

Hobart,

July, 1934.

Senator the Hon. A.J. McLachlan,
Minister in Control of Development,
CANBERRA. F.C.T.

Dear Sir,

In presenting the accompanying report of the Tasmanian Shale Oil Committee (1934) I desire to bring to your notice the valuable information which has been contributed by Mr. E.E. Kurth, Lecturer in Chemistry at Hobart University. It is mainly due to Mr. Kurth's long continued research into the distillation of Tasmanite oil shale and the shale oil derived therefrom that this Committee and the previous one were able to include much valuable information and data in the reports.

At the suggestion of Mr. J.B. Scott, Secretary for Mines, and with his continued interest and encouragement Mr. Kurth's researches have been continued as regards the production of bitumen with the result that the Committee is able to recommend an experimental enquiry into a method of treatment which promises to be at least much more economical than the production of oil from this shale by distillation.

Yours faithfully,

(Sgd.) P.B. Nye,
CHAIRMAN.

Report of the Tasmanian Shale Oil Committee (1934).

Senator the Hon. A.J. McLachlan,
Minister in Control of Development,
CANBERRA. F.C.T.

Sir,

The Committee appointed to enquire into the economics of the shale oil industry in Tasmania has the honour to submit the following report. -

At the first meeting, convened by the Hon. Claude James, M.H.A., then Minister for Mines for Tasmania, Mr. P.B. Nye was appointed chairman of a technical committee constituted as follows:-

Mr. P.B. Nye, Government Geologist, Department of Mines, Tasmania.	} Nominated by the Government of Tasmania.
Mr. E.E. Kurth, Lecturer in Chemistry, Hobart University.	
Mr. A. Walker, Manager, Tasmanite Shale Oil Company.	
Mr. J.A. Stevenson, Chief Investigation Officer, Development Branch, Prime Minister's Department.	} Nominated by the Commonwealth Government
Mr. L.J. Rogers, Commonwealth Fuel Adviser.	

This Committee met in Launceston from June 18th to June 21st inclusive, and on the completion of its deliberations presented an interim report giving the conclusions reached on certain matters which might require immediate attention. The present submission amplifies the previous report, and sets out in some detail the Committee's findings and recommendations.

SOURCE OF INFORMATION.

Much of the information used in the compilation of this report is taken from a publication of the Department of Mines, Tasmania, Geological Survey Mineral Resources No. 8, Volume II, Report of the Tasmanian Shale Oil Investigation Committee. This information has been supplemented by further work carried out by the Mines Department under Mr. Nye's direction, by Mr. Kurth at Hobart Technical College, and by Mr. Walker at Latrobe.

Since the publication of the bulleting referred to above, two grants of £1000 and £500, respectively, have been made available by the Commonwealth Government for further proving the extent of the shale seam by drilling. The first grant has been expended in sinking ten bores, each of which has intersected the seam. One other hole has been

drilled with part of the money provided in the second grant, but in this instance no shale has been located. Further boring is in progress.

Mr. Kurth has continued his research work on the constitution and treatment of Tasmanian Oil Shale, and has made available to the Committee additional information of considerable value on the preparation of bitumen for road-making purposes.

Mr. Walker's report, published as Appendix No. 5 to bulletin already mentioned, gives the out put of crude oil by the Tasmanite Shale Oil Co. to 29th June, 1932, as 105442 gallons. The total production has now been increased to 268,333 gallons as on 16th June, 1934.

SCOPE OF THE INQUIRY.

The report takes the form of an economic inquiry, firstly into the preparation of oil products from Tasmanian shale, and secondly into the manufacture of bitumen as the principal product of the industry. Further technical investigations must be undertaken before the industry can be established on a commercial scale, and justification for this work and expenditure must be sought in the results which may be achieved in large-scale practice. The Committee therefore has considered it necessary to estimate as accurately as possible the economics of operating a plant of commercial size. These estimates are submitted subject to verification or revision of certain figures, which at the moment must be regarded as only approximate.

A consideration of the quantities of oil products imported into Tasmania indicates that the largest distillation plant whose erection can be contemplated has a capacity of only 250 tons of shale per day. The output of finished products from this plant compares with Tasmania's consumption approximately as follows :-

Annual Quantities of Oil Products.

		Recoverable from 250 tons of selected shale per day	Imported into Tasmania - 1932/33.
Motor Spirit	Galls	250,000	4,000,000
Kerosene	Galls	250,000 (Power only)	500,000 (Power & Lighting).
Fuel Oil	Tons	5,700	200 *
Bitumen	Tons	1,800	3,000 *

NOTE

* These figures fluctuate considerably from year to year. The greatest quantity of Fuel Oil imported in any one year was 900 tons in 1930/31, while the 3,000 tons of Bitumen imported in 1932/33 is the greatest quantity of that commodity that has been imported in any year.

Some doubts may be entertained regarding the disposal of certain products, but marketing problems may be deferred

for later consideration.

