Brought over by Senator Lynch.
C. H. Boydell
Clerk of the Senate.
10-5-16.

PARLIAMENTARY STANDING COMMITTEE ON PUBLIC WORKS.

PAPERS

to be laid on the TABLE of the SENATE.

REPORT,

together with Minutes of Evidence,

relative to the proposed

CEMENT WORKS FOR FEDERAL CAPITAL AND OTHER COMMONWEALTH PURPOSES.

1915.

COMMONWEALTH OF AUSTRALIA.

PARLIAMENTARY STANDING COMMITTEE ON PUBLIC WORKS.

REPORT,

TOGETHER WITH

MINUTES OF EVIDENCE,

RELATIVE TO THE PROPOSED

CEMENT WORKS FOR FEDERAL CAPITAL AND OTHER COMMONWEALTH PURPOSES.

Printed and Published for the GOVERNMENT of the COMMONWEALTH of AUSTRALIA by ALBERT J. MULLETT, Government Printer for the State of Victoria.

F.14710.

MEMBERS OF THE PARLIAMENTARY STANDING COMMITTEE ON PUBLIC WORKS.

First Committee.

EDWARD RILEY, Esquire, M.P., Chairman.

Senate.	*House of Representatives.*
Senator the Honorable JOHN HENRY KEATING, Senator PATRICK JOSEPH LYNCH, Vice-Chairman, Senator WILLIAM HARRISON STORY.	JAMES EDWARD FENTON, Esquire, M.P., WILLIAM FYFE FINLAYSON, Esquire, M.P., The Honorable HENRY GREGORY, M.P., SYDNEY SAMPSON, Esquire, M.P., WILLIAM HENRY LAIRD SMITH, Esquire, M.P.

EXTRACT FROM THE VOTES AND PROCEEDINGS OF THE HOUSE OF REPRESENTATIVES.

No. 90 OF 10TH SEPTEMBER, 1915.

12. PUBLIC WORKS COMMITTEE—REFERENCE OF WORKS—Mr. Archibald moved, pursuant to notice, That, in accordance with the provisions of the *Commonwealth Public Works Committee Act* 1913-14, the following works be referred to the Parliamentary Standing Committee on Public Works for their Report thereon, viz. :—

. . . . . .

Coment works for Federal Capital and other Commonwealth purposes.

Mr. Archibald having laid on the Table plans, &c., in connexion with the proposed works—

Question—put and passed.

INDEX.

LIST OF WITNESSES.

PARLIAMENTARY STANDING COMMITTEE ON PUBLIC WORKS.

PROPOSED CEMENT WORKS FOR FEDERAL CAPITAL AND OTHER COMMONWEALTH PURPOSES.

REPORT.

THE PARLIAMENTARY STANDING COMMITTEE ON PUBLIC WORKS to which the House of Representatives referred for consideration and report the question of the establishment of Cement Works for Federal Capital and other Commonwealth purposes, has the honour to report as follows :—

INTRODUCTORY.

1. The Commonwealth is at the present time a large consumer of Portland cement. There is a prospect of still larger consumption in the future in connexion with Federal Capital engineering works and building construction and other Commonwealth activities. The market price of Portland cement has ranged from 13s. to 24s. per barrel—the latter price being reached since the outbreak of the war.

It is at present being obtained from the Commonwealth Portland Cement Co. at 14s. 9d. per barrel in truck at Canberra, under a twelve months' contract, which will expire in about six months' time. This is considered a special rate to the Commonwealth as a large consumer and a possible manufacturer.

2. There is nothing to indicate what price Portland cement may not reach within the next few years, and as the progress and cost of many Commonwealth works depend to a large extent on the cement market, it will be seen that any shortage would be most serious and result in increased outlay—either for purchase or through deterring the progress of works.

THE PROPOSAL.

3. To preclude the possibility of the Commonwealth being unable to obtain at all times sufficient cement of first class quality at a reasonable price, it has been suggested that the Commonwealth should manufacture its own cement.

The proposal placed before the Committee is that the Commonwealth should erect at Fairy Meadow, New South Wales, about 30 miles from the boundary of the Federal Territory, works capable of producing 20,000 tons or 120,000 barrels of cement per annum.

4. The Commonwealth has acquired an area of land at Fairy Meadow, comprising about 56 acres and said to contain sufficient limestone to permit of the manufacture of 120,000 barrels of cement per annum for at least 75 years. It is considered, however, that it will be necessary to acquire an additional area of about 250 acres to provide for the housing of workmen, for railway and road approaches, and shale deposits.

5. In connexion with the proposal it is intended to lay down a rough line of railway of 4 ft. 8½ in. gauge, with 6-chain curves, over which the shale and limestone will be conveyed from the quarries to the factory and the finished product conveyed to the Fairy Meadow station, a distance of about 1 mile from the works.

ESTIMATED COST.

6. The estimated cost of the proposal is—

	£
Erection of factory, exclusive of power plant..	50,000
Power plant	19,000
Railway connexion between factory site and the existing railway at Fairy Meadow	5,000
Workmen's dwellings and other buildings	16,000
Contingencies	10,000
Total	100,000

It is anticipated that it will take eighteen months to have the building erected and the machinery installed, and a further six months before the factory is turning out cement.

COMMITTEE'S INVESTIGATIONS.

7. The Committee inspected the site of the proposed works at Fairy Meadow, visited the cement works of Messrs. Goodlett and Smith, at Homebush, New South Wales, where the "dry process" of manufacture is carried on, and the works of the Australian Portland Cement Co., at Fyansford, Geelong, Victoria, where both the "wet process" and the "dry process" are in operation. Evidence was obtained also from cement experts in Brisbane and Melbourne; and the Committee endeavoured to acquaint itself with the latest opinions of reliable authorities as regards the process of manufacture, machinery used, cost of manufacture, &c.

PROCESS OF MANUFACTURE.

8. The process to be employed at the proposed factory is what is known as the "dry process" in which the raw materials are ground and mixed dry, as distinct from the "wet process" in which the raw materials are usually obtained wet and mixed wet, or the "semi-wet" in which the raw materials are obtained dry, and water is added in the grinding or mixing.

9. The advice of experts was obtained and the opinions of leading authorities were quoted as to the relative merits of the various systems. It would appear that the dry process is the one more generally in use throughout the world, but each system has something to recommend it, and in the opinion of the Committee the adoption of any particular system is mainly dependent upon the minimum output and the class of raw material to be treated. The raw materials obtained at Fairy Meadow are hard and dry, and as it was ascertained in evidence that the use of the dry process would be equally suitable and more economical than the wet process in this instance, the Committee is agreeable to such process being adopted.

MACHINERY.

10. The Committee having learned that hitherto almost all of the cement-making machinery installed in Australia has been manufactured in England, the United States, Denmark, or Germany, set about making inquiries as to whether such machinery could not be manufactured in Australia.

11. It is obvious that the success of an industry such as is contemplated depends to a large extent upon the quality, adaptability, and efficiency of the plant, and the Committee recognises that it might not be possible to have locally manufactured all the special appliances and machinery which the long experience of specialist firms has devised for the economical production of the article. At the same time the Committee recommends that an endeavour should be made to obtain in Australia as much of the machinery as possible.

COST OF MANUFACTURE.

12. It was stated that the cost of coal delivered at the factory at Fairy Meadow would be about 21s. 1d. per ton and that shale would cost 3s. per ton, and the limestone 3s. per ton. Estimating on this basis and allowing for cost of labour, bags, repairs, and stores, management, interest, and depreciation, it is claimed that the cement can be delivered at Canberra at 10s. per barrel.

13. By manufacturing its own cement at this figure it is stated that the Commonwealth would save on departmental work £10,000 per annum.

14. Although it is not claimed that the whole of the cement produced at the proposed factory at Fairy Meadow can be absorbed on Government works within the Federal Territory, it was represented to the Committee that a plant capable of an output of 120,000 barrels per annum is the smallest plant which can be worked efficiently and economically. As any surplus cement produced could be readily absorbed in other Commonwealth works, the Committee considers that the installation of a plant of that capacity is justified.

WORKMEN'S DWELLINGS.

15. In view of the distance from a township, it is proposed to erect on an area about 500 yards west of the factory and about a mile from the Fairy Meadow station, residences for about 41 workmen, who will be employed at the works.

The site selected for the location of these residences is gently sloping country and appears suitable; and being to the west, while the prevailing winds are from the north-west, will be free from any smoke or dust nuisance as far as the factory is concerned.

CONCLUSION.

16. The Committee learned that about two-thirds of the cement used in Australia is at present imported, and in view of the enormous demand anticipated in Europe after the war, is of opinion that it is improbable that the establishment of private cement factories in Australia would cheapen the price to the Commonwealth until the total Australian production was sufficient to fully supply Australian needs.

17. It is considered, therefore, that from the point of view of economy as well as convenience, it is a sound proposition for the Commonwealth to proceed with the establishment of cement works to supply its needs for Federal Capital and other Commonwealth purposes.

DECISION.

18. The decision arrived at by the Committee is shown in the following extract from its Minutes of Proceedings.

Mr. Finlayson moved—That the Committee approves of the establishment of a factory at Fairy Meadow for the manufacture of cement for Commonwealth purposes.

Seconded by Mr. Fenton.

The Committee divided on the motion—

Ayes, 7.	No, 1.
Senator Keating,	Mr. Gregory.
Senator Story.	
Mr. Fenton,	
Mr. Finlayson,	
Mr. Riley,	
Mr. Sampson,	
Mr. Laird Smith.	

And so it was resolved in the affirmative.

Note.—Mr. Gregory moved as an amendment—"That the establishment of the proposed cement works at Fairy Meadow by the Federal Government is inimical to the best interests of the Commonwealth;" but, failing a seconder, it was resolved that the amendment be not put.

Edward Riley
Chairman.

Office of the Parliamentary Standing Committee on Public Works,
120 King-street,
Melbourne, 24th November, 1915.

MINUTES OF EVIDENCE.

(Taken at Brisbane.)

THURSDAY, 23RD SEPTEMBER, 1915.

Present:

Mr. RILEY, Chairman;

Senator Keating,	*Mr. Finlayson,*
Senator Lynch,	Mr. Sampson,
Senator Story,	Mr. Laird Smith.
Mr. Fenton,	

Arthur Morry, Architect and Building Surveyor, and Surveyor to the Department of Agriculture and Stock, Queensland, sworn and examined.

1. *To the Chairman.*—For some years I have been interested in the development of the cement industry in Queensland. For several years the quantity of cement imported to Queensland has been between 30,000 and 40,000 tons per annum. Each year there has been a considerable increase, except last, owing to the conditions abroad. A large proportion has come from New South Wales, and some from South Australia, the rest from Great Britain, Germany, and Belgium—a large quantity from Germany, where some of the best cements are made, but the British are also excellent in quality. We have found more fault with some of the cheaper brands of German and Belgian cement than with any of the English brands. New South Wales cements have been found good for some years, although for about two years after the establishment of the works in that State it was not constant in quality, showing carelessness or want of knowledge in manufacture. The great difficulty in the way of establishing the industry in Queensland has been the absence of limestone deposits of suitable quality within 200 miles of Brisbane. Limestone is found at Gympie, but it varies greatly in quality. There is also limestone of a class at Ipswich, but it contains a large percentage of magnesia. Deposits have been at last discovered at Gore, the other side of Warwick, sufficient to carry on a cement manufacturing industry for about 200 years at the rate of 30,000 tons per annum. A company in which I am interested has been successfully formed with a nominal capital of £150,000. One hundred thousand shares have been taken up, and 15s. in the £1 paid up on them. A site for the erection of the works has been selected at Darra, 10 miles from Brisbane, where we have 80 acres with an inexhaustible supply of shale and clays. Eminent firms in London and elsewhere agree that our raw material is equal to that to be found in any part of the world. They say there is no reason why, if properly manufactured, cement equal to anything produced anywhere else should not be produced in Queensland. The shares are held by between 200 and 300 people. Machinery has been ordered from Edgar Allen and Company, of Sheffield. The Babcock boilers and electrical motors will be obtained from English firms, and the bulk of the machinery is now on the water. We expect to have the machinery installed and the factory in operation by February or March next year. The plant will be capable of turning out 30,000 tons per annum, and provision is made for duplicating it if required. It will be all electrically driven. The process of manufacture will be the modern wet, or thick slurry, process, now almost universally adopted as being more economical, and turning out a more reliable article, and freer from manufacturing difficulties. The absence of dust makes it better for the health of the workmen. It requires 100 gallons of water for every ton of cement produced. The material will be burnt in rotary kilns about 100 feet long. The fuel is coal dust driven in by hot compressed air. The packing will be automatically done by suction. The process is patented by Smidth and Company, Copenhagen, Denmark. The object of the company is to produce cement cheaply so as to encourage its use. There are larger openings in Queensland for its use than have so far been taken advantage of. The limestone deposits are situated 3 miles from the main railway line, but a tramway is now being constructed along the public road to the quarry. The stone will be crushed at the quarries in an ordinary 2-in. crusher, brought down by rail to the works, put through granulators, reduced to powder, mixed with shale or clay in the wet vats, and pumped into the rotary kiln. We hold the limestone property on mining lease for 21 years from the Government, with right of renewal. We will bring the limestone by rail about 200 miles. If the *via recta* is completed that distance will be shortened by 70 miles. The Railway Department have already made a concession to the company for carrying the limestone. The Government have given the company every possible assistance. Coal will be obtained at Ipswich or Bundamba, about 10 miles from the works, which are also 10 miles from the city. We, therefore, get the benefit of the 10-mile radius. Twelve months ago we could get coal at 7s. 6d. a ton delivered at the works. That price may have been added to recently. The limestone will cost us about 15s. a ton delivered at the works. The only cost of the clay and shale is the digging, and we reckon that at 2s. 6d. per ton. The quantity of coal required is about one-third of the quantity of cement turned out. Our estimated cost of production is 42s. a ton, net cost put into the warehouse at Brisbane, without profit, six casks to the ton. Our works will be built much on the same lines as the Commonwealth Cement Company's works at Portland, but with all the latest improvements. We propose to use bags, as we do not intend to export. These will cost us about 6d. each. The packing machinery, known as Smidth and Company's "exilor" process, is coming from Copenhagen, but the rest of the machinery is from England. We submitted samples of our limestone and other ingredients to the company making our machinery. We expect to employ about 100 men at the works, and the same number at the quarry.

2. *To Mr. Laird Smith.*—The rotary kiln will be working night and day. Allowance is made for a month or six weeks during the year for repairs. We must work three shifts. It will not destroy the kiln to let the fire go out.

3. *To Senator Lynch.*—The deficiency in Australian cement at first was due to some defect in the process of manufacture. I do not think there

is any difference in the material. The manufacture should be supervised by a proper cement chemist. The composition is 66 per cent. lime, 22 per cent. silica, and 9 per cent. alumina and iron—these should be constant. I have no fault to find with the Australian article, and we also get good cement from New Zealand. I used some Japanese cement within the last month—one quality is very good, and the other is indifferent, due to defective composition. We have been paying 25s. a cask for cement in Brisbane—a war price. Before the war our usual standard price was 15s. It is better to erect the works close to Brisbane than close to the quarry. Otherwise we should have to take all our coal from Ipswich to the quarry and pay the increased freight on the finished article. We get a different rate of freight on the raw material. We have coal on the site, but the company do not consider it wise at present to work it. I favour a site for the works close to the centre of distribution or the point of consumption. Brisbane is our centre of distribution. There was less expense in managing the works near the distribution centre, and that consideration influenced the company in deciding on the site.

4. *To Mr. Finlayson.*—We have 44 acres of limestone acquired by myself, but the company have acquired further leases from the Government since. Faija and Company, of London, eminent testers of building material, reported that the material we were about to operate upon was equal to anything that could be shown anywhere. The Queensland Government have assured us that if our cement is as good as the imported article, other things being equal, they will buy all the cement they want from the company. The company does not consist of builders and contractors. A few have shares, but the directors are Brisbane business men. It is a purely business speculation, and not based on any guarantee or understanding as to orders. It would be a good thing for the Commonwealth Government to manufacture their own cement so long as they can see their way clear to use not less than from 20,000 to 30,000 tons per annum. Modern cement works cannot be made to pay with a less output. Twenty thousand tons is the absolute minimum. Probably before twenty years had passed you would require to duplicate your plant. The machinery has a life of about 25 years. The thick slurry process was introduced by Smidth and Company, of Copenhagen, about ten years ago, and nearly all works put up since have been on that system. You can get the latest machinery and estimate it at a 25 years' life. We have based our estimate of income on the present rate of duty in the Commonwealth. We have given in our prospectus simply the estimated cost of production. As the selling price varies considerably it is difficult to estimate profits. I do not regard it as necessary to increase the present duty unless the Japanese article comes in. If that happens, seeing that the industrial conditions in that country are very different, the position will have to be reconsidered. We need not fear European or American competition. We can maintain the industry as successfully here as in the south. Japanese competition will be no more severe with us than with New South Wales or Victoria. There are quite a number of places in Queensland where cement works could be profitably established. Queensland is very rich in these materials except in the metropolitan district. Wide Bay and other districts are examples. The possibilities of the industry in Queensland are such as to warrant the Government in making the duty against foreign cement absolutely prohibitive. In fixing the duty I would give New Zealand favorable consideration

5. *To Mr. Fenton.*—The moisture content of finished cement is very small. The company hope to sell cement very much below 15s. We have calculated that our engineers will be paid about 16s. a day, and have reckoned all the labour throughout at 1s. 6d. per hour. We should have considerable difficulty if Japanese cement comes in, if the wages there are only 9d. per day. We are afraid only of Japan. Shipping facilities between there and Australia have lately been greatly augmented, and cement importations from Japan are likely to increase. Manufactured cement goods, such as asbestos, cement tiles, and cement roofing tiles, are coming here from Japan. These are things we are trying to make here and the Japanese are undercutting local suppliers. Cement roofing tiles made of cement and sand, and tiles of a material manufactured in Victoria together with cement, which could be made in Queensland, are being manufactured in Brisbane. *There is serious competition already from Japan.* Cement fencing posts have been made, but have not yet been put on the market. The Aquatight Cement Products Company, of Brisbane, are *manufacturing all those articles, and hope* to get Queensland cement to do it with. To allow Japanese imports to come in would be a serious matter for the shareholders and the *workers in the industry. If we had coal* convenient to limestone and shale deposits I would manufacture on the site of the raw material. A deputation was appointed to wait on the late Government on one occasion to suggest the establishment of State cement works, but it was never received.

6. *To Senator Story.*—A Sydney firm has taken the contract from our company to import the machinery from different firms in the Old Country and assemble it. They will be responsible for its efficiency. Some of the German and Belgian cements set too quickly, and others would not set at all. The former may have contained too large a proportion of carbonate of lime, which had not been properly combined in the burning process. This would make it too fiery. Cement that sets too slowly has too much silica in it or has been too much exposed, and absorbed too much CO_2. It is absolutely necessary to have an efficient chemist to prevent inferior cement being turned out. I do not think our prospectus is too highly coloured regarding the cost of production. Queensland cement requirements are between 30,000 and 40,000 tons per annum. We shall probably manufacture only from 20,000 to 30,000 tons for a year or two. If the importation of cement was prohibited, I do not know how the company would regard a proposal to fix a maximum selling price, but they would have to fall in with the others. I would not object so long as we got a fair profit. Being a public officer I am debarred from the directorate.

