the results of artificial laboratory experiments with the typhoid bacillus and the cholera vibrio.

In a previous report* it was shown that if typhoid bacilli be added artificially in large number to **raw** river water the great majority of them die within one week. In a future report it will be shown that what is true as regards the typhoid bacillus is equally true as regards the less hardy cholera vibrio. The microbes, then, which are associated with the cause of the two most important water-borne diseases soon perish in river water under storage in the laboratory.

(b) The microbes of water-borne disease are probably never present in raw river water in like number with B. coli.

The probable truth of this statement will perhaps be conceded. However this may be, no pains have been spared in attempting to demonstrate its truth. Thus, in a previous report† it was shown that a prolonged search for the typhoid bacillus in samples of raw river water yielded negative resul's. It is not, however, contended that the typhoid bacillus is never present in river water. What is maintained is that it is unlikely to be uniformly present, unless in sparse number, and that it is never likely to be present in as great a number as B. coli.

(c) The marked reduction in the number of B. coli when river water is stored for a sufficiently long period affords a fair basis for inferring a still more marked reduction (if not the total elimination) of the less hardy and less numerous microbes of water-borne disease.

In Addendum C it is shown that it takes (under laboratory conditions of experiment) on the average ten days for B. coli to disappear from 10 c.c. of **raw** river water (Thames and Lea). Ten days would suffice for the destruction of the vast majority of typhoid bacilli even if these were artificially added to river water in enormous numbers; but it is hardly to be imagined that the typhoid bacillus, or indeed any other microbe capable of causing water-borne disease, could ever be present in river water in greater abundance than B. coli. Even in the serious event of typhoid epidemics occurring at one or more of the towns which discharge their sewage into the Thames and Lea above the "intakes" it is hardly conceivable that the number of typhoid bacilli in any considerable bulk of water in these rivers could ever exceed the number of B. coli. It has already been shown that B. coli is not only nearly always absent from 10 c.c. of the Lea stored water, but that it is frequently absent even from 100 c.c.

It will be understood that I do not confine myself to the B. coli test alone as a method of inferring the "safety change" in river water as the result of storage. By chemical, as well as by additional bacteriological, methods it is possible to correlate the time it takes to effect certain definite changes in a river water under storage with the time required for the devitalisation of pathogenic bacteria in water.

The triple plea in favor of the "safety" of stored water is thus based on:—

(a) Proved 99 per cent. reduction within one week of the typhoid bacillus and the cholera vibrio when **artificially** added to raw river water.

(b) Inferred paucity in the number of pathogenic bacteria in raw river water, both actually and relatively to the number of B. coli.

(c) Proof, that it takes, under laboratory conditions of experiment, ten days (on the average) for B. coli to disappear from 10 c.c. of raw river water, an interval of time more than sufficient to eliminate the great majority of pathogenic bacteria assuming these to be present in the river water. It follows that the absence of the more hardy and initially more numerous B. coli from 10 c.c. of a **stored** water affords inferential proof of the relative, if not absolute, absence of the less hardy and initially (presumably) less numerous microbes of water-borne disease.

(2) The next strongest plea, if valid, would be that stored and subsequently filtered waters are not only safer epidemiologically than unstored and filtered waters, but are in a better condition, chemically and physically.

This, however, is a difficult point to establish for various reasons. As stated earlier in this report sand filters possess what may be called a "reserve of purifying ability" which enables them within certain limits to bring waters of quite different character to the same plane of apparent purity. The subject is really much more complex than would appear at first sight, and in connection with the Water Board's works it is difficult to institute valid comparisons. Perhaps the best plan is to concede the ability of sand filters to deal effectively (in a chemical and physical sense) with raw river water under favorable conditions, and to institute a comparison during periods of stress and storm. A single example may suffice. The New River district derives its supply from the River Lea (high up), and receives as well a large proportion of deep-well water. The East London (Clapton) district derives its supply from the River Lea (low down), and receives in addition only a small proportion of deep-well water. The former district has hardly any storage accommodation, the latter district is well off in this respect.

Between December, 1905, and December, 1907 (both inclusive), the monthly average **color** result for the New River filtered water was during four of these months + 837, + 337, + 275, + 137 per cent. above its own average for the year 1907. The worst four results to be recorded against the Lea filtered water during the same period, either during the same months or separate months, were + 57, + 43, + 36, and + 36 per cent. above its own average for the year 1907.

While, therefore, it may be conceded that when the river water is in good condition the use of stored water may not be essential to the delivery into supply of a physically and chemically satisfactory water, it cannot be denied that during periods of stress and storm the use of stored water is most desirable. Indeed, one of the great advantages of storing river water is its "levelling" effect on the quality of the water eventually reaching the filter-beds. Even if storage were powerless to affect the physical, chemical and biological qualities of **raw** river water, this "levelling" process would be an important gain from many points of view. To take a single example, any sudden accidental pollution of the river water near the "intakes" instead of reaching the filter-beds in a concentrated condition would be so diluted in a storage reservoir as to be rendered (apart from the "time element") possibly, if not probably, harmless.

(3) Next to questions of quality the strongest plea that could be advanced in favor of storage would, if valid, be that of economy.

This question of cost has already been referred to, but here the matter may be considered in a somewhat different light. To deal with it at all it is necessary to start with an assumption. The assumption is that, for purposes of safety as regards **quantity** of water, storage accommodation will have to be provided which will incidentally suffice for purposes of reasonable safety as regards **quality** of water; and, further, that the principle of "active storage" is recognized as sound. If such assumption be granted, then, apart from the increased cost of pumping, etc., consequent on adoption of this principle of "active" as opposed to "passive" storage, and which would not apply to a gravitation scheme, I believe there will be a considerable saving in the cost of filtration under normal conditions. Under normal conditions (e.g., an excessive development of algæ) the reverse might be true; but, in that case, assuming that an **adequately** stored water can be accepted as epidemiologically "safe," I should be satisfied, I think, if such water were passed through mechanical filters at an exceptionally rapid rate with a view to sending the water thus dealt with directly into supply. These mechanical filters, unlike sand filters, can be rapidly cleaned and put into operation again, which would be a great advantage in such circumstances. It is not to be supposed that I have lost faith in the

*Vitality of the typhoid bacillus in artificially-infected samples of raw Thames, Lea and New River water, with special reference to the question of storage (May, 1908).

†The negative results of the examination of samples of raw Thames, Lea and New River water for the presence of the typhoid bacillus, October, 1908.