," together with the Superintendent of the Mine, Mr. Brown, when exploring the workings after the explosion at the Allan Shaft in December, 1914. The Deputy Commissioner of Mines and Chief Inspector referring to this accident in the Mines Report for 1915, says Mr. Blackwood lost his life "through a high conception of his duty."



Collieries, General Office, and Rescue Corps, of the Acadia Coal Company, Stellarton, N.S.

At practically every mine there is an organized surface fire brigade, with equipment. Considerable use is made of portable chemical fire extinguishers, which are provided at suitable points, both above and below ground. At many collieries the compressed air pipe lines in the mine are so arranged that they can be quickly connected to a pump, and used as water lines in case of an underground fire.

Oil-Shales and Inferior Coals.

Bituminous shales, or oil-shales, occur in considerable quantities in New Brunswick and Nova Scotia. A brief reference to these deposits will not be out of place, as the oil-shales are associated with the coal seams, and have many characteristics in common.

The matter of the profitable commercial utilization of the oil-shales of the Maritime Provinces was thoroughly investigated about 1908, and a very full and detailed report of the occurrences of these oil-shales was published by the Department of Mines, Ottawa, in 1910; together with a description of the successful oil-shale industry of Scotland. Full information on this interesting subject will be found in the various writings of Dr. R. W. Ells, to which the reader is referred. (See Bibliography).

Dr. Ells' report is of greater interest since the war commenced than it was when published, because of the increased importance that now attaches to all sources of hydrocarbon compounds, within the Empire, and because improved processes of distillation, and more complete recovery of the by-products, have enlarged the commercial possibilities of the oil-shales, cannels, and inferior coals.

A series of samples of New Brunswick shales, aggregating 41 tons, was passed through the experimental retort of the Pumpherston Oil Company in Scotland, and yielded an average of 40·09 gallons of crude oil, and 76·94 pounds of ammonium sulphate per ton of shale retorted.

Tests made of the Pictou oil-shales have shown a yield of crude oil of from 20 to 40 gallons per ton; while the oil-coal, or "Stellarite" from the Pictou district is said to have yielded from 53 to 77 gallons per ton, and picked samples, over 120 gallons per ton.

The oil-shales of Albert, Kings, and Westmorland counties, in New Brunswick, exist in enormous thicknesses. The shales yielding the largest quantities of oil and ammonium sulphate are the so-called "paper shales," a finely laminated deposit having numerous remains of fossil fishes between the leaf-like layers of the shales; and a close-grained chocolate-coloured shale, having a conchoidal fracture, and sometimes, a "curly" texture resembling felt.

In Pictou county, and in Antigonish county, Nova Scotia, large deposits of oil-shales exist, of which the most striking and well known example is the "Stellarite" oil-shale found near the town of Stellarton.

Previous to the discovery of the petroleum wells in the United States, about 1860, the Pictou oil-shales were mined for exportation to the United States, where they were used for the enrichment of illuminating gas, and a

commencement was made in the retorting of the New Brunswick shales for the extraction of oil. The finding of petroleum in huge quantities stopped the further development of oil-shale mining.

Should the demand for mineral oil at any time become such that its extraction from the oil-shales of the Maritime Provinces is made commercially profitable, these immense deposits will doubtless be utilized.

The commercial possibilities of the extraction of oil from shales will depend very largely on the successful recovery of the by-products, as has been exemplified in the case of the Scotch oil-shale industry.

The coal companies are more interested in the distillation of oil-shales than is perhaps realized, because not only do some of the oil-shale deposits occur within the mining areas of coal companies now operating in Nova Scotia, but these companies have also access to large quantities of inferior coals, coaly shales, and screenings, which, at some future date may, very conceivably, be found to yield a sufficient percentage of hydro-carbons to justify the extraction of these.

Brickmaking.