7. *To Mr. Sampson.*—Our raw material contains about 99 per cent. of carbonate of lime. That particular deposit is very constant, but limestone varies greatly in different parts of the Commonwealth. Chalky or amorphous stone requires different machinery to treat it from crystalline material, such as this company will use. The clay and shale also vary. You require in your shale or clay a silica easily reducible to a soluble condition by acid, and without too much iron. The use of cement is spreading. We have several wharfs built with reinforced concrete piles. They are more lasting than wood, but must be properly constructed. They stand the pressure of vessels quite well. If the operations of the Commonwealth Government in cement making are confined to the Canberra district they will not interfere

with our company. If they supply the whole of the Commonwealth public works requirements they must interfere with us to some extent. The Queensland consumption I gave previously includes the proportion used by the Commonwealth here.

8. *To Mr. Finlayson.*—The Commonwealth could put up works at Canberra cheaper than we are putting them up here. You could put up excellent works there for £60,000 or £70,000 for a 30,000-ton production. We are expending about £100,000. I do not think the Commonwealth can manufacture more cheaply than we could. It could not compete with our article in Brisbane and if our company made up its mind to cut out the Commonwealth cement in price it could do so The only danger we should run would be from the other companies in the south. If the Commonwealth started works at Canberra we would have some difficulty, but not a very serious one, in the shape of competition with it.

9. *To Mr. Laird Smith.*—We will get our coal at, say, 8s., whereas the Commonwealth will probably have to pay considerably more at Canberra.

10. *To Mr. Finlayson.*—I would not be afraid of the Commonwealth Government competition, if all it did was to send cement to Queensland for its own works. The 42s. per ton estimated cost of production represents simply net cost, exclusive of overhead charges, management, &c.

11. *To Senator Story.*—I have not seen the South Australian works; their material is blue lias. It is much easier to manufacture from our material than from the blue lias, which is not constant in quality, although it makes a first-class hydraulic lime.

12. *To Senator Lynch.*—It is better to employ machinery in making cement on the unit system. The final grinding is done in two machines, the first bringing the material down to the consistency of coarse sand, and the second reducing it to a very fine flour free from grit, requiring no sifting. A 30,000-ton factory would require about 870 horse-power, or about 800 k.w. to drive the *machinery.* For a 30,000-ton output with the rotary mills working continuously, you would require about four different electrical units or motors. We provide for sixteen motors for a *30,000-ton plant.* We are allowing for a margin in producing capacity. We have no obtrusive bands in our limestone formation.

13-14. *To Mr. Sampson.*—Water in Brisbane costs 1s. per 1,000 *gallons,* but special concessions are given to manufacturers. We have our own private supply. Water may probably cost us £200 per annum.

15. *To Mr. Sampson.*—We shall pay about £60,000 for our plant including motors, power and everything else. We are getting an automatic packing plant from Smidth and Company for £1,192. *After testing the material* that we forwarded to them, and estimating that we shall pay 16s. a day for engineers, and 1s. 6d. an hour for unskilled labour, they bring out our cost of production at 31s. 9d., or, *allowing for* depreciation, 35s. per ton. I will supply later a statement showing the percentage of increased cost entailed through having to purchase our machinery from Great Britain.

16. *To the Chairman.*—Smidth and Company's offer is the cheapest. We are getting our machinery from a very reputable firm.

17. *To Mr. Finlayson.*—I should allow 50 per cent. for depreciation and other charges.

18. *To Senator Lynch.*—We cannot get an equal amount of machinery for the same price from a British firm as from Smidth and Company. The patent "exilor" packing plant must be got from Copenhagen, although we will obtain it through a British firm All the rest of the machinery can be got, and is already ordered from British firms We shall spend about £10 000 on our buildings at the works These will be of very simple construction, consisting of brick safes to protect the cement, and other buildings of galvanized iron sufficient to answer our purposes.

(Taken at Sydney.)

FRIDAY, 1ST OCTOBER, 1915

Present:

Mr. RILEY, Chairman.

Senator Keating,	Mr Finlayson,
Senator Lynch,	Mr Gregory,
Senator Story,	Mr Sampson,
Mr. Fenton,	Mr. Laird Smith

Percy Thomas Owen, Director-General of Works, Department of Home Affairs, sworn and examined.

19. *To the Chairman.*—I have prepared the following statement regarding the proposal to manufacture Portland cement at or in the vicinity of the Federal Territory:—

1. Consideration was first given to this proposal in connexion with the requirements of Portland cement for Federal Capital construction.

2. On the 6th August, 1912, I submitted a report to the Minister in which I drew attention to the fact that the Commonwealth was a large consumer of Portland cement, and that there was a prospect of a still larger consumption in the future.

3. The market price of Portland cement at that time ranged from 13s. to 17s. 6d. per barrel, and the price on the Federal Capital site was about 18s. per barrel. Attention was also drawn to the fact that the cost of manufacture of Portland cement in America was as low as 4s. per barrel.

I went on to say—

(a) There is no guarantee what price the manufacturers of Portland cement may not raise it to within the next few years.

(b) The progress and cost of many Commonwealth works depends to some extent at the present time on the cement market.

(c) I consider that the most lasting material used at the *present day* for building construction of the types undertaken by the Commonwealth are well-made modern bricks and concrete. Assuming that those materials will be used in the majority of Commonwealth buildings at the Federal Capital, the consumption of cement for engineering works and buildings there will be about 180,000 barrels. If the Commonwealth can save 10s. a barrel (and I see no reason why at the present market price of cement it should not save that sum per barrel), the saving on Federal Capital works alone would be about £90,000.

(d) The proposal which I submit is that the Commonwealth shall now consider the advisability and expediency of manufacturing its own cement. . . . .

4. The Minister approved of such consideration being given to the question and to a report being obtained from an outside expert.

5. Mr. Gibson, who is connected with the cement works at Adelaide and Geelong, and who, outside the Commonwealth Cement Company, is a leading cement expert in Australia, was chosen to make this report.

6 A geological reconnaissance was carried out over the Federal Territory by Mr. D. J. Mahony, partly with a view to ascertaining whether suitable raw materials were available in sufficient quantity in the vicinity.

7. Eight groups of limestone deposits within Federal Territory and ten groups outside the Territory were observed and reported upon by Mr. Mahony. Most of the deposits were of small extent, and therefore unsuitable for manufacturing the quantity of cement required.

8. After all such matters as suitability and extent of limestone and shale, and vicinity, railway access, &c., were considered, it was decided that a deposit of limestone at White Cliffs, on the Queanbeyan River, about 3 miles from Queanbeyan, of about 168,000 cubic yards in extent, was worthy of full investigations, with a view to the establishment of the cement factory near Queanbeyan, but within Federal Territory.

9. Samples of limestone and shale from this locality were taken and worked up into Portland cement in the laboratory of the Victorian Geological Survey, Melbourne, and the result of these investigations showed that a good quality of cement could be made with such materials. With a view to fully investigating whether the physical conditions in which the limestone occurs were such as to warrant the establishment of a factory in connexion with this deposit, shafts were driven into the body of the stone, with the result that it was ascertained that the rock was as broken in character and included shale laminations to such an extent as to render it quite unsuitable for the purpose of manufacturing Portland cement.

10. *The next deposit to be investigated was at Fairy* Meadow, about 20 miles beyond the Federal Territory, on the Goulburn-road. The limestone occurs in three outcrops on the Sand Hills Creek, about 1¼ miles in south-westerly direction from Fairy Meadow Railway Station. It is about 30 miles north-east of the city site, and it is on the line of the proposed Federal railway to Jervis Bay. *The exact position is on* portion 167, parish of Fairy Meadow. The deposit is of considerable extent, and the estimated available quantity is stated by Mr. Mahony to be at least 2,000,000 cubic yards. The configuration of the deposit lends itself to quarrying operations. Suitable shale is said to have been observed in the vicinity of the limestone deposits. Two drives, each about 200 feet long, have been cut into the body of the deposit, and the physical condition in which the stone occurs appears to be quite satisfactory. These drives are being continued, and this matter further investigated.

11. Summarizing the geological investigations and experiments, the Department first turned its attention to White Cliffs, near Queanbeyan, and the results were satisfactory so far as the chemical constituents of the raw materials were concerned, but the quantity of limestone in massive formation was found to be insufficient to warrant making the cement in that vicinity. The other main proposition was that at Fairy Meadow, not far from Bungendore, and the geological formations at Fairy Meadow are now being investigated, *with, so far, satisfactory results.*

12. It is advisable, however, to give a statement of the entire researches and reports carried out by Mr. Gibson, *i.e.*, both in relation to White Cliffs and Fairy Meadow.

White Cliffs.

13. *Mr. Gibson visited the locality*, was shown the various deposits in the Territory, and then prepared his preliminary report, which was furnished in June, 1913, and was followed by a second report.

14. Acting upon Mr. Gibson's report, I advised the Minister, on the 13th November, 1913, "that approval be given for this branch to take further steps towards the manufacture by *the Commonwealth of Portland* cement in Federal Territory for the purposes of construction of the city," and that bulk samples of limestone and shale should be obtained for despatch to manufacturers of cement-making machinery, because when ordering machinery for the manufacture of cement it is necessary to send along a few tons of the material to be treated, so that the machinery makers may determine the particular kind of mill that is required to grind it. The makers of such machinery mentioned by Mr. Gibson at the time were Fried. Krupp, of Magdeburg, and F. L. Smidth, of Copenhagen, and I recommended that those firms should be asked, through their Melbourne agents, if they were prepared to quote for the supply of the machinery. I recommended, further, that, in the event of a reply being received in the affirmative, the specifications be sent to those firms. Apart from the provision of this machinery, the work would be done by ourselves in accordance with Mr. Gibson's direction. We should erect the necessary buildings, but the cement-making machinery would be supplied by one of those firms, who would also undertake that the plant supplied would do the work required of it. This recommendation was minuted by the Minister of the day (in 1913-14), "Re-submit in connexion with the establishment of Federal Capital Commission."

15. Since I made recommendations regarding machinery *from* Krupp or Smidth, the European War has intervened, which places Krupp out of consideration. Quite recently I was informed by a manager of cement works in Australia that he considered almost all the cement-making plant could be manufactured within the Commonwealth. It would be necessary to prepare full working drawings. I understand, however, that the English manufacturers of cement-making machinery are now prepared to supply complete plants. Local manufacturers of the plant, I presume, would be favorably considered by the Government, and, therefore, my previous recommendation with reference to Smidth, of Copenhagen, could be placed on one side.

16. The matter of bulk samples mentioned by me in paragraph 14 would also be modified if the machinery is to be made in Australia, and the best course would be to send a small sample to one of the manufacturers to have it put through the process.

17. Mr. Gibson, in his second report of 9th October, 1913, stated—

> "The financial aspect of this proposition is now *somewhat modified by the fact that Mr. Christie* now estimates the cost of power from the central station at ¾d. per kilowatt delivered, instead of 1d. This will reduce the estimated manufacturing cost at the Federal Territory site by 8.4d. per cask, and permits of a more favorable consideration of the proposal (designated "C") to manufacture cement to be used for the requirement of the Federal Capital only. This proposal covers a production of 50,000 casks per annum, and if a like consumption can be reasonably maintained, and having regard to the present purchase value of cement at Queanbeyan, which Mr. Hill states to be 14s. 6d. per cask, unquestionably very considerable savings are to be made by manufacturing cement on the spot. The assumption is that 500,000 casks will be used within the next ten years, and again assuming that the works will be kept going more or less continuously, also a delivered cost of 10s. 7d. per cask, a saving of something like 4s. per cask will be made, or £10,000 per annum."

That is to say, a saving of £100,000 for the ten years' period. In that time we should wipe off the whole cost of our plant.

> "The value of this saving is, moreover, accentuated by the fact that the estimated manufacturing costs not only cover the interest upon invested capital, but also provide for the redemption of the whole of the capital outlay within ten years."

Mr. Gibson went on to say that, with respect to the machinery, he could not advise that this be manufactured, at least in the first instance, in Australia. He reported—

> "It is the usual custom of cement manufacturers to get quotations from well-known makers of cement plants, such as Fried. Krupp, Magdeburg, or Messrs. F. L. Smidth and Co., Copenhagen, for the whole outfit."

Mr. Gibson, in his report of 8th August, went on to say—

> "To summarize the foregoing, it would appear that the cost of cement manufactured at site "D" would be, delivered at the Federal Capital, 8s. 10.31d."

He proceeded to set out the different items upon which his estimate was based, and it was decided that, having regard to the cost of labour and other items, the estimated cost should be increased to 10s. per cask.

Fairy Meadow.

18. Following on the decision to abandon the White Cliffs proposal, attention was turned to the Fairy Meadow proposition.

19. Portland cement has been made in the laboratory of the Victorian Geological Survey, Melbourne, from the raw materials obtained at Fairy Meadow, and the cement produced is of a high *grade*, the *tensile strength* being considerably in excess of that of the cement made from the raw materials obtained at White Cliffs.

20. The analyses, however, show that the magnesia content is a shade above that permitted under the standard British specification, but it is well within the requirements of the American standard specification.

21. In view of the question of the percentage of magnesia, I advised the Minister that the limestone formation and shale deposits should be thoroughly prospected by driving tunnels and sinking shafts, and that, in order to carry out the prospecting, the Commonwealth should acquire the sites of the limestone deposits. Accordingly, the Commonwealth acquired an area of about 56 acres at Fairy Meadow, and the work of driving two tunnels was put in hand. At the present time about 200 feet have been driven in an easterly and westerly direction. In August last, the Department of Trade and Customs was asked to carry out analyses of the limestones, and to place Mr. Wilkinson, the Commonwealth Analyst, in touch with Mr. Bayley, of the Mines Department, State of Victoria, who had done the work previously.

22. Mr. Wilkinson has forwarded the results of analyses of limestone obtained from various positions in the tunnels, with the result that the percentage of magnesia is satisfactory in the eastern tunnel, and, *subject to the shale analysis being equally satisfactory*, there is every prospect of the raw materials being suitable. At the date of writing this report, the analyses of the shales have not been received, but it is anticipated within a few days the investigations will be complete. In obtaining samples of shale, three different deposits were selected, each within reasonable access of the proposed site *for cement works.*

23. The driving operations are being continued with a view to thoroughly testing the nature of the whole deposit, and it is proposed now to send up a sufficient quantity of raw materials won from this deposit to enable a small quantity of cement to be made on a commercial scale.

24. The extent of the limestone deposit at Fairy Meadow is such that, on the basis of a consumption of 50,000 casks per annum, the raw material would last for at least 180 years, or, on the basis of 100,000 casks per annum, at least 90 years. The site is within a mile of the Fairy Meadow Railway Station, and the quarry site has been acquired by the Commonwealth.

25. Further investigations taken up by the Department have been the contour survey of the limestone formations and the site for works, the reconnaissance of the water catchment area of Sand Hills Creek, and contour location survey of access from Fairy Meadow Railway Station to proposed site of works.

26. In the event of the result of the prospecting being conclusively satisfactory, and the Commonwealth determining to proceed, it will be necessary for the Commonwealth to acquire additional land for the housing of workmen, for railway and road approach, and shale deposits. However, I have not advised the Minister to proceed with such acquisitions pending further knowledge as to results.

27. All land required for the purposes mentioned in paragraph 26 would not involve a large expenditure, be cause land is of poor value. The additional area would be about 250 acres.

28. The question has been considered whether the output of a factory at Fairy Meadow should be such as would supply only the needs of Federal Capital construction, or whether it should be enlarged to enable it to *supply for other Commonwealth requirements in* New South Wales.

29. Estimates were drawn up to ascertain whether the average cost for all Commonwealth works would be reduced by placing the cement factory on some site other than Fairy Meadow (using raw materials obtained from Fairy Meadow), and it was ascertained that Fairy Meadow holds a considerable advantage over other sites, inasmuch as the cost of transporting raw material to any other site would considerably exceed the cost of transporting the finished cement from such other site to Federal Territory. For instance, the cost of manufacturing cement at Fairy Meadow and transporting same to Sydney would be approximately the same as manufacturing the cement in a factory situated in Sydney with materials won from Fairy Meadow, namely, about 10s. per barrel.

30. In the event, however, of establishing the factory at Sydney to use Fairy Meadow limestone, the cost of freight on cement would have to be added, which, in the case of construction at Canberra, would bring the cost up to about 12s. 6d. per barrel, whereas it could be manufactured at Fairy Meadow and transported to Canberra and delivered at 9s. per barrel.

31. The main principle, however, which will determine whether cement should be made at Fairy Meadow is the prospective consumption of cement at Canberra, it being assumed that such consumption will be a large, steady demand, and that the cement will be made available for purchase by the general public for building premises. Perhaps I may put forward the view that the supply of a cheap cement for ordinary domestic and other construction at Canberra is of the greatest importance, because it will admit of a Building Act which will constrain people to build well without unduly increasing rentals (and, as a corollary, the cost of living). The whole intention of my original recommendation of the 9th August, 1912, was to bring about such a result. I then thought that Portland cement made at Canberra would be used for Commonwealth works in other parts of New South Wales only in the event of the regular supply of the cement works outpacing, for the time being, the demand at Canberra.

32. It is proposed to fix the size of the factory so as to produce an output of 20,000 tons per annum, which is on the basis of at least 10,000 tons per annum being used on Federal Capital construction, and the remaining 10,000 tons per annum available for other Commonwealth works, if not required for Canberra.

33. In order to provide for the transport of coal to the factory at Fairy Meadow, and of cement to Canberra and other centres, it will be necessary to connect the quarry site to the existing railway by means of a railway siding. This siding is shown approximately by a red dotted line on accompanying plan.

34. In view of the distance of the Fairy Meadow *deposit from Canberra, the central* power plant at Canberra would not provide power for operation of cement works at as cheap a rate as in a power station situated on the works, and it is, therefore, proposed to establish such a power station in connexion with the factory. There is an ample supply of water in the Sand Hills Creek for the condensing plant of a steam power-house. The cost of such a *power plant erected at Fairy* Meadow is estimated at £10,000, exclusive of buildings.

35. The cost of erecting such a factory as proposed, exclusive of power plant, would be in the vicinity of £50,000.

36. The cost of the railway connexion between the factory site and the existing railway at Fairy Meadow will be about £5,000.

37. In view of the isolated situation of the proposed works, it will also be necessary to construct workmen's dwellings, this will involve an additional expenditure of £10,000. There will be other unspecified expenditure contingent upon the establishment of the factory amounting to, say, £10,000, bringing the total capital cost of the undertaking up to £100,000 (in round numbers).

