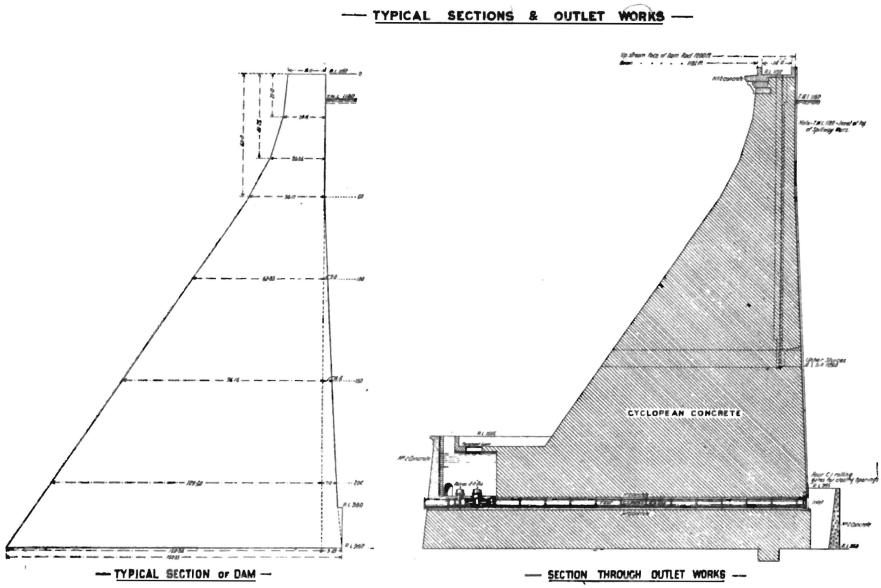

PLATE 5

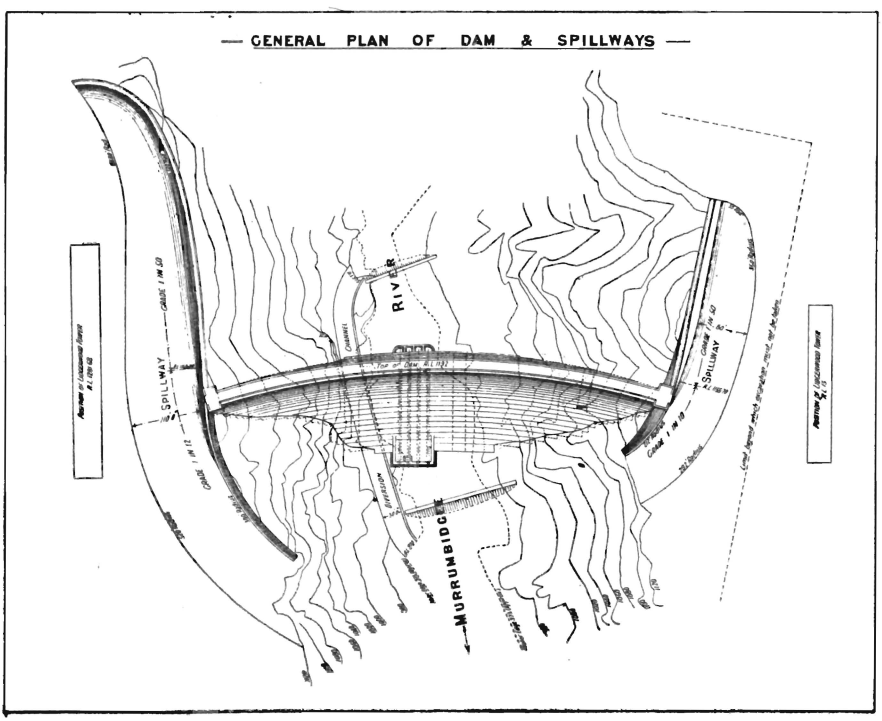

PLATE 6.

desirable to design the wall curved to the radius stated. It might be of interest to point out that the nature of the gorge at the site is such that the lower portion of the dam wall is pracically wedged in between the two sides, and that under these conditions it would be impossible for any tension to be set up in the up-stream heel of the structure.