No use has, up to the present time, been made of the shales accompanying the coal seams in Nova Scotia, great bodies of which are admirably adapted for brickmaking; with the single exception of the fireclay bed underlying the third seam at the Drummond colliery of the Intercolonial Coal Mining Company, at Westville, Pictou county. At this colliery a seam of fireclay 5 feet 6 inches thick, is mined along with the coal seam. A buff-coloured firebrick, suitable for lining ladles used in handling molten metal, and for the lining of slag cars, is made from this clay, and is extensively used for these purposes by the local steel companies.

Suitable shales are obtainable from the roof and wastes of the underground workings of the collieries, or can be quarried where the shale cliffs are exposed along the sea-coast. Trial samples have demonstrated that an excellent brick can be made from the shales associated with the coal seams in Cape Breton, and there is no reason to doubt that the shales in the other coal-fields of the Province would give equally good results.

The Nova Scotia Steel Company, will, by the autumn of 1916, have completed a small brick plant for the utilization of colliery shales. The shales will be ground dry, the water being afterwards added, so as to obtain a uniform clay. If a suitable fireclay is available, this Company may find it possible to supply its own needs in bricks for ladle linings. If the enterprise of this Company proves successful it will probably be the means of creating greater interest in the possible utilization of the colliery shales.

There is, unfortunately, a decided scarcity of true fireclay in the Province, and no ganister beds, such as are associated with some of the Millstone Grit coal seams in England, have as yet been discovered in Nova Scotia.

SOCIOLOGY AND ECONOMICS OF THE MINING INDUSTRY.

General Conditions of Employment.

The population of Nova Scotia still justifies its name, a glance through the directories being sufficient to reveal how large a proportion of the inhabitants of the Province are of Scottish ancestry. In Cape Breton island the population is preponderatingly of Highland descent, intermingled with the descendants of Irish settlers and the Acadian French. The Gaelic language is still in common use, especially in the country districts, and in Inverness county.

In the Sydney district probably 60 per cent of the mine employees are native Nova Scotians, from 10 to 15 per cent are of non-English-speaking nationalities, chiefly Italians, Frenchmen, Belgians, Germans, Austrians, Russians, and Slavs of various countries. The remainder are persons born in the British isles, or in Newfoundland; the latter place being an important contributor to the labour supply of Nova Scotia. In Inverness county, and at the mainland collieries, the percentage of Nova Scotians and others of British nationality is greater.

Although the immigration from Europe has furnished an important part of the labour required at the collieries, and notwithstanding the constant drain of the Canadian west and the New England states on the younger men of Nova Scotia, it cannot be said the percentage of British born workmen has decreased, as the immigration from the British Isles and from Newfoundland has been large. The ratio of nationalities has been, temporarily, greatly altered by the war, as enlistments among the miners has been large. Since August, 1914, there has been a more or less complete exodus of French, Belgian, and Italian reservists.

The Nova Scotian miner does not generally desire his son to follow his own trade, and while the day is far distant when the collieries of Nova Scotia will be so largely manned by foreign workmen as is now the case in the collieries of the United States, a tendency in this direction is discernible, and perhaps unavoidable.

The mines work on single shift, commencing work at seven a.m., and hoist coal up to four or five o'clock in the afternoon. The double shift system has been employed on occasions in the past, but it is distinctly unpopular with the workmen. The miners and contract-men are, usually, out of the pit by three p.m., but the bottomers, and men engaged on the haulages, remain until the day's coal is drawn.

Wages are paid fortnightly; but from May, 1917, they will be paid weekly. Miners' cottages rent at from $4 to $8 per month. Wages range from $1.75 per day for surface-labourers; up to $5 and $6 per day earned by skilled machine-runners, and other men paid by piece-work and tonnage rates, underground. The average wage of all classes at the collieries, taking in all grades of labour employed, will be about $2.60 per day.

Boys under fourteen years of age are not allowed to work at a colliery, and in cases where a boy has not passed the standard of school proficiency required, the age limit is sixteen years. No female labour has at any time been employed in or about Nova Scotia collieries.

The law requires that each miner in charge of a working place must hold a certificate, and certificates of competency are required for shot-firers, overmen, underground managers, and mine managers. Stationary engineers, and certain classes of boiler attendants, must also be certificated.