The quantity and price of coal has been thoroughly considered, and the cheapest place to make cement is at Fairy Meadow, with either Maitland, Waratah, or Metropolitan coal. There is always a possibility that coal will be got along the south line, but I have not allowed for that. If coal is got at Appin it will reduce the cost of manufacture. The cost of Metropolitan coal is high, but we have allowed for that in our estimate. If we got coal at Robertson it will be all to the good. Shale at Fairy Meadow costs just on 2d. a cask. It is got at three places quite close to where we shall get our limestone, and half a mile from where the kilns will be. The limestone constituent being the bigger, we propose to erect the works nearer to where we get it. Probably 30 or 40 acres of shale land will be required. We have acquired only the limestone land, as we wanted to prospect it. We can produce cement at the price worked out by Mr. Gibson. It depends on the cost per unit, and includes charges on the plant. The dry process of manufacture is the best. We have very dry material up there, and that is the factor which determines the process. Either process gives an equal standard. Mr. Gibson's original statement was on the basis of a 50,000-barrel plant. I have considered a 20,000-ton or 120,000-barrel plant, which reduces the average cost of production, the overhead charges remaining about the same. The *Commonwealth* requirements for Canberra alone will be at least half that output, and we can use the remaining 10,000 tons for Commonwealth works in New South Wales. The naval works will use a lot of cement. I have not proposed to put up a plant which will compete in *the general production of cement for New South*

Wales. An alternative means of transit from Fairy Meadow railway station to the site is a ropeway, but the railway offers advantages over this. With a railway the second handling of coal can be avoided, and the load on a ropeway is not a very heavy one. The cost of constructing a railway for 1½ miles would be about £6,000. A ropeway would cost very much the same, but I think the railway would be preferable, although I recommended a ropeway first. After considering the cost of acquiring a road for the transmission of power, patrolling, and maintaining it, coupled with the small load at the factory end, I have come to the conclusion that an independent power unit at the works will be an economy. I have allowed 1d. per unit of current, and estimated the cost of the power plant at £9,000, exclusive of buildings. The type of buildings that we would erect at Fairy Meadow would be the cheapest possible—probably strong-framed structures with galvanized iron. The total cost of the proposition in round figures is £100,000.

20. *To Mr. Gregory.*—Mr. Gibson is probably the best man in Australia on questions of this kind. The magnesia standard of our limestone is just about the English standard, but I apprehended that when we get into the great mass of the stuff it may decrease. It gave about 4 per cent. magnesia on the first rough test, but as we got into the mass it is getting less, which is satisfactory. Until an exhaustive examination is made, I could not give conclusive evidence on the point. It looks now as though we will be all right for magnesia, and I would not recommend the deposit unless we were within the Continental and American standard. In making my estimate of £100,000 I have made provision for everything I could think of, and added £10,000. We shall have 41 workers there. Mr. Gibson estimates that we will be able to produce cement delivered at Canberra at 8s. 10d. In normal times, including the duty, I have never seen the Sydney price of cement under from 12s. to 12s. 6d., but it has gone up now to about 25s. We have had large quantities tendered by the Portland Cement Company, and our best price has been about 12s. 3d. Portland cement is made about 4s. or less per barrel in America. We bought it in England recently at 7s. 6d. The ordinary freight charge is 4s., and the duty 2s. 6d., while wharf charges add largely to the cost. It ought to be possible to turn out cement at 10s. I am prepared to stake my reputation, and that of my Department, that if we get £100,000 to put in a plant we shall be able to turn out cement at 10s., with a 120,000-barrel plant at present wages. I would be responsible for the advice I obtained from manufacturing experts.

21. *To Mr. Laird Smith.*—It would be fair to allow 4 per cent. for interest on capital, and 10 per cent. for depreciation on permanent outlay. We want from half to two-thirds of a ton of coal per 32 cwt. of raw ingredients, which produce 1 ton of clinker, or 2 cwt. of coal per barrel of cement. The following is the manufacturing cost estimate:—

MANUFACTURING COST ESTIMATE.

Items.	Mr. Gibson's Estimate of Fairy Meadow Proposal.
Basis of Estimate.	
Limestone and gypsum ..	3s. per ton at factory
Shale	3s. " "
Coal	21s. 1d. " "
Labour	9s. per 8 hours "
Power consumption ..	290 k.w.

Details of Estimated Cost per Cask on Site near Fairy Meadow Station.

Items.	Cost per cask, 50,000 casks per annum. (Scheme K.)			Cost per cask, 100,000 casks per annum. (Scheme F.)		
	£	s.	d.	£	s.	d.
Raw material and gypsum	0	0	10.11	0	0	10·11
Labour	0	3	4	0	2	4
Coal for burning ..	0	1	3	0	1	1
Coal for power	0	0	9	0	0	9
Bags	0	0	9	0	0	9
Repairs and stores ..	0	0	9	0	0	9
Management, &c. ..	0	0	6	0	0	3
Depreciation on permanent outlay at 10 per cent ..	0	1	9·12	0	1	0
Interest on capital at 4 per cent.	0	0	9·6	0	0	5·76
Total cost per cask ..	0	10	8·83	0	8	2·87

Transport to Canberra would be 7d. additional. Our cement composition will be: 75 per cent. limestone, 20 per cent. alumina, 5 per cent. adulterants. I advise that the Commonwealth should undertake the construction of these works to provide cement for the Federal site. These are conservative figures, and I have made no attempt to paint a rosy picture. We can make cement at a low enough rate there to ask people to build solidly and well. The market price of cement fluctuates, and there are times when it cannot be got. It is bad to have works stopped for want of cement. The Commonwealth with its own works would not be at the mercy of a cement combine, but what we propose to make is so small a proportion of what will be made in New South Wales if the German imports cease that it can hardly have much effect in steadying the price. If a private firm offered to supply cement at Canberra at less than 9s. a cask I would not recommend going on with our own works, but we are paying 14s. 7d.

22. *To Mr. Finlayson.*—We have been using 50,000 barrels per year for the last three years at the Federal Capital. I have estimated that we will use 180,000 barrels there in the next three years.

23. *To the Chairman.*—It will take eighteen months to erect and get the works going.

24. *To Mr. Finlayson.*—We are using on the average about 60,000 barrels per annum for Commonwealth works in New South Wales other than Federal Capital works. That demand is likely to increase, especially if the Port Stephens naval base is gone on with, unless progress or activities diminish on account of the war. We would cater for people who wish to erect their buildings at Canberra, letting them apply for cement at factory cost, including charges, in order to encourage a solid type of construction. We could not insist on people putting up concrete houses with cement at 18s. a barrel. My estimate of cost is not based on getting the whole of the plant made in Australia. It is based on the prices of English-made plant. It would be practicable to make practically the whole of it here. It might not be expedient to make some of the ball or grinding mills here, but the kilns and crushers could be made locally. Eighteen months is a fair hope to get the work started after placing the order for machinery either in Australia or England, but it might be a little more. It is possible, in view of war conditions, that it would save time to order the plant in Australia. My original scheme was that the contractors should erect, run, and guarantee the plant, but to do that you must go

to a firm like Krupp or Smidth, that makes the complete plant. In the circumstances this would not be advisable. We should have to take the responsibility and erect and run it ourselves. I would not hesitate to accept that responsibility. We should employ experts. We propose to put in simply a construction line of railway, running our own small locomotive on it. As soon as we know the chemical analysis of the shale and limestone, if it is good I will straightway recommend the Minister to acquire the shale deposits. Probably 40 or 50 acres will be sufficient, because we have 52 acres of limestone. We purchased the limestone land unproved. We propose a boarding-house for single men, and as many cottages for married men as are necessary. These will be somewhat cheaply constructed, and subsequently, when we get cheap cement, we can do something better. We expect the works to be there for 30 or 40 years, and there should be no difficulty in getting men to settle on the spot. About ten of the forty employees would be skilled, but the other hands would in time become skilled cement workers. The burning mill must be kept going continuously.

25. *To Senator Lynch.*—The question of supplying the cement requirements of other States was considered, but the freight difficulty would knock the idea out. We are getting Portland cement for as low as 12s. in Victoria, and it would not be an economical proposition to supply all Australia from Canberra. If that is to be seriously considered it would become a question of whether we should take the works to Canberra. The freight would not be a deterring factor in New South Wales. I have not considered the question of suitable location for cement works in the other States. My figures were taken out before the war began. The price of machinery may have been added to, but the increased capital outlay due to that cause will not be a very serious factor in considering the cost of producing cement. The plant will be composed of two units.

26. *To Mr. Sampson.*—The State Governments have no cement works of their own. The New South Wales Government once considered the matter. I recommend Fairy Meadow as a site because I make such a big saving on half the output sent to Canberra, where we have a sure and steady market. It would pay to send cement by water to Port Stephens, but I do not think it would pay to send it to the other States. If we could put up a 250,000 barrel plant we could bring down the cost of manufacture, but the Commonwealth would be saddled with a big concern. Fairy Meadow is about 90 miles from Jervis Bay which would probably be as good a port as Sydney for the shipment of cement to different parts of the Commonwealth. The construction of a direct line of railway from Canberra to Jervis Bay would not alter my calculations, because I do not think we can produce cement in a 120,000 barrel plant cheaply enough to distribute to other States, and even with a direct line I do not think it would pay to put up a 250,000-barrel plant

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(Taken at Melbourne.)

WEDNESDAY, 17TH NOVEMBER, 1915.

Present:

Mr. RILEY, Chairman.

Senator Keating,	Mr. Gregory,
Senator Story,	Mr. Sampson,
Mr. Fenton,	Mr. Laird Smith.
Mr. Finlayson,	

William Percy Wilkinson, Commonwealth Analyst, *sworn and examined.*

27. *To the Chairman.*—I have received a number of samples of shale and limestone from Fairy Meadow. Samples of limestone taken from different points in the drives have been coming forward practically every week for the last three months. Twelve samples of the shale have reached me, and my analyses of these are now complete. In the following table they are divided into three groups, No. 1, No. 2, and No. 3, according to the locality from which they were taken:—

Analyses of Shale from Fairy Meadow, New South Wales.

Body.	Portion.	Silica (SiO_2).	Alumina (Al_2O_3).	Iron Oxide (Fe_2O_3).	Manganese Oxide (MnO).	Lime (CaO).	Magnesia (MgO).	Potash (K_2O).	Soda (Na_2O).	Loss on Ignition.
No. 1 ..	No. 1 ..	60·15	16·02	5·23	0·56	0·60	1·08	2·07	1·11	3·05
" 1 ..	" 2 ..	60·00	17·84	4·76	0·09	0·80	1·08	2·04	1·32	3·85
" 1 ..	" 3 ..	68·45	10·84	4·91	0·84	0·90	1·69	2·70	0·28	3·72
" 1 ..	" 4 ..	71·60	14·44	4·76	0·83	0·80	1·62	2·04	0·95	3·30
" 2 ..	" 5 ..	69·00	13·74	5·64	1·28	1·03	1·27	2·05	0·36	5·20
" 2 ..	" 6 ..	68·00	15·71	5·60	2·04	..	0·34	2·60	0·68	4·95
" 2 ..	" 7 ..	66·70	14·90	5·91	1·33	1·68	1·88	2·70	0·68	5·10
" 2 ..	" 8 ..	64·24	17·36	6·16	1·14	0·86	1·81	2·70	0·67	5·12
" 3 ..	" 9 ..	68·00	16·10	5·24	0·63	0·68	1·15	3·03	0·32	4·80
" 3 ..	" 10 ..	66·20	16·35	6·05	0·98	1·06	1·23	2·07	0·63	4·90
" 3 ..	" 11 ..	64·35	17·67	5·50	1·10	1·26	1·02	2·50	0·83	5·30
" 3 ..	" 12 ..	64·00	18·13	5·07	0·75	1·28	1·81	3·40	0·53	5·45
	Average Analyses of the Three Groups.									
No. 1 ..	..	66·55	16·23	4·91	0·53	0·77	1·37	2·23	0·91	3·70
" 2 ..	..	66·08	15·42	5·83	1·07	1·04	1·32	2·51	0·59	5·09
" 3 ..	..	65·64	17·04	5·46	0·86	1·07	1·52	2·03	0·58	5·11

It is important to know the exact composition of the shale in order to be able to decide whether it is possible to mix it with any given limestone in such proportions that, when burnt under certain conditions, the two materials will form a clinker, which, on grinding, will produce good cement. I have no data before me showing the analyses of shale taken from other parts of the Commonwealth for the manufacture of cement; but there should be no difficulty in obtaining them from any of the cement companies. No general work on the subject has been published here.

Many years ago, when the Fyansford works were starting, I conducted a lengthy series of analyses for Mr. Richard Taylor, but the data so obtained were private property, and therefore I could not quote them. My analyses undoubtedly show that the shale taken from Fairy Meadow is suitable for use in the manufacture of cement. It compares favorably with shales from other parts of the Commonwealth which I have analyzed. I cannot say offhand that it is equal to any that I have analyzed for cement making, but it is certainly suitable for that purpose. If you have shale of a given composition and limestone of a known composition, you can apply certain formulæ recognised in current cement making to determine whether they are suitable for cement making. It is on the basis of such knowledge that I have formed the conclusion just stated. I submit the following table showing the analysis of limestone from Fairy Meadow:—

ANALYSIS OF LIMESTONE FROM FAIRY MEADOW, NEW SOUTH WALES.

	1.		2.		3.		4.		5.		6.		7.	
	A East.	B West.	A East.	B West.	A East.	B West.	A East.	B West.	A East.	B West.	A East.	B West.	A East.	B West.
Silica (SiO_2) ..	0·86	1·06	1·06	1·26	1·26	1·06	0·99	0·85	0·92	0·78	1·12	1·67	1·35	0·85
Iron Oxide (Fe_2O_3) ..	1·46	0 86	0·66	0·46	0·85	0·85	1·26	1·36	0·86	0·96	0·96	1·06	0·85	0·85
Alumina (Al_2O_3) ..														
Lime (CaO)	53 06	53 06	52 46	53 86	52·06	52·86	53 55	50·58	52·35	52 05	53·05	51 05	52·05	52·25
Magnesia (MgO) ..	1 36	1 44	1 39	1 22	2·81	1·94	1·35	3 85	2 22	3 55	1 17	2 62	2·15	2·26
Total Sulphuric Acid (Calc. as SO_3) ..	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace
Loss on ignition ..	43 25	43·20	43·20	43·00	43·40	43·20	42·85	43·60	43 65	43 30	43·10	43·4	42·80	43·10
Calculated as Carbonate $CaCO_3$	94 68	94 68	93 60	96 10	92 89	94 32	95 55	90·18	93 41	92 88	95·71	91·10	94·48	93·24

ANALYSIS OF LIMESTONE FROM FAIRY MEADOW, NEW SOUTH WALES

	8.		9.		10.		11.		12.		13.	
	A East.	B West.	A East.	B West.	A East.	B West.	A East.	B West.	A East.	B West.	A East.	B West.
Silica (SiO_2)	1·55	1·05	1·15	0·65	0·60	0·64	0·78	0·72	1·62	1·56	1·48	0·78
Iron Oxide (Fe_2O_3) and Alumina (Al_2O_3)	0 75	0 45	No iron 1·05	Oxide 0·25	0·60	0·44	0·34	0·28	1·64	2·08	1·20	2·50
Lime (CaO)	51·15	52·45	53·65	47·48	54·40	52·94	54·24	53·02	52·88	51·72	52·60	48·36
Magnesia (MgO) ..	2·37	2·04	0·89	2·60	1·84	2·70	1·02	2·28	1·33	1·11	1·47	4·66
Total Sulphuric Acid (Calc. as SO_3) ..	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace
Loss on ignition ..	42 05	42 00	42 00	43 70	42 45	43·56	43·40	43·30	43·14	43·06	43·11	43·05
Calculated as Carbonates $CaCO_3$	93·06	93 57	95·74	85·36	97·06	94·46	96·80	96·22	94·36	92·28	93·86	86·30

I have had twenty-six samples of limestone. Those referred to in the table as "A" come from the east drive, and those referred to as "B" from the west drive. I have not made any averaged analyses of the different groups of limestone, because samples are still coming forward. When the samples are complete I shall do so. The figures as to the percentages of silica, oxide of iron, alumina, lime, magnesia, total sulphuric acid contents, and loss on ignition are interesting. The table I have just handed in shows the variation in these contents according to the position from which the samples were taken. In respect of silica, the variation lies anywhere between 2 per cent. and ½ per cent. With the exception of sample 9, where the iron oxide rises to 6 per cent., which is quite abnormal, the presence of this constituent in the limestone in no case exceeds 2 per cent., while in some cases it is down as low as 0.3. Lime is an important constituent, and it will be noted that the range is remarkably close. The presence of magnesia is an important consideration, because if it existed above a certain proportion it would render this limestone quite unsuitable for the successful manufacture of cement. The maximum quantity found in these samples is 4.6, and the minimum 0.8 per cent. My analyses show that there is a marked variation in the percentage of magnesia.

28. *To Mr. Gregory.*—Different countries have different standards as to the percentage of magnesia that may be allowed in the composition of cement. In the latest British specification the proportion in the finished cement is fixed at 3 per cent. German specifications, on the other hand, allow 4 per cent., while the same percentage is allowed in the United States of America specifications, sometimes even a slightly higher proportion being tolerated. Having regard to the admixture of the limestone with the shale, it will be seen that the materials obtained from Fairy Meadow would produce, on the average, a cement that would comply with the British standard specification. In the manufacture of cement the ideal practice would be to test all limestone before grinding, and to use only that so proved to be suitable. When the ground is more opened up it may be found that the composition is far more regular than the analyses so far show.

29. *To Senator Story.*—There were more fluctuations in the samples from the west drive than in those from the east drive. The samples show

that practically all the limestone obtained from the east drive could be used, without any doubt, for cement making.

30. *To the Chairman.*—There is only a doubt so far as two exceptional samples are concerned as to the suitability of the limestone obtained from the west drive. The points from which samples were taken are 10 feet apart. The quantity of sulphuric acid present in these limestone samples is so small that it would have been unprofitable to attempt to estimate it. The absence of sulphuric acid is an advantage. I would say without hesitation that my analyses of the shale and limestone taken from Fairy Meadow show that the manufacture of cement could be safely undertaken there. I have made many analyses of limestone from the Fyansford district, near Geelong. The limestone from Fairy Meadow is of fair average quality, and both limestone and shale are good enough to warrant the establishment of cement works there. I have brought with me the most recent information on the theory of the constitution of cements, but I do not think that it would have any direct bearing on the question immediately before you. I have been informed by Mr. Hill that some question has arisen as to dealing with dust in the process of manufacture.

31. *To Mr. Laird Smith.*—Mr. P. C. H. West, in a book entitled *The Modern Manufacture of Portland Cement*, published in London in 1910, says in his introduction to Vol. I., in which he has summarized the various views expressed regarding the dry and wet grinding processes, that—.

> Every endeavour has been made to refrain from dogmatism. Positive statements not infrequently do harm, and often they are untrue. Now, it will be declared that the dry process is superior in all cases to the wet, then it will be declared that the wet process is best even for hard raw material; while at one time it was generally stated that a good cement could not be made by any process other than the wet. The truth lies between the above statements, while each of them in itself is wrong.

