the search for, and the growing of, rust-resistant varieties have increased annual wheat production by forty million bushels. Better rust-resistant strains than the present ones are, however, being sought.

More efficient utilization of moisture on twenty million acres of arid prairie land is being obtained by developing wheats with low moisture requirements, and by encouraging practices of strip cropping, trash farming and the ploughless fallow. As in Australia, large sums of money have been allocated to the extension of the irrigated area, especially in Alberta. Special attention is being given to the possibilities of extending the present limit of agricultural production northwards, and experimental farms have been established beyond the Arctic Circle. Soil surveys are enabling newly opened land to be used in an efficient manner, and continuous progress is being made in methods of soil conservation and crop nutrition. Weed eradication with hormone weed-killers was carried out on four million acres in 1948. Grassland improvement is being intensively studied, and in some regions the carrying capacity of pastures has been increased three- or four-fold. Together with this, livestock improvement has received considerable attention.

None of the speakers at this meeting knew beforehand how the others would treat the subject, consequently there was considerable diversity in approach. There was, however, general agreement that the present resources of the world, if properly exploited, are more than adequate to feed the present population. The danger is that progress in expanding food production and distributing the products of agriculture may prove to be too slow to avoid widespread want.

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LONDON'S WATER-SUPPLIES

By Prof. H. L. HAWKINS, F.R.S.

AMONG the many problems aggravated by human gregariousness, none is more pressing than that of the supply of water. Life, whether bodily, domestic or industrial, is impossible without a continuous and reliable source of water. Early settlers were, for the most part, influenced in their choice of sites by the ready availability of springs, rivers or dipping-wells. But if the settlement flourished the local supplies soon became inadequate in volume and dangerous in quality. Cities became plague-stricken for reasons obvious enough to us, but mysterious and supernatural to their inhabitants.

The founders of London were more fortunate than they knew in their choice of location, and (to be wise after the event) their descendants were perhaps more fortunate than they deserved. The common suffix 'well' that follows so many names of streets and districts in London testifies to the abundance of springs that served the city and its environs. When, owing to the congestion of domestic and industrial sewage, these springs changed from sources of welfare to cesspools of disease, others remote from populous areas were of necessity exploited, and the water from them had to be transported by conduits or pipe-lines to the region of its consumption. One of the latest of those schemes still functions as the 'New River' in the valley of the Lee. To-day Chadwell Hole, which was the fountain-head of that aqueduct, is more of a swallet than a spring.

When the art of well-boring developed, the vast hidden reservoir over which London was extending was soon discovered. Very many of the early deep wells in the area gave an artesian overflow, for the geological structure of the London Basin, with its impervious seal of clay covering a downwarped mass of porous chalk about 700 ft. thick, is one that might be considered ideal in that respect. Not only is London near the open end of a pitching syncline, but also a series of cross-folds located there bring the Chalk within fairly easy reach, and so shatter its fabric that its porosity is vastly increased.

So saturated was this huge body of Chalk that innumerable springs, some permanent and some 'winterbournes', broke surface along the margin of the clay covering. Practically all those springs are to-day in no better case than Chadwell, nor does any well in the area provide an artesian overflow Over a large part of the district the level of saturation is well below the base of the covering clay, so that the upper portions of the Chalk are virtually dry.

Where natural overflow was insufficient or lacking, it became necessary to pump from the wells, so that, in addition to the drain on current account, the capital reserve was tapped. With no sort of effective control, well after well was sunk, and a tragic game of 'beggar-my-neighbour' ensued. There are now four thousand or more pumping-wells in the Greater London area, sucking out the water from the Chalk at the rate of about 260 million gallons per day. Natural replenishment cannot keep pace with such voluminous and persistent withdrawal. It is not surprising that the marginal overflow springs have failed, and that many of the less deep wells are out of action.

To-day, as in the past, the tendency is to exploit the water resources of the periphery, since the central region has begun to fail. New factories and extended public supplies thus catch the water that was on its way to replace the depleted central supplies, and their heavy pumping tends to produce new areas of depression in the chalk water-level. Even in the far west of the London Basin, the level of saturation is falling; and, although natural causes may be at work in this, the relentless suction of thousands of pumps lower down the syncline must be at least partly responsible.

With the discovery of chemical means of purifying water, the rivers are now tapped to make up the balance of the 568 million gallons required every day in the Greater London area. The Thames, Lee and Stour provide London with about 300 million gallons daily; and, except in seasons of extreme drought, exceed in their contributions the output of the wells. But much of the permanent flow of the rivers is maintained by springs, and these are dwindling with the general lowering of the water-level in the Chalk. Sufficient water must be allowed to flow over Teddington weir to flush the sewage from the estuary; and the Lee is fast becoming so polluted that its purification is approaching the economic limit.

The problem of maintaining and co-ordinating the supply of water to the ever-growing metropolis has been the subject of many inquiries. From the point of view of determination of the resources available, the problem is difficult enough; but in the matter of administration it is profoundly complicated. The expansion of London has involved the incorporation of townships and villages that had already developed their own schemes of water-supply; and many of these corporations and companies continue to function independently. In the early part of this

century some measure of centralization was achieved by the creation of the Metropolitan Water Board; but still nearly all suburban districts are served by their own special undertakings.