Since the beginning of the coal industry in Cape Breton the coal companies have carried on retail stores for the supply of groceries and other goods to the workmen. This has been a necessary part of the operations of the Companies, because the collieries, when first opened, were in unsettled districts, and provision had to be made for the needs of the workers. In the early days of mining operations, and until within the past fifteen years, the winter was a very slack period, and the earnings of the workmen were correspondingly reduced. The "Company Stores" sold goods on credit, and collected the debts through the payrolls during the busier summer period. Certain undesirable conditions arose out of these circumstances, and a good deal of odium attached to these stores. Legislation was enacted providing that wages should be paid in cash only; but permitting collection, through the medium of the payrolls, of certain specified deductions, such as debts incurred for rental, coal, relief fund dues, doctors' fees, mining supplies, and goods purchased from the stores. The workmen were safeguarded by a provision that in each case a written order for the deduction must be given by the workman concerned.

In later years, the "Company Stores" have been used to supply necessary articles of good quality and at moderate rates, to the workmen; the purchasing power of the large companies being used to the considerable advantage of the workmen, and to effect an appreciable reduction in the cost of living at the mines.

The original conditions that made these stores a necessity are still to some extent present. The undeveloped sites of the newer collieries were in wooded, unsettled country, and it was necessary for the coal companies to provide all the ordinary conveniences of a community, such as railways, streets, water, light, and retail stores. Large numbers of new workmen had to be brought to the new collieries, and in many cases provided with food and clothing until they had accumulated earnings sufficient to pay for these necessities.

The difference between summer and winter conditions has almost disappeared, but the other circumstances referred to make the "Company Store" a necessary provision, apart from the fact that nowhere else can the workmen purchase to better advantage than at these stores as now managed. The choice in this matter is, of course, entirely optional with the workmen.

The development of large new collieries in unsettled localities has in the same way compelled the coal companies to build large numbers of

dwellings, and to become the chief landlords in the mining centres. In recent years great advances have been made in the design and comfort of these dwellings, particularly at the newer colliery towns.

The substitution of electricity for steam, as a motive-power, has brought about a very noticeable improvement in the cleanliness of the collieries and adjacent villages. The entire absence of smoke and steam at those of the newer collieries, where electricity is exclusively used, is very noticeable by comparison with the older steam operated collieries.

Miners' Relief Societies.

Miners' Relief Societies have been in existence in Nova Scotia for between thirty and forty years. In 1910, the Provincial Government enacted a Workmen's Compensation Act, similar in its provisions to the first British Act, but exempted the coal companies at whose collieries approved relief societies were in existence.

It was represented that the application of the Compensation Act to the collieries would endanger the existence of the relief societies, as in such event, the coal companies would withdraw their contributions to these societies, and it was pointed out that a gradual extinction of the colliery relief societies had followed the passing of the Workmen's Compensation Act in Great Britain. The perpetuation of the relief societies in Nova Scotia seemed particularly desirable, as they form the only organized safeguard of the miner against disability from sickness and disease. The population of the country is as yet too small to support wealthy friendly societies, and the existing fraternal and friendly societies and the insurance companies do not favour miners as members, because it is supposed that miners are more susceptible to disease than the ordinary members of the community. Further, the almost complete absence of Poor-Law provision in the mining municipalities creates a very real need for some provision against sickness, apart altogether from the disability caused by accident sustained in the course of employment. A Workmen's Compensation Act, of course, makes no provision for loss of earning power due to sickness, except in the rather obscure and debatable field of occupational diseases.

A typical relief society is the Dominion Coal Company Employees' Benefit Society, which insures workmen of all grades against disability or death from sickness and accident; whether arising out of the employment or not. The income is derived from a monthly contribution of fifty cents by each member, supplemented by an equal amount contributed by the Company, and a grant from the Nova Scotia Government based on the tonnage of coal sold, and approximating to ten cents per month per member. Relief is granted at $6 per week for 26 weeks; $3.50 per week for the following 26 weeks; and $2 per week for a further two years; after which time, special grants may be given. Widows are granted $8 per month for a period of five years; and $3 per month for each child under 14 years of age. Although the by-laws of the Society do not provide it, in

cases of protracted total disability from accident, it has become customary to continue the full payment of $6 per week during the period of disability.