The economics of the 250-ton per day distillation plant appear so unfavourable that the Committee has considered it desirable to prepare similar estimates for a smaller plant of 60 tons daily throughout. It is not contended that this plant would be an economic unit, but its installation might be contemplated by the Government as the nucleus of a plant which might be needed in a time of national emergency.

Finally, the Committee desires to present the financial position of the existing retorting plant at Latrobe, so that the Government may have an opportunity of deciding whether further assistance for the industry is justified as a measure of unemployment relief.

It has not been possible to estimate the prospects of a bitumen industry as closely as those of an oil industry in Tasmania. The Committee therefore has confined its attention to two hypothetical plants of different types, each of sufficient capacity to meet Tasmania's requirements of road bitumen. The financial position of these plants has been estimated as closely as the limited amount of information readily available would permit, and a programme of experimental work has been prepared for the purpose of defining the prospects of a bitumen industry more accurately.

DISTILLATION OF SHALE ON A COMMERCIAL SCALE.

The following estimates of the cost of erecting and operating a 250-ton per day shale distillation plant are based upon the assumption that private capital would be raised for the purpose, that the Government would provide such assistance as might be required for declaring a 6% dividend, and that the administration of the company would be entirely in private hands. All capital and working expenditure has been reduced to a minimum. No allowance has been made for a head office at Melbourne or elsewhere, nor is any capital provided for building homes for miners or refinery employees. It is considered that, if accommodation in Latrobe should prove inadequate or inconveniently distant from the works, new homes could be constructed and financed in such a way as not to be a charge on the industry.

If an output of 250 tons of shale per day is to be maintained for several years it will be necessary to conduct mining operations in the relatively undisturbed area approached from the old Railton-Latrobe tunnel. When working on such a scale also, it will not be possible to confine operations to certain sections of the field, where the shale is richer than elsewhere. Estimates of revenue must therefore be based upon the average grade of shale throughout the field.

The shale seam is composed of three bands. The middle band, constituting 25% of the thickness of the seam, is very poor in quality, yielding only 7 gallons of oil per ton in an assay apparatus. The average value of the top and bottom bands varies from 33 to 39 gallons

per ton in different parts of the field. A consideration of mining and retorting expenses for the whole seam and the two bands, respectively, shows that the cost of the crude oil is lower when the middle band is rejected. The following estimates of working costs and yields of products are based, therefore, upon a rough separation of the low-grade material in the mines.

The treatment plant would be located for preference on the site of the refinery belonging to Shale Oil Demonstrating Company Limited, so that full advantage may be taken of the rail connection and the existing equipment. A nominal figure of £10,000 is included in the estimate of capital cost for the purchase of plant and leases from the various companies who have such assets in the field. It is not pretended that this figure represents the value of the plant and leases, either as a going concern or for break-up purposes. It is included rather as a formal item, the exact magnitude of which can only be determined by agreement among the companies themselves. The scrap value of the equipment on the field is probably within the figure allowed.

It has been assumed that the crude shale oil would be refined merely by distillation and chemical treatment. No information of any value is available on the cracking of Tasmanian shale oil, but the general nature of the oil suggests that it would be a poor cracking stock. Cracking would also accentuate the sulphur problem to be mentioned later. In any case, this refining process could only be adopted on a scale so large as to make the disposal of the products in Tasmania quite impracticable. Hydrogenation would overcome the sulphur difficulty, but only at great expense. In this instance, again, the yield of petrol would be far in excess of local requirements. Both cracking and hydrogenation would appear commercially more unattractive than straight distillation. No further consideration need be given, therefore, to these methods of refining.

The Railton-Latrobe mine is approximately one mile distant from the site of the proposed treatment plant. The shale would probably be delivered to the works most economically by means of an aerial railway. Provision is made for such transport in the estimates of capital and operating expenditure.

The revenue of the company is based upon the nett wholesale value of the products at the refinery. At this stage, there is no justification for a detailed enquiry into the distribution and marketing of the products, such as would be necessary for assessing their value more precisely. The cost of storage and bulk distribution facilities is included in the estimates of the capital required, but working expenses for the marketing of the products are considered to be covered by the difference between retail selling prices and the corresponding wholesale values assumed in the revenue account.

In the following tables sufficient information is given to assess the complete economic position of the proposed plant, both from the commercial and the national point of view. The figures presented are subject to certain reservations to be discussed later.

Capital cost of Mine, Works, Distribution Facilities, etc.-

Development and equipment of mine, aerial ropeway to plant,	£48,000
Retorts, refinery, buildings, shale bin, boilers and power plant, overhaul of existing equipment, water supply, drains, etc., supervision of construction... ..	74,5000
Storage tanks, kerosene drums, bitumen drum factory, tank waggons, Launceston depot	18,500
Contingencies - 10% on above	14,000
Purchase of plant and leases	10,000
Loss on operations during adjustment period	<u>6,000</u>
TOTAL:	<u>£171,000</u>

Working capital

Operating Costs :-

Mining	10/6 per ton of shale.
Crushing and transport	1/- " " " "
Carbonisation, exhausting, condensing, scrubbing	6/- " " " "
Distillation of crude oil, refining of petrol and power kerosene	1.15d. per gal. of crude oil.

