

him to maintain his organization intact. Further, it benefits him professionally by enabling him to concentrate his practice within a limited field, and thus he has the opportunity of increasing his detailed knowledge along his chosen line; in short, he renders himself more expert. There are many men in consulting practice to-day who attempt to cover such a broad field that it may be frankly said they are not thoroughly competent in any one line.

**Modus Operandi of Expert Supervision.**—For the purpose of illustration and not with any intention of giving a treatise on how to supervise waterworks operations, a brief description will be given of the manner in which expert supervision should work out. Three factors form the basis upon which this work is conducted:—

1. Operation Records, relating to the physical facts connected with waterworks operation.
2. Financial Accounts, relating, of course, to the finances.
3. Technical Skill, which is required in obtaining and interpreting the operation records and financial accounts in such a way that all of the needs of the waterworks plant are fully revealed.

It will be of advantage to inquire a little more fully into these three items and consider them separately.

**Operation Records.**—Records may be subdivided into several groups as follows: Those relating to source of supply, purification works, pumping station, and line distribution system.

(a) *Records Relating to Source of Supply.*—Records relating to the source of supply comprise measurements of the quantity of water available, sources of possible pollution and analyses of the water.

The measurement of the quantity of water available may be made in a variety of ways, some simple, some elaborate, depending upon the character of the source of supply. At any rate, such records are exceedingly valuable in forecasting the adequacy of the source of supply for future requirements. In the southern part of Illinois are two communities, each of which obtain their water supply from an impounding reservoir. During the past summer both of these reservoirs went practically dry, and remained so for some months. In one case no emergency supply could be secured, the community suffered for want of water for ordinary domestic purposes and was left helpless against a conflagration.

In the case of surface-water supplies, the records relating to the condition of the watershed, particularly if the water is used in an unpurified condition, are exceedingly important. Inspections of the watershed, when intelligently made, are much more reliable than analyses in showing dangers to health. It is merely necessary to mention the Plymouth, Pennsylvania, epidemic of typhoid fever in 1885 to demonstrate the futility of analyses in detecting intermittent pollution, such as was responsible for that disastrous outbreak.

Analyses, however, should not be ignored, especially when it is possible to secure a long series of analyses, as they then become a measure of the pollution and give a record of the physical and mineral characteristics of the water. Where purification of the water is employed, such analyses are well-nigh indispensable, as will be discussed later.

It is much easier to give examples of the evil results of failure to maintain proper records regarding the source of supply than to give examples of water famines and other disasters that have been averted by the maintenance of such records. The latter instances are ordinarily not

recorded and the danger is never realized by the general public.

(b) *Records Relating to Purification Works.*—A volume might be written upon this subject alone. Experiences with small filter plants are most disheartening. Practically all of the small filter plants in Illinois, numbering half a dozen or more, are being ineffectively operated. The same is true in Ohio and Kentucky, and, no doubt, in other States. Some of the difficulty is due to bad design. Very small filter plants are apt to embody bad design, whereas the conditions under which they are operated are such that they should embody the very best design.

Expert supervision over mechanical filter plants (those most generally used in the middle west) does not necessarily result in reduced cost because of the prevalent reprehensible custom of omitting the use of coagulant when the raw water is moderately clear, but within the limits of efficient purification the cost can undoubtedly be reduced. The average small purification works is placed in charge of a pumpman or fireman, having many other duties to attend to, and it is but natural that this, combined with his lack of knowledge of water purification, results in almost total neglect. In many instances such men, through ignorance of the danger of impure water to public health, have no hesitancy in by-passing the raw water into the mains when it becomes convenient to do so.

Records necessary for maintaining proper supervision over mechanical filter plants include analyses of the raw and filtered water, the quantity of water treated, quantity of chemicals used, the frequency of washing the filters, the quantity of wash water used, and numerous other details. For obtaining analytical data there should be established, in connection with every filter plant, however small, a modestly-equipped laboratory. It is an easy matter to train any ordinary waterworks employee of normal intelligence how to make simple analytical determinations which will not only furnish the desired records, but will guide the filter attendant in his daily operation of the plant. If the expert has laboratories at his command, additional analytical control may be maintained on a somewhat more elaborate scale.

(c) *Records Relating to Pumping Station.*—A small waterworks pumping station, for which complete records are maintained, is a great rarity. Often it is impossible to get even an approximation of the quantity of water pumped, and generally the only records are from pump revolution counters without any allowance for slippage. It is a comparatively simple matter to weigh the coal and ash, to maintain pumping records both from revolution counters on the pumps and from a meter placed upon the main discharge from the station, and records of the discharge pressure, suction lift, quantity of boiler water used, etc. With such items as these it is possible to always know the condition of the pumps, figure accurately the station duty, and otherwise reveal opportunities for improvement and cutting down the demands on the coal pile. The expert can also arrange, where conditions warrant, for purchasing fuel and possibly other supplies on an analytical basis.

(d) *Records Relating to Distribution System.*—Most deplorable of all are the records ordinarily maintained in connection with the distribution system. The location of mains, valves, and service connections is generally stored in the memory of ex-waterworks employees and local plumbers, who regard these facts more or less as stock-in-trade, and would consider it business suicide to record them. In many towns there is no vestige of