32. *To Mr. Sampson.*—The question of whether the wet or the dry process should be used would be determined to a large extent by the character of the raw material. The dry process is undeniably the cheaper. There are nowadays so many suitable dust collecting plants that no difficulty should be encountered in securing a satisfactory plant to remove all possibility of danger to the health of workmen arising from the inhalation of excessive dust. It must be remembered that whether the raw materials are ground wet or dry the final product—that is the cement clinker—must be ground dry, and that the clinker has to be ground the finest of all. I have taken the following from an abstract of proceedings of the eighteenth annual meeting of the American Society for Testing Materials, which took place this year:—

THE EFFECT OF FINER GRINDING UPON THE PHYSICAL PROPERTIES OF PORTLAND CEMENT.

The following is from a paper on this subject by P. H. Bates:—

The question of the finer grinding and the addition of more SO_3 to Portland cement is frequently discussed, and the consensus of opinion seems to be that further investigation is needed. Ten commercial cements either had more SO_3 added to them, were ground finer, or were both ground finer and had more SO_3 added. From the four groups of ten cements each, the customary physical tests and small specimens were made. In addition, cylinders of 1 : 1½ : 3½ concrete were made, and expansion bars of neat 1 : 3 standard sand mortars. Some of the neat tension briquettes were also examined microscopically for relative amounts of hydration.

The results show that the time of set is affected somewhat by each of the above treatments, finer grinding tending to produce a quicker set, and the addition of more SO_3 a quicker initial but slower final set. The addition of SO_3 to the coarser ground cements does not materially affect the strength; finer grinding produces considerable increase; while the addition of SO_3 to the finer ground cements tends to produce results very slightly less than those obtained when they contain the normal amount. Expansion measurements show that the addition of SO_3 to the coarse cements produces a large increase in length of neat cements; to finer ground cements the increase is not so great. Finer grinding alone does not materially affect the expansion due to hydration; the expansion of the mortar bars is not materially affected by the use of the different cements.

All conclusions made in this paper are deduced from results obtained from specimens tested at the end of ninety days. Specimens have been made to be tested at the end of six months, one year, and two later periods, and, consequently, the present conclusions may have to be materially modified.

Mr Bates, the author of the paper referred to, is one of the officers of the Bureau of Standards in Washington. I have had the pleasure of meeting him, and know that he is a very able man. The SO_3 referred to is calcium sulphate, which is invariably used to regulate the time of setting. Other papers on the subject have been published by Mr. Bates, and the conclusion arrived at from these researches is that it is only the finest particles in cement—those which pass through a sieve of 300 meshes to the lineal inch—that have any real value.

33. *To Mr. Finlayson.*—It is possible to obviate the injury to health due to the inhalation of the finer particles. At the seventh semi-annual meeting of the American Institute of Chemical Engineers held last August, the first paper presented by Mr. W. C. Hannah, of the California Portland Cement Company, Riversdale, described the Fleming Dust Collecting System, which, according to information I have received, is successfully used by the company for collecting any dust, and preventing damage to the surrounding orange groves.

34. *To Mr. Gregory.*—The dust can be controlled within the factory itself, and its escape from the factory prevented. I have not seen it done, but that is the statement in this advanced note. It is stated that, by the use of the Fleming Dust Collecting System, the escape of the dust from the factory has been prevented. I have the full details of the Fleming Dust Collecting System, as published in *Metallurgical and Chemical Engineering*, for 15th September, 1915, from which the following may be of interest:—

> "Orange growers in the vicinity of Slover Mountain, California, began to complain in 1909 about dust emanations from the kilns and driers of the cement plants operated at Colton. At that time, the new, or largest plant, was one of the most modern in the United States, and was considered by cement manufacturers a clean plant; and, as there had never been any recorded injury to people or vegetation in the neighbourhood of cement mills, the orange-growers' complaints were believed to be without grounds, but serious enough, however, to warrant an extensive line of investigation and experiments with all known methods for capturing the dust.
>
> "These investigations were continued with zeal, but nothing of sufficient effectiveness was found. In the meantime, the orange-growers, not being satisfied with the efforts of the cement company, brought suit against it. In the trial, during July and August of 1910, expert testimony from many parts of the world covered much of the field of cement manufacture, dust-collecting devices, and agriculture as practised in the vicinity of Colton.

"The Superior Court granted the orange-growers an injunction in April, 1911, which became effective in June of that year; but, by that time, experiments at the old cement plant had proved so satisfactory that Mr. T. J Fleming, secretary and general manager of the company, had most of the material on the ground for constructing his dust-collecting system on a practical scale for five rotary kilns 7 ft. 6 in. in diameter, and 120 feet long. By September, 1911, the first kiln was operating to the dust-house; and, shortly afterwards, all of the kilns were operating at full capacity with the Fleming system. Meanwhile, throughout the mill, a campaign against dust was made, resulting in all grinding machinery, elevators, and conveyors being made practically dustless.

"This same system of dust collecting has been in continuous use since that time, and has proved to be not only an efficient means of capturing the dust, but also to be more than self-supporting; there being a saving to the company in the dust captured, better output per barrel of fuel oil, and less shut-downs than before the Fleming system was in operation.

"Very briefly, the installation consists of normal rotary kilns using dry process and oil for fuel. The draught for the kilns and driers is produced by fans sucking at the end of each separate flue. Instead of discharging the gases into the atmosphere, the same exhauster fan blows the dust and fumes into a large chamber known as the dry-dust settling chamber, where the velocity of the gases is reduced about 90 to 95 per cent., resulting in a large amount of dust being deposited. The extremely fine dust which does not settle, and the gases, then go to the wet washing chamber, where the gases are forced up and down several times while following a serpentine course through a system of seven baffle chambers; and the last of the original so-called cement dust is captured by sprays of water which are in each chamber. These sprays of water also bring into solution much of the gases, lime, and alkalies. In connexion with both the dry and the wet chambers, there are means provided for removing the captured dust to the cement kilns.

"The amount of water required to operate the Fleming system is much less than at first would be expected. The fresh water need not exceed 75 to 100 gallons per minute, and it has been found desirable to add this in the form of coarse sprays in the exit chamber, above the screen to the same, and in the baffle chamber just before exit chamber. The greatest part of the washing is done by the circulating water, which amounts to at least 1,000 to 1,200 gallons per minute. The heaviest sprays of return water are located in the second baffle chamber after leaving the dry chamber.

"The amount of dust captured each day in the dry dust chamber is about 30 to 40 tons, while about 15 tons is captured in the wet baffle chambers. Where only rotary kilns are operated in connexion with the dust-collecting system, the proportion of calcium oxide, silica, and alumina, in both the dry dust and slurry, are found to be such that they can be returned to the kilns without special attention being given to them. Where dust from driers, such as clay driers, is also collected in the same system, the dust will contain an excess of clay, and it must be returned with proper care. At the Colton plant, the dust is used so as to balance any irregularities in the composition of the raw mix as it goes to the kiln feed bins.

"The method of using the dust will be of interest, so I briefly tell you how it is blended.

"The rotary kilns and the dust-collecting system are in operation twenty-four hours each day, while the clay drier operates at night long enough to fill the empty clay bins. The slurry from the wet baffle chambers, after being thickened in the tanks, is pumped about every hour over kiln-stack bases to a tank holding almost one day's run, and the slurry kept in agitation by compressed air. The hundred spouts under the dry chamber are opened daily, only on the day shift, and the dust conveyed to a bin of almost one day's capacity in the raw grinding department.

"The amount of dust deposited in the collector from the kilns is very uniform, and from the amount of clay used one day, it can be closely estimated how much clay will be deposited in the chamber that night to be mixed with the dust for use the next day and night.

"The raw mix, as proportioned at the scales, is made of such composition that the dust must be added to it in order to give it a suitable composition. The dry dust can be added to the ground raw mix at any desired speed, and from one to fifteen raw mills can operate without causing inconvenience. When everything is normal, the miller operates the dust feeder at a specified speed for each different number of mills that he may be operating, but in the case of raw mix, as tested in the laboratory, if found to require a little more or less clay, the laboratory orders the dust feeder to be speeded up, or reduced sufficiently to give the desired mixture. As the dry raw mix runs into the kilns, a small stream of the well-mixed slurry from the slurry tank runs by gravity into the kilns.

"The dust captured in the dry chamber is very fine, practically all passing a No. 200 sieve, and about 97 per cent. passing a No. 300 sieve. Both this dust, and the extremely fine dust captured in the form of slurry, have much more sulphur, potassium, and sodium than the raw mix; but after a few returns to the kilns, they do not show any further increased percentages of these elements.

"The water used in the wet baffle chambers very rapidly becomes heavily laden, chiefly with sulphur compounds and potassium, sodium, and calcium, and when more than half-a-pound per cubic foot is found, some of the water is taken out and replaced by fresh water in order not to cause trouble with the sprays. Plans are being made to recover the potash.

"The dust which is discharged into the air from the exit to house amounts to about 1 ton per day. This dust bears no resemblance to the original cement dust, it being for the most part sulphur compounds of potassium, sodium, and calcium, and about 88 per cent. to 94 per cent. soluble in water. This dust is produced by the draft drawing out the fine sprays of water from the wet washing system, much the same as the wind carries inland the salt-water spray from ocean breakers.

"The Fleming system requires very little labour. The power consumption is reasonable, not exceeding 2,000 kw. hours per day, of which 57 per cent. is used on the return water pumps.

"The cost of placing the Fleming system in an old plant would depend upon the general outlay of the plant, the amount of room available, and type of construction. In a new plant, the apparatus can be placed with ease and at minimum cost.

"In concluding my remarks with the customary contrast of results 'before and after using,' it is impossible to deal exclusively with the unit used thus far in this paper, as that unit has always operated with the dust collector in connexion. Therefore, it will be necessary to take results obtained with one clay drier and five kilns, 7 ft. 6 in. in diameter, and 120 feet long, which were operated for about two and a half years with normal practice, and then for the same length of time with the Fleming system.

"With this dust-collecting system in use, there was obtained:—(1) About 24 per cent. more clinker per barrel of fuel oil consumed; (2) about 5 per cent. more clinker produced per hour of kiln operation; (3) about 2 per cent. more actual operating time of kilns; (4) over 7 per cent. less raw materials required for the manufacturing of a barrel of cement; (5) the quality of the output was improved; (6) dust from driers and kilns collected, and the nuisance abated."

I should like to say that, in connexion with the work of cement making, every stage should be conducted on the lines of proper scientific inquiry. Nothing should be left to any rule-of-thumb procedure.

35. *To the Chairman.*—I think it would be advantageous for me to visit the site at Fairy Meadow, from which samples are being drawn. It might be advisable to open up other parts of the ground to determine whether the extensive variation shown by the analyses in the magnesia contents—the element most to be feared—is equally great there; or whether it is more constant in respect of certain parts. I repeat that I am satisfied from the analyses I have made that the proposal to establish cement works at Fairy Meadow is a good one.

36. *To Mr. Gregory.*—Mr. Hill has submitted to me a ground work plan. All the samples vary. The variation in magnesia contents in the limestone samples is slight, save in the two instances to which I have drawn special attention. I cannot say whether those two samples were obtained near the surface. The samples are not marked so as to show the depth from which they were obtained. Mr. Hill has just handed to me a memorandum, dated 9th instant, from the clerk of works at Canberra, to the effect that of four bags of limestone just forwarded two were taken from the face at a depth of 32 feet, and two at a depth of 40 feet. The greatest depth from the surface is, I am told, 80 feet. All beds of limestone show some slight variation in their composition; the variation in the samples I have examined might be due to the different depths from which they were taken. I do not think it would be safe to infer that more equable samples would be obtained at some depth from the surface than from near the surface itself. The oxidation of the stone on the surface would not make it more variable, because the leaching would have effect for only a very short distance. I cannot say to what depths the limestone deposits at Fairy Meadow have been proved. I have just been handed by Mr Hill a departmental file showing the actual position from which all the samples submitted to me were taken. Here, for instance, is a memorandum from the clerk of works dated 1st October, 1915, setting out that four bags of limestone are being forwarded—two from the eastern drive "A," 237 feet in from the face, and two from the western drive "B," 186 feet in from the face. I have not gone further than the analyses by making tests of the shale and limestone to determine what class of cement they would produce. That would not be of any advantage. The analyses show that it is possible to make cement from these materials. As a general rule, an excess of magnesia in limestone is detrimental to cement making. On the other hand, the presence of a moderate amount of magnesia would replace an equivalent amount of lime, and would be taken into account in calculating the mixture for the firing in the furnace. No doubt it would be best to determine, before incurring a large expenditure in erecting the necessary plant, whether the wet or the dry process should be adopted; but I do not think it would be particularly advantageous to make laboratory tests with that object in view. The point must not be overlooked that whether you adopt the wet or the dry process, the final grinding of the cement clinker must be a dry process. That cannot be overcome. As to the injury to the health of workmen in connexion with the use of the dry process, I presume that more harm would be likely to arise from the inhalation of the excessively fine dust rising from the grinding of the clinker than from the inhalation of the coarser dust particles from the grinding of the limestone and the shale. Health considerations, amongst other reasons, have been responsible for the change from the dry to the wet process, that has been made in certain cases, but another important point is that the wet process is supposed to give a more intimate admixture of the materials. The best authorities on the subject, however, are still at variance on the point. At the Fyansford cement works the wet process has been substituted for the dry process, but I am in a position to say that a very excellent cement was made at those works while the dry process was in use. For five and a half years, I made tests of the Fyansford cement for the Melbourne and Metropolitan Board of Works, and found it to be of excellent quality. In conjunction with Mr. Oliver, the present Engineer-in-Chief of the Board, I contributed a paper before the Australasian Association for the Advancement of Science, held in Melbourne in 1901, in which we gave the result of five and a half years' tests of various brands of cement used by the Melbourne and Metropolitan Board of Works. A paragraph at the end of that paper shows that the cement made at Fyansford compared very favorably indeed with cements imported from Great Britain. I shall not say that the dry process would be the best to adopt in this case, but it would be perfectly suitable. I presume that the Commonwealth would find it necessary to erect a dust-collecting plant in connexion with the grinding of the clinkers, for it is in connexion with that process that the greatest effort will have to be made to protect the health of the workers. When installing a first-class dust collecting plant in connexion with the grinding of the clinker a slight extension of that plant would suffice to protect the workers in the dry grinding of the limestone

and shale. While it is true that the limestone grinding creates more dust than the clinker grinding, it has to be remembered that the clinkers have to be ground far more finely than the raw material, and that particles of cement are possibly more injurious to the lungs than are particles of a comparatively inert substance like limestone. I cannot say whether there would be any danger of fibrosis amongst persons engaged in this industry if the dry process were adopted. I did not anticipate such a question, otherwise I should have come prepared to answer it. The danger would be greater in the case of a hydraulic-setting substance like fine cement dust than in the case of limestone or shale particles. Limestone can be crushed wet or dry. The chief object of the wet process is to secure a more intimate admixture of the materials. I have followed up this subject for many years. Mr. Richard Taylor, in establishing the Fyansford factory, experienced difficulties, extending over the greater part of two years, and incurred considerable expense in the selection of materials. The difficulty arose, however, only in connexion with the materials. I know that the wet process has been substituted for the dry at the Fyansford works, but I do not know of any other factory out here that has made such an alteration.

37. *To Senator Story.*—I cannot give first hand information on the question as to whether the variation in the samples from Fairy Meadow is greater than in the case of other deposits that are being worked in Australia; but I have been told that at Cave Hill, Lilydale, a very considerable percentage of magnesia is found in certain portions of the limestone deposits, making them unusable for cement burning. It has been found necessary to select the material. That would be necessary, I think, in the case of any cement works. It is customary to analyze the charges, or, at all events, to analyze all the faces, from which the material—both limestone and shale—is being drawn, so as to guard against any undue variation in the percentage of magnesia and other constituents. I am prepared to say that, judging from the samples I have analyzed, the average limestone and shale at Fairy Meadow can be used without any rejections. The difficulties experienced in the early days were, no doubt, greater than those likely to be encountered to-day in establishing cement works. The whole process of manufacture is now reduced to a very exact technical science, and the general tendency is in the direction of showing that some of the difficulties experienced at Fyansford would not occur at Fairy Meadow.

38. *To Mr. Laird Smith.*—If we accept the English standard, finished cement should not contain more than 3 per cent. of magnesia, while, according to the German and United States standards, it should not contain more than 4 per cent. Many natural cements contain over 30 per cent. of magnesia, but they have not the same power and strength as have cements of the Portland cement type. The percentage of oxide of iron in the samples examined by me is, perhaps, slightly high, but I do not think it is disadvantageous. It merely means that the cement will have to be burnt at a lower temperature on account of the fluxing effect of the iron, and other secondary constituents, on the clinker. That is not detrimental to the manufacture of a good cement. As a matter of fact, it means that less coal will be required, since less heat will be necessary to produce the finished product—the clinker

39. *To Mr. Finlayson.*—With the exception of potash, there is no tendency on the part of the detrimental constituents to disappear in the process of manufacturing cement. The shale examined by me contained up to 2.9 of potash. Potash, especially at the present time, is exceedingly valuable. The potash accumulates in the flue dust in cement burning, and, in some cement works abroad, they are extracting it because of its great value to-day. The possibility of the recovery of the whole of the potash from the flue dust should be taken into account by the Committee. The process of recovery is comparatively simple. A patent has recently been taken out in the United States by S. B. Newbery for recovering potash from the stack-cases of cement kilns. The patent is No. 1,160,297 of 17th August, 1915. We have at present no Australian sources for the supply of potash. We are dependent wholly on outside sources for the supply of that material, which is most important to Australian agriculture. The potash recovered from the flue dust would be a small, but nevertheless a very valuable by-product. None of the ingredients used in the manufacture of cement tend to deteriorate from the time of their extraction from the bulk to the time of manufacture, so that the location of the works is merely a question of convenience. There would be no detriment in transferring the raw material from the quarries to some other site. The question of cost would be the governing factor. Apart from that consideration it is immaterial whether the factory is, or is not, located on the site of the limestone and shale deposits.

40. *To Senator Keating.*—Where there is an excess of magnesia the finished cement has a tendency to "blow" or disintegrate. There have been one or two classical examples of that. A recent authority on the subject is Searle's *Cement, Concrete, and Bricks*, published in London in 1913. At page 73 of that work we have the following statement—

> Magnesia is only present in small quantities in the better class commercial cements, as the use of magnesic materials is prohibited in all specifications for Portland cement, but larger proportions are present in many natural cements. It combines with alumina and silica in a manner analogous to lime, but there is a great difference of opinion as to the value of magnesic cements.
>
> Magnesia needs a much higher kiln temperature than lime, in order that it may combine with silica and alumina; hence an excess of it in a cement mixture is undesirable, as it will largely exist in an uncombined state unless an unusually high kiln temperature is employed.
>
> Newbery has found that magnesia up to 20 per cent. produces a satisfactory cement if due care be taken in mixing and burning, and the relatively high proportion of magnesia in many satisfactory natural cements shows that magnesia is not in itself a disadvantage, providing that the cement is properly burned. Therein lies the difficulty.
>
> Tests of cement to which magnesia has been added just previous to gauging show that magnesia causes expansion, but much less rapidly than in the case of free lime, and the damage effected is correspondingly less.
>
> Since the failure of a French bridge and a portion of the Aberdeen Harbor works, it has been customary to limit the percentage of magnesia compound to a maximum of 3 per cent. MgO.

