the foothills on the edge of the plain country to the north of the Murrumbidgee; the second-class lands lie inside the highest-class lands and at a lower level; the pastoral lands lie inside these again at a still lower level, and a channel that will command the former will also serve both the latter.

"It is necessary to consider the areas on the South side of the Murrumbidgee at the same time as those on the north side when determining the policy to be adopted. There are no lands on the south side equal in quality to the highest-class lands on the north side. The highest-class lands on the south side are in quality about midway between the first and second class lands on the north side, and comprise an area of less than 100,000 acres; the remaining irrigable lands on the south side are of the same quality as the second class lands on the north side."

A reference to Plate I. will shew the relative positions and areas of the first and second class lands and the foothills on the north side of the river, as well as the large area of second and third class lands on the south side of the river. It was considered that in the first scheme projected, the waters should be conducted on to the highest class lands that can be commanded and which are represented by those rated as first-class on the northern side of the river, and which also have the additional advantage of being in the vicinity of two existing railways.

First Canal to be Constructed on North Side of Murrumbidgee.

A reference to Plate III. shews that the flow of the Murrumbidgee River, as regulated by the storage at Barren Jack, is capable of supplying a total volume of 2,300 cubic feet per second from the months of September to April inclusive, to meet irrigation and riparian requirements. It is not considered advisable to carry out a scheme at this stage of irrigation development in the State that would absorb the whole of the volumes that could be made available from the Murrumbidgee River by the Barren Jack storage. The agricultural and pastoral conditions of the State at the present time are such that no forecast can be made of the probable future uses to which the irrigation areas, when fully developed, will be put. At present, the areas surrounding the lands proposed to be irrigated are utilized almost entirely for pastoral purposes. These areas are subject to drought conditions and one of the uses of the irrigated lands will be for the supply of fodder from time to time when required to meet these drought conditions. The first-class irrigable lands themselves are eminently suitable for the most intense forms of irrigated culture and for the production of all classes of horticultural products that afford the highest return from the land.

Mr. Allen, of the Department of Agriculture, in giving evidence before the Public Works Committee, said regarding the quality of these lands:—

"There are several different classes of soil suitable for growing to perfection almost anything that can be grown in the State. If such a scheme as this were carried out, it would place those who took up or owned this soil in a position to defy droughts, and, with good crops of lucerne assured it would be possible to make pig-raising a very profitable industry. Raising early lambs for market could also be carried on with profit by small holders, and, in my opinion, dairying would soon be taken up, and would prove as lucrative an industry there as in almost any part of the State. Vegetable raising could also be carried on successfully, and I feel sure that potato-growing, particularly for the early market, would receive considerable attention; and as for fruit growing, it could be carried on under the most favourable conditions, as there can be found here large areas of soils particularly adapted for the raising of citrus fruits, as also grapes and stone fruits, and soils which are second to none of the very best to be found in Mildura, where, as is well known, some of the very best Australian dried fruits are produced."