Yield of Products :-

Crude Oil	29 gallons per ton of shale (83% of assay value).
Refined petrol	10% of crude oil
Refined Power Kerosene	10% " "
Fuel Oil	54% " "
Bitumen	16% " "
Losses	10% " "
	<hr/> 100% <hr/>

Profit and Loss Account :-

(350 Working days per annum)

Expenditure	£	Revenue	£
Mining, crushing and transport of 87,500 tons of shale; retorting exhausting, condensing, scrubbing	76,560	Petrol 254,000 gals. @ 1/-	12,700
		Power Kerosene 254,000 gals. @ 10½d.	11,100
Distillation and refining	12,160	Fuel Oil	
Management, insurance, office expenses	6,200	5,700 tons @ £3	17,100
Excise, 5½ per gal. of petrol	5,820	Bitumen 1,800 tons @ £6	10,800
Interest on working capital 6%		900 Deficiency assistance required from Government	69,510
Dividend on share capital, 6%	10,300		
Depreciation reserve, 15 years mean life, 5% of capital value	8,500		
State dividend duty	<u>770</u>		
	<u>£121,210</u>		<u>£121,210</u>

(In estimating the above costs, the wage rates assumed for mining were those of the Coal and Shale Employees Federation and for retorting, refining etc. those used by the Newnes Committee).

Annual Loss to Governments:-

	£	£
Assistance required by the Company	69,500	
Loss in Customs Duty and Primage	<u>9,600</u>	79,100
<u>Less</u> - Excise paid	5,820	
Dividend Tax	<u>770</u>	<u>6,590</u>
Net cost of supporting industry		<u>72,510.</u>

Employment created 170 men

Oil Products prepared in Australia:-

Petrol	...	...	254,000	gallons per annum
Power Kerosene	...	...	254,000	" "
Fuel Oil	...	...	5,700	tons " "
Bitumen	...	...	1,800	" " "

The figures given in the foregoing tables are subject to certain reservations which may now be discussed.

1. It is considered impracticable to refine the motor spirit to a sulphur content of less than $1\frac{1}{2}\%$. Such a petrol could not be distributed for universal application, particularly in the cold climate of Tasmania, without leading to serious trouble in the corrosion of engine bearings. Lorry engines are less susceptible to corrosion by sulphur compounds than private cars, but it may be doubted even in this case whether a fuel containing $1\frac{1}{2}\%$ of sulphur will give continued satisfaction. It is assumed in these calculations, however, that a quarter of a million gallons of shale spirit could be sold annually at the price of second-grade petrol, either for use in heavy vehicles or for blending with imported spirit. This assumption may be considered optimistic.

If a considerable demand for kerosene were to exist, some of the petrol could be sold as a tractor fuel, with only a small loss in revenue. But, as explained below, the market for power kerosene in Tasmania is not greatly in excess of the potential output of this product from a 250-ton per day plant. There is no prospect, therefore, of relieving the petrol position in this way.

2. The effect of high sulphur fuels on tractor engines is not definitely known, and it is by no means certain that shale kerosene containing 2% of sulphur could be used indefinitely without trouble developing from corrosion. The possibility of capturing 60% or 70% of the Tasmanian market, without accepting a reduced price for power kerosene, may be regarded as unlikely. It may be necessary in practice to decrease the kerosene yield by including part of this fraction in the fuel oil. The revenue would be reduced accordingly.

3. The disposal of 5,700 tons of fuel oil per annum is dependent entirely upon securing a contract for bunkering the oil burning steamer, which is shortly to replace one of the existing vessels on the Melbourne-Launceston service.

4. No difficulty is anticipated in the disposal of the bitumen, although the quantity to be produced would be sufficient to supply the whole of Tasmania. Roads are constructed exclusively by Government departments and public authorities, from whom ready support may be expected from patriotic notices. In the last three or four years, some 50 tons of shale bitumen have been used with every satisfaction by various local authorities in the neighbourhood of Latrobe. The same product has been found to give good service in Melbourne also. If the establishment of a large refinery were contemplated, it would be advisable to distribute bulk samples of the bitumen to all potential purchasers for testing purposes. The information before the Committee at present, however, is sufficient to justify the assumption that no difficulty will be experienced in selling the full production of bitumen at market rates.

Subject to the qualifications considered above, the economics of establishing the shale oil industry in Tasmania, on a scale of 250 tons per day, may be condensed into the following figures:

Share Capital required ...	£171,000
Working Capital required ...	15,000
Annual deficiency in revenue	69,500
Annual loss to Government...	72,500
Employment created ...	170 men.