According to that authority, there may be a serviceable cement containing even 20 per cent. of magnesia. Everything depends on the proportion of iron compounds present in the material. These govern the temperature of the burning of the cement. The authorities do not state what proportion of magnesia was present in the cement used in the French bridge and portion of the Aberdeen Harbor works which failed. The reasonable inference is that if there was a high percentage of magnesia in the material, there was not a corresponding temperature in the kilns. Mr. C. H. Desch, in his work entitled *Chemistry and Testing of Cement*, which was published in London in 1911, says—

> Expansion, due to magnesia, does not show itself in many cases until after a much longer period, as strongly heated magnesia often remains inert for a long time before undergoing hydration. Expansion, due to this cause, was first observed in 1884, when, almost simultaneously, attention was called in France to the destruction, two years after erection, of a number of railway bridges and viaducts, and, in Germany, to the cracking of the Town Hall of Cassel, which it became necessary to rebuild. Both cements were found to contain much magnesia, the French from 16 to 30 per cent., and the German 27 per cent., as they prepared from dolomitic limestone.

The maximum quantity of magnesia that we have so far found in the samples of limestone is only 4.6 per cent., whereas from 16 per cent. to 30 per cent. of cement was found in the finished French cement referred to in this authority. Our finished cement, having regard to the shale which would be mixed with it, would contain much less than 4 per cent. The percentage will be reduced in the finished article. The magnesia existing in the raw limestone and shale will be found in the finished article, although not to the same extent as in the former, because of the admixture. That being so, there is no need for any apprehension in this regard. The investigations upon cement now being conducted at the Bureau of Standards, Washington, are of particular interest, as bearing upon the effect of magnesia in cement, which has been a most disputed question. Mr. P. H. Bates, of the Bureau mentioned, published lately some "Further Results in Investigating Properties of High Magnesia Portland Cements," in the *Concrete Cement Age*, 7, 1915, in the course of which it is stated that, "High Magnesia Cements produce concrete showing as good a department as regards expansion as the low magnesia cements. Satisfactory thirteen and twenty-six week strength results are obtained with a cement containing 10.3 per cent. magnesia." Cement manufactured from the whole of the limestone and shale samples submitted to me would comply with the British standard. As soon as the analyses of all the samples to be forwarded to me have been completed, I shall prepare a statement giving the average percentage that would be found in the finished product, as well as an estimate of the general average. Leaching vats would be necessary to recover the potash from the flues. The cost of these would be so immaterial that it would not matter whether they were introduced at the outset of the factory, or later on.

41. *To Mr. Gregory.*—I shall be glad to supply the Committee later on with the formula of an ideal cement.

42. *To Mr. Fenton.*—I shall be glad later on to give you in detail the fundamental structure of Portland cement, and shall supply the result of some investigations that are still going on at the Carnegie Geophysical Institute at Washington as well as at the Bureau of Standards, Washington. All the material used in the manufacture of cement should be subjected to the closest analysis.

43. *To Senator Keating.*—A chemist has synthetical as well as analytical duties, and the former are often of greater value than the latter. The composition is a very happy one.

44. *To Mr. Fenton.*—I have not analyzed many samples of Portland cement for some years, but in the paper that I prepared with Mr. Oliver, showing the results of five and a half years' tests of various brands of cement used by the Melbourne and Metropolitan Board of Works, and which was read before the Australasian Association for the Advancement of Science in 1901, I presented a table showing the chemical analysis, specific gravity, and tensile strength of numerous cements. That table shows that the average percentage of lime was as follows:—Alsen brand, 62.09 per cent. of lime, Tower (German), 62 70, Gibbs, 61.73; Gresham, 61 35, Gillingham, 60.77, Knight Bevan, 59 84, Formby, 59 62 Invicta, 61.20, Anchor, 60 71, Australian Portland—that is, the Fyansford cement—61.99, Tower, 60 73; Emu, 60.55; Wouldham, 61 35; and White Brothers brand, 58 43 Those analyses were made prior to 1901, since when there has been a great improvement in the quality of cement. The combination of properties which govern the quality of Portland cement, however, has never changed. Cement can be made from an absolutely pure limestone, but in the actual practice of cement burning, all the secondary constituents are of considerable value. My analysis of the two chief constituents found at Fairy Meadow lead me to have no doubt that from them a first-class cement can be manufactured.

45. *To Mr. Sampson.*—The wet process of manufacture, as I have said, has the advantage of giving a very intimate admixture of the raw material before the firing, but the water used in wet grinding has to be got rid of in the furnace and that means an additional consumption of fuel. The limestone and shale from Fairy Meadow are suitable for the manufacture of lime by either the wet or the dry process. I have had nearly twenty-five years' experience in the testing of cement. Our laboratory is confined to Commonwealth work. We make no analyses for private concerns. The functions of my laboratory are approximately those of like laboratories in other parts of the world. Our outfit is not nearly as complete as I should like it to be, but we are gradually getting together a satisfactory equipment. A really complete equipment would involve an expenditure of many thousands of pounds. During the recent visit of the British Association for the Advancement of Science, Dr. Rosenhain was asked to advise the Government as to the equipment necessary for an enlarged Commonwealth Laboratory, capable of undertaking all classes of duties I believe that the Prime Minister has in mind at the present time something in that direction. Such a laboratory would be of enormous advantage in connexion with the public works of the Commonwealth. By way of illustration, I would point out that there is no apparatus for testing the compression strength of cement, concrete, or building materials of any kind in the Commonwealth Laboratory, whereas similar institutions in other parts of the world have very complete outfits. I have no equipment whatever for the proper testing of materials used in building the Federal Capital. Each State has its own separate laboratory. The transfer of the material to be tested to one central laboratory might be a difficulty in the way of the Commonwealth taking over the whole of this work for the States. In Germany there are large complete testing stations which undertake all sorts of analytical work and the physical testing of materials of every description. England has a well-equipped National Physical Laboratory, which undertakes all classes of testing and physical investigation relative to scientific and technical standards. It determines the accuracy of thermometers and of all graduated apparatus—measure, volume, and weight—and also undertakes the examination of all kinds of physical apparatus and the testing of steels and other metals for tensile strengths. The Government laboratory in London undertakes the work of the various Government Departments, including the Board of

Customs and Excise, Admiralty, Foreign Office, Home Office, Local Government Board, Post Office, Stationery Office, Board of Trade, Office of Works, &c. France has a splendid laboratory for testing construction materials of every kind. That laboratory tests all materials for the Government Departments. In the Bureau of Standards at Washington, the United States has one of the most complete laboratories in the world. It possesses a splendid installation. It is generally recognised that these laboratories have been exceedingly important factors in the industrial progress of these countries. A chemical laboratory for the Bureau of Standards is now being constructed, the contract price for which is £39,000. In addition, there are a number of separate buildings, in which all classes of physical and chemical tests and investigations are conducted. The Bureau has splendid physical appliances for the testing of cement. The machines are built up to a strength of 10,000,000 lbs., and blocks of concrete and full-sized columns can be put in these to determine how many tons are required to break them. The activities of the Bureau (report of the Director for 1914) in regard to the actual testing of materials to ascertain whether or not they comply with specifications, is confined almost exclusively to Government purchases; but in making these tests—in which the Bureau has the hearty co-operation of practically all the Departments of the Government service—it is compelled to make many investigations concerning the properties of materials, their specification and measurement. While the work is of great value in placing Government purchases on a correct basis, the results of the investigations as to the properties of materials, and the information gained in testing Government supplies, are even more important to the general public, and are distributed in the form of suitable publications. During the fiscal year 1913-14, the Bureau tested 15,810 samples of cement at the Washington and branch laboratories at Pittsburg and Northampton, representing Government purchases. Samples of cement to be used in construction of Federal buildings throughout the country, and miscellaneous samples received from Government Departments and the public, were tested at the Washington laboratory; also cements to be used in the construction of docks and inland river improvements. At the Pittsburg branch laboratory most of the routine testing was done for the War Department. The cement for the Panama Canal was tested at the Northampton branch laboratory. The Bureau, in its work of testing and research, co-operates with regulative and inspection services, such as the standardization of the specifications for materials issued by the General Supply Committee, under the United States Treasury, the Wireless Service, the regulation of navigation, the Inter-State Commerce Commission, &c. Many industries are just beginning to realize the importance of precise methods of measurement and scientific investigation, which, in practically every case, involves some kind of measurement. It is upon quality, as well as upon price, that competition must finally depend, whether in domestic or foreign commerce. The use of exact methods and scientific results is the greatest factor in the improvement of quality, efficiency, or the development of new industries. In the particular field of the testing of materials, it is stated by the Bureau, in Circular No. 45, 1913, "The growing appreciation of the vast waste due to defective materials and the misuse of good materials, has raised the question of efficiency, and made it the object of a searching inquiry in many different fields—the solution of the problem has for its key the *scientific testing* of materials. The testing of materials serves two important and distinct purposes: first, to ascertain whether or not they comply with *specifications*; and second, to add to the general fund of knowledge concerning them. When done with both objects in view it ceases to be of merely transient value for the immediate case in hand, important as it may be, but adds to the world's useful knowledge of the materials. Data accumulate rapidly in the regular work of the testing laboratory, and when properly correlated, will yield information of permanent value to the industries."

48. *To the Chairman.*—For chemical and analytical work the Commonwealth laboratory is as well equipped as any of the State official chemical laboratories; but, as to all other classes of testing and investigation, which we should be doing in connexion with public works and construction, it is very incompletely equipped.

John Gibson, *Managing Director* of the Reinforced Concrete and Monier Pipe Construction Company Proprietary Limited, sworn and examined.

47. *To the Chairman.*—I have had experience extending over very many years in the manufacture of cement in England, New Zealand, and Australia. Some time ago I was asked by the Commonwealth Government to report upon a proposal for the manufacture of the cement requirements of the Federal Capital City. I visited the Fairy Meadow and White Cliffs sites, as well as that at Paddy's Creek, and as the result of my special investigation, selected the White Cliff site, near Queanbeyan. On that I reported fully. I also reported to some extent on the Fairy Meadow site. Physically, the limestone at Fairy Meadow is quite suitable for cement-making purposes. There are shales there which are also physically suitable. I have seen some of the analyses made by Mr. Wilkinson, and they disclose that the limestone is also fairly suitable, from a chemical point of view, for cement making. It certainly contains a good deal of magnesia—an element that is limited in all specifications. Under the Victorian railway specification, 4 per cent. is the limit fixed, but in other States the limit is 3 per cent. Some American, and, also, I understand, some German specifications, permit of 4 per cent. of magnesia in cement. The question of what proportion should be allowed is a very debatable one. It is well, perhaps, to keep the percentage as low as possible. With careful selection, you will get sufficient stone at Fairy Meadow to enable you to keep the percentage of magnesia below 3 per cent. As an Australian expert of wide experience, I find that magnesia is one of our troubles in cement making. It occurs in the most unexpected ways through deposits. I have seen stone which contained, in some cases, from 1 per cent. up to 12 per cent. of magnesia. Where such a variation occurs, care is necessary in selecting the stone, and the working of the quarry is thus made more expensive. I am satisfied from Mr. Wilkinson's analyses that you will be able to obtain from Fairy Meadow sufficient material to make the cement you require without an excess of magnesia. I have made a cursory examination of Mr. Wilkinson's analyses

of shale, which also disclose the presence of magnesia. That does not improve the position, but I have taken it into account in saying that, by careful selection, you will be able to keep below 3 per cent. of magnesia in your cement. The shale at Fairy Meadow is a siliceous one. It is higher in silica than the bulk of the shale I have examined, and you will probably find that the cement manufactured from it will have high hydraulic properties. It may be rather slow in induration; that is common to most cements that are high in silica. I understand from Mr. Wilkinson that there is practically no sand—which is uncombined silica—present. That, again, renders it physically suitable for cement making. I should say that there is nothing in the shale at Fairy Meadow to which particular exception could be taken. If I were asked to advise you as a board acting for individuals about to put their own money into such a venture, I would say that the manufacture of cement at Fairy Meadow to meet the needs of the Federal Capital would show a great saving. On the other hand, it would not be a suitable site for cement works for general supply. I have reported already to that effect. It is away from your coal supplies, and some distance from the seaboard, so that the cost of distribution for general supply would be considerable. But for the distinct purpose of supplying the Federal Capital requirements a considerable saving would be effected by the establishment of a cement factory there. I know of no other site near the capitals that would be more suitable. Investigations were made at White Cliffs, at my instigation, and I understand they proved the deposits to be unreliable in quantity, so that if I were asked to select a site, acting upon my own knowledge, I should chose Fairy Meadow. I reported on the probable cost of manufacture of cement for the requirements of the Federal Capital on an estimated consumption of 50,000 casks per annum. That was the estimate supplied to me, and for such an output I would favour the dry process. To produce such a comparatively small quantity of cement, you would have a relatively short kiln, and with a short kiln, there is no provision for eliminating the large percentage of water—it amounts to over 30 per cent.—which is used for making the slurry in the wet process. You would consequently require a larger percentage of fuel. A long kiln—say, with a 150 feet travel—would provide for the elimination of the moisture from the slurry as it went forward. In determining the question as to which process should be adopted, you must have regard, first of all, to the output of the factory, and then to the nature of the material. Both processes have certain advantages. The wet process has the advantage of eliminating from the kiln the dust trouble, which is always present with the dry process. Various methods of avoiding that trouble have been tried, but have not proved wholly successful. I understand that a process recently tried in Southern California, and also introduced at Geelong, to avoid the escape of dust from the kiln, is not altogether a success. If the factory were away from all habitations, the escape of the dust would not be of much consequence. You could have your chimney-stack 100 feet high, and the dust would thus be distributed so thinly that it would not be much noticed. The escape of dust from the machines can be easily coped with by the use of the "Bath" system of filtration. For this particular proposition I think the dry process would be the more suitable. The wet process is being used in only one factory in Australia. I refer to the Fyansford factory. I believe that the principal reason for the introduction of the wet process there was the desire to overcome certain kiln dust troubles. When on the continent of Europe, and in America, about four years ago, I visited a good many works, and except where the material used was peculiarly adapted to the wet process—such as chalk and clay—the dry process was being used. For example, near Berlin, where they were using the harder kind of limestone and shale, the dry process was in operation, while at big works near Hamburg, where they were using chalk and soft clay, the wet process was in operation. The physical characteristics of the materials that are used seemed to govern the selection. The wet process was being introduced at the works near Berlin on the ground that it was cheaper; but the works there that were being altered were very antiquated, and it seemed to me that they were simply erecting new works upon what they conceived to be the most up-to-date system. Having regard to my knowledge of the limestone and shale at Fairy Meadow, I think you would find the dry process most suitable. There are troubles associated with every new enterprise. That is common to all industry. I have not heard of a cement industry that did not have some trouble in its initial stages. That is quite understandable. However much you may theorise, when you come to the practical working of a factory you are almost sure to find yourself up against some unexpected difficulty. Such experiences are not of long duration, and need give you no concern. If you go back to the pioneering days of the industry in Australia, and, in fact, in all countries, you will discover that for years those engaged in it had to struggle against unknown conditions and the lack of knowledge on the part of the labour employed. But nowadays, having regard to modern appliances and knowledge, and to the fact that fairly skilled labour is available, there is no serious risk of anything but a few initial troubles. In my original report, I recommended that experts such as Krupp's or F. L. Smidth, of Copenhagen, should be entrusted with the work of supplying the requirements of the factory, because their knowledge in some respects is greater than that of any other firms. Those sources of supply, however, have now been closed to us. I think it is possible to have portion of the plant made here, but to some extent that would take the form of a pioneering effort. Certain British manufacturers are turning out good material of the kind required. Messrs. Edgar Allen and Company, of Sheffield, are among the number. There is a cement factory near Mudgee. Its plant in the first place was to be obtained from Krupp's, but when war broke out, they had to look elsewhere, and I think a section of their plant came from a Milwaukee firm. I am not certain whether the company obtained its grinding plant from Krupp's. The rotary kilns could certainly be manufactured here, and if you propose to install high-speed triple expansion engines, I dare say you could obtain them from Thompson's foundry, Castlemaine. They make very good engines. There are other Australian firms, but Thompson's specialize in the class of engines I have named. As to the type of machinery which the Commonwealth should obtain, I think that, as there is plenty of water available at the site, you might have a turbo-generator. I assume that you would also put in water tube boilers of the Babcock type. There is nothing to equal them. You might also put in alternatively triple-expansion high-speed engines of the Allen or Bellias-Morcam type. In the report that I submitted to the Government, I gave an estimate of

the cost of installing the necessary plant, my figures being based, of course, on the then existing circumstances. I estimated that power would be obtained from Canberra for the Molonglo site, but that there would be a separate power-plant for the Fairy Meadow site. There were two propositions in respect of the latter site. One of these was for the erection of a factory capable of producing 50,000 casks of cement per annum. This was to be erected near the Fairy Meadow railway station. In my estimate, raw materials were taken at an all-round price of 3s. per ton, and coal at 21s. 1d. per ton, at the site. The total cost of manufacture on an output of 50,000 casks per annum, after providing for interest on capital at the rate of 4 per cent., and 10 per cent. for depreciation on permanent outlay, was 10s. 8.83d. per cask. On a production of 100,000 casks, my estimate was just under 8s. 3d. per cask. These estimated costs were conservative; allowance was made for possible troubles in the way of stoppages, and so on, that are bound to occur. The larger output would bring down the cost of labour, but would not necessarily affect the other items. For instance, one man would be required to look after a grinding mill, yet he could, at the same time, look after a battery of mills without any more trouble. Then, again, one man could take charge of a kiln turning out 1,000 casks of cement, whereas he could also take charge of a kiln turning out 6,000 casks without incurring any more trouble. I set out in my report that the cost of erecting and equipping a factory at either Fairy Meadow or the Molonglo site capable of producing 100,000 casks per annum should be taken at not less than £50,000. That included the provision of a power-plant. A factory capable of producing 50,000 casks per annum would cost much more proportionately, say, £44,000. That estimate did not include anything in the way of liquid capital—that is to say, for carrying stores, and so forth. I made a separate estimate of £10,000 for horses, drays, &c., in respect of a factory to produce 100,000 casks per annum, and of £6,000 for a factory with a 50,000-casks output. These figures were based on normal prices, and, because of the war, would not serve as a very reliable guide at the present moment. The difficulty of obtaining machinery and raw material is simply appalling. The American market has just closed down on us for the supply of steel. My original suggestion was that tenders should be called for the provision of the whole plant of the factory as a going concern. That could not be done now, because I do not think that any English manufacturers would undertake such a contract. Krupp's were prepared to do so. As it is, you would have to call tenders for the supply of machinery on a local specification, or you could tell a firm like Allen and Company, of Sheffield, exactly what you wanted them to supply. If you sought to obtain machinery locally, you would have to supply designs and specifications, because there is no local knowledge. In this way, some things would be obtained more cheaply, while others would be more expensive. It would be unnecessary, for example, to get a kiln abroad. Any firm capable of building an ordinary Lancashire boiler could build a kiln. I do not think you could get a ball mill in Australia. Such mills were made here, but were an utter failure. Part of the plant required could be obtained here, and part of it would have to be secured in England. The difficulty in obtaining it would delay the construction of the work. Owing to the war, you could not fix any time within which you could say the works would be completed.