The latest inquiry was held before a departmental committee of the Ministry of Health in 1947, and the committee's report was issued a year later. That report endorsed the contention of the Metropolitan Water Board that a central authority should be established for controlling and allocating the water-supplies of London. In the area suggested by the Board (but not wholly accepted by the committee), there are at present no fewer than sixty-five public water-undertakings responsible for providing supplies to areas of very varying extent.

The Metropolitan Water Board has just issued a "Review of the Resources and Consumption of Water in the Greater London Area"* compiled by Prof. P. G. H. Boswell from the technical evidence submitted at the inquiry. The greater part of the evidence is that supplied by Prof. Boswell himself; only those with experience of that sort of work can appreciate fully the immensity of the labour involved in establishing the facts and the difficulty of submitting the results in a concise and intelligible form. This lavishly illustrated review is both concise and readable, and it will be an outstanding example in the succession of reviews that is inevitable in the case of a problem that can never be static. The only material omission seems to be the date of publication; but that can be inferred from internal evidence.

In twenty-one folio pages, packed with statistics but never unreadable, the complete balance sheet of supply and demand, actual and potential, is set forth; and the verbal account is illustrated by ten large coloured maps and three full-page diagrams.

Although the factual data are beyond dispute, the calculations concerning future resources and needs are naturally less precise. One element of uncertainty is inevitable, for it is impossible to foresee the future history of the London area. But the uncertainty as to resources could be lessened if our knowledge of the behaviour of water, above ground and below, were enlarged. The flow of but few of the rivers in and about the area has been gauged; such measurements must be carried out over long periods if they are to become significant; they should be instituted forthwith. Again, our knowledge of the direction, rate and other aspects of the percolation of water through the Chalk is very imperfect, and it can be improved only by long-term research.

The last few pages of Prof. Boswell's review are devoted to suggestions for researches, many of which could scarcely have been envisaged by a water-engineer who was not also a 'pure' geologist. It is a lamentable fact that in spite of more than four thousand borings reaching to the Chalk in the Greater London area, the zone of the Chalk next below the Tertiaries is known in scarcely a score of cases. Without that knowledge the structural features in the body of the Chalk cannot be determined, and those are the determinants of costiveness and permeability. Palæontology, and in particular micro-palæontology, may well prove to be as important for locating water as it is in the case of oil.

It would be unlikely that small, and often competitive, undertakings could finance researches which must be prolonged before any practical results accrue. But when the central authority is established, it may be expected that enough financial patience will be available to instigate such research; as well as, if need be, to embark on the large-scale work involved in bringing water to London from distant sources.

The need for more reliable supplies is urgent, if not desperate. Perhaps, had there been central control during the past fifty years, the problem would not now be so acute; it is a matter for hope and expectancy that its establishment will lighten the burden of anxiety before this century has come to an end.

* Metropolitan Water Board. A Review of the Resources and Consumption of Water in the Greater London Area. By Prof. P. G. H. Boswell. Pp. 23+10 pl. (London: P. S. King and Staples, Ltd.) 10s. 6d.

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THE IMPACT OF SCIENCE ON SOCIETY

DURING the fourth annual conference of the Rationalist Press Association, held at Magdalen College, Oxford, during August 5–9, the main theme for discussion was "Science and Society". In his presidential address, which opened the proceedings, Prof. A. E. Heath (University College, Swansea) dealt with scientific method, as applied to the social field. Referring to the opinion held in some quarters that as soon as we enter the domain of social and political affairs something other than normal scientific procedure is called for, he asserted that science is only common-sense reflexion more critically and more consistently applied, and that any field of human experience can become a science. What makes a study scientific is not the nature of the things it deals with but the way it deals with them. The first step in scientific method is the critical observation of any given body of facts, and the second is the setting out of these facts in some sort of scientific order; then that order is tested and we are led to new facts which in turn have to be ordered, and so on in an endless series. In saying that reflexion upon facts becomes scientific by becoming more critical and systematic, we must not suppose that the change was an easy one; it involved centuries of human struggle. Resistance to scientific treatment was particularly strong in human and social studies because we lack the courage to be critical in matters which come too closely home to our frail human nature. This perpetual struggle to put statements about our experience in testable form is not, however, the end of the story. In the less mature sciences there may still be alternative modes of ordering the facts. Social studies are still at the stage when there are many divergent possible modes of dealing with the same body of facts concerning human behaviour. To pass from J. B. Watson to Freud, or from Jung to Adler, is like moving into different worlds; yet all these psychologists dealt with the same human facts, however different the terms they employed to interpret them and throw them into fruitful combinations. Our trouble in applying scientific method to the social sciences would be overcome if we could realize that novelty is a directly observable fact in the development of men and society. The theory of evolution is a critical step in our methods of thinking because it involves a recognition of novelty in science: if we are to master and direct our world, we must learn how to cope not only with the orderly but also with the novel aspects of the universe, even when that novelty is of our own making. Scientific method can be applied by taking into account the