IRRIGATION FROM THE MURRIMBIGEE RIVER, NEW SOUTH WALES.

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Possibly, some of the Members of the Society I am addressing may be some day charged with the responsibilities of the preparation of irrigation proposals in a new and undeveloped country where water laws of Anglo-Saxon origin have been transplanted, and where reliable hydraulic records over an extended period are not available. The author proposes, therefore, in this paper, to set out all the steps that have been taken in this State, where conditions as described existed, in order to ensure the development of a successful irrigation policy.

In no class of engineering is a preliminary ground-work of sound legislation and reliable information on all points more necessary than in connection with the design and operation of large irrigation projects.

PRELIMINARY LEGISLATION.

The nature of the business of irrigation is such that it demands express recognition in the laws of any arid country, seeing that it makes use of an element necessary for life that must be controlled in the public interest. A well-known authority on Irrigation Laws in the United States (Mr. Wm. Ham Hall says:—

"Irrigation laws and regulations must be grounded upon the fundamental water laws of a country, and these should be based upon right pricniples and ideas for the best solution of the broad problem of human life under the special physical conditions to be dealt with. It is at once absurd to suppose that the necessities of man can be subserved in an absolutely arid country—where every economic consideration demands the conservation and use of water supply out from the natural streams to the extremest available limit—by the application of fundamental ideas in water law which have grown up and become sanctified in humid countries, where almost every consideration of man's comfort and necessity demands that waters be kept in their natural channels, and be led away, as harmlessly as possible, to the sea."

It is one of the ironies of fate that the common law of humid Great Britain, which country has become populous by draining her lands, should have, under the original Constitutions of the various States, been the law of arid Australia, whose agricultural and pastoral development largely depends on the use of water for irrigation. This common law doctrine of "riparian rights" requires that water taken from a stream be returned undiminished in volume. The Water Rights Act of this State, which superseded this portion of the common law, and was enacted in 1896, embodies the soundest principles of the water laws of the arid countries of Europe, and defines the right of the Crown to the use and flow and the control of all surface flowing waters, and has cleared the way for their beneficial use for irrigation purposes, both by the State and private individuals. The only obstacle then to the projection on safe lines of large irrigation schemes by this State was the lack of an agreement between the riparian States of New South Wales, Victoria and South Australia regarding the allotment to each State of a proportion of the waters of the Murray River, the tributary streams of which afford the only large permanent supplies of water for irrigation purposes to the arid interior of Eastern Australia. Here, again, the Common Law of Great Britain, which in effect gives navigation priority of claim over irrigation, has, owing to the divergent interests of the three States, proved in the past an effectual bar to a common agreement.

The difficulties of holding a balance between the claims of navigation and irrigation were appreciated by the elected bodies who were responsible for the framing of the Commonwealth Constitution. Section 100 of the Commonwealth Constitution enacted a principle, but left its interpretation and application to the future. This Section provides that: "The Commonwealth shall not by any law or regulation of trade or commerce abridge the right of any State or of the residents therein to the reasonable use of the waters of rivers for the purposes of water conservation or irrigation." The position at the present time is that several attempts have been made to arrive at a common agreement between the three riparian States to allow of the maintenance of navigation and at the same time the development of irrigation, but hitherto unsuccessfully. It is more than probable that the ultimate settlement of this vexed question will be by a reference to the Federal High Court, or the Inter-State Commission, when constituted. Meantime, the Murrumbidgee project is being proceeded with. It is, however, hoped that the settlers on the lands that will be commanded by the canal will before long have a legal assurance, either under Inter-State agreement or High Court Decision, of permanent and uninterrupted supplies beyond those which may be built up as a vested interest as the result of the construction of the works.

Preliminary Information.

The first necessity, from an engineering point of view, for the successful design of a sound irrigation project is an accurate estimate, extending over many years, of the volume of flow of the streams forming the source from which the irrigation supplies will be drawn.

The catchment area of the Murrumbidgee River may be divided into effective and non-effective areas as regards contributions to the flow of the River, the effective area being represented by the more impervious and steeper surfaces of the hilly and mountainous country, and the non-effective by the more absorbent, alluvial, flat country. The total effective catchment area of the Murrumbidgee, which is situated practically above Gundagai, is 8,400 square miles in extent. It consists geologically of granite and hard, compact Silurian slates and shales, with scattered deposits of lime-stone. The contour of the surface varies from undulating table-lands, at an elevation of 1,500 to 2,000 feet above sea level, thinly covered with soils, to rugged and mountainous areas rising to elevatins of 4,000 and 5,000 feet, marked by bold outcrops on the ranges, and fairly extensive swamps in the higher valleys. The rainfall varies from a yearly average of 20 inches over one comparatively dry belt, small in area, on the table-land, to about 70 inches of rainfall and snow on the highest summit. The highest elevations are as a rule snow-clad throughout the winter months, and afford a supply of water to the streams from the melting snows throughout the early spring months of the year. The swamps situated at the higher elevations also act as regulators to the run-off, and afford the low supplies which flow down the river channel through the summer months.