48. *To Mr. Findayson.*—There was at one time a patent in respect of the tube mill, but I think it has expired. With the exceptions to which I have referred, you would be able to obtain in Australia most of the plant required. You would have to purchase your motors abroad, and you might find it expedient to purchase abroad your turbo-generator. I do not know whether you could secure one of local manufacture. Then, again, if you decided on the Babcock water-tube boilers, you would have to obtain them abroad. Tube mills are being made here, I believe, and they and the kilns could be obtained locally. As a substitute for the ball mill, what is known as the Hardingo mill is being made in Australia. It is an intermediary, as distinguished from a preparatory and a finishing grinder. The Hardinge mill is an American patent, but is being manufactured locally, under licence. There is a difference of opinion in America as to its value. It has been tried, not for cement grinding, but for reducing various forms of minerals in connexion with mining operations. You would not need packing machinery—and, indeed, it would not pay—for a factory with a small output. My figures as to the manufacturing cost are not necessarily much affected by the present condition of affairs. The principal alteration would be in respect of the cost of the plant. In estimating the manufacturing cost, I allowed for certain prices which could be varied if the cost of labour or fuel varied. As to the erection of the plant within a reasonable time, I would point out that the basis of all manufactures is steel plates, and my recent experience makes me very doubtful as to the possibility of obtaining supplies from abroad. If you could obtain steel plates from the Newcastle (New South Wales) works, you could set about the manufacture of certain parts of the plant, but a good deal of it must come from abroad.

49. *To Mr. Laird Smith.*—In my travels on the Continent and in America I saw machinery in use in the dry process for the extraction of dust. I saw it in operation at works such as the Alsensche, at Itzehoe—the Both system. A vacuum was created, and the air was passed through filters. This system is applied to many continental works, and overcomes the dust problem very satisfactorily. The dust was used over again, being returned either to the mixing machines or to the kilns direct.

50. *To Senator Story.*—The loss of material by the dry process is said to be approximately 5 per cent., but my experience, extending over many years in connexion with one factory, is that it is 4 per cent. By saving the dust and returning it the bulk of that loss can be avoided, though I do not think that the saving of material is very important from a financial point of view. The process certainly eliminates discomfort, and it is beneficial to the machinery by preventing hot bearings. In all well-organized factories similar means are adopted, unless the works are carried out in such a way that the dust blows right out into the open. I have said that the dry process would be suitable at Fairy Meadow, because the output was not to be more than 50,000 casks a year; but, assuming that the plant was to be equal to an output of 100,000 casks a year, I would still say that the dry process would be suitable. The kiln is not of any great length. A kiln 110 feet long would be quite big enough for an output of 100,000 casks, but it would hardly give enough travel to get rid of the moisture from a wet slurry. A kiln 120 feet long would be about the minimum length required for the wet process to make it economical by utilizing the waste heat

to the fullest extent. The minimum quantity required to be turned out to enable cement works to be a paying proposition would be 50,000 casks per annum, and I would not recommend the erection of any plant unless that quantity could be consumed by the Commonwealth. A smaller output would be too paltry altogether.

51. *To Mr. Sampson.*—The minimum output required for the wet process would be 180,000 casks per annum. A longer kiln is required in order to utilize the waste heat. It is a question of the material being treated. At one cement works, which I operate, I should always use the dry process, because the material lends itself so admirably to it. I agree, to a certain extent, with the expression of opinion given in evidence by the director of a Queensland company, that the wet process is the more economical, and turns out a more reliable article. There is no doubt that wet compound can be mixed more intimately than a dry—that is, a slurry mixes more intimately than a powder, and you can turn out a larger quantity of raw material by the wet process, through a given plant, than by the dry. In that way a saving is effected. On the other hand, there may be greater expenditure on the kilns. More fuel may be required. Thus, the one thing may counterbalance the other. If you gain economy in one direction there may be a little more expense in another. At the same time it would be difficult to find a better article than that turned out by the dry process used by the Commonwealth Portland Cement Company of New South Wales. By the wet process the dust trouble is eliminated up to a certain stage, but it is present in the finishing stage. After the material passes through the kiln, the subsequent process is the same in either the wet or the dry.

52. *To Mr. Gregory.*—In the wet process the limestone and shale are put into a ball mill and ground wet, after which it is passed through the tube mill and pumped into the kiln.

53. *To Mr. Sampson.*—I do not wish to revise my estimate of the cost of manufacture. The minimum wage is 9s., but I have provided for the payment of higher rates. The rate of 9s. applies to the ordinary labour employed on the works. That was the standard rate at the time I drew up my report. My figures have been taken from actual practice, but they have been slightly enlarged. Of course, if wages increase there will be a ratio increase in cost.

54. *To Mr. Gregory.*—I advised Colonel Owen in regard to this matter. I understand that the officers of the Department have made a considerable investigation into the extent and quality of the limestone and shale available, and those investigations fully satisfy me that the proposition is a reasonable one. I am reasonably satisfied with the work done and the analyses which have been made. It would be advisable to have laboratory tests made as to the various component parts before finally deciding on a plant, but it would make no difference as to the cost of plant that would subsequently be ordered. Assuming that a practical test of the material were made, there would be an analysis of the finished cement which would enable you to satisfy yourself that you were turning out a standard article. Theory and practice do not always accord. The magnesium content will sometimes be so much theoretically, but in actual practice it may turn out to be 1 per cent. more. If, however, a practical test satisfies you upon this point, you are absolutely certain as to the course you should pursue. There will be difficulty in obtaining the class of plant that I recommended. We can shut out the prospect of getting plant from the German makers. There are at least two companies making tube mills in Australia. Ball mills have been made in Australia, but they have not been successful. This morning I spoke of the Hardinge mill as a substitute because at this time it is necessary to do a little experimenting in such matters. It is a pear-shaped mill, revolving on its axis, as does a tube mill. I am investigating it at the present time, but I am only prepared to go to the extent of saying that it is worthy of an experiment. It will be more expensive to erect a plant now than it would have been when I first reported on this matter. I assumed that the machinery would be imported, but the prices of the imported machinery have increased by 50 per cent. On the other hand, articles of local manufacture have increased in some cases 25 per cent, and, in other cases, 50 per cent since I made my report. Taking all things into consideration, on the one hand the difficulty of obtaining a plant, and, on the other hand, the present price of cement, and a certain market for 50,000 casks a year, I certainly recommend the erection of a plant. The figures commend themselves. Prior to the war a good German cement, a first class brand, cost about 12s. 6d. per cask in Australia. When I was in America I was told that cement had been selling at a dollar a cask. It was a hopeless business proposition. They viewed with elation the fact that the price had risen to a dollar and a half. There were many cement works in America in difficulties. I visited a $5,000,000 proposition at Santa Cruz, 90 miles south of San Francisco. It had twenty-four kilns, each 120 feet long. It was using oil fuel and hydro-electric power obtained from the mountains. The superintendent asked me how many kilns I thought they had running, and when I answered him, "About twenty in constant use, with four out for repairs," he told me that they were running only eight, and never ran more. He also told me that the proposition was an absolute failure. The works were erected for the purpose of supplying the whole of the western coast, but other people started at San Diego, Oaklands, and other places, and secured all the local markets, leaving this big concern at Santa Cruz with its own small local market. That is the position I wish to emphasize. Central works for distribution over a big continent are not advisable. Small works in the various States are a better proposition, because the freight charges are very heavy; on a cheap and heavy article they make up the bulk of the price. The Fairy Meadow plant should apply only to the needs of the Federal Capital. There is a precedent for doing so. The Government of Arizona erected temporary cement works for the purpose of supplying the material for irrigation channels on account of the enormous cost of freight to the spot where the cement was to be used. I have seen photographs of these works. It seems to me that the position in regard to the Federal Capital is somewhat the same. It is considerably distant from commercial centres, the freight charges are very heavy, and there is a large local consumption. The figures demonstrate the fact that a considerable saving should be made by manufacturing cement on the spot. Consequently, the erection of cement works for the purpose of the Federal Capital is a justifiable proposition; but when it comes to a question of a general distribution of cement, from works erected in a locality which cannot be said to be altogether suitable, it does not present itself as a business proposition. If you wanted to secure a continental market you would select some spot where you could get your coal, and your limestone and shale, and everything together, so that there would be only the charge of conveyance from the

works to the sea. My view is that the Fairy Meadow plant should be limited to the needs of the Federal Capital, whatever they may be—50,000 barrels per annum or 120,000 barrels. In the wet process the limestone is crushed wet. You use the wet ball mill and pump it slowly into the kiln. In that way the dust is considerably minimized. But the wet process has its own troubles. The outbreak of the war will only add to the provision I made in my estimate for interest upon capital outlay, and for depreciation. Interest and depreciation would increase in ratio to the outlay upon plant.

55. *To Mr. Fenton.*—I agree with Colonel Owen when he said that an expenditure of £100,000 would cover everything including railway sidings. There is a question as to whether a railway siding, or a ropeway, should be built, but the difference is a matter of about £5,000 only. The bulk of the machinery could be made in Australia. It would be necessary to import the ball mills. I would not like to take the responsibility of having them made here; it is a question of design. The ball mill would be much the same as that which is used in gold-mining, but that remark only refers to one department—to coal grinding and the grinding of raw material, and not to the cement. We would use a combined mill, or a preliminary grit mill and then a finishing mill. The Hardinge mill might be suitable. The greater portion of the machinery could be made in Australia, and the balance could be obtained in the United Kingdom. The packing machinery is a patent, and if it is required it can be obtained from Great Britain, but it might not be required. Freight is the principal difficulty in regard to the importation of plant. It is very high. Also, shipping facilities are very irregular. Taking these things into consideration, it is absolutely certain that the local manufacture of some of the plant would be the best course to pursue. I anticipate considerable delay in obtaining the necessary machinery. Some time ago I approached a large firm of Australian engineers, and they would not guarantee to deliver a rotary kiln within twelve months; but I fancy that the firm had other orders. It had had previous experience of making kilns. The difficulty would be to get steel plates for the manufacture of the kilns. Any firm manufacturing boilers would have no difficulty in manufacturing the rotary kilns. Taking everything into account—the present price of cement, and the fact that a considerable amount of cement will be required for the Federal Capital—I have no hesitation in recommending the establishment of works at Fairy Meadow. It will mean a saving to the Commonwealth Government.

56. *To the Chairman.*—I have seen a report by Mr. Bayley, analyst and assayer, attached to the Geological Survey branch of Victoria, upon the cement manufactured at Fairy Meadow. The analysis bears out what I was saying this morning—that the magnesia content is very high. We have a shale with a magnesia content of 1.65, and a limestone with a magnesia content of 2.24. This gives a total of 3.62 per cent. of magnesia in a finished cement, or .62 per cent. higher than most specifications allow, though I see no objection in the magnesia content being up to 4 per cent. Otherwise, the cement is a well-balanced product. As there is a considerable variety of material to be operated upon, a selection of material could probably be made. The tests to which the cement have been put are very good. I do not know whether Edison has eliminated Sunday labour at his works, but I know that those works have been largely looked upon as freak works. The elimination of Sunday labour at Fairy Meadow would not be satisfactory. It would mean shutting down the kiln, which would not be good for the kiln, nor tend to cheap manufacture. With a rotary kiln cessation of Sunday operations would let down the heat and bring about shrinkages, causing the chipping of the walls, and when the kiln was started again there would be a loss of an hour or two in getting it to the proper heat again.

57. *To Senator Story.*—I would not say that Australian engineers could not manufacture the machinery required if they were supplied with proper plans and specifications, but they would not make it as well—not even the rotary kiln. The large steel castings are a difficulty. However, the Commonwealth must take its chance in that regard, as well as every one else. Experience and practice would lead to greater perfection. After one or two attempts the Australian engineers would probably get close enough to perfection. Private cement works are having some of the machinery made in Australia, and are taking the risk of imperfection in regard to certain details. I do not know of any one in Australia who would be competent enough to provide working plans and specifications for the plant, and they could not be obtained from America or Denmark for the guidance of Australian makers. An engineer could inspect machinery in operation, and draw plans and specifications that would enable Australian engineers to make a duplicate satisfactorily; but the position of makers like Smidth and Krupp is quite different from that of the local maker. From their vast experience they can supply you immediately with all the information you require. If you want a mill to turn out 20 tons a day they can at once give you the size of the mill, and the weight, and make the mill necessary. On the other hand, the Australian manufacturer, not having previously made anything of the kind, and knowing little or nothing about it, would find it impossible to do this. It is the duty of the manufacturer to supply machinery of certain capacity; that is his speciality. You propose a general scheme of operation and give the lay-out, and then submit it to a practical engineering firm and they recommend the particular size of mill for the specified output. With the assistance of Mr. Dickson, of the Home Affairs Department, I drew up a specification in which the whole lay-out of the mills was stated, also the production from each mill, and the necessary details, and I suggested that this specification, accompanied by a general plan, should be placed in the hands of Krupp or Smidth with samples of the raw material, and that they should be asked to supply a plant to those general specifications. Of course, they would supply details and guarantees as to the size of the mill. They were also to be asked to erect the plant and run it for three months under a guarantee. This was Colonel Owen's very practical suggestion; because, as I pointed out, and Colonel Owen concurred, we would then get all the experience of firms which had been manufacturing cement machinery from the beginning of modern cement making. I still recommend that the same thing be done, perhaps, in a modified way, with firms such as Edgar Allen and Company, of Sheffield, F. L. Smidth, of New York, with which Smidth, of Copenhagen, is connected, and Ellis Chalmer, of Milwaukee. There are other firms who could be asked. They could be asked to quote on these specifications, and it might be suggested to them that they might get certain portions of the plant made in Australia. Of course, they may not do it. When we had Smidth and Krupp available

I recommended that one firm only should be held responsible for the perfect working of the plant, because it would lessen our risks and anxieties and tend to more perfect amalgamation of the various mills. I would limit the output to the requirements of the Federal Capital. An output limited to 50,000 casks a year would increase the cost of the cement by 2s. a barrel. The field to be supplied might be extended to the State of New South Wales, as the greater economy to be secured by a larger output would probably equalize the additional freight; but if you ask me, as a commercial man, I would not recommend the site as suitable for the manufacture of cement for distribution throughout the whole of Australia. I am in favour of the establishment of cement works in different localities, because of the heavy charges for transit on a bulky material. It is possible that cement could be supplied throughout New South Wales at as low a figure as it can be obtained from elsewhere, but it must be remembered that at present coastal freights are very high. The prospect of supplying cement for Commonwealth requirements at Jervis Bay and Sydney, by the erection of a plant of the capacity of 100,000 casks per annum, might be considered. I do not remember having estimated the number of men who would be employed at the works. My reason for saying that I would not revise my estimate of cost for working was because my figures were fairly full, and a rise of 1s. a day in wages would not greatly affect the result. It might be a matter of 2d. per barrel. I gave my figures fairly full, allowing for all possible reasonable fluctuations in wages.

58. *To Mr. Finlayson.*—The proposed site of the works is suitable. My idea was to build on a flat adjacent to the present Fairy Meadow railway station, and bring the raw material to the works by means of a ropo-way. The determining factor in regard to the situation of works is the suitability of the site for building purposes—whether there would be much expenditure in regard to excavation, and from that point of view, for the small works proposed I recommended the flat site; but I understand that, with comparatively little excavation, a suitable site can be obtained near the deposit of limestone. Then, again, in determining a site there is the question of the proximity of material, and the cost of taking the raw material to the works. In one proposition I had before me some years ago, the raw material was 50 miles from the market. The coal had to be brought past the market, and taken along 50 miles of railway to the raw material, and the latter had to be brought 3 miles to a selected site, which was chosen because of the water. On comparing costs of manufacture, rail charges, and so on, we found that it was cheaper to manufacture on the site of the raw material than at the market, although the coal had to be brought such a great distance. Here, however, I do not think it makes much difference whether the works are situated on the flat at the present Fairy Meadow station or at the deposit. In either case a railway or a ropeway must be constructed for the conveyance of the cement or the raw material. I have been informed that the projected railway between Canberra and Jervis Bay will pass near the limestone deposits, and that the projected works will be largely utilized for buildings at Canberra and Jervis Bay. In order to supply both places, Fairy Meadows is about the only spot where works can be erected adjacent to the raw material—which is the dominant factor in the matter of choosing a site. If the original proposition is enlarged to embrace the supply of cement to works within a reasonable vicinity, say, at Jervis Bay, it would be better to erect a larger factory, and thus turn out the cement more cheaply, but I have been confining my observations to a purely local demand. A plant with a capacity of 50,000 casks per annum would be a payable proposition under the conditions set forth in my report. Additions could be made to meet further requirements, but if there is any immediate prospect of utilizing a larger output at Jervis Bay, it would probably be better to start with a larger plant.

59. *To Mr Gregory.*—Assuming all the ideal conditions, a railway to Jervis Bay, a large consumption at Jervis Bay, and a large consumption at Canberra, the proposition of establishing a larger plant answers itself.

60 *To Mr. Finlayson.*—In the absence of railway connexion with Jervis Bay, it would be cheaper to erect a plant at Jervis Bay if the works there could consume 50,000 casks per annum. It has been suggested that a plant for the extraction of potash could be added to these works. When I was in cement works on the Thames, many years ago, the British Government conducted an investigation into the nuisance created by the dust escaping from the works—it was said that it was noxious and injurious to health—and Dr. Blakey, who conducted the experiments, discovered that the flue dust contained a lot of potash. He suggested that a plant should be attached for the extraction of this potash; but at the time it was considered that the cost of extraction and preparation would be such as not to warrant the expenditure. Possibly, in war time it might pay to do so, but after the war it would be questionable whether you could make it pay in competition with Germany. There is no system whereby the magnesia contents can be eliminated. The potash passes off.

61. *To Mr. Gregory.*—One cement works has been endeavouring to get its plant erected for the last eighteen months, and it is still short of machinery. I still maintain that these works could be in operation within two years. My original estimate was eighteen months. The elimination of Sunday labour is not so much a question of additional cost as a question of injury to the kiln. A small engine is employed for the purpose of keeping the kiln and the necessary elevators running, and all other work ceases at midnight on Saturday until midnight on Sunday. The kiln goes on all the time. It is only a question of employing about three men on the Sunday.

