THAMES WATER SUPPLY AND STORAGE.

By HUGH W. RUSSELL.

THE question of the storage of Thames water, in times when the flow of water is in excess, in order to meet the requirements of periods of deficiency, has been forced upon the attention of the public by the severe droughts of 1893, 1898, and 1899. It is unfortunately a question that to some extent is liable to the prejudices of those who are interested in the adoption of the scheme of the London County Council to go to another source for the water supply of London, and who fear that the demonstration of the sufficiency of the existing sources of supply, for a long period, may militate against the adoption of their scheme.

I desire in this paper to, as far as possible, treat it without any bias, but to place before the Congress some of the information gained over a long series of years of residence in the valley of the Upper Thames, and of practical work in the control of the river.

The conditions of the flow of the water have very much altered during the latter half of the century just closed. It may appear a paradox, but is nevertheless true, that the same causes which produce floods also produce droughts, and the upper river districts suffer quite as seriously from the latter as from the former. During the period mentioned, land-owners all over the watershed have laid down millions of drain pipes, with the result that the rainfall is rushed into the river with great rapidity; the water no longer lies on the land for a sufficient period to enable a large portion of it to percolate through and replenish the springs, but, especially in the late autumn when active vegetation has ceased to absorb a large quantity of moisture, an abnormal amount of the rainfall, undiminished by the action of absorption by the soil, runs direct into the river.

The channel of the river is quite inadequate to the sudden strain, and more or less disastrous floods ensue. The half submerged towns on the banks clamour for relief, and the severest pressure is put on the Conservancy to get rid of the water as quickly as possible. Fresh weirs are constantly being constructed, each with a still larger capacity for facilitating the escape of the water, and we see every year an enormous mass

of water rushed down to the sea, the want of which we know will be felt a few months later on. This difficulty is steadily increasing, and points to the conclusion that some effort should be made to retain a portion of this bountiful excess nature provides to secure London at least from the shortness of supply.

It has been urged by some that as a consequence of cultivation and deep drainage the level of the subsoil water has been lowered, and a larger depth of soil made available for the absorption of the rainfall; but it must be pointed out that to carry into effect the deep drainage, it has been found necessary to provide deep and clear channels to get rid of the surplus water, and this has had the effect of increasing the rapidity of the rise of the water in the river, and, in the opinion of the writer, more than compensates for the reduction due to the greater depth of soil available for absorption.

Still, supposing the causes adduced are erroneous, the fact remains patent to everyone familiar with the river for the last forty or fifty years, and demonstrable by the figures I now give, that the rise of the river, after comparatively moderate rainfall, is of much more sudden and acute character than in former times, and that a large amount of water, instead of running to waste, might be abstracted with advantage to the river. In support of these views, I give a few instances of enormous increases in the flow over Teddington Weir taking place within a few days:—

Mill. galls.					Mill. galls.				
1884.	Jan.	23	...	960	1891.	Oct.	6	...	400
	"	28	...	4,055		"	9	...	2,530
1885.	Jan.	28	...	675	1892.	Oct.	27	...	366
	Feb.	3	...	3,145		"	30	...	3,089
1885.	Nov.	24	...	880	1894.	Oct.	23	...	363
	"	28	...	3,630		"	28	...	2,038
1886.	Dec.	4	...	990	1896.	Dec.	3	...	887
	"	10	...	3,590		"	6	...	4,293
1888.	Mar.	5	...	660	1898.	Nov.	24	...	737
	"	12	...	3,200		"	26	...	2,615
1888.	July	27	...	860	1898.	Dec.	6	...	793
	Aug.	3	...	3,156		"	9	...	3,472
1889.	May	25	...	880	1900.	Feb.	14	...	1,111
	"	28	...	3,405	*	"	17	...	8,747

* This was largely owing to the sudden melting of heavy snowfall, the ground being frozen and incapable of absorbing any of the water.

The following facts, as regards the flow of the River Thames, should remove any doubt which may exist in the minds of any members of this Conference as to the capability of the River to spare the large quantity of water which is required to supply the Metropolis.

The area of the watershed of the River Thames, above the intakes of the Water Companies at Hampton, is 3,548·7 square miles, and the average rainfall about 28 inches per annum.

The average flow of the River, gauged at Teddington Weir for a period of 18 years, is 1,128·3 million gallons per day.

NATURAL FLOW OF THAMES AT TEDDINGTON.

Maximum flow on 18th Nov., 1894 ... about 20,000 mill. galls.

Minimum flow on 13th Sept., 1898 ... „ 176 „ „

MONTHLY AVERAGE PER DAY.

Maximum in Nov., 1894 ... 6,465 mill. galls.