The volumes flowing from the effective contributing area can be only very approximately estimated from the rainfall records, there being numerous varying factors governing the volumes discharged into the stream as the result of each separate fall of rain. The only reliable method of arriving at the available volumes is by measuring and recording the actual discharge of the streams at suitable places over a long series of years, including dry, normal and flood years. The volumes flowing down the Murrumbidgee River, past the town of Gundagai, represent the contributions from the effective contributing area and the capacity of the stream for water supply purposes. The system adopted by the Department of recording and measuring volumes discharged is as follows:—

Rods or gauges, marked to feet and inches, for the purpose of reading the daily surface levels of the river flow, are established at suitable stations, and a reading taken at the same hour each day. Observations by means of current meters are made for the purpose of measuring the volumes of flow corresponding to various heights on these rods or gauges. From these observations a curve is constructed, from which the volume of flow at any reading of the gauge may be ascertained. By applying this curve to the daily gauge readings, the daily, monthly and yearly volumes of flow at the particular station are computed and tabulated. Appendix A gives a copy of the instructions issued to officers by the Irrigation and Drainage Branch of the Department of Public Works for the measuring of the volume of flow of rivers.

Appendix B gives a tabulated statement for the Gundagai station of the maximum, minimum and mean discharges in cubic feet per second for each month; the total volumes discharged in each month and year in terms of acre feet and millions of cubic feet; also the total run-off per month and year in terms of depth in inches and second feet per square mile. Tables of a similar nature sometimes attempt to shew the relation of these annual volumes to the depth of annual rainfalls in terms of percentage of run-off; the author consides that such a statement in the case of the catchment area of the Murrumbidgee would be misleading and unreliable, seeing that the heaviest snow and rainfalls occur on the summits of the highest peaks, where there is no settlement and consequently no established rain recording stations, such records being only kept in the lower valleys where the best lands exist and settlement has taken place and lesser rainfalls occur.

The volumes of water discharged from the effective contributing area flow under natural conditions down the channel of the Murrumbidgee River, spreading in flood-time over adjacent river flats and through ana branch channels until its junction with the Murray is reached, the only volumes permanetly diverted from the river valley under natural .conditions being those flowing down the Yanco Creek, following a southerly and south-westerly course through the Colombo and Billabong Creeks to the Edward River, and eventually to the Murray River. The spread of these flood-waters and the volumes diverted down the Yanco Creek would be sensibly reduced by the construction of regulating storage reservoirs on the upper river.

Between the towns of Wagga Wagga and Hay, the river banks are fairly high, and overflows do not occur each year. Below Hay, the river banks gradually decrease in height, and very extensive areas adjacent are subject to inundation at different stages of the river flow, the lowest zones being affected by medium freshets. The owners of the inundated lands which claim to receive benefit from flooding, assert that a depreciation in the value of property will follow if flood levels are lowered by the abstraction or the storage of water for irrigation purposes. It is, however, considered that these landholders have no riparian ownership in the flood-waters, and that this natural irrigation of grass lands is a wasteful use of water

Site of Barren Jack Dam Wall.


MURRUMBIDGEE RIVER NORTHERN AND SOUTHERN IRRIGATION SCHEMES
MAP SHOWING
IRRIGABLE AREAS
SCALE
Reference
First Class Irrigable Land shown thus
Second " " "
" " " but not proposed to be dealt with under present scheme
Flooded Country (maximum area)
L. Ablett
Principal Engineer, for Rivers, Water Supply, & Drainage
BOOLICAL
Mirrool
Creek
GUNBAR
RAILWAY
TRIAL
SURVEY
BARELLAN
RAILWAY UNDER CONSTRUCTION
WYALONG
BARMEDMAN
MANDAMAH
TEMORA
DISTRICT No 3
WAH WAH
Wah Wah Creek
DISTRICT No 2
DISTRICT No 1
MIRROOL
MAIN
CANAL
BRANCH
CANAL
DISTRICT No 3
DISTRICT No 2
DISTRICT No 1
YANKO
ONE TREE
OXLEY
LACHLAN
RIVER
Box Creek
L. Pitarpunga
L. Cannaway
Paika L.
MAUDE
HAY
MURRUMBIDGEE
BALRANALD
Waldaira L.
Taila L.
Noeyanga L.
MURRAY
Condoulpe L.
Talbetts L.
Canegrass
Abercrombie
Watercourse
The Gum Ck
Telegraph Creek
Coleambally Ck
Spillers Ck
Box Creek
Native Dog Creek
The Box Forest Creek
Nyangay Creek
BOOROOBAN
WADDI
NARRANDERA
GUBBELL
NEW PARK
MOROUNDAH
WIDGIEWA
Yanko Creek
COONONG
BUNDURE
Colombo Creek
NORTH YANKO
Lake Urana
URANA
JERILDERIE
COREE
L. Cullivel
REGULATOR
OFFTAKE
WEIR AND REGULATOR
COOLAMON
JUNEE JUNCTION
RIVER
WAGGA
LOCKHART
KINGSTON
Brookong Creek
Urangeline Creek
KYALITE
MOULAMEIN
Moulamein Billabong
OR EDWARD
RIVER
WANGANILLA
BARRATTA
GONARGO
DAHWILLY
Photo-lithographed by W. A. Gullick, Government Printer, Sydney, N.S.W.