Local production of oil per annum :-

Petrol	...	250,000 gallons
Kerosene	...	250,000 gallons
Fuel Oil	...	5,700 tons
Bitumen	...	1,800 tons

If the establishment of the industry on this basis be contemplated, further investigations should be undertaken on the following subjects :-

Marketing of all products.

Corrosion of lorry engines and tractor engines, due to the presence of sulphur in the fuel.

The value of shale bitumen for road-making.

The depth of the shale seam, and the existence of possible faults in the immediate neighbourhood of the Railton-Latrobe mine, for the purpose of laying out the mine workings. This work could be carried out for a sum of £1,500 approximately by drilling.

Preparation of more detailed estimates than those given in this report, on all matters of capital and operating expenditure.

The committee recommends that this work should not be undertaken unless the Government is prepared to meet a continuing loss of at least £70,000 per annum.

INTERMEDIATE SCALE DISTILLATION PLANT

In view of the fact that a 250-ton per day plant would be unprofitable and a burden on public finances, the Committee has estimated the cost of erecting and operating a 60-ton per day unit as an alternative to the more ambitious scheme. The smaller plant would certainly be uneconomic, but it would provide a certain amount of employment, and would retain the nucleus of a staff which might be of value in a national emergency. Since the erection of the plant can be contemplated only as an unemployment relief and national defence measure, it is considered that the project, if adopted, would be financed entirely by the Government. Estimates of annual expenditure are therefore based on the assumption that no dividends need be paid on the capital invested. No provision is made for a depreciation reserve fund, but maintenance charges are included, sufficient to keep the plant in working order for its life of fifteen or twenty years.

The Committee believes that if the industry were established on a small scale, mainly for the relief of unemployment, the men working in the mine and on the plant would accept a wage rate similar to that paid by the Tasmanite Company in the past. In the following estimates of expenditure, the basic rate is assumed to be 12/6d. per shift for unskilled labour, and the average wage for all hands is approximately 13/6d. per shift.

When treating only 60 tons of shale per day, it would be possible to confine mining operations to a section of the field where shale richer than the average is obtainable.

Under these conditions, and subject to certain reservations to be discussed later, capital and operating costs, revenue and expenditure, Government losses, and employment would be as follows:-

Capital Cost of Mine, Plant and Transport Facilities.

Mine equipment and development, motor lorries for transport of shale	...	...	£	13,200
Retorts, refinery, buildings, repairs to existing plant, supervision of construction				19,500
Tank waggon	...	...		700
Contingencies - 10% of above	...			<u>3,300</u>
		TOTAL :		<u>£36,700</u>
<u>Working capital</u>	...	...		£ 5,000

Operating Costs :-

Mining	...	...	10/-	per ton of shale.
Crushing and transport	...	...	2/6	" " "
Carbonisation, exhausting, condensing, scrubbing	...	...	6/-	" " "
Distillation of crude oil, refining of petrol and power kerosene	...	...	1.55d.	per gallon of crude oil.

Yield of Products :-

Crude Oil	...	...	31 gallons per ton of shale	(83% of assay value)
Refined Petrol	...	...	10%	of crude oil.
Refined Power Kerosene	...	...	10%	" " "
Fuel Oil	...	...	54%	" " "
Bitumen	...	...	16%	" " "
Losses	...	...	10%	" " "
			<u>100%</u>	

Annual Profit and Loss Account :-

Expenditure	£	Revenue	£	
Mining, crushing and transport of 21,000 tons of shale; retorting, exhausting, condensing, scrubbing	...	19,400	Motor Spirit - 65,100 gals. @ 1/2	3,800
Distillation and refining	4,200		Power Kerosene - 65,100 gals. @ 11d.	2,980
Management and office expenses	1,800		Fuel Oil - (1,464 tons @ £2/10/-)	3,660
Excise	...	1,500	Bitumen (466 tons @ £5/10/-)	2,560
	<u>£26,900</u>		Deficiency	<u>13,900</u>
				<u>£26,900</u>

Employment created : 68 men.

Annual Cost of Financing the Industry .

(exclusive of interest on capital and depreciation of plant)

Deficiency in revenue a/c.	£13,900	
Loss of Customs Duty & Primage	<u>2,600</u>	£16,500
<u>Less-excise paid</u>		<u>1,500</u>
Net cost per annum		<u>£15,000.</u>

Oil Products prepared in Australia:-

Motor Spirit	...	65,000	gallons	per annum.
Power Kerosene	...	65,000	"	" "
Fuel Oil	...	1,460	tons	" "
Bitumen	...	466	"	" "

The value of the petrol and kerosene credited to the 60-ton per day plant is somewhat higher than the prices assumed for the commercial unit. This is because a larger proportion of the output can be sold in the immediate vicinity of the plant, at a higher retail price, and with reduced distribution charges.

