

is not available, lateral drains laid at depths of 12 to 18 inches, at intervals of 20 to 40 feet across the roadbed from the side drains and draining into them, may serve the same end. The problem is to keep the subgrade dry by the use of such resources and material as are available. But if under adverse conditions this is likely to be impossible, the fact should be recognized in advance and provided for in the design of the concrete slab.

## DIFFICULTIES IN THE DESIGNING AND OPERATION OF MEDIUM SIZED WATERWORKS PLANTS.\*

By E. B. Black.

**I**N the early history of the development of the business of furnishing cities with an adequate supply of pure and wholesome water, the cost of such service was necessarily large, as is to be expected in the development of any commercial enterprise, so only those cities of sufficient size, or of such peculiar location that a fair return seemed possible on a considerable investment, could interest private capital in the building of waterworks systems.

The demand for the many advantages a modern water system brings a city comes as a result of education. Gradually the small cities and towns began to demand such improvements, and when private capital could not be interested on account of the limited revenue possible from a small community, special legislation allowed the building of systems by these small cities themselves. It seems now that a town of from 1,000 to 5,000 inhabitants can build a waterworks system, in some sections of the country at least, with as little trouble in financing the proposition as was formerly experienced in towns of 50,000 or 100,000.

Perhaps no other state has made possible the building of public utilities in the same way that Kansas has. With an allowable indebtedness of 15 per cent. of the assessed valuation, and with the assessed valuation taken as the full value of property, it has been an easy matter to vote bonds for the purchase of existing systems or the building of new ones. Three years ago an emergency law was enacted by the state which allowed all cities and towns already owning their waterworks systems to issue bonds for necessary improvements until the total indebtedness of the municipality should reach 15 per cent. These bonds may be issued without vote of the people, the only requirement of the law being the approval of detailed plans, specifications and estimates of cost by the State Utilities Board prior to the issuance of the bonds.

All these things have worked together to stimulate the building of new systems in the small cities and towns of Kansas, and the building of needed improvements in those towns already owning their systems, until now there is a total of about two hundred and fifteen water systems in the state, and about 90 per cent. of the total number are in towns ranging from 500 to 4,000 inhabitants. It may be of interest also to note that not more than a dozen of these systems are privately owned. While conditions in Kansas may have been more favorable than elsewhere in the past for the building of small water systems, such improvements have by no means been confined to that state, and the small cities and towns throughout the country, realizing the benefits coming from the establish-

ment of such systems, have been actively shaping legislation so they also may have water systems.

The design and operation of systems in towns of small size present difficulties foreign to the design and operation of large plants. In designing, the services of an engineer are often dispensed with, and practically never is an engineer retained to advise relative to the operation of the system. This may be on account of the size of the proposition and the desire to put every dollar available into the improvement. Then again, the design may be handled by a concern manufacturing or selling equipment. Admitting the fact that such concerns may have the best engineering talent available, it is not reasonable to assume that other concerns will feel free to bid on their competitor's design; or that the proposal of the designer, if accepted without competition, will be either an efficient or economical one. Many small systems have been built by the contracting engineer. The design and the construction both frequently suffer in such cases. It is difficult for a man to design a system, bid on it with other bidders, and then construct under his own plans, specifications and supervision.

In some systems the poor ideas of the owner or city officials are followed; this is sometimes the case even when an engineer is retained. In going over a sewage disposal proposition recently, plans of the city's sewers were furnished. The engineer who had planned the sewers had evidently suffered from suggestions of various officials; for on one sheet of the profiles was this note:

The number and location of Wye branches and manholes on this sewer were fixed by the city clerk and the plan does not therefore represent my ideas in the matter. Please refer to my letter of ..... date in this connection.

A short time ago a city retained engineers to design a storage reservoir to be used in connection with one already in use. The bottoms of both reservoirs were to be on the same elevation only a few feet from wall to wall, and the water was to be carried in both at the same levels. The superintendent asked that a syphon be used to get the water from one reservoir to the other. He had never built a syphon, here was his opportunity. This reason is probably responsible for more mistakes in construction than any other.

Some of you are familiar with a plant in which the discharge line from the pumps is carried up the outside and over the top of the standpipe supplying the town. This is a scheme evolved by one of the plant engineers, which enables the pumps to operate against a column of water only 10 inches in diameter instead of one 30 feet in diameter, the size of the standpipe. You may have heard of the gravity flow line, the size of which was increased by sections from the upper to the lower end in order to overcome friction.

Some years ago the writer made an appraisal of a privately owned power plant for a town contemplating its purchase. The plant originally consisted of a generator, clutch-connected to a line shaft driven by a water wheel. The time came when the water power was insufficient, so the line shaft was extended and two large gasoline engines belted to it from a single clutch pulley between them; so connected that either or both engines could help the water-wheel. But even then the power was insufficient at times, and at the time the plant was examined a traction engine was belted to the line shaft through a hole in the wall of the power house. The owner was even then looking for more power, and wondering why the plant did not operate satisfactorily. Some one had advised him that all well-regulated plants kept records of ammeter and voltmeter readings. These had therefore been faithfully recorded

\*American Water Works Journal, June, 1916.