which must give way, if necessary, to the requirements of intense cultivation under irrigation. The natural off-take of the Yanco Creek has been artificially improved to allow of supplies being draw from the river until its flow has fallen to summer level. This creek supplies an extensive area of country for stock purposes, and the diversion of volumes of water down its course will still continue as part of a general irrigation scheme from the Murrumbidgee.

A vital point in the success of any irrigation scheme is the selection of the most suitable lands to which the water is to be applied. An examination and classification of all the irrigable lands on the non-contributing portion of the Murrumbidgee valley, and that could be commanded by gravitation, has been made, and the results are indicated on the attached map (Plate I.).

The whole of the information thus obtained regarding volumes of river flow and areas and quality of irrigable lands, which is a necessary preliminary to the projection of an irrigation scheme, shewed that the areas of high-class irrigable lands on either side of the river were such that the whole of the waters of the Murrumbidgee available for irrigation in normal years were insufficient for their development, and that the fluctuations in flow of the Murrumbidgee in all years are such that storage works are necessary to afford the volumes of water to be supplied during the irrigating season. The scheme which it was decided be first put in hand was then from the construction of a storage on the most suitable location on the Upper River, and the construction of diversion works and excavation of a canal to convey a supply of water to the high-class lands situated on the north bank of the river, below Narrandera.

Barren Jack Storage Site.

The most suitable site for such a storage would have been on the main river channel, below the confluence of the principal tributaries, where the flow from the whole of the contributing catchment area could have been regulated. No such site was, however, available. A detailed examination of all the tributaries shewed that the most economical conditions for construction and storage, and at the same time to include the greatest available catchment area, existed a short distance below the confluence of the Goodradigbee and the Murrumbidgee Rivers, at a site since known as "Barren Jack." The available catchment area above it is 5,000 square miles.

It became necessary to decide upon the greatest volumes that would be justifiable to store at this site and to ascertain the effect of this regulating work on the flow of the river. The site selected for the dam wall is between the walls of a very deep gorge, situated below extensive flats, and the capacity of the storage is limited only by the safe height to which such a wall can be carried, combined with facilities for safely passing large volumes of flood-water. The maximum height of the dam wall was ultimately fixed at 240 feet, the volume of water retained amounting to 33,613,000,000 cubic feet. The stored water, which will cover 13,000 acres and includes 8,000 acres of rich river flats, will be held up the Murrumbidgee River a distance of 41 miles above the site of the dam wall, 15 miles up the Goodradigbee River, and 25 miles up the Yass River (see Plate II.). The effect of this storage upon the flow of the river is shewn by Diagram —, Plate III., and tabular statement (Appendix D). This diagram has been based upon the assumption, which has been verified by discharge observation, that the Murrumbidgee and Tumut Rivers contribute practically equal annual volumes to the flow of the main Murrumbidgee River, as measured at Gundagai. An inspection of the estimated yearly volumes discharged through the river channel at Gundagai, as given in Appendix B, shew that the most critical period in the history of the river regarding years of low flow extends from 1902 to 1908 inclusive. The diagram (Plate III.) illustrating the behaviour of the proposed Barren Jack Reservoir as a regulator of the river flow, therefore, has been constructed to cover the years 1903-8 inclusive, the year of 1902-3 being so abnormal that no scheme could be devised with a storage reservoir of sufficient capacity to meet conditions that might occur once only in a hundred years. It will be seen from the diagram that the natural flow of the river, with the regulation afforded by the Barren Jack storage, will supply a volume of 2,000 cubic feet per second at the proposed canal off-take for irrigation purposes during the irrigating season, from September to March inclusive; a volume of 500 cubic feet per second for the months June to August inclusive, for a supply to the Yanco Creek; and a flow past the canal off-take of 300 cubic feet per second at all times to meet riparian requirements on the lower river or a yearly total of 61,000,000,000 cubic feet.

Supplies Available for Irrigation from the Murrumbidgee River.

A study of the amounts of the annual volumes flowing down the Murrumbidgee River past Gundagai, as recorded in the tabular statement (Appendix B), shews extremes of a maximum volume of 290,000,000,000 cubic feet for 1891, and a minimum volume of 20,000,000,000 cubic feet for 1902. It has already been stated that the year 1902 was abnormal, and that it must be disregarded; irrigation supplies over that period must, therefore, be cut down to such an amount as would be sufficient only to preserve permanent plantations from destruction. Again, the year 1891 was so unusual as regards high