The fuel oil obtainable from 50 tons of shale per day is in excess of Tasmania's present requirements, but too small in quantity to be economically sold for bunkering at Launceston. In these circumstances, the Committee can only credit the fuel oil with its value as a substitute for coal in furnaces and boilers. For this reason the revenue from the sale of fuel oil is assessed at £2/10/- per ton, instead of the £3 per ton assumed in the previous calculations.

It is considered that, for an output of 460 tons of bitumen per annum, a drum manufacturing plant could not be operated economically at the refinery. The wholesale value of the bitumen at the works has been reduced accordingly to allow for the increased cost of drums purchased in Launceston or Melbourne.

On the reduced scale of operations, the problem of the sulphur content of the petrol and kerosene does not assume such serious proportions. The possibility of objections being raised against these products must not be overlooked, however, and if a decision is made to proceed with the sixty-ton per day plant, some work should be done on this problem.

The economics of the intermediate scale plant may now be summarised as follows :-

Capital Required	...	£36,700
Working Capital	...	5,000
Deficiency in Revenue Account		13,900 per annum
Less to the Government	...	15,000 " "
Employment created	...	68 Men.

Oil Products prepared in Australia:-

Motor Spirit	...	65,000	gallons	per annum
Power Kerosene	...	65,000	"	"
Fuel Oil	...	1,460	tons	" "
Bitumen	...	466	"	" "

If it be decided to establish the industry on this basis, further preliminary investigations should be undertaken, particularly with regard to the marketing of products and the wages to be paid to employees. The estimates presented in this report should be prepared in greater detail, and the present owners of plants and leases should be approached for their co-operation. It should be noted that in these estimates no provision has been made for the purchase or hire of existing assets. A drilling campaign costing £750 would be necessary before mining began.

PRESENT POSITION OF THE INDUSTRY.

Since September 1st, 1933, the 12-ton per day Crozier plant at Latrobe has been worked on a co-operative basis by 13 men, preparing power kerosene, fuel oil and bitumen. The retort has been in production for 37 weeks in a total of period of 43 weeks, and has treated 2,592 tons of shale for a yield of 51,095 gallons of crude oil. The output of shale has been limited by the labour available in the syndicate, and has been somewhat under the capacity of the retort.

The State Hydro-Electric Department, by arrangement with the Tasmanite Shale Oil Co. Ltd., has made power available till the end of July for a payment of £100. This sum has been paid by the Company to assist the syndicate. The normal commercial power charge for the period under would be £435. As a result of the above arrangement, the syndicate has been operating free of power charges.

Under these conditions, the members of the syndicate have been paid, on an average £2. 4. 6. per week, and have outstanding credits and stock as at June 30th which increase this by 7/10d. making a total average weekly earnings of £2. 12. 4. This has been made possible through Federal Government subsidy payments amounting to £441. 11. 2., a grant from the Tasmanite Company of £50 and of oil stocks worth £168, without this assistance, the actual earnings from operations would have amounted to 28/9d. per week. The average cost of operating and maintaining the plant, apart from payments to members, has been £12 per week. If the syndicate had been required to pay normal commercial rates for power, the weekly earnings from production operations alone would have fallen from 28/9 to about 13/3 per man, and the operating and maintenance costs of the plant and mine would have risen from £12 to £22 per week. The crude oil has returned an average of 6.15d. per gallon, and the average production earnings of the plant when operating under syndicate conditions amount to £36 per week.

During the six weeks non-producing period, the mine was maintained in production, and the other members of the syndicate were engaged in installing a new dump conveyor belt, replacing worn discharge gear, installing a reserve compressor, and in other works of maintenance.

The earnings from the production period of 37 weeks have therefore been averaged over the whole period of 43 weeks.

The earnings per man when the retort is operating would be around 21/- per week when paying full commercial power rates, the lower rate of 13/3 being due to the non production period.

A rental of £1 per week payable to the Tasmanite Shale

Oil Co. Ltd. is included in the above figures.

The agreement under which the subsidy is paid expires at the end of June, 1934.

The Committee is of the opinion that the results of continued operations on this plant cannot shed any further light upon the economics of establishing the industry on a commercial or intermediate scale. The only justification for keeping the plant at work is the employment which it finds for some thirteen men. Before an estimate can be submitted, giving the cost to the Government of further supporting the industry in its present stage of development, certain enquiries should be undertaken.

- (1) It should be ascertained whether the Tasmanite Shale Oil Co. Ltd. is agreeable to continue the lease of the plant to the syndicate.
- (2) The minimum price for power acceptable to the Hydro-Electric Commission of Tasmania for a continuance of the supply should be ascertained.
- (3) The employees should be approached to ascertain whether they are prepared to continue work under the present conditions regarding rates of wages.