Minimum in Sept., 1898 ... 214 „ „

YEARLY AVERAGE PER DAY.

Maximum in 1883 ... 1,922 mill. galls.

Minimum in 1898 ... 760 „ „

It will be seen from these figures that, with a daily average flow of over 1,100 millions, there is ample excess to provide storage for eighty or ninety days supply of London which would probably satisfy all prudent requirements without at all interfering with the quantity required for navigation and properly scouring the channel and preventing accumulation of mud below Teddington Weir.

When the reservoirs at Walton and Staines, authorised by Parliament to be constructed and now in course of construction, are completed, there will be storage for 8,000 million gallons of unfiltered water.

I am not, of course, in this paper, dealing with any other river than the Thames, though, in considering the question from the view of London Water Supply, it must not be forgotten that the reservoirs in the Lea Valley, constructed or in course of construction, have a capacity of nearly 8,000 million gallons.

The present average daily withdrawal of water from the Thames by the Water Companies amounts to 118 million gallons per day, or equal to about 10 per cent. of the average flow of the river.

When we are dealing with the future we come to highly debatable ground; the question of the increase of population is one upon which

experts of equally high authority hold diametrically opposite opinions; the allowance to be made for evaporation and loss incurred by the proposed vast storage areas seems also quite problematical, and a matter for hopeless disagreement between the great authorities on such subjects.

The author deems that his safest course is to adopt the conclusions of the Royal Commission on the Water Supply of the Metropolis, issued as recently as 1899, which were, that in 1941, with an estimated population for Water London of a little over 12 millions, the supply required would be 423 million gallons a day, of which the Thames would have to contribute about 300 million gallons, or roughly about one-fourth of its average daily flow.

Eighty days' storage for this quantity would mean accommodation to be provided for 22 thousand million gallons in excess of that already constructed or in course of being constructed.

The author believes that there is an ample excess of water at times which could be abstracted with advantage to the river to provide for this quantity, and he is of opinion that, if this question were argued solely on its merits, without any reference to any competing scheme, the conclusion arrived at by the general public would be in accordance with the opinion expressed in the report of the recent Royal Commission.

The CHAIRMAN (W. Whitaker), in commenting upon the second paper by Mr. Russell, on "Thames Water Supply and Storage," a description which he suggested should have been altered to "Thames Water Storage and Supply," referred to the statement in the paper "that the conditions and the flow of the water have very much altered during the latter half of the century just closed." He thought how dangerous it was to take statistics of a short period—they must allow for change; things were always changing. Figures were given showing the sudden changes in the flow of the river over Teddington Weir, a point upon which he thought further information was needed.

Mr. R. E. MIDDLETON, M.Inst.C.E. (London), who was unable to attend the Conference, sent the following remarks on Mr. H. W. Russell's paper, "Thames Water Supply and Storage": Mr. Russell states the average flow of the Thames to be 1,128·3 million gallons a day, but this is not the true average flow of the Thames but the average for the last 18 or 19 years, during which period the rainfall has been two inches below the average of 28·5 inches. The true average flow of the Thames at Teddington Weir is approximately 1,450 million gallons a

day. As a check on this figure, the rainfall in the Thames Valley for the year 1897 was 28·06 inches and the run-off was 1,489 million gallons a day, while for five years, with an average rainfall of 29·15 inches, the run-off was at the rate of 1,443 million gallons a day. Mr. Russell says, with a daily flow of 1,100 million gallons a day, there is ample excess to provide storage for London ; it is still more reassuring to find that the actual surplus is much greater than was calculated on. I hope it may be still more reassuring to the public if I state that the Thames is of more than sufficient capacity to supply an average of 400 million gallons a day, and there is water available in the Thames and Lea Valleys and in Kent, without taking into account that which is obtainable from neighbouring counties, for the supply of a population of 22 million persons. I trust I may be excused if I refer, for full details of the supplies obtainable for London and its vicinity, to a paper which I read before the members of the Surveyors' Institution on December 10th, 1900. It is no doubt true that under-drainage does tend to send water to the river more rapidly than would be the case if the drains were absent, but subsoil drainage is much older than 1882, the year when the continuous gaugings of the Thames commenced, and there is no evidence that the winter run-off is heavier now in comparison with the summer than it was years ago. It is true that the Thames does rise very rapidly at times, but several of its tributaries run over clayey land from which the rainfall would run off rapidly under any circumstances, and it cannot be said that there is any difference between the present time and former years in this respect. I do not think there is any reliable evidence for or against the theory that subsoil drainage in the Thames Valley has increased flooding. I am glad to read Mr. Russell's valuable testimony to the improvement effected by the Thames Conservancy in the water of that river.