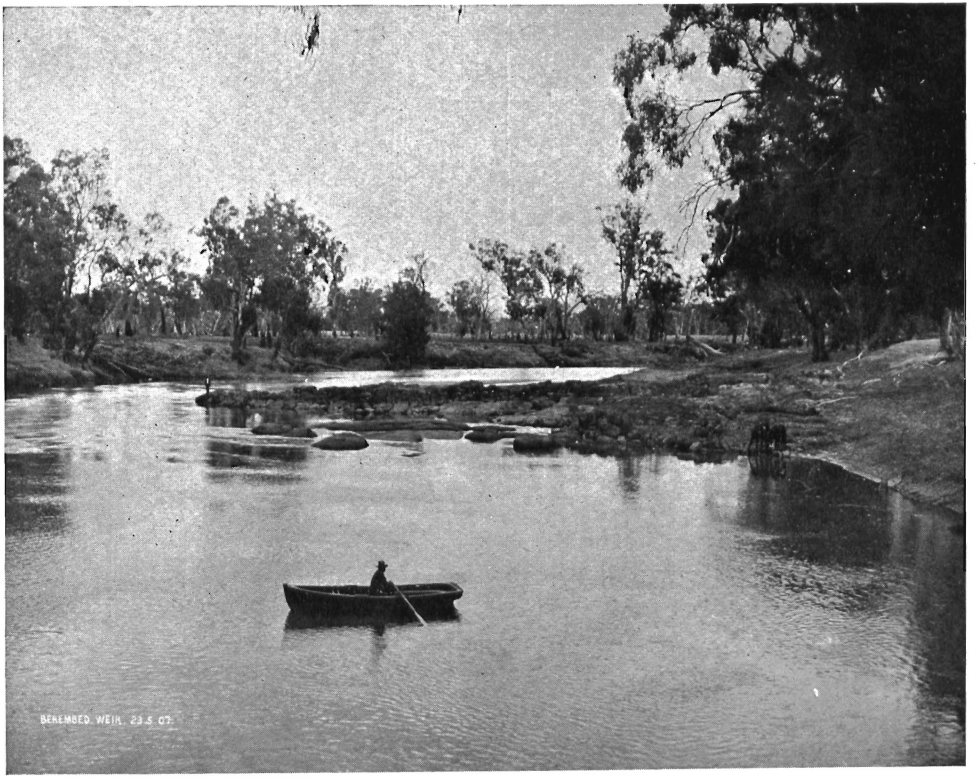
Unfortunately, the markets in the Commonwealth at the present time for horticultural products are not sufficient to justify the intense cultivation of the whole of the first-class lands on the northern side of the river. It is considered that all of the irrigable lands to be supplied with water can be immediately put to beneficial use, but that the ultimate forms of production should be allowed to develop slowly on the most suitable lines, and that avantage will be taken in the future of the experience gained as a guide in projecting other schemes. That being so, it was decided to construct in the first instance a canal to convey a supply of 1,000 cubic feet per second to the high-class irrigable lands on the northern side of the river. It will be a question for subsequent determination whether the surplus over this amount available for irrigation purposes from the Murrumbidgee River will be conveyed to the lands on the southern side of the river, or whether the proposed canal on the northern side will be enlarged to convey larger volumes of water and to carry out more intense cultivation on the high-class lands on that side.

Location of Main Canal.

There are two suitable points of off-take on the north side from which a canal may leave the river to convey supplies to the irrigable lands, the upper one being situated at a point known as "Berembed," at the head of the Bundidgerry Creek, the lower situated a short distance below the town of Narrandera. A canal constructed from the upper off-take at Berembed would

be at such an elevation as would allow of it being carried in a falling contour round the base of the foothills and thus command the largest possible area of the first-class irrigable lands. A canal from the lower off-take would have to be carried at a considerable distance from the base of these foothills, and would thus be unable to command a strip of about 100,000 acres of these lands situated between it and the course which the upper or high-level canal would take. All things being considered, it was deemed that a canal constructed to take off at Berembed and command the maximum area of high-class irrigable lands would give the best results, and it was, therefore, decided to adopt that location, particularly as there were no engineering difficulties that could not be met and satisfactorily dealt with. At the proposed point of off-take at Berembed, which is the native name for "a heap of rocks," the river impinges on its right bank against low hills which stand well above maximum flood level, and crosses a wide granite bar extending under the river bed and banks, which affords an excellent foundation for the construction of a diversion weir and regulator to control supplies down a canal.

The Bundidgerry Creek, which is an ana branch of the Murrumbidgee River, forms a few chains below this point and skirts the hills in a defined channel for a couple of miles before it works out into the river flats, where it again practically dies out. It re-forms again about 5½ miles from the proposed off-take, it being fed at that point by overflows from the river through a couple of high-level channels that commence to run when the Narrandera gauge reaches 21 feet. From this point onwards the cross section of the Bundidgerry Creek is deep and well-defined for a length of 20 miles until it reaches a point opposite to the Bundidgerry woolshed, where it again becomes shallow and spreads over the river flats. A short wing embankment will connect the regulator at the head of the canal at Berembed with the low hills above maximum flood level. From thence the existing channel of the Bundidgerry Creek for a distance of two miles will be deepened and improved to carry the supplies proposed to be sent down the canal; the excavated material will be placed on the river side of the improved creek in the form of a flood embankment, the crest of which will be kept 6 feet above highest known flood level. From the end of this creek improvement, at 2 miles, a channel will be excavated across the river flats to the head of the Bundidgerry Creek, at 5½ miles, where it again forms as a result of the high-level overflows previously mentioned. The excavated material from this cutting will also be placed on the river side of the channel, thus forming a continuous flood embankment 5½ miles in length from the off-take. The remaining length of the Bundidgerry Creek to the Bundidgerry woolshed, at 25½ miles from



BEREMBED WEIR.