THE PREPARATION OF BITUMEN

Mr. Kurth has submitted to the Committee several samples of bitumen prepared by him from Tasmanian shale, by processes differing from the normal procedure of distillation for crude oil. The quantities of bitumen available are too small to permit tests being made of its resistance to wear and exposure, but the general appearance of these samples indicates that the bitumen should be an excellent road-making material. In view of the fact that bitumen distilled from Tasmanian shale oil has been found to give satisfactory service in practice, the Committee feels justified in assuming, for the purpose of this report, that the material specially prepared by Mr. Kurth is equal to the imported product.

Of the organic matter present in Tasmanian oil shale, three-quarters approximately consist of spore cases, which on slow distillation at carefully controlled temperatures yield about 70% of bitumen. The other products of this treatment are oil and a small volume of gas. The remaining organic matter in the shale yields no bitumen when distilled under these conditions.

Theoretically, a number of different methods may be adopted for producing bitumen, mixed with varying amounts of shale residue. The essential processes consist in finely crushing the shale, and then subjecting it, or a concentrate of the spore case material, to a temperature of 370° - 390° C. for several hours. The possible variations in the procedure are as follows:

- (a) Preparation of bitumen mixed with all, or most of, the ash present in the shale, by -
 - (1) crushing and heating the whole shale, or
 - (2) crushing the shale, rejecting the finest material which is relatively poor in spore case material heating the residue.

(b) Preparation of bitumen containing approximately 30% of shale ash. The material which is to be heated is a spore case concentrate prepared by froth flotation, elutriation, or some other applicable commercial method of concentration.

(c) Preparation of pure bitumen by extracting with a solvent the bitumen contained in the product from processes (a) (1), (a) (2), and (b).

Process (c) may be disregarded from the outset as unlikely to prove economic in competition with other processes. Method (a) (1) is not applicable on any large scale, because so much ash is present in Tasmanian shale of average quality that the mixture of bitumen and residue would be hardly strong enough to withstand road traffic. It is sufficient, therefore, to consider the economics of processes (a) (2) and (b).

In either case, the demand for bitumen in Tasmania would limit the scale of operations to approximately 60 tons of shale per day. To save transport charges, the treatment plant would be installed close to the mine. The lean bitumen mixture prepared by method (a) (2) could be handled and distributed in bulk, but the richer material from the alternative process would need to be despatched in drums. The value of pure bitumen delivered on rail to the purchaser is assumed to be £8 per ton. A credit of 10/- per ton is allowed for the filling material, and average transport charges are assumed to be £1 per ton of the actual product. In the case of the rich bitumen mixture from process (b) a deduction of 15/- per ton is made to cover the cost of drums. Under these conditions, the values of the bitumen and by-products and the operating expenses are approximately as follows:-

(a) Lean bitumen mixture -

Operating Costs:-

Mining	...	...	10/-	per ton of shale
Crushing, Classifying and handling	...	...	2/-	" " "
Retorting	...	...	10/-	" " concentrate.
Refining the oil by-products	...5	...	2/6	" " "

Assuming the rejection of 25% of shale free of spore cases, the total cost of operating amounts to 21/4 per ton of shale, of 28/6 per ton of concentrate.

Yield of Products:-

Bitumen mixture	...	12 $\frac{3}{4}$	cwt. per ton of shale
Power kerosene	...	3	gallons per ton of "
Fuel oil	...	7	" " " "

Value of products from 1-ton of Shale:-

Bitumen mixture-		
Pure bitumen, 14% of shale	£1. 2. 6.	
@ £8 per ton	...	
Filler - 50% of shale		
@ 10/- per ton	...	5. 0.
		£1. 7. 6.
Less Transport	...	1. 0. 0.
Nett value at works	...	7. 6.
Power Kerosene -		
3 gallons @ 11d.	...	2. 9.
Fuel Oil -		
7 gallons @ £3 per ton		1. 9.
Total value of products		£12. 0.

(b) Rich Bitumen mixture -

It has been shown qualitatively, by experiments in the Mines Department Laboratory at Launceston, that spore cases may be separated from Tasmanian shale by froth flotation. This method of concentration appears likely to be the most practicable and economical for the purpose. The estimated costs, yields and revenue are then as follows:-

Operating costs :-

Mining	...	...	10/-	per ton of shale
Crushing and handling			2/6	" " "
Floating	...	...	2/-	" " "
			<u>14/6</u>	" " "
Drying and heating	...		12/-	per ton of concentrate
Refining the oil				
by-products	...		2/-	" " shale.

It is assumed that 80% of the spore cases would be floated and that the concentrate would represent 25% of the original shale. The ash content of the final product would be 33%, and the yield of bitumen 10% of the shale. The total operating costs are then 19/6 per ton of shale.