The cross section adopted for the wall is a modification of Wegmann's Practical Profile. The top width, exclusive of parapet projections, will be 18 feet over all, giving 14 feet in the clear between parapets. The maximum height above the lowest point in the river bed will be about 232 feet, and at this level the width will be 160.33 feet. The up-stream face will be vertical for 60 feet below the crest, battering at the rate of 1 in 20 from 60 to 210 feet, below which level the batters will be somewhat more rapid. The down-stream face will be battered throughout in three short lengths of varying inclination, and one long slope at the rate of two horizontal to three vertical. A cut-off trench or apron wall to prevent any possible creep of the water under the base will be provided near the up-stream face; a rubble drain will be carried along the down-stream bottom corner of the trench excavated for the reception of this apron wall, and any water entering this drain will be then carried clear of the foundations down-stream of the wall by pipes. The crest of the wall will have an elevation of R.L. 1192.00 above mean sea level, or 12 feet above the maximum height (R.L. 1180) at which it is proposed to store water.

The by-washes or spillways will be designed so that the maximum estimated volume of flood-waters will be passed when the surface level of the water behind the wall reaches R.L. 1190.00, thus leaving 2 feet of free board between the surface of the flood water and the crest of the wall. These by-washes or spillways have been provided on each side of the gorge, flood-waters being passed into each over a weir wall of O.G. section, and then discharged out of their end well down-stream of the dam wall. The capacity of these by-washes or spillways has been fixed on the assumption that provision must be made to pass a maximum flood at the rate of 80,000 cubic feet per second, or equal to 16 cubic feet per second per square mile of catchment area. The configuration of the sides of the gorge is such that a maximum length of 560 feet on the northern side and 110 feet on the southern side can only be economically obtained for the construction of weirs over which the flood-waters can be passed into the by-washes. It was found that a depth of 10 feet of water flowing over this total length of 670 feet of weir, with a free overfall, would discharge the required volume as determined by the usual accepted formula, which is undoubtedly conservative, viz.:—

$$\text{Discharge} = 3.33 \text{ x Length x Height}^{\frac{3}{2}}.$$

$$Q. = 3.33 \text{ x l. x H.}^{\frac{3}{2}}.$$

The width, gradient and form of by-washes as adopted was only determined after experiment on a model. The nature and results of these experiments are set out in Appendix E. It will be noted that some curious effects resulted from the different designs of channel experimented with. Such experiments are very necessary in connection with the design of similar works where the data afforded by text books does not contemplate any such operations.

The volume of 80,000 cubic feet per second assumed as the maximum flood, for which provision is to be made in the by-washes or spillways, is deduced from the estimated maximum volumes calculated to have passed over the Goulburn Weir in Victoria from a somewhat similar catchment, no actual maximum flood measurements being available for the Murrumbidgee River. Formulæ for calculating the maximum flow off a catchment must be used with great caution. Those most generally in use are:—

Col. Dickens ... $D = C \sqrt[3]{M^2}$

Col. Ryves ... ... $D = C \sqrt[4]{M^3}$

in which M represents the area of the catchment in square miles, C a co-efficient, and D the maximum discharge of the river. The value of C varies as much as 500 per cent. with the rainfall, soil, slope, area and shape of catchment. The available co-efficients from text books, etc., have been mostly deduced from information gathered in tropical countries, and are not applicable to the physical conditions of the catchments of the tributaries of the Murray River. Sets of co-efficients must be gradually evolved from experience that will be applicable to the rainfall and conditions of the different parts of Australia. The volume of 80,000 cubic feet per second provided for appears small compared with the maximum floods off similar catchments in tropical countries, but the regulating effect of the gradual filling of the storage contained in the 10 feet above the top water level of Barren Jack, which amounts to about 6,000,000,000 cubic feet, must be taken into consideration.

Proposed Construction of Barren Jack Dam Wall.

The foundations on which the dam will be built consist of a very hard, close-grained, red granite. The actual site is described by Mr. E. F. Pittman, Government Geologist, in giving evidence before the Public Works Committee on the enquiry into this project, as follows:—

"It appeared to me what you would call an ideal site for an enormous reservoir. It appeared as if Nature had prepared everything in the best possible way for the construction of such a reservoir. It seems to invite the placing of a retaining wall across that narrow valley with the effect of damming back an enormous supply of water."