Berembed regulator, will remain in its natural state, no improvemet being necessary except the removal of timber and a few sand bars. An examination of the flow of small volumes of flood-waters down this length of creek channel shews a minimum of losses and absorption. Three large drainage depressions converge from a catchment area on the north side of the river valley, and join the Bundidgerry Creek about opposite Grong Grong railway station. This catchment area is approximately 900 square miles in area, but consists entirely of flat, absorbent agricultural country; the creeks only flow under very abnormal conditions of rainfall, and, in fact, there is only one record of their having run through and joined the Bundidgerry Creek, which happened in the flood year of 1891. There is, therefore, no difficulty to be anticipated in either controlling flood-waters coming into the Bundidgerry Creek from this catchment area or dealing with any probable volumes of silt that might be transported from these agricultural areas.

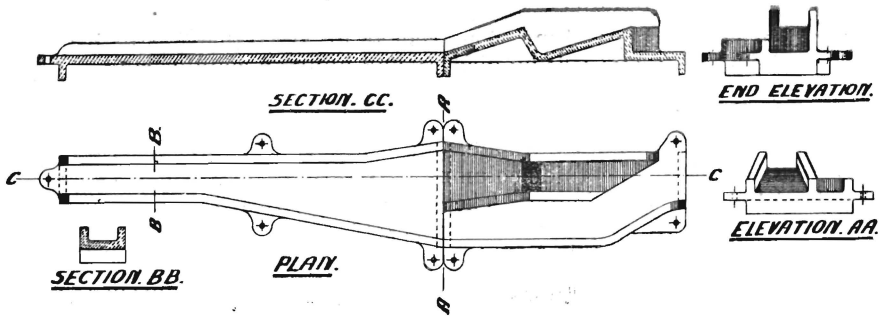
From the point where the channel of the Bundidgerry Creek partially dies out, in the vicinity of the Bundidgerry woolshed, a channel will be excavated for a length of about half a mile to a point where the creek channel again forms and is fed by high-level overflows from the river down the Middle and Oak Creeks. The creek channel is again utilized from this point until it again dies out opposite the eastern end of the town of Narrandera. The whole of this length of excavated and creek channel will be protected on the river side by a flood embankment, with crest 5 feet above the highest known flood level, and will be controlled by two regulators, one being placed at the head near the Bundidgerry woolshed and the other near the eastern end of the town of Narrandera. An excavated canal then starts from this point, opposite the eastern end of the town of Narrandera, and skirts the foothills from thence until it terminates at a point east of the town of Gunbar. A branch excavated channel leaves the main canal in the vicinity of the Yanco railway station, and follows a course parallel to the Hay railway line.

Berembed Weir and Regulator.

The site selected for the canal off-take at Berembed is situated in one of the narrowest portions of the river valley, between Wagga Wagga and Narrandera, and precautions must be taken that neither the diversion weir nor the flood embankments in connection with the canal or regulator form any obstruction that would result in the raising of flood levels, or in any way affect the regimen of the stream or set influences at work that might result in alterations to the course of the river channel. For this reason it has been decided to construct a diversion weir of a

movable type, of such a nature that it will present no obstruction to the river flow during flood periods. The weir, which will be founded throughout on the granite bar extending under the river bed and banks at this point, will consist of one opening of 165 feet of "Channoine" shutters, and two openings of 40 feet each of "Stoney" sluices. The object sought to be attained by the weir is the holding up of the surface of the river during periods of low flow to such a level that a full supply can be afforded through the regulator down the main canal, while at the same time provision is made for the passage of river traffic, which consists as a rule of a single steamer, towing one or more barges. This water level in front of the regulator will be maintained by manipulation of the Channoine shutters and Stoney sluices. As the volume of the river flow increases as the result of freshets, the surplus will be passed through the Stoney sluice openings until such time as the tail-water below the weir has reached a height that will allow of a full supply being passed through the regulator for the use of the canal, without the assistance of the shutters and sluices.

The Channoine shutters, which will be built up of longitu- so far that this being the first large irrigation scheme proposed, dinal timber planks, fastened together by straps and transverse through bolts, will be 3 feet wide and 13 feet high. They will be hung by means of a pair of trunnion sockets, bolted to their down-stream side at a point that will allow of their automatic tilting when the tail-water level below the weir fulfills the conditions above set out. These shutters will be supported on horses or trestles, the trunnion sockets pivoting on trunnion arms, forming an extension of the top rail of the trestle. Each trunnion socket will be provided with a lug which will engage upon the trestle and prevent the shutters tilting to a greater angle than that determined upon. The trestles will be provided with further trunnion arms, forming an extension of the bottom rail, which will engage in cast iron sockets attached to a timber beam, forming the crest of the fixed portion or floor of the weir. Each trestle will be supported at its top in an upright position by a loose-fitting hinged prop or strut, the lower end of which will be stepped into a "Hurter." The operation of these shutters will be as follows:—During flood time and at such periods as the flow in the river is at a sufficient height to afford the necessary supplies through the regulator down the main canal without the artificial raising of river levels, the shutters will be laid down flat on the floor of the fixed portion of the weir. When the flow of the river falls to such a level that artificial regulation is required, then a crane operating from a punt will hook on to a bow on the up-stream or bottom end of the reclining shutter; the shutter will be drawn forward in a horizontal position, causing the trestle to revolve and rise on its bottom trunnion arms; the strut following with it, will drop into a recess or step in the



C.I. GUIDE PLATE AND HURTER.