Yield of Products :-

Bitumen mixture (33% ash content)	...	3 cwt.	per ton of shale.
Power kerosene	...	3 gallons	per ton a shale
Fuel oil	...	7	" " "

Value of Products per ton of shale:-

Bitumen mixture -			
Pure bitumen 2 cwt. per ton of shale @ £8 per ton	-	16	0
Filler - 1 cwt. per ton of shale @ 10/- per ton	-	-	6
			- 16 6
<u>Less - Transport</u>			
£1 per ton of bitumen mixture	-	3	-
Drums: 15/- per ton of bitumen mixture ...	-	2	3
			- 5 3
			- 11 3
Net Value of Bitumen			
Power Kerosene -			
3 gallons @ 11d. per gallon	-	2	9
Fuel Oil -			
7 gallons @ £3 per ton	-	1	9
			- 15 9
Total Value of Products			- 15 9

These rough calculations indicate that in neither case does the revenue equal or exceed the operating expenses. The estimated deficiency is 9/- per ton of shale for the lean bitumen mixture and 3/9 per ton of shale for the rich bitumen. Even when all possible

allowances are made for inaccuracies in these preliminary estimates, it seems unlikely that process (a) (2) will ever prove as economical as the alternative method (b). In preparing a tentative annual profit and loss account for the bitumen industry, this latter method of operation has therefore been selected as the better of the two.

Probable Capital Cost of Plant to prepare bitumen from 60 tons of shale per day ... £30,000

Probable Working Capital 5,000

Tentative Profit and Loss Account :-

(excluding interest on Capital and depreciation of plant).

Expenditure	£	Revenue	£
Mining, crushing, floating and handling 21,000 tons of shale per annum	15,220	• Bitumen mixture 3,150 tons @ £3/15/-	11,810
Drying and heating concentrate	3,150	• Power Kerosene - 63,000 gallons @ 11d.	2,890
Refining oil by-products	2,100	• Fuel Oil - 613 tons @ £3	1,840
Management and office expenses	<u>1,200</u>	• Deficiency	<u>5,130</u>
	<u>£21,670</u>		£21,670

Annual Loss to Government :-

Deficiency in Revenue account	...	£5,130
Primage	...	<u>1,220</u>
Total Loss :		£6,350.

Employment Created 50 men.

The foregoing estimates are based upon the same assumptions as those already used in considering the economics of a 60-ton per day distillation plant. That is to say, rich shale is selected for mining, the establishment and control of the industry is in Government hands, and the employees are paid a wage rate similar to that paid by the Tasmanite Company in the past.

If a plant of the same capacity were to be operated by a private company as a commercial project, the loss to the Government would be increased by £5,000 per annum approximately in respect of dividends, depreciation reserve and higher wages.

The Committee considers that it has insufficient information upon which to base estimates of the cost of erecting and operating a larger plant than that already discussed. Even the figures presented above must be regarded merely as preliminary estimates. It should be pointed out, however, that the production of bitumen from

60 tons of shale per day would suffice for the whole of Tasmania's requirements. Latrobe, fortunately, is favourably situated for an export trade with Melbourne, where a market for bitumen exists equivalent to the potential production from several hundred tons of shale per day.

A lower price would have to be accepted for any bitumen exported from Tasmania, but partial compensation for this loss would be found in the reduced cost of operating on a larger scale.

The estimates presented in this report show that bitumen may be recovered from Tasmanian shale as the principal product of the treatment process much more economically than oil. The Committee recommends, therefore that the industry be regarded in future as one in which petrol, kerosene and fuel oil are prepared merely as by-products.

PROGRAMME OF EXPERIMENTAL AND MARKETING INVESTIGATIONS.

The installation of a large bitumen plant cannot be entertained until some practical experience has been gained on an intermediate scale unit. The Committee recommends that at this stage attention should be confined to the possibility of installing and working a 50-or-60-ton per day plant. Before any expenditure on this project can be contemplated, it is essential that detailed information be collected on the treatment of the shale and disposal of the products. If the Government considers that the industry could be supported to the extent indicated by the preliminary estimates presented in this report, then the following programme of enquiries should be undertaken. -

Marketing of Bitumen- A close survey should be made of the market for bitumen, the costs of distribution, and the revenue obtainable. Due attention should be given on the one hand to the possibility of securing orders from patriotic motives, and on the other to the possibility of shale bitumen being confused with local tar, which is not a satisfactory road-making material.

Quality of Bitumen. - Bulk samples of bitumen should be made available for testing purposes to the most important prospective customers. They should be approached in advance for advice regarding the quantities required, and the time necessary for the completion of their tests.

Technique of Flotation.- Samples of crushed shale should be floated in the small intermittent K & K plant of the Tasmanian Department of Mines, for such information as these tests may afford on the efficiency of flotation and effect of reagents.

A parcel of 20 tons of shale approximately should be treated in bulk by the process proposed for the preparation of relatively pure bitumen.