The income and expenditure of the Society in 1915 were as given below:—

Income:—		
Workmen's contribution	$60,396	
Company's contribution	60,422	
Government's contribution	12,842	
Interest on investments	9,718	
		$143,378
Expenditure:—		
Weekly indemnities, including claims arising out of sickness and accident	$100,419	
Death claims	9,596	
Widows' and children's allowances	24,243	
Management, etc	6,176	
		$150,434

The reserves of the Society total about $200,000. The members number around 10,000 persons, and before the war the membership reached 11,500 persons.

A new Workmen's Compensation Act was passed by the Nova Scotia Houses in 1915, providing compensation on a much more liberal scale than the first Nova Scotia Act. A comparison of the benefits provided by the new Act with the payments made by the Dominion Coal Company Employees' Benefit Society, would, at first glance, seem to favour greatly the operation of the Compensation Act, and there is no doubt of the more favourable nature of the Compensation Act so far as payments for disability from accident is concerned. So far as the expenditure of the coal companies is concerned, the payments required by the Compensation Act would be no greater, and would probably be much less than the payments from the companies necessary to sustain the relief societies. The explanation is that two-thirds of the monies paid out is on account of death and disability from sickness.

Under the new Compensation Act, the employees are allowed to contract out of the provisions of the Act, and substitute an approved relief society, consent, or otherwise, being indicated by a secret ballot.

The present scheme of the Benefit Societies is admittedly an experiment, and the experience gained should aid in elaborating a revised scheme that would place the relief societies on a solid and permanent financial basis, combining the benefit of the Compensation Act, and the Relief Societies as now constituted.

The management of the Relief Societies is arranged on equal representation of employer and workmen alike, but is actually directed by the men themselves, the most efficient safeguard against malingering.

A community of interest and contribution by employers, employees, and the Government—representing the owners of the royalty rights—providing for all and every disability, whether arising out of sickness or work-accident, would, from past experience, seem to be the ideal solution.

The requirement of the Act, that all contracting-out schemes must be approved by the Compensation Board, will ensure that all the existing Relief Societies will be placed on a satisfactory basis.

It will be noticed in the figures given relating to the Dominion Coal Company Employees Benefit Society, that the expenditure exceeded the income in 1915; and in addition, liabilities were incurred for the future support of the families of deceased members. The experience of this Society, since the consolidation of all the colliery branches into one Society, in 1910, has been made the subject of expert actuarial investigation, and a scheme is under consideration to improve the benefits, and to place the Society on a basis that will ensure permanent solvency. To do this will necessitate increased contributions from all parties concerned.

The medical needs of the miners and their families are looked after by the colliery doctors. These practitioners are paid by monthly amounts, usually about fifty or sixty cents from each man, deducted from the payrolls. The workmen designate the doctor they desire to have, and the coal companies are required to collect the amounts and pay them over to the doctors.

The chief colliery districts are well provided with hospitals. These are maintained by monthly contributions from the colliery workmen, usually thirty cents per month, supplemented by the Government hospital grant, by donations from the coal companies and private individuals, and by hospital fees paid by private patients. The miner receives free hospital treatment, although some fees are charged by the hospitals and the doctors for special operations. The hospital equipment is good, and modern.

Legislation and Technical Education.

The regulation of the coal mines is directed by provincial statutes: embodying, in their present form, the accumulated experience of one hundred years in the working of coal mines in Nova Scotia.

Mine inspection is carried out by a staff of Deputy Inspectors of Mines, reporting to the Inspector of Mines in Halifax, who is also the Deputy Commissioner of Public Works and Mines, reporting to the Commissioner of Works and Mines. The last named office is really that of Provincial Minister of Mines, and the holder is ex-officio a member of the Provincial Executive.

Federal legislation has so far had little or no bearing on the coal industry except in so far as it has related to customs duties, labour laws affecting disputes between employers and employees, and laws regulating immigration.