"Hurter." When it has reached this position, the strain from the crane on the shutter will be released, and the flow of the stream will force the shutter into its upright position. When it is desired to lower the weir, the crane will again be attached to the bottom of the shutter, which will be brought into as nearly a horizontal position as the lug on the trunnion socket will allow. It is then drawn up-stream until the foot of the strut drops out of the recess or step in the "Hurter." The strain of the crane on the shutter is then released and the pressure of the flowing water forces the shutter down-stream, the foot of the strut being then engaged in a curved groove which carries it round and clear of the step, and allows of its resuming its original flat position on the floor of the fixed portion of the weir. The efficiency of this manipulation is largely dependent on the details of the "Hurter," which acts both as a supporting step and tripping arrangement. It might be here mentioned that this type of "Channoine" shutter and "Hurter" has been in use for the past 13 years at the weir forming part of the Bourke Lock and Weir across the Darling River, near Bourke, and has been found to answer its purposes most satisfactorily, no trouble having arisen in its manipulation.

The two "Stoney" sluices will be separated from each other and from the "Channoine" shutters by substantial concrete piers, these piers being carried to such a height as will allow of the sluice being lifted to about 2 feet clear of the highest known flood level. The pier separating the middle "Stoney" sluices from the shutters and the adjoining pier separating the two Stoney sluices have been carried down-stream for a distance of 155 feet to form a navigation lock for the passage of steamers and barges. The up-stream end of the lock thus formed will be controlled by the "Stoney" sluice, the lower end being controlled by an ordinary pair of timber lock gates, operated by a quadrant, geared to a small pinion, worked with a capstan. When not being used as a navigation lock, the lock walls will act as guides for the water passed through both "Stoney" sluices for regulation purposes. These sluices will be of the

ordinary "Stoney" type, constructed of steel plates stiffened on the down-stream side by girders, and hung on counterbalanced chains passing over sheaves carried on an overhead shaft. The pressure on the sluices will be borne by free rollers, that is, rollers unattached to the gate, but which roll between the gate and the path of the guide columns. By this arrangement friction is reduced to a minimum. The gates will be raised and lowered by a bevelled wheel gearing, operated on an overhead shaft. This gearing will be of a simple design and capable of being operated by one man, since the gates being counterbalanced, the friction only on the journals supporting the shaft will have to be overcome, while the gates being borne on free rollers will move up and down with ease and freedom.

The regulator openings controlling the passage of supplies down the main canal are situated at right angles to and immediately above the line of the weir and "Stoney" sluices. The river bank up-stream for a distance of 85 feet and 180 feet down-stream of the regulator openings will be protected by a heavy retaining wall.

The bays, which are 10 in number, of 4ft. 11in. clear width, separated by piers, each 2 feet in thickness, are closed above the openings by reinforced concrete curtain walls, and the whole structure carried to a height of 6 feet above highest known flood level. The regulator will, therefore, be able to control and exclude any probable floods below that level.

The openings will be closed by three timber leaves sliding in iron grooves; each leaf is capable of being raised or lowered independently, and by this means supplies can be drawn from the river at such a level during periods of freshet as to obviate to a large extent the risk of drawing into the canal the sand that is then carried in suspension by the river waters. The gearing for working each of the leaves will be of simple design, and consist of three screwed rods passing through units actuated by bevel gearing, the gearing being carried on the floor forming the top of the regulator. The bed of the regulator openings and of the canal will be 6 feet above the sill upon which the "Stoney" sluices in the weir will rest and close down. The operation of the "Stoney" sluice nearest to the regulator will have the necessary scouring effect to remove all silt that may by any means become deposited in front of the regulator openings.

Main Canal.

The excavated portion of the canal from its head at the Berembed regulator to 5½ miles, where it joins the defined portion of the Bundidgerry Creek, will have a bed width of 48 feet, side slopes of 1 to 1, and with an inclination of 9 inches per mile will be capable of carrying 1,125 cubic feet per second, with a flow of 8 feet in depth, and a velocity of 2½ feet per