The existence of a deposit of lime-stone within the area that will be covered by the impounded water led to doubts being raised by the public as to the holding capacity of the granite barrier upon which the dam wall would be constructed, and which extended on both sides of it. Mr. Pittman, in dealing with this aspect, stated:—

"From the site of the dam a high range extends for many miles on both sides of the river in a direction approximately at right angles to the course of the latter. For 9 miles on the southern side it is formed of fine-grained granite, while on the northern side of the river the granite extends for about 4 miles, and is succeeded by quartz, porphyry, felsite and other igneous rocks equally impervious to water. In no instance is this range crossed by beds of lime-stone. In fact, it forms a gigantic retaining wall, the only gap in which is where the Murrumbidgee has, in the course of ages, cut its narrow channel through the solid granite. When this gap is filled with concrete, there is every reason to believe that the waters of the river and of its tributaries above this point will be effectually impounded. In short, from a geological point of view, it would appear as if Nature had provided all the conditions essential for the successful carrying out of this great engineering work." The specific gravity of the granite rock upon which the wall will be founded, and which will be used in the construction is 2.596, or equal to a weight of 162.05 lbs. per cubic foot. It is proposed to construct the dam wall of Cyclopean rubble, generally known as "concrete and plum-stones"; this method gives with this class of rock the greatest weight per cubic foot, combined at the same time with economy and efficiency of construction. It is proposed to embed granite blocks in the concrete up to a maximum weight of 15 tons, and it is anticipated that the proportions of concrete to plumstones will be as $66\frac{2}{3}$: $33\frac{1}{3}$. The concrete in the body of the dam will consist of 375 lbs of cement, 12 cubic feet of sand, 20 cubic feet of stone, consisting of three parts broken to $2\frac{1}{2}$ inch gauge and two parts broken to $\frac{3}{4}$ inch gauge. On this basis it is estimated that the average weight of the Cyclopean rubble in the body of the dam will be 154 lbs. per cubic foot. The dam wall, to secure water-tightness, will be faced up-stream and down-stream with 12 inches of finer and richer concrete, composed of 375 lbs. of cement, $7\frac{1}{2}$ cubic feet of sand, 15 cubic feet of stone, three parts being broken to 2 inch gauge and two parts to $\frac{3}{4}$ inch gauge. Cyclopean rubble will not be placed in layers, but will be built in blocks or units of varying heights and dimensions, which will break joint with each other both horizontally and vertically, and have irregular rectangular lines in plan. Each unit is to be built to the dimensions, to the lines and to the height ordered by the Engineer. Plate VII. shews in outline a plan and

Barren Jack Dam

Diagram showing Method of Construction.