62. *To Mr. Sampson.*—The minimum output required for the dry process is 50,000 casks per annum, but that output will not be suitable for the wet process, because of the shortness of the kiln. A wet-process plant would probably require an output of 180,000 casks per annum. My estimates have been based on the adoption of the dry process. An output of 50,000 casks or 100,000 casks would mean the adoption of the dry process. My general opinion is that I could not recommend the adoption of the wet process unless there were an output of 180,000 barrels per annum. In this case the proposition is of an exceptional character; it is for the supply of one market, with a certain limited output. If it were proposed to erect works to supply a large general market, it would probably start with an output of 180,000 barrels, but the adoption of the wet process would be out of question with a smaller output than 180,000 barrels.

63. *To Mr. Fenton.*—Prior to the war the bulk of the cement came from Germany. Now much of it comes from Denmark and Japan. Some is imported from Hong Kong. There is a good deal

of Chinese capital in the Hong Kong works. The largest quantity is imported from Denmark. America is not sending much cement here.

64. *To Senator Story.*—The best brick for lining a cement kiln is an acid brick. I distinguish between the acid and the alkaline brick. Originally it was assumed that a basic brick should be used, because the contents of the kiln are alkaline, on the principle of base to base, but it was found that the magnesite brick was too friable. It would not stand the crushing consequent upon shrinkages, and so on, and broke up. Various experiments were then tried, and it was ultimately found that a brick in which the alumina and silica contents were evenly balanced was about the best that could be employed—that is, a brick containing 40 per cent. of alumina and about 56 per cent. of silica. Bricks obtained from Germany and America by me analyzed very much the same. They were admirable for the purpose, but they were very expensive, and we, therefore, determined to use a local brick, which in most cases is very high in silica contents. We found that by using care and intelligence we could make the local brick last quite as long as the imported, and now nearly every cement works in the States is using the Australian brick. It is not quite as satisfactory, but, taking the cost of the one as against the other, it pays to use the local article if reasonable care and intelligence are used, and if the coatings of the kiln are kept on. That is why a kiln should not be stopped on a Sunday. I have used bricks from the neighbourhood of Bacchus Marsh for rotary kilns, and suitable bricks have been turned out at Nairn, in South Australia, for years. There is no difficulty in getting suitable Australian bricks.

(Taken at Melbourne.)

THURSDAY, 18TH NOVEMBER, 1915.

Present:

Mr. RILEY, Chairman;

Senator Keating,	Mr. Gregory,
Senator Story,	Mr. Sampson,
Mr. Fenton,	Mr. Laird Smith.
Mr. Finlayson,	

Thomas Hill, Engineer, Department of Home Affairs, sworn and examined.

65. *To the Chairman.*—Under the Director-General of Works I have had charge of testing the material obtained at Fairy Meadows for the manufacture of cement. Action in this direction was taken on the advice of Mr. Mahony, the State Geologist, who, in company with Mr. Gibson, the Consulting Engineer, visited the site to inspect the ground. Two drives were put in at positions selected by them, and as shown on the plan submitted. They are known respectively as the east and west drives. They commence from the bottom of the bed of the small creek known as Swampy Creek, above its junction with the Sand Hills Creek. I produce a sectional diagram drawn on the scale of 10 feet to the inch, showing the length of the drives and the positions from which samples have been taken. Two cement bags full were taken in each case and forwarded to the Federal Analyst, who has submitted to you in evidence the results obtained from samples at those points. The formation of the deposits throughout is fairly solid, and only between joints have other materials than limestone been met with. In the easterly direction the drive has been extended 238 feet. I have not the exact depth at that point, but it is about 65 feet. At the 238-ft. level the air got bad, so a shaft was put down to improve the ventilation and also to test the material in a vertical direction. I do not think Mr. Wilkinson has yet given you the results of samples 18 and 20. In the west drive, at point 15, the highest percentage of magnesia (4.66) was shown. All the rest of it was below 2 per cent. Before the Director-General of Works went to India he knew the results of this examination, and he decided that there was sufficient material on the east side to justify continuing with the proposal to manufacture cement on the site. So far as we can see there is sufficient limestone to enable operations to be carried on for 50 years at least at the rate of 120,000 casks per annum. This estimate is based on the material in sight at the drive level. We have no idea at present how much further it goes. The deposit extends some hundreds of feet to the north and about 200 feet to the south. We do not know how far it goes to the east, but we do know that it extends at least 250 feet in that direction. We have not driven on the western side on account of the magnesium. We thought we would concentrate our efforts for the present on the eastern side, leaving any further operations on the western side to the future. We have acquired about 54 acres of actual limestone deposits. This area was secured to prevent any other companies being floated alongside the Commonwealth site. We propose to acquire the rest of the land for tramway, roadway, workmen's homes, and shale deposits before the end of the year, because under the *Lands Acquisition Act* 1906 the value of land so acquired is based on its value at 1st January in the year in which it is acquired; and, in view of the publicity given to the Commonwealth proposal, it is thought that if we leave this matter over till next year, we shall have to pay a considerable amount for land which is really poor in quality.

66. *To Senator Story.*—The shale deposits, in their relation to the limestone deposits, are shown on the plan before the Committee, the scale being 20 chains to the inch. The area acquired (56 acres) is shown in heavy red colouring, and the shale deposits are indicated by the figures 1, 2 and 3 in red. These figures are those quoted by Mr. Wilkinson in the analysis which he furnished to you yesterday.

67. *To the Chairman.*—The distance of the shale deposits from the limestone deposits varies from about 10 chains to just under a mile. I think No. 2 deposit will prove to be the best. The homes for workmen will be situated about a mile from Fairy Meadow station to the left of the factory site, just on the spur at the junction of the Fairy Meadow and Sand Hills Creeks. They will be about 1,500 feet west from the actual factory, so that the prevailing winds which, as at Canberra, are from the west, will blow all the dust away from the homes. The land is nicely undulating, and in every respect suitable for dwellings. There would also be a good water supply from the Sand Hills Creek.

68. *To Mr. Finlayson.*—The Sand Hills Creek heads some 5 miles out in, at present, very sparsely-settled country. At a point near the site of the proposed cement works the creek splits into two branches, the Fairy Meadow Creek going up to the Fairy Meadow station in a north-westerly direction, and the Sand Hills Creek going in a westerly direction, each a distance of about 5 miles.

69. *To the Chairman.*—The water has been analyzed, and is suitable for domestic purposes. The Federal Analyst, Mr. Wilkinson, made an analysis in July of this year, and reported as follows:—

> The sample of water referred to in the attached memorandum from the Director-General of Works, dated 24th ultimo, and said to have been taken from Sand Hills Creek, New South Wales, has been analyzed, with results as detailed hereunder:—
>
> 1. Total solids, 31 grains per gallon.
> Lime (CaO), 4 grains per gallon.
> Magnesia (MgO), 3.9 grains per gallon.
> Chlorine (calc. as Sodium Chloride), 13.4 grains per gallon.
> Sulphuric Acid (calc. Traces only, as SO_3).
> Free Ammonia, nil.
> Albuminoid Ammonia, .004 parts per 100,000.
> Oxygen consumed, 0.36 parts active oxygen per 100,000.
>
> 2. It is suitable for feed water and domestic purposes.

70. *To Mr. Gregory.*—The percentage of magnesia, 3.9, might appear high for domestic water, but, if necessary, we can attach rain-water tanks to the residences. I might mention that the analysis was taken with the object of ascertaining if the water were suitable for use in the boilers.

71. *To the Chairman.*—A fair amount of water would be required for the condensers, but beyond that very little. The proposal is to construct a dam, about 15 feet to 20 feet high, on Sand Hills Creek alongside the factory. This will conserve a large body of water. As I have stated, the prevailing winds will take all the dust from the cement works away from the dwelling-houses, and, therefore, very little dust should lodge on the roof, but I would remind the Committee that we often clear water supplies by adding a little cement to it. Frequently we wash rain-water tanks with cement in order to improve the quality of the water. The Director-General of Works has given instructions in regard to machinery. The prime mover, that is, the steam plant, will be of the triple expansion vertical type, and it could be made in Australia by such firms as Thompson, of Castlemaine. The generator, I think, would have to be imported, because up to the present no firms in Australia manufacture generators. All the rest of the electrical motors and appliances could be made in this country. We have had a great many of these made already for different works, and they are quite satisfactory. Weymouth's, of Richmond, have built hundreds for us. We are using 30 in the Federal Capital now, and they give every satisfaction. They are dearer by 25 to 50 per cent. than the imported motors, but it is an advantage to be able to get a motor of any speed quickly, and, moreover, it is considered desirable to assist local firms. We endeavour to get them all one size, and as a case in point, I may state that at the Commonwealth Brickyards there will be three 100 horse-power motors made by Weymouth's. We will keep one of these motors as a spare, so that if anything happens it will be ready to drop into its place. Prior to the manufacture of these motors by Australian firms we bought them in the United States of America, Great Britain, and Germany, about an equal number coming from each country. We propose also to obtain the grinding plant in Australia.

72. *To Mr. Gregory.*—There will be practically no increased consumption of coal by using the locally-made boilers as compared with those imported from other countries. Babcock and Wilcox boilers, for instance, are more suitable for plants with a variation in the load, and when a quick demand for steam has to be met, whereas the load at the cement works will be uniform and continuous, and the boilers may be simpler in type with a larger water capacity. In order to convey the limestone to the factory, we propose to use the same engine that will take the trucks to the Fairy Meadow station. We are going to have a 4-ft. 8½-in. railway running right into the shale quarry.

73. *To Mr. Fenton.*—It is not steep enough for a gravitation scheme, and in any case we would have to pull the empty trucks back to the quarry. The proposition is to purchase one of the small four-wheel locomotives from the New South Wales Government, an engine similar to those in use on the Newcastle trams. We can buy one for about £750, and that will be capable of hauling all the material we require. We can put a load of 60 tons behind one of those engines.

74. *To the Chairman.*—Acting on Mr. Gibson's advice, it is intended to make the kilns in Australia.

75. *To Mr. Gregory.*—There is some doubt about the ball mill. I think it will be difficult to have them made here, but the policy of the Department is to use as much Australian material as possible.

76. *To Mr. Fenton.*—The proposition does not provide for bags, as we intend, if possible, to avoid the cost of bagging by handling the material in bulk. For that purpose we intend to construct bins which can be placed on the trucks and delivered at the other end. This will save 6d. per bag, besides the labour of handling, the saving in a cubic yard representing about 1s. 6d. per cask. We hope to be able to deliver the bin right into the works at the other end.

77. *To the Chairman.*—We do not anticipate any difficulty with the bins in wet weather. It is not proposed to empty the bulk stuff out of the bins and leave it exposed to the weather, but, as we will be pretty steady in our consumption, we think we would be able to handle it in bulk and deliver at the works in the way I have described, thus effecting a considerable saving in the cost of bags. We have abandoned a proposal for a 50,000 cask plant, and intend to install one with a capacity of 120,000 casks per annum. Mr. Gibson was asked to advise on a 50,000 or 100,000 plant. The 120,000 cask plant will represent an output of 20,000 tons per annum, and it is the opinion of the Director-General of Works that we can use all that material on Commonwealth buildings. There will be a tremendous demand for cement in Europe after the war. The factories at present operating in Australia cannot keep pace with the demand; they can supply only about one-third of the local consumption, the balance of two-thirds being imported material. The consumption of cement is increasing very rapidly all over the world, and I will go so far as to say that, from the experience of the last few years, any surplus not used in the Capital city could be most profitably employed in either Sydney or Melbourne, and at a cost below that for which we could purchase cement from private companies. With an output of 20,000 tons at the Fairy Meadow Cement Works there would be no fear of a glut. The number of employees (41) is based on the installation of a plant with a capacity of 20,000 tons per annum. Several propositions have been put

before the Department for the supply of coal from within a distance of 100 miles of the site. They are being inquired into, but so far none have been considered satisfactory. The nearest coal is at Mudgee, but some developments have been made at Moss Vale, and there is also another proposition down near Jervis Bay. I would say that for the purchase of our coal we will have to rely on the supplies from the existing mines in New South Wales, and the cost has been set down at 21s. a ton delivered at the works. We get mining coal delivered at Canberra for just under £1. Wallaroo slack costs us 23s. Mr. Gibson's estimate is based on 21s., and, after meeting all charges, I think we could manufacture cement at 10s. per cask. Hitherto Canberra has been in rather a happy position in regard to supplies of cement, because, at the inception of the Capital city works some five years ago, we got into communication with the Commonwealth Cement Company, with the result that we have had a steady supply with slight fluctuations at 14s. 9d. per cask delivered at Canberra. That was the most favorable price we could get. We have always desired to use Australian cement, of which we have a high opinion. I have had that cement delivered in Melbourne at 11s. 6d. Before the war we got it at 12s. The price was 12s. 6d., but on account of the paper in the bags being a nuisance the company took off 6d. per cask. Even then the supply was erratic, and we could not rely upon it. Geelong has supplied us with cement at 12s. 6d., and imported cement, K. B. and S., has varied in price from 12s. 6d. to 13s. 6d. under contract delivered on the works, Melbourne. Just before the war broke out it was 13s. 6d., but we have bought it as low as 12s. The cheapest price in Canberra has been 14s. 9d. If we entered into any further contracts now, I do not know that they would overcharge us, but we should be in the hands of the Commonwealth Cement Company.

78. *To Mr. Sampson.*—I think at the present time the Commonwealth Cement Company are asking 24s. per cask in Brisbane, and I believe they have been getting £1 per cask in Sydney for their cement.

79. *To Mr. Gregory.*—I have bought cement, in former years, at 11s. delivered on the works, Melbourne. I think the price in Brisbane should be the same as at Canberra.

80. *To the Chairman.*—Assuming that we had a plant with an output of 20,000 tons a year, and placing the cost at 10s. per cask, we would effect a saving of £10,000 a year in departmental work

81. *To Mr. Gregory.*—The freight on cement from Fairy Meadow to Canberra, a distance of 36 miles, would be 7d. per cask.

82. *To Mr. Finlayson.*—Colonel Owen's estimate of £19,000 for a power plant, £50,000 for the factory, £5,000 for the railway, £10,000 for the workmen's homes, and £10,000 for contingencies is a recent one. I gave consideration to the question of electrical generators last week when advising the Minister about a duplicate set for the Geelong Woollen Mills and approached the manufacturers here. I found there is not sufficient demand for that type of machinery in Australia. These are very high-speed machines, and require to be manufactured of special grade steel, otherwise they would fly to pieces. I do not think the demand here up to the present justifies any manufacturer proceeding with the manufacture of these special machines. If imported they will be of British manufacture, and we do not anticipate any delay in delivery. As a matter of fact, at the present moment we are guaranteed delivery from England of a similar generator in 30 weeks under a penalty. We anticipate no difficulty in getting the machinery required from Great Britain. The railway from Fairy Meadow station to the factory will be built with 6-chain curves, so as to comply with New South Wales regulations, but otherwise it will only be a rough railway, although sufficient for our purposes, and enable a speed of 8 miles an hour to be maintained. This railway will take the place of the proposed ropeway which was originally suggested. It will cost just about the same, and, moreover, it will enable us to get our coal right under the work and take the cement out without handling it at Fairy Meadow station. The estimate for the workmen's homes comes out at about £400 each for 40 homes. Colonel Owen proposes to build as many cottages for married men as may be necessary. The estimate might appear high if regarded as one for homes only, but provision has to be made for water supply, lighting, sewerage connexion, and some buildings for recreation purposes, as well as a slightly better house for the manager; so, when regarded in that light, it is not a high estimate. We propose, as far as possible, to engage only single men until the factory is established, and will have temporary buildings at first. After the factory is a going concern, we will use the product for the erection of permanent dwellings.

83. *To Mr. Sampson.*—I have read Mr. Morry's evidence in regard to the different processes of manufacture, but I am not a cement expert, and I would not place my opinion against that of a man like Mr. Gibson. Therefore, I have no comment to make on Mr. Morry's statement that Smidth and Company, of Copenhagen, about ten years ago, introduced the wet or thick slurry process. I leave that matter to Mr. Gibson. As far as my reading and observation go, I think the dry process would be most suitable at Fairy Meadow, but I would prefer not to express any opinion, as cement making is not my profession. It is estimated that there would be a consumption of 10,000 tons per annum on Commonwealth buildings in the Federal Territory, and that the balance of 10,000 tons could be utilized elsewhere on purely Commonwealth works. I know the Director-General is anxious to supply a good, cheap article to private builders in the Capital city. I was with him when he made his return as to what the consumption by private people was likely to be, and he estimated that over a period of ten years it would be something like 200,000 casks, or 20,000 casks per annum minimum. The Defence and Naval Department are always in need of cement. I know that during the last five years, if we had had that cement, it would have all been used in New South Wales, and possibly it would have paid to have brought a little of it to Melbourne or to have sent some to Brisbane. I rather regard the Brisbane field as one worthy of consideration. I am aware that a private company proposes to erect a plant with a capacity of 30,000 casks in Queensland, but that will not alter the position in Queensland so far as Commonwealth works are concerned. I have never contemplated the construction of a railway line to Jervis Bay as being necessary for the distribution of the surplus of 10,000 tons. That has never been part of the scheme. It seems to me that it will be a great many years before that railway is built, and it has not been taken into consideration as a factor in the disposal of our surplus cement. From the experience of former years, I think the cement works at Fairy Meadow could compete with private companies, and I am convinced the factory would exercise a very beneficial influence on prices. I am satisfied that the surplus of 10,000 tons per annum could all be utilized for other Commonwealth works. The final grinding, in my opinion, is the most dangerous period in the processes of cement manufacture, because the substance is then active. When lime and clay are inert they do not extract the moisture from the lungs, but I would not like to breathe in the dust during process of final grinding. Of the total amount set down for machinery, I think about £5,000 worth will have to be imported, but the balance could be made here.

84. *To Mr. Gregory.*—I estimate that under present conditions we would be ready to start the manufacture of cement in two years from the time we got authority to go ahead. I am aware that Mr. Morry, in his evidence, stated that they were carting limestone a distance of 200 miles to the factory in Brisbane; but, in my opinion, it would be wiser to have the factory at Fairy Meadow than at Sydney, as supervision would be better in an isolated spot like that than in big works; there would be nothing to distract a man's attention The cost of conveying coal to the factory has been included in the estimate of cost of the output, and even allowing for an increase of 1s. in the minimum wage, I think we would be able to produce cement at 10s. a cask landed at Canberra. It is estimated that we will be able to turn out a good cement three or four months after the machinery has been started. I have allowed for that in the period of two years from the date of starting operations. I reckon it will be eighteen months before we get the machinery installed, and six months is allowed for getting the mixture of materials right. Judging from past experience, I think we will be able to compete successfully at Sydney or Brisbane with privately-owned cement works. Probably there will be a tendency to try and knock it out, and, if successful, prices would, of course, creep up again. I do not think the establishment of other private factories in the Commonwealth will affect the price of cement until the sum total of the output completely wipes out all importations. We have been purchasing cement for some years from the Geelong works. I understand that the directors of that undertaking have not yet declared a dividend. I think other cement works have proved successful undertakings, and I know the Commonwealth Portland Cement Company is very successful. In my opinion, Mr. Gibson is the best authority on cement in Australia at the present time. Mr. Gibson was not asked to advise as to the maximum plant to be installed at Fairy Meadow, as he did not know our requirements, and was not asked for an opinion on that phase of the proposal. His opinion would be governed by the fact that we told him we were going to use 50,000 barrels in Canberra.