A pressing need exists for the establishment of a central authority on such matters as the testing of mine explosives, and general research work on problems affecting mining, following, in some measure, the lead of the Bureau of Mines in the United States. The financial resources of the individual provinces of Canada will not permit of separate provincial establishments, nor in any case, would such a duplication of effort be advisable.

Some very useful investigations have been conducted by the Federal Department of Mines such as the investigation into the economic qualities of Canadian coals; and the compilation of research data regarding mine timber, that have been undertaken by the Forestry Branch of the Federal Department of the Interior, in coöperation with the mining faculty of McGill University.

That the fringe only of many necessary investigations has been touched in Canada, may be gathered from a perusal of the various "Technical Bulletins" issued by the United States Bureau of Mines, which, by a pleasing instance of international courtesy, are sent to Canadian readers, upon request, gratis, and post free.

The Mines Branch of the Department of Mines, Ottawa, has done well, with the means at its disposal; but a greater money appropriation and more extensive equipment is necessary if this Department is to adequately fill the need that now exists.

The technical education of mine officials is a matter in which Nova Scotia has been a pioneer on the American continent. The provincial mining schools are designed to enable aspirants for official positions to qualify for the certificates of competency of various grades required by the provincial laws. These schools—really evening classes—are held in the various mining centres; and a small equipment is provided to enable elementary instruction to be given in physics, machine-drawing, surveying, electricity, and other mining subjects.

For higher education the Province has provided a Technical College in Halifax, where mining, and general engineering courses can be taken. There are also five other colleges in Nova Scotia at which engineering courses can be taken. Yet, with all this provision of educational institutions, not one of them has the financial resources to equip really adequate laboratories for research work; nor are there any of these colleges sufficiently near to the mining districts to allow of the use of their laboratories and scientific equipment by students who work during the day time and attend school in the evenings; a procedure that has been so successful in the mining districts of Great Britain, under the "University Extension" movement.

The difficulty is a real one, and the Department of Technical Education of Nova Scotia is doing its best to solve the problem. A recent and commendable innovation is the commencing of correspondence courses by the Provincial Technical School. In the past, a great deal of the technical education of the officials has been obtained through the study of correspondence courses, originating in the United States. The correspondence courses of the Halifax Technical School will be coördinated with the work of the evening technical classes throughout the Province, and the idea is in every way a distinct advance.

The Technical College at Halifax has been the subject of criticism because of its distance from the chief industrial centres, but it is difficult to see how the Provincial authorities could better reconcile the conflicting claims of the scattered coal districts than by building the *first* technical

college at Halifax, as a centre from which the activities of the Technical Education Department can work.

It should be found possible, by a system of scholarships awarded on the excellence of work done in the evening mining schools, to select promising students for short mining courses in Halifax, and thereby remove the financial limitation that prevents many young miners from taking advantage of the Halifax Technical College.

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[1] This Memoir contains a very complete summary of the chronology of geological investigation in the Maritime Provinces, and valuable references are given to the writings of Francis Alger, C. F. Jackson, Abraham Gesner, Sir J. W. Dawson, Rev. D. Honeyman; officers of the Geological Survey of Canada; namely, Hugh Fletcher, H. M. Ami, R. W. Ells, E. Billings, J. F. Whiteaves; also Professor R. A. Daly, of Harvard; Prof. J. E. Woodman, of New York City University; Prof. W. H. Twenhofel, of the University of Kansas; and Prof. Charles Schuchert, of Yale University.

EXPLOSIONS AND FIRES IN NOVA SCOTIA COAL MINES.

Chronological List of the more important Coal-Mine Explosions, and Underground Mine Fires that have occurred in Nova Scotia.

(Summarized from a Paper written in 1894, by Dr. Edwin Gilpin, and read before the Institution of Mining Engineers, with the addition of particulars of explosions and fires of subsequent date. This list is not given as being absolutely complete, but as a summary of the more important occurrences).