It is proposed that 20 tons of top and bottom shale should be mined; that it be crushed at some convenient works (possibly the Goliath Cement Company's plant, or that of the Mt. Lyell Company); that the crushed shale be bagged and sent to the Fuel Research Station, East Greenwich; that the Research Board be asked to float the shale in their experimental "Elmore" vacuum froth flotation plant, giving particulars of the yield of concentrate, reagents used, and rate of throughput; that a sample of the rejected ash be returned for analysis; that the whole concentrate be returned for conversion into bitumen at some convenient works in Hobart or Launceston; that the bitumen so recovered be offered to road constructing authorities in Tasmania for testing

This investigation is estimated to occupy six months and to cost £200 approximately, assuming that the Fuel Research Board would undertake the flotation test free of charge.

It is not likely that the amount of bitumen prepared in this test would be sufficient to afford all potential purchasers an opportunity of making road tests of the material. The question of obtaining further supplies for testing purposes should be considered after information has been received as to the quantities required.

In order to accelerate the obtaining of information and to supplement the above investigation, it is proposed that the Mines Department of Tasmania endeavour to have a similar quantity of shale crushed and treated by flotation locally, and the remainder of the procedure outlined above followed. This would make available further supplies of bitumen for road tests. The estimated cost would not exceed £100. It is possible, moreover, that after a closer investigation of local facilities for flotation tests, the delay and expense incurred in sending samples to England may no longer appear necessary.

Production of Bitumen Mixture Direct from Shale.

About 2 tons of crushed top shale only should be treated according to method (a) (1) in an existing experimental plant to be recommended by Mr. Walker. If the product appears satisfactory it should be offered to the Latrobe Council or some other local authority for a road test.

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS.

The Committee has estimated the cost of constructing and operating shale oil distillation plants of 250 and 60 tons per day capacity. Subject to certain reservations discussed in the text of the report, the following conclusions may be drawn from the Committee's estimates and discussions.-

- (1) The continued operation of the present 12 ton per day plant can be considered only as a measure of unemployment relief. It would not shed any further light upon the economics of establishing the industry on a larger scale. (See page 14).
- (2) The operation of a 250 ton per day commercial plant would involve the Government in a loss of £72,500 per annum approximately. The number of employees in the industry would be 170. (See page 9).
- (3) The operation of 60 ton per day intermediate scale plant would involve the Government in a loss of £15,000 per annum, without allowing for interest and depreciation on the capital investment. About 68 men would be employed in the mine and works. (See page 12)

It is the Committee's opinion that the most attractive and economical avenue for the exploitation of the shale oil deposits in Tasmania is the preparation of bitumen as the main product of a modified process of distillation at low temperatures. Only meagre information is available on this subject at the moment, indicating that operations would probably result in some financial loss. (See pages 17-19). It is possible, however, that the Government may be prepared to accept this loss for the purpose of providing employment, and for the establishment of the nucleus of a plant and staff which might be of value to Australia at a time when supplies of imported petroleum would be restricted or interrupted.

The construction of a plant cannot be contemplated on the basis of the information at present available. A programme of investigations and experiments has been prepared, designed to afford the information needed for estimating more accurately the economics of an intermediate scale plant treating 60 tons of shale per day.

Department of Mines Laboratory,
Launceston, 17th July, 1934.

P.B. Nye, Esq.,
Government Geologist,
HOBART.

Dear Sir,

Concentration of Tasmanite
spores by flotation.

At your request experimental work has been carried out on Tasmanite with the object of investigating the possibilities of concentrating the spores by froth flotation.

Previous laboratory experiments during 1931 indicated that the spores could be floated but the concentrates contained a large amount of inorganic matter.

Experiments have now been carried out with a K & K machine on the lines of previous laboratory work and I conclude from the results obtained with this machine that it is unsuitable for this particular work.

Run at lower speeds than specified (400 r.p.m.) down to speeds utilized commercially (170-200 r.p.m.) the volume of air in the froth compartment was so excessive that it produced a very voluminous froth with reagents that under more controllable conditions would have resulted in a desirable froth with consequently lesser mechanical impurities. The sample used was a composite from discards of the Geological Survey sampling and registered as Lab. No. 837 (Ash 73.6%).

The recovery of the spores in the machine was good but, as expected the ash contents ranged from 63.3% to 54.7%. The best result being obtained using sodium chloride as a dispersion agent. Experiments were conducted in the K & K machine with the object of obtaining a clean concentrate only; this resulted in a product containing 38% of Ash. This concentrate was refloated twice (bottle agitation) resulting in a 13% Ash with a loss of approximately 30% of the spores.

An experiment with a small pneumatic type of flotation cell gave an encouraging result with a good recovery and a concentrate containing 32% of ash.

It is indicated from the work carried out that the spores of the Tasmanite can be satisfactorily separated from the inorganic matter by flotation. Dispersion agents are necessary to obtain a product of low ash content.

I wish to state that the work carried out is particularly limited by reasons of the fact that we do not possess the necessary flotation and grinding machines to carry out this type of work.

Yours faithfully,

(Sgd.) W.St.Manson. Govt. Chemist & Assayer.