85. *To Senator Story.*—My recollection of Mr. Gibson's evidence yesterday was that he thought the decreased cost in the output of a larger plant would enable the cement to be delivered in Sydney at about the same price as cement, produced with a smaller plant, could be delivered in Canberra. In my opinion, Fairy Meadow is the best site for cement works, the limestone and shale being close together.

86. *To Mr. Fenton.*—In the estimate of cost of output of a 50,000-casks plant, and 100,000-casks plant there is an advantage of about 2s. in favour of the latter, and this would just about pay the freight on a cask of cement from Fairy Meadow to Sydney, so that with a larger plant cement could be delivered in Sydney at about the same price as the article could be produced and delivered in Canberra with a smaller plant. The limestone at Fairy Meadow deposit is much harder than that in the Commonwealth Portland Cement Company's works, and the product will be quite as good. The £10,000 provided for contingencies is on the estimate of a plant with a capacity of 20,000 tons. That estimate is well within the mark. It cost 9d. per bag to handle the cement when marketed in bags, and the use of bins for handling the product will mean a reduction in the cost of the output.

87. *To Mr. Finlayson.*—The bare machinery will cost about £15,000, and the building will be a two-story structure of reinforced concrete, costing, I think, about £8,000. There will be a tremendous lot of accessories, such as wiring, motors, elevators, &c.

88. *To the Chairman.*—We have examined several other properties that were submitted to us, including one in the vicinity of Michelago, but none was found to be so suitable as Fairy Meadow. Altogether, I think nine different propositions were inquired into, but explorations did not support the surface indications. Some of them had good limestone deposits, but no shale handy, while others had shale only and no limestone. The conjunction of the two at Fairy Meadow makes that the best proposition.

Wesley Burrett McCann, Manager and Director, Australian Portland Cement Company, Fyansford, Geelong, sworn and examined.

89. *To the Chairman.*—I have been connected with the Fyansford works since 1890, and have occupied my present position for ten years. My father was one of those who established the works, and was one of the first directors. The works have been established since 1890, and I have an intimate knowledge of them since that date. A good deal of difficulty was experienced at the start, and the works had a very up and down career for a number of years. This was due to the fact that, although we had an expert in cement manufacture from the old country, we were starting with material which was new to those who had to deal with it. Of course, we had not the same Tariff on cement in the beginning as we have now, when the duty has been considerably increased. For ten years previous to the time our works were started the average price of cement was 18s. per cask. That was a decent price. During the time I have been in charge of the company the price has varied. We took a contract about eight years ago from the Melbourne City Council at 8s. 9d. per cask. That is the lowest price at which we have sold cement during the time I have been in charge. That was not a payable price. The Commonwealth Government could not manufacture cement and expect to make a profit at that price. We lost money on that contract. We manufactured then on the old system of grinding and mixing the calcium, aluminas, and silicates, and forming them into bricks. These were dried and put into kilns, in the same manner as lime is burned, in alternate layers of bricks made of cement mixture and coke. The dry process refers to the grinding of the raw material, and not to other stages of the manufacture of cement. The material was burned in ordinary pot kilns, like the ordinary lime kiln, only much higher. The works were fairly

successful under the dry system with rotary kiln before we introduced the slurry system. We run part of the works on the dry process at the present time Cement works should be established as near as possible to the raw material, and particularly to the lime which forms the greater portion of the materials required for the making of cement. The proportion of lime depends on the percentage of calcium carbonates; but, roughly, it is five of lime to one of the other materials. I have examined your plan of the proposed location of the Commonwealth works, and I should say that a suitable site has been selected right at the lime-stone. I am told that it is proposed to install a plant capable of an output of 120,000 casks per year. That is about what we are doing at Fyansford under the dry process. We turn out 150,000 casks, or about 25,000 tons of cement a year. As to the number of men who would have to be employed, you would be doing very well if you could reckon on twelve casks per man per day, seven days a week. We have not up to the present moment reached that.

90. *To Mr. Fenton.*—With a rotary kiln it would be out of the question to stop work on Sunday. It would be impossible to run a rotary kiln intermittently.

91. *To the Chairman.*—The fact that our factory is situated at some distance from the material used does not seriously affect the labour employed, because we have established a ropeway. Our capital cost has no doubt been greater than it would have been had we been established right on the material; but we have only one man in charge of the ropeway, and that is all the additional labour involved, as the loading would be the same in any case. There is expense involved in the carting of the manufactured article. It costs us 3s. a ton to get the cement from the works into the town, which is about 6d. per cask for cartage. With a railway line into the works, the cartage cost would not be more than 6d. a ton. It is costing us at the present time 18s. 6d. per ton for Maitland coal, delivered at the works. We are using a small percentage of Wonthaggi coal; but that would not concern you in the establishment of works in the Federal Territory. We have found the Bore-Hole, Maitland, coal very suitable. We established the wet system because a local resident issued an injunction against the company to prevent the escape of dust. The case was tried before Mr. Justice Higgins, in November last, in Geelong, and a verdict was given in favour of the company. The action was brought because of the dust that emanated from the works. Following this, when duplicating the plant to dispel any likelihood of further trouble through dust escaping from the works, we decided to introduce the wet system. The fact that we wished to put in additional plant to double our output enabled us to do this at a much less cost; and that is the reason we decided to put in the wet system instead of the dry system. The new system has been the means of eliminating the dust nuisance. Where you are grinding 50 tons of material a day there is bound to be a certain amount of dust, and the locality in which the work is carried out must be looked upon as a manufacturing area. On the raw side, the wet system has been the means of eliminating the dust, and has certainly led to an undoubted improvement in that direction. We have had no complaint whatever from our employees of any difficulty on account of the dust getting into their lungs. I think that the nature of the dust is such that directly it meets the moisture of the mouth or nostrils its progress is checked, and it does not go down the throat into the lungs. I have had some experience of it, and have found that it collects in the mouth and nostrils, and can be spat out. We have men who have been employed at our works since their inception, and they are quite healthy, and have nothing the matter with them at all as a result of their occupation. Of course, if men were employed in a similar occupation in a closed building you might expect some difficulty, but the occupation carried on in an open building has no bad effects. Of course, our elevators and conveyors are carefully closed in, and that is essential in works of this description. This does not amount to a very big outlay in the first instance, and, as I have said, some of our employees have worked for us since the installation of the works, and have scarcely missed a day.

92. *To Mr. Laird Smith.*—The man who endeavoured to get an injunction against us because of the nuisance caused by the dust lives about half-a-mile from the works, but with a decent chimney you need not have the least hesitation in erecting workmen's cottages close to the works. In America they have an electric system for precipitating the dust. Whether you should adopt the dry process or the wet process for your works must depend entirely on the material you will use. For instance, some of the chalks used in the manufacture of cement in England are simply soaked away by the wet process. Where you are working with hard limestone you have to deal with quite another proposition. There are certain works in America and England where, by treating the material used with water, the first grinding is practically eliminated altogether. If the material which would be used at the Commonwealth works is similar to the specimen of limestone you have shown me, I would say that you could not expect to do very much with it with water. In installing a system you have to be guided by the nature of the material to be used. If cement works are established in a densely populated community it might be worth considering, in order to avoid the dust nuisance, whether it would not be better to adopt the wet process or provide some other means, by putting in large dust chambers, for instance, to deal with the dust. I should say that 4 per cent. is rather too high a percentage of magnesium for a satisfactory material. Oxide of iron in small quantities is not detrimental. Six per cent. would be rather too high. A high percentage would be detrimental. If you have a big percentage of oxide you will be dealing with a material that is not necessary. On the question of Sunday work, it is necessary to keep a sufficient number of hands employed on Sundays to work the rotary kilns and coal mills. There is a danger in storing coal turned out of the coal mill. When the coal is reduced, and you get 11 per cent. residue on 32,400 meshes to the inch, you have a very inflammable material. It would be dangerous to store coal in that condition over the week-end. In making provision for Sunday work, you must make provision for the working of the coal grinding plant as well as the rotary kiln. I think you would be quite safe in saying that cement could be produced at the works contemplated at 10s. a cask.

93. *To Mr. Gregory.*—I am quite satisfied that it is better to establish a cement works where the lime deposit is, rather than at a distance from the material which has to be used. If there is a sufficient water supply, and the lime and shale are on

the spot, I have no doubt that that is the best place to establish the factory. In my view, a factory with an output of less than 20,000 tons a year would not be a profitable proposition with a rotary kiln. Assuming a monopoly of 50,000 barrels a year for works at Canberra, it would appeal to me as a safe proposition to start a factory with an output of 120,000 barrels, 150 miles from Sydney. It is essential to put in the most up-to-date machinery that it is possible to secure. The greater the labour-saving appliances of your plant the better your chance of success. I do not think there is any firm in Australia to-day that would be prepared to tender for the machinery required for a cement factory unless you guaranteed to supply them with the drawings, plans, and specifications of the whole of the plant you require. A Krupp ball mill is not essential. Ball mills are manufactured in America and in England that will do the work required as well as the Krupp mill. The reason we put in Krupp machinery was because at the time we were securing our plant Krupp's were practically the only people locally represented. We had prices from America, England, Sweden, and other countries, but at the time Krupp's were represented here by Noyes Brothers. According to some arrangement, which I understand they had with Krupp's, they had an engineer here who was an expert in cement manufacture. This man had already installed plants in other parts of Australia. We got into touch with him, and the fact that we could utilize his services, and that the price was right, are the reasons why we gave Noyes Brothers the order. Other manufacturers of ball mills turn out machinery quite as satisfactory as Krupp's. Cement is being produced to-day in America with American machinery quite as cheaply as it has ever been produced in Germany. This week we are installing the largest ball mill at the present time in the Commonwealth on the wet side, and it was manufactured by Newell and Company of England. Ball mills have also been made in Australia. In our old works we had one that was made by the Otis Company. If this company were provided with drawings and specifications, I have no doubt that they could manufacture ball mills. There would be a certain amount of experiment connected with their local manufacture, and it would be essential that local manufacturers should be supplied with proper drawings and specifications. We have replaced some of the plates of our ball mills and tube mills by local manufactures that have been found very satisfactory. We have a tube mill manufactured by Chas Ruwolt Pty. Ltd., of Richmond, that is running very satisfactorily. It must be said that we have had very good results from our Krupp ball mill. but satisfactory plants could be obtained from England or America. In starting a factory of the kind unforeseen difficulties are met with. It may be that chemical conditions are not entirely what were anticipated, and that physical conditions are not what were expected, but these are minor difficulties, which can be overcome by capable men. The trouble arising from them will, of course, be accentuated if you have an inferior plant. In my opinion, for a 20,000-ton works a cost of 8s. 2d. per barrel of cement, including interest and depreciation, is a low cost.

94. *To Mr. Finlayson.*—You inform me that your proposal is to establish a factory capable of turning out 120,000 barrels of cement a year, and the estimates of cost are £100,000 for the factory, which includes £10,000 for a power plant, £5,000 for a railway, £10,000 for residences, and £10,000 for contingencies. This leaves £50,000 for the factory alone. I may say that we were going to put in a plant of the same size. We had part of our power plant already on the works. We did not require to construct a railway, or to provide any amount for workmen's homes. We were advised that the cost of a factory capable of an output of 400 tons per week would be, approximately, £60,000, and we exceeded that amount You must now take into consideration the fact that prices have considerably increased since that time. The price of steel, for instance, before the war was anything from £6 to £8 per ton. It has risen about 100 per cent., and is now anything from £13 to £15 per ton. If you had to provide drawings, plans, and specifications for the manufacture of the plant in Australia, the cost would be still further increased. I think that the estimate of £19,000 for power plant is rather a high estimate; £1,000 per 100 horse-power would be a fair thing. When I am informed that it is intended that the power plant should provide for lighting of the workmen's cottages as well as the factory itself, I have only to say that I do not think that cost ought to be debited to the factory. I am inclined to think that anything under £80,000 to provide the machinery and power plant would be an under-estimate. Exclusive of the power plant, £50,000 is too low an estimate for machinery and establishment of the factory, in view, amongst other things, of the increase in prices, especially of steel. I do not think it would be profitable to establish a factory capable of any less output than that suggested Your estimate of the cost per ton of limestone and gypsum at the factory is 3s.; the cost of shale, 3s. per ton; and of coal 21s. 1d. per ton. These prices are satisfactory, but I think the price of coal is somewhat high. Further estimates of cost you submit are for an output of 100,000 casks per an num; raw material and gypsum, 11d. per cask; coal for burning, 1s. 1d.; coal for power, 9d.; bags or receptacles, 9d.; repairs and stores, 9d.; management, 3d.; and labour 2s. 4d.; or a total of 6s. 10d. per cask. In my view, the estimate of labour cost is fairly high. The cost of material is about right; the cost of coal is, I think, on the low side. It takes 10 cwt. of coal to produce a ton of clinker, and a ton of clinker makes a full ton of cement. You have a little in, because the calcium sulphates are added after the clinker is burned. The estimates for bags and for repairs and maintenance seem reasonable. You allow 5 per cent. for interest on capital, and 10 per cent. for depreciation. I have always maintained that it is necessary to allow 10 per cent. for depreciation. When we started we put £22,000 into the plant. Later on the whole machinery was thrown out, but not worn out. If we take the ball mill, for instance, we had to renew the balls time after time. The mill was not being worn out, but it was becoming obsolete to a certain extent, and new machinery has had to be introduced from time to time. My experience is that it requires all of 10 per cent. to cover depreciation on account of machinery having to be replaced. There has been very rapid progress in the development of cement manufacturing machinery. Even within the last twelve months wonderful improvements have been made in conveyors and elevators. If we were establishing our plant to-day we would, of course, put in the most up-to-date machinery. To deal with the material used in the manufacture of cement a ball mill is most suitable when dealing with hard limestone. The sample of limestone shown to me appears to be a very hard material, but it might not prove very costly to grind. Any one looking at the material we use would say that it could be much more easily ground, because it can be disintegrated with the hands. It separates, however, into large particles, and the limestone shown me might, by

grinding in the first instance, be disintegrated into much finer particles, and might really be found cheaper material to grind than ours. The use of ball mills of some pattern is the up-to-date method of dealing with the materials used in the manufacture of cement. With 4 per cent. of magnesium contents you are getting near the danger line. Any excess would certainly be detrimental. It would never pay to extract the magnesium contents from limestone. The lower the magnesium contents in the material used the better. It is a foreign material, and the cement is better without it. I know of no means of extracting potash from the escaping dust.

95. *To Mr. Fenton.*—There is a lot of Swedish cement on the market at the present time, which has not proved satisfactory. It has been rejected by different Departments. A certain quantity of Chinese and Japanese cement is being introduced. I have not the figures with me, but the quantity of cement imported could be readily ascertained. So long as the works are fairly ventilated, the dust should cause little or no harm to the workmen. I have said that men have been working at our works for the last twenty years without any injurious effects from the dust. Apart from the fact that I am interested in our works, I am quite emphatic that the manufacture of cement is not an unhealthy occupation. The careful analysis of all raw material before it is put through the mills is absolutely essential. You may have 60, 80, or 100 feet in the face of a quarry composed of different strata of material. The method we adopt is to analyse our raw material very thoroughly. After it is thoroughly mixed we take several samples, and see that the contents compose the right constituent parts of cement before the material is put through the kilns. None of our material is ever allowed to go through the kilns without analyses and check analyses being taken of it. This is the most essential matter in cement manufacture. It is important to remember that the cement is made before the material goes into the kiln, because you cannot rectify any defects after it has been through the kiln. You may compensate, to some extent, for the effects of inferior cement by mixing it with good cement, but you cannot improve the material after it has been through the kiln. The chemist is the man who has the most important duty to perform in connexion with cement manufacture. When I am informed that a witness who appeared before the Committee in Brisbane stated that a company there let a contract for about £60,000 for a factory capable of an output of 30,000 tons of cement per annum, I have only to say that I could express no opinion upon that without seeing what was contained in the order. It is quite possible that the contract referred to did not cover all the expenditure involved in the establishment of the factory. An order for a "complete plant" may not cover the whole of the expense involved in setting the machinery running. If I were making provision for such a factory as you propose to establish, I would estimate the cost at not less than £80,000 for plant and power complete. I think you will find that my estimate is not far from what the cost will be. You have to add 30 per cent. for freight to the price quoted for a plant from abroad, and the freight cost would be considerably more than that now. Given proper drawings, plans, and specifications, Australian workmen could turn out this machinery. There is nothing very difficult about the manufacture of a rotary kiln, but it must be made very true. Our rotary kilns are electrically welded. There is no plant at present in Australia to do that. It is not necessary that a rotary kiln should be electrically welded if it is satisfactorily riveted; but, as I have said, it must be made very true. Humbolt, who are big English makers, do not electrically weld their kilns. There are big German manufacturers who make as much cement machinery as Krupp's, and their kilns are riveted. It is not essential that they should be welded, but that makes a better job. I have said that with 4 per cent. of magnesium in limestone we are reaching the danger point. The limestone percentage of the finished article should be about 63.4. If you reduced the magnesium percentage from 4 to 3 per cent. in the finished article, it would pass the analyst. The difficulty is that you introduce into the cement a certain amount of material that is of no value to it, and the remaining material requires to be so much better to carry that percentage of what is practically waste material.

96. *To Mr. Sampson.*—I have said that the adoption of the wet or dry process depends upon the character of the material to be used. When I say this, I refer, not to what is shown by chemical analysis of the material, but to the physical character of it, and the way in which water would be likely to act upon it. When I am informed that the sample of limestone exhibited is to be used in the new Queensland works, in which it has been decided to adopt the wet process, I have only to say that it may, as I have already remarked, be more easily ground than might be anticipated from its appearance. I have experience of both the dry and wet systems. The cost of labour and the cost of coal are the two big items in cement manufacture. The cost of burning in the kilns is not so great with the dry process as it is with the wet process. On the other hand, before you can grind the raw material under the dry system you have to dry it. For our stone, and the conditions under which we are working, I prefer the wet process. The system of mixing is much better with the wet process than with the dry process. When you say that the slurry process introduced by Smidth and Company, of Copenhagen, because of the absence of dust, is better for the health of the workmen, I say that the Americans manufacture cement as cheaply as it is made in any part of the world, and, for the most part, they use the dry system. From a working point of view, I favour the wet system, because you get the materials mixed much better, the conditions under which the work is done are better, and you get a more uniform article; but in the matter of economical manufacture, there is very little difference between the two systems. A plant for an output of 120,000 barrels a year on the wet system could be economically installed. At present we turn out about 90 tons with the wet system as compared with about 64 tons with the dry system. We use a longer kiln of larger diameter for the wet system than is required for the dry system. It is a little more costly on that account, but there is no difference in the cost of the other parts of the machinery. You could, of course, adjust the size of your kiln to your output by the wet process. It is, of course, in the earlier stages of grinding that the dust is most noticeable, but it is possible, by a system of dust extractors, to eliminate all difficulty from the dust nuisance. We do not make fencing posts of cement, but it is, of course, quite possible to make them.

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