ANALYTICAL TESTS AT WATER PURIFICATION PLANTS.*

THE elimination of unnecessary analytical work is a matter that needs consideration at this time quite as much as the making of the necessary tests. Laboratory practice at various purification plants has shown that many of the determinations which are ordinarily included in the standard water analysis schedule are here of little or no importance. For example, the determination of nitrogen in the usual forms of free and albuminoid ammonia, nitrites and nitrates serves no particular purpose in water purification except in special cases. They neither assist the superintendent in the operation of the filter, nor give any adequate idea of the safety of the filtered water. On the other hand, some of the simpler physical tests, such as numerical determinations of turbidity, color and odor, microscopical examinations and tests for alkalinity, iron and carbonic acid, have come to be regarded as most valuable; and in special cases various other tests, such as dissolved oxygen and manganese. Bacteriological tests are, of course, important.

One step in making an analysis of water has never received half the attention that it deserves, namely, sampling. Of what value is it to use analytical methods of great refinement if the samples themselves are not representative, if the mass of water from which the sample is taken is not homogeneous, or if the water changes in character from one day to another? Samples for chemical analyses are almost never larger than 4 liters (1 gallon); and samples for bacteriological analyses are seldom larger than 100 cubic centimeters (4 ounces), while the quantities actually used for the different tests are still smaller. In counting the number of bacteria, the quantity is less than a thimbleful.

On the other hand, we know that bodies of water are not homogeneous. In a lake or settling basin there are vertical and lateral variations; a river is constantly changing, not only in volume but in the character of the water; filter effluents vary, especially the effluents from mechanical filters where the runs are short and the rates are high. The causes of these variations which affect the results of water analyses through unfair sampling are so numerous that they cannot be studied by themselves, and the only course left is to apply to them the laws of probability, or, in other words, to arrange the data secured in some such way that the importance of the inevitable variations may be indicated and an index of the character of the water examined be obtained.

Thus we see that a question of fundamental importance is that of frequency of collecting samples. The question is, how often must samples be taken to obtain reliable results? As a general proposition it may be stated that the frequency of sampling should depend upon the frequency of change in the character of the water examined. For a water of constant quality, a few samples taken at infrequent intervals may serve to give a fair idea of the water, but if a water be subject to great fluctuations in character, a few samples taken at long intervals might or might not give a fair idea of the water. The reliability of the average result will be determined by the laws of probability. The average result does not tell the whole story, for it eliminates the individual results, and a water supply should be safe and wholesome all of the time.

The frequency of sampling has a limitation, which is controlled by practical and financial considerations. In a small plant the cost of daily analyses would usually be prohibitive, and even weekly analyses might be a burden. It would be recognized, however, that results based on infrequent samples are less valuable than those based on frequent samples; and that irregular sampling gives the most unreliable results. In order to emphasize this point it seems desirable to establish certain grades of control of operation, based upon the character of the records kept, as follows:

First Grade: Water purification plants under first-grade supervision are those where the analyses of the filtered water are made one or more times a day, and where engineering and such other data regarding the operation of the plans as are necessary are collected by one or more attendants constantly employed.

Second Grade: Water purification plants under second-grade supervision are those where analyses are made regularly, say once a week or once a month, by a trained analyst, and where an attendant constantly on duty makes simple daily tests.

Third Grade: Filter plants under third-grade supervision are those where analyses are made irregularly and infrequently, and where no daily tests are made by the attendant.

Sometimes it is difficult to grade the supervision given a plant. As an example, we have the Lawrence city filter, where daily tests are made during five winter and spring months of the year, and weekly tests during the remaining seven months. Here frequent analyses were made during those seasons which were most critical. This might be termed a mixed supervision of the first and second grades.

This grouping should not be considered as necessarily casting a stigma upon second- or third-grade supervision. Some water supplies may not demand first-grade records. In general it may be said that the safer the raw water, the lower may be the grade of analytical supervision. In other words, polluted waters require the purification plant to be operated with a higher factor of safety, and to this end a more careful analytical control is needed. Stored waters are safer than unstored waters, and with them a lower degree of analytical supervision may suffice. A corollary to this would be that small plants which cannot afford high-grade supervision of filters should endeavor to protect the quality of the supply by storage or by incorporating a large factor of safety in the design of the plant.

NOTE—The Committee on Statistics of Water Purification Plants, acting for the American Water Works Association, consists of Geo. C. Whipple, chairman; Robt. S. Weston, Frank D. West, Frank W. Green and E. E. Lockbridge. Blanks have been prepared illustrating the recommendations of the committee regarding the form of report, tests to be made and methods of recording results. These are arranged to show the analytical data by months and years, and are as follows:

Table 1.—Chemical and Microscopical Character of Raw Water.

Table 2.—Turbidity and Color of Raw Water.

Table 3.—Bacteria in Raw Water.

Table 4.—Chemical Character of Water Delivered to Mains.

Table 5.—Turbidity and Color of Water Delivered to Mains.

Table 6.—Numbers of Bacteria in Water Delivered to Mains.

Table 7.—Numbers of B. Coli in Water Delivered to Mains.

*From the report of the Committee on Statistics of Water Purification Plants submitted at the annual convention of the New England Water Works Association, September, 1914.