Date.	Locality	Lives Lost	Remarks
1832	Albion Mines, Pictou Co.....	.....	Mine fire. Workings flooded.
1834	" " "	.....	Mine fire. Feeder of gas ignited by shot.
1836	" " "	Several	Explosion.
1838	" " "	3	Explosion. In No. 2 Pit Sinking Shaft.
1839	" " "	.....	Gas feeder ignited by shot set fire to coal, a violent explosion following. Mine abandoned.
1858	" " "	2	Gas explosion.
1862	" " "	3	Night watchman ignited gas.
1864	" " "	.....	Gas explosion.
1867	" " "	.....	Ignited gas feeder. Shafts abandoned.
1869	" " (Ford Pit)....	.....	Fire. Mine flooded.
1873	Drummond Mine, Pictou Co...	55	Shot ignited feeder, most violent explosion following.
1878	Sydney Mines, Cape Breton....	5	Gas explosion. Naked lights.
1880	Albion Mines, Ford Pit.....	44	Explosion. Said to have been originated by shot, and to have been aggravated by dust. Mine abandoned.
1885	Vale Colliery, Pictou Co.....	13	Blown-out shot. Gas explosion extended by dust.
1888	Albion Mines, Third Seam.....	.....	Explosion. Supposed ignition of gas in walled-off fire-area, originally caused by hot "stythe," let down from Cage Pit Seam by pillar-drawing in Third Seam.
1891	Springhill Mines, Cumb. Co....	125	Explosion, supposed to have been caused by overcharged and "flaming" shot, igniting gas in roof-stone, and extended by dust.
1892	Drummond Colliery, Pictou Co.	.....	Explosion following electrically detonated shot of "Roburite." Cross-measure stone-drift was holing into top of Deep Seam, gas-feeders being present. Coal ignited. Fire area dammed off and flooded.
1893	Disused Shaft mine on Deep Seam, near Drummond Mine.	.....	Workings temporarily closed and filled with gas. Explosion caused by lightning flash.
1894	Caledonia Colliery, C.B.....	.....	Mine fire. Caused by naked light torch used for lighting pit bottom. Extinguished by hose and water.
1895	Dominion No. 1 Mine, C.B.....	2	Ignition of accumulation of gas causd by displaced brattice. Naked lights.
1899	Caledonia Colliery, C.B.....	11	Mine fire, followed by explosion. Men died from carbon monoxide poisoning.
1903	Dominion No. 1 Colliery, C.B..	.....	Mine fire. Caused by careless use of naked light. Mine flooded from ocean. Pumping-out occupied 12 months.

Date	Locality	Lives Lost	Remarks
1906	Hub Colliery, C.B.....	.....	Mine fire. Careless use of naked light. Mine flooded from ocean. In this case flames came up hoisting-shaft and destroyed all surface erections. Mine afterwards pumped out.
1908	Port Hood Colliery, C.B.....	10	Gas explosion. Mine worked by naked lights and loose powder used. Exact cause of ignition of gas unknown, but thought that powder had some share in the occurrence.
1908	Sydney Mines, C.B.....	.....	Mine fire. Coal ignited by "hung shot." Fire area dammed off and flooded.
1911	Sydney Mines, C.B.....	8	Gas explosion, aided by dust. Ignited by Deputy who had opened his safety-lamp.
1912	Springhill Mines.....	.....	Mine fire. Area sealed off.
1913	Drummond Colliery.....	.....	Mine fire. Area sealed off. Three apparently separate gob fires.
1913	Albion Mines.....	.....	Mine fire. Caused by overheated brake-drum at top of a staple shaft. Excellent service was rendered in fighting this fire by oxygen breathing-apparatus. Fire extinguished.
1914	Allan Shaft Mine, Pictou Co...	2	Explosion. Deputy Inspector and Mine Superintendent suffocated in exploring workings after explosion. Mine sealed off and recovered four months later.
1915	Drummond Colliery.....	.....	Mine fire. Area sealed off, and mining discontinued on the Main Seam.