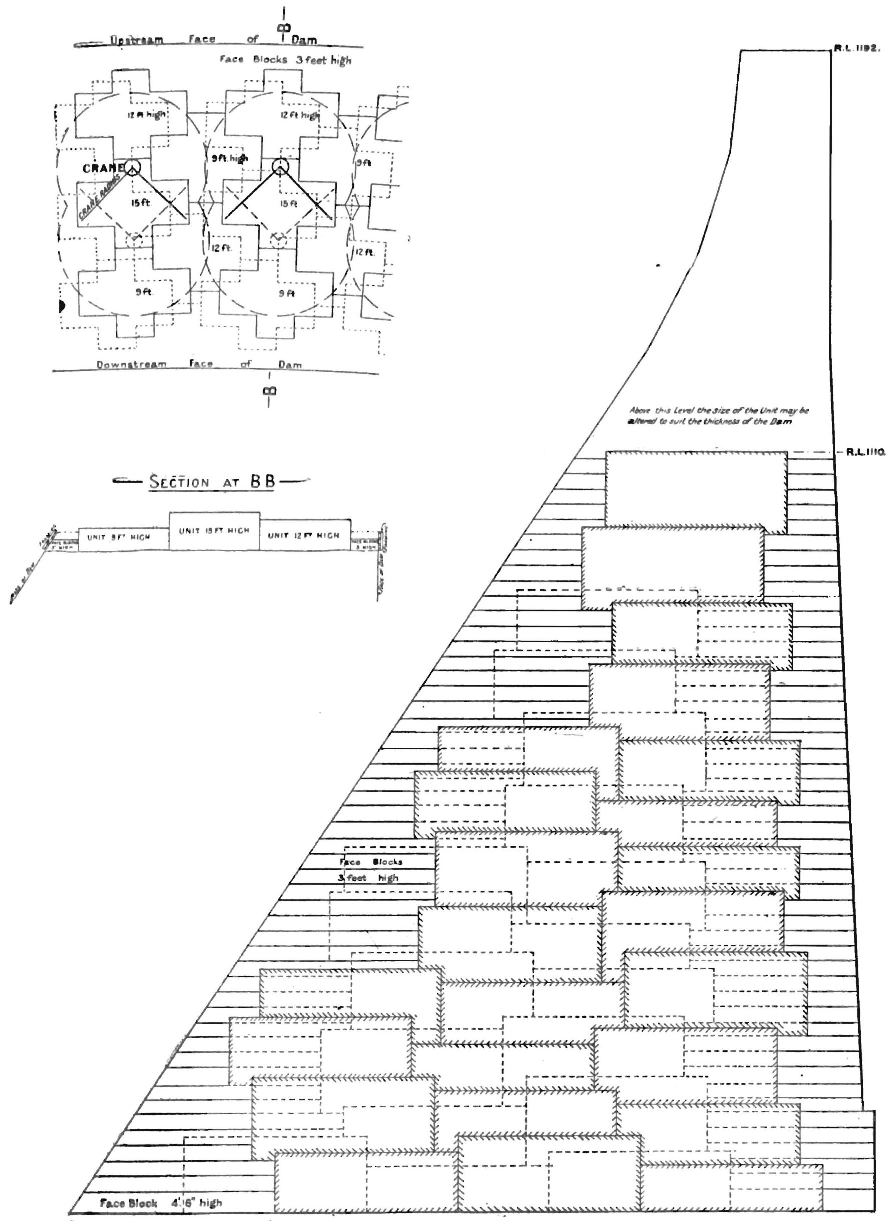

Plate 7

section of the system of blocks or units proposed to be constructed; they have been designed to give the bond desired, and at the same time with a view to economical construction. It will be seen that their greatest length is along the longitudinal axis of the dam; this is with a view of the concrete and plum-stones in the more centrally situated line of blocks being placed from a cableway, handling up to 15 tons weight. Their area and dimensions in plan are such that a large crane, to handle 10 ton loads, can then be placed upon them for the purpose of constructing the surrounding blocks. The areas are also sufficiently roomy to allow of the embedding of very large-sized plum-stones without any discomfort or danger to the labourers working inside the boxing which will have to be erected to contain them. The up-stream and down-stream faces will be carried up in 3 feet layers, and will break joint horizontally with the units in the heart of the wall; the large plum-stones embedded in the concrete will be placed to project through the top finished surfaces and make an additional bond with the succeeding units or layers.

Tests of granite, sand and concrete have been made with a view to arriving at a determination as to the maximum stresses that may be allowed in the wall. The details of these tests are given in Appendix G. The stresses provided for are calculated on the usual methods, as described in Wegmann's standard work, the limiting pressure being fixed at 15 tons to the square foot and all resultants kept within middle third of the cross section. The maximum calculated pressures in the wall, as designed, are estimated at 14.7 tons to the square foot storage empty and 14.2 tons to the square foot with storage full. Due attention was given to the recent experiments made by Messrs. Atcherly and Pearson, Ottley and Brightmore, Wilson and Gore and others with model dams of various construction, but the results obtained were not considered sufficiently definite to justify a departure from the recognised and well-tried methods for the design of large dams.

Deviations of Existing Roads Necessitated by Barren Jack Storage.

One main road only, crossing the Murrumbidgee River at Taemas, will be affected by the stored waters, which will be held up at top water level to the under-side of the steel bridge crossing the river channel at this place. It is proposed to reconstruct this bridge at a suitable site across the Murrumbidgee about 2½ miles above Taemas, and to construct necessary deviations of the main road to connect with it.

