

per minute of 12-inch pipe, while for sizes other than 12 inches, the allowable loss is taken in the same proportion as the ratio of the diameters. One drop a second is not much of a leakage, and yet one drop a second from every joint in a mile of pipe would amount to approximately 1,400 gals. in 24 hours.

When the volume of consumption is abnormally high, there is reason to suspect that there are unaccounted for losses, and the best way to satisfy oneself on the matter is to have a water waste survey made.

As an instance of what such a survey may accomplish, I wish to cite the results obtained in a city of some 3,500 people, in which the waterworks is owned by a private corporation. For some years the pumpage had been excessively large. Repeated appeals to the consumers to be more careful brought no apparent relief, and finally an additional source of supply was developed entailing an expenditure of \$10,000. This increased the available amount of water, but the volume of the pumpage in no way diminished, but rather increased. During April and the early part of May of last year the average daily pumpage varied from 680,000 to 700,000 gals. per 24 hours. A water waste survey located a blown-out lead joint in an 8-inch main wasting more than 300,000 gals. per day. This leak occurred under a broken stone-filled roadway, and behind a stone arch bridge at a point where the pipe was 14 feet below the street surface. The water was finding a ready outlet into the creek. Had this waste been discovered and stopped prior to the development of the new supply, the company would have been \$10,000 better off in cash, and would have felt much easier in regard to the adequacy of their supply.

Another instance is a city of 2,000 population. The city operates a motor-driven 400,000-gal. triplex pump. From October, 1911, to June, 1912, it was necessary to operate the pump practically all the time to keep up the pressure, and even at that it seemed impossible to fill a 100-ft. standpipe more than half full. A water waste survey was made and a 4-inch pipe was found cracked squarely in two, permitting a leakage of 200,000 gals. per day, which found a ready outlet in an abandoned 12-inch tile storm water sewer, which crossed directly over the crack about 8 inches above the water main. There was no indication at the street surface of any such leak, though the pipe was laid but 4 feet deep, in fact the ground was not wet 2 feet away from the break. Incidentally I might add that the pump slippage was 25 per cent., leaving a consumption of about 100,000 gals. or 50 gals. per capita per day.

The method of making these surveys was substantially the same in both cases. At a point near the standpipe, an opening was made in the ground down to the main, and a 1-inch corporation tap was placed in the pipe in the usual way. A pitometer, which is a portable recording meter, was set up at this point, and a measurement of the flow during the night when the station was shut down was made. The city was then divided off into a number of districts, and during the day all the valves on the boundary line of the districts were closed, except one, which was left open to supply water to the district. That night after one o'clock this last valve in each district was closed, and the time when the valve went down was recorded. The rule was to begin at the outlying district and work toward the instrument. As each district was closed off from the supply the valves between it and the foregoing district were opened, so that when the night work was finished all the valves would be left open.

A comparison of the time each district was closed down, with the chart from the instrument, disclosed the district in which the loss occurred, for the minute the valve went down,

which cut off the leak, the instrument recorded a drop in the rate of flow from the standpipe.

With the location of the loss in any particular district, it is generally a comparatively simple matter to locate the point of leakage by using an Aquaphone on the fire hydrants and sill cocks of the residences. Sometimes, however, the final location of the leakage is not so simple, and it is necessary to make a subdivision of the district, in this way usually the suspected territory may be reduced to a few blocks at the most.

The subdivision of a district into its smallest units is usually the method required when the losses are from defective plumbing, and in addition it is necessary to make a house to house inspection of the entire plumbing in each building. Carelessness in making proper plumbing repairs seems to be more prevalent in cities where the water is sold at a flat rate, the installation of meters having a wholesome effect on this class of consumers.

Carelessness as to fixture waste and wilful or deliberate waste are like defective plumbing, confined largely to the systems supplying water at flat rates. The sentiment seems to exist that so long as one is paying so much, what is the use of being careful, "We are entitled to all we can get out of the fixtures." This sentiment really reacts against the consumers, for with everyone in the same frame of mind the system becomes virtually a sieve, and of course the pressure is always low, especially in territory some distance from the pumping station. It all comes home to him in case of fire and no pressure.

Where such conditions exist it is sometimes a tedious task to locate and correct such losses, and the only way it can be done successfully is by a minute subdivision of the district, and night tests in the curb cock, together with daylight inspection of the individual premises. The returns in the value of the water saved usually far exceed the cost of doing the work.

Surreptitious or uncharted connections may occur almost anywhere, though they seem to be more frequent in the manufacturing districts of the larger cities. The making of a connection to a city water main by a private person or corporation is, of course, a deliberate intent to get something for nothing. Very frequently such connections are made from the fire service lines, which are extended into the grounds of the individual or company.

Where a survey indicates that there are surreptitious connections, the only way of definitely locating them is to segregate the suspected plant and measure the total amount of water going into the same. This, together with a very careful inspection of the fire lines and legitimate services, will usually produce a solution of the problem. It is needless to mention, however, that such work must be quietly and carefully done that correct results may be obtained.

It is a very unpleasant charge to make, but nevertheless it is true that in many of our cities and villages no record is kept of the location of the house service, and when the top of the curb box gets broken off or covered up, the service is "lost," and in case of repair or an order to shut off the service much time is lost in looking for the old box. In such cases the exact location of the service pipe can be quickly located by the use of a small electrical instrument called "A wireless pipe finder," and with the line of the service located in the ground, the shut-off box can be quite easily located by the use of a miner's compass, or as it is frequently called, a dip needle.

The latter instrument also comes in quite handy in locating street valves on the mains in unpaved streets where the boxes have been covered up by a road grader in crowning or shaping the surface of the street.