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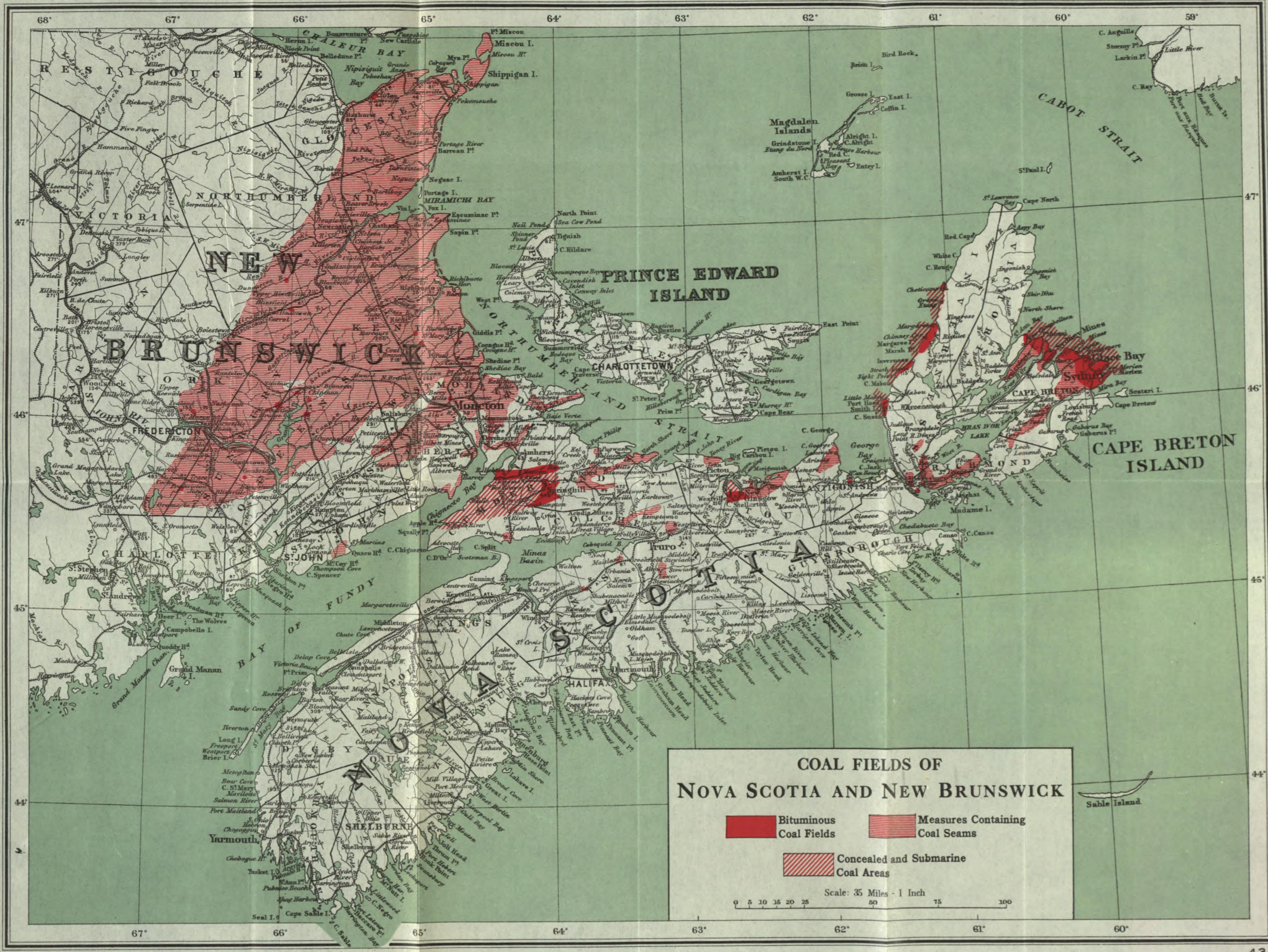
CANADA

DEPARTMENT OF MINES

MINES BRANCH

HON. P. E. BLONDIN, MINISTER; R. G. M^C CONNELL, DEPUTY MINISTER.
EUGENE HAANEL, PH. D., DIRECTOR.

1916



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