Arrangements for Construction Barren Jack Dam Wall.

The experience of the Department of Public Works in connection with the construction of large storage dams such as proposed at Barren Jack is that the most economical course to pursue is to carry out all preliminary operations by day labour and then to call tenders for completion by contract. In the case of Barren Jack, it has, therefore, been decided to construct the connecting railway from the main southern line at Goondah by the Department either by day labour or by contract, the estimated cost being £70,000; to supply all the heavy plant required for the construction of the dam wall, the estimated cost (see Appendix H.) being £27,605; to construct the diversion channel and the diversion dams across the river bed, the estimated cost being £15,000; to lay bare the foundations; and to excavate them until a sound base on which to place the dam wall is reached. All cement required in connection with the work will be supplied by the Department and delivered to the contractor on the work. When tenders are called, the successful tenderer will then be required to supply only any minor plant that may be required, his contract being practically for the supply of labour, fuel, stores and the necessary timber for the boxing for the concrete work.

By pursuing this course, the Department not only widens the scope of the market for tenders, but at the same time eliminates all the risks upon which contractors may have to gamble, such as dealing with floods during the operations of the diversion of the river and construction in the river bed; and also the element of uncertainty regarding the depth to which the excavations for the foundation are to be carried, as it frequently happens that in spite of the preliminary explorations by shafts and borings, unanticipated soft seams are discovered in the foundation rock that have to be followed out for a considerable depth, and possibly entail the dealing with large volumes of water. The construction of the access railway is a work that under any circumstances would, owing to its magnitude, justify a separate construction contract. The provision of plant and diversion of the river, which are estimated to cost £43,000 is all dead work which must be undertaken before the construction of the dam wall is put in hand, and there are few contractors in the Commonwealth who could carry this preliminary expense without substantial assistance from the Department.

Plant to be Provided for Construction at Barren Jack.

Appendix H. includes a list of plant which is to be actuated electrically, the past experience of the Department in constructing the high dam wall across the Cataract River in connection with the Sydney Water Supply demonstrating that such a system was the most suitable and economical for carrying out this class of work. This list comprises the main items of plant essential for construction and which would be supplied by the Department; in addition, there will be numerous minor items which must be supplied by the contractor. It is possible that the contractor might find it advisable to add to the items in the list supplied by the Department; for instance, he might find the conditions of the work such that economy would be effected by the installation of an additional cable. The list, however, fairly sets out the major items of plant required.

Housing Workers at Barren Jack.

The Department find it advisable, in such a work as this where the construction will extend over a period of five or six years, to make special arrangements for the housing of the workers, and to take special precautions to maintain a sanitary state of affairs and to obviate outbreaks of epidemics. The usual custom is to lay out a township, situated on Crown land and under the control of the Department, and to construct barracks for the housing of the single men, the married men and tradesmen being allowed to build their own tenements on the subdivided allotments. A water supply is afforded from standpipes through the township, all nightsoil and refuse is removed, and a medical attendant is supplied, together with a hospital, by the Government, a small charge being made to each employee on the work for these services, and, in addition, the single men charged a small rental for the barrack accommodation, and the married men for their building allotments.

Irrigable Lands in the Murrumbidgee Valley.

After the stored water has been liberated from the reservoir at Barren Jack it will be conveyed by means of the channel of the Murrumbidgee River for a distance of about 220 miles until it reaches a point where it can be diverted for application to the irrigable lands.

It has been previously stated that an examination and detail classification had been made of all the lands that could be commanded by gravitation for irrigation purposes from the Murrumbidgee River. Such a classification is an essential preliminary for the successful design of any irrigation project and is a particular necessity where the area commanded by gravitation is in excess of what can be irrigated by the available supplies of water, and the most suitable lands must, therefore, be selected to enable the best results to be afforded. The following extract from a report made by the author sets out the conditions existing on the Murrumbidgee River:—

"The area of the highest class land suitable for intense culture and closer settlement is so small in comparison to the whole that can be commanded by gravitation that, as a matter of policy, the greatest area possible should be included in the scheme. These highest class lands are situated at the base of