

tion was started, but the improvement has not been as well marked as the result of the examination of the water after chlorination might have led one to expect. Lastly, there is the possibility that a water previously subjected to chlorination may, for some reason or other, not filter so well as one which has not been exposed to any such treatment.

The 1917-18 results (obtained by chlorination) are slightly better than the 1906-16 averages (pre-chlorination period).

The results during the summer months showed some deterioration, thus helping to bring down the year's average. This may have been due in part to increased consumption of water, and, therefore, increased rates of filtration, but the excessively heavy rainfall during this period must also not be forgotten. The natural inference would be that the flood water, despite chlorination, was to blame, but during, at all events, the worst periods Staines stored water was actually being used, so that this explanation is not wholly convincing. There are puzzling features associated with heavy rainfall which might almost be said to suggest the possibility of some unknown factors sometimes operating unfavorably on the condition of the filtered waters. This might arise, for example, if unpurified adventitious water could in any way reach the supply after its filtration. From source to consumer a waterworks should be absolutely free from the entrance of adventitious water. By adventitious water is meant water which has no real relation to the source of supply. Such water may pierce the armor of the purification works at a number of points. It may be pure or impure, but it is apt to be a secret and most undesirable addition to the supply. Again, January was an unfavorable month from a filtration point of view. Up to about the middle of the month the cold was intense, and this meant running taps, burst pipes, waste of water generally, increased rates of filtration, and practical difficulties in connection with filtration. Later, heavy rain and floods further complicated the position, although here again during the worst period the treatment was stopped and Staines stored water used for supply purposes.

Altogether the year was a trying one, and the works not affected by chlorination showed in their output some falling off in quality. If, as seems clear, more *B. coli* in river water are killed by chlorination than by storage, the presumption is that, given equal chances of purification afterwards, and no fresh contaminations, the former water would be, at all events, not less safe to drink than the latter. Against this must be set the circumstances that storage has an important "levelling" influence or "equalizing" effect. In the present case the chlorinated water is stored in the West Middlesex (considerable storage capacity), Grand Junction (only slight storage capacity), Kempton Park (considerable storage capacity, if in use), and Sunbury (very slight storage capacity) reservoirs before being filtered. It is a sufficiently noteworthy achievement to effect a clear saving of nearly £12,000 a year by substituting chlorinated for stored river water, without attempting to plead that the former process conferred not only equal, but additional security to the consumer.

There is at least one more aspect of the question deserving of consideration. Chlorination might save pumping charges and be satisfactory chemically, bacteriologically, and in relation to health. If, however, the effect of using chlorinated river water instead of stored water led to serious "blocking" of the sand filters, this might be urged legitimately as an objection to the

method. There can be no doubt if Walton or Chelsea stored water could be passed down the Staines aqueduct instead of Staines stored water, the foregoing argument would meet with considerable support, as unquestionably these stored waters filter much better than river water.

Staines stored water, however, is quite different, inasmuch as it develops from time to time the abundant growth of *Asterionella*, *Fragillaria*, *Cyclotella*, etc. On these occasions Staines stored water filters much worse than river water.

In the 1915-16 year the influence of Staines stored water was paramount, the filtration difficulties being acute in the spring and likewise in the summer. It is true that in the spring of 1916 the results were unsatisfactory, but in point of fact this antedates the start of the chlorination treatment. It might be supposed that the winter floods would entirely annul the advantages gained in the spring and the summer. This, however, is not the case, for when the floods are at their worst stored water is again used, and at this period of the year algal troubles are usually at a minimum.

The West Middlesex No. 6 reservoir water shows a widely different result, and the reason is not far to seek. The storage here is considerable; the reservoirs contain the "seeds," so to speak, of past growths, and the effect of the chlorination has been largely lost. In consequence, a redevelopment of growths occurs, although, happily, not attaining the dimensions previously encountered. There would thus seem to be full confirmation of the writer's previous prophecies that probably a chlorinated water would filter best if not stored too long subsequent to chlorination. It is not disputed that in interfering, or seeming to interfere, with the laws of Nature there may be many disappointments, but on the evidence so far available the creation of purely artificial conditions has resulted in the saving of a large sum of money and the partial solution of many filtration difficulties. These results have been attained without inconvenience, annoyance, or semblance of danger to the public.

It is, perhaps, too early to speak of post-war conditions. Presumably the cost of pumping will fall in far greater ratio than the cost of chlorination. Even so, the margin will always be in favor of chlorination, and there the matter may be left temporarily at rest. Perhaps one word of caution should be added, namely, that the problems connected with chlorination and sterilization may appear simple to the inexperienced and irresponsible, but they are nevertheless of anxious moment to those who have had experience in these matters and who carry the responsibility of acting in an advisory capacity. The trite phrase that "matters have now passed the experimental stage" must not be allowed to obscure the fact that few things are so perfect as to be insusceptible to radical improvement.

Super-Chlorination and De-Chlorination

The two great factors which militate against successful chlorination are extreme cold and short contact. Separately, and still more in conjunction, they tend to prevent sterilization, or if sterilization takes place owing to a super-dose, the water is apt to have a chlorinous taste and to contain active chlorine. By a super-dose is meant a dose in excess of what is actually required under more favorable working conditions. It is always best to provide for so prolonged a contact that however cold the water may be, the active chlorine will have disappeared and the water at the same time have been sterilized. In practice, however, for one reason or another, this may