The tonnage of traffic is assumed at one-half the number of vehicles, and the annual cost of the road assumed also is conservative and most favorable to the cheaper type of construction.

The cost of a road is essentially an annual cost. Man has not yet constructed any permanent structure and no highway has yet been constructed which, if it is used, does not require annual expenditure for maintenance. This rule applies to the Appian Way and every other road. We have not lost the art of road building, but we have lost the willingness to spend a sufficient amount of money on the road.

A permanent road is a road that is permanently maintained. The cost of a mile of road is the cost per mile of road per year. Too much attention is given to the original cost of construction and too little interest and attention is given to the cost of permanent service. A rational study of the cost of a mile of road must be arrived at by adding the interest on the original investment to the cost of annual maintenance necessary to retain the original structure. This seems all that must be considered as a part of the cost of the road; however, the most important matter to be considered is the cost to the traffic using the highway as affected by the condition of the highway.

TABLE 1—ASSUMPTIONS USED IN CALCULATING THE CURVES IN FIG. 3

Curve	Kind of Road	Cost of Surface only in Thousands of Dollars	Annual Maintenance*	Total Cost per Ton Mile (Dollars)
1....	9′ Gravel	3	y	$(150+y)/182.5y+0.22$
2....	16′ Gravel	5	$0.8y$	$(250+0.8y)/182.5y+0.21$
3....	16′ Bit. Gravel	8	$0.6y$	$(400+0.6y)/182.5y+0.20$
4....	16′ Asph. Mac.	9	$0.4y$	$(450+0.4y)/182.5y+0.19$
5....	9′ Concrete	10	$0.2y$	$(500+0.2y)/182.5y+0.18$
6....	16′ Concrete	18	$0.15y$	$(900+0.15y)/182.5y+0.17$
7....	16′ Brick	25	$0.1y$	$(1,250+0.1y)/182.5y+0.16$

*y = number of vehicles a day (assumed to be ½ ton per vehicle).

The use of the road occasions a cost to traffic amounting to a certain rate per ton mile. The improvement of the road is an economic waste unless a saving is effected by its expenditure as an investment in reducing the cost of the traffic using the road. The cost per mile of road per year should never exceed the reduction in the cost of transportation using said mile of road, made possible by the improvement.

E. H. Harriman is remembered as being a railway wizard as well as a financial genius. He took over unprofitable railways and bankrupt railways and spent millions of dollars on these losing ventures to improve the roadway, reducing the grades and laying heavier rail and building better track. He did not reduce the cost per mile per year of maintaining the track thereby, but he did reduce the cost per ton mile of all traffic using the road, thus transporting the tonnage at an enormous saving, which went into dividends. Yet he was able to accomplish only the small saving of approximately one-half of 1% per ton mile.

The seventeenth annual convention of the American Road Builders' Association will be held at Louisville, Ky., Feb. 9th to 13th, 1920. Both the sessions of the convention and the exhibition will be accommodated in the First Regiment Armory. About 53,000 sq. ft. of floor space will be available.

The United States Navy Department has just increased the pay of its technical employees. The force had been working for over seven months to obtain a greatly needed readjustment in compensation. Their case was handled through special wage boards at the navy yards and a department board.

Dr. C. J. Hastings, medical officer of health for the city of Toronto, favors the construction of another water works intake at that city, declaring that the supply should not be entirely dependent on one intake, as a serious situation might be created in case of certain accidents to the present system.

WATER WASTE CONTROL BY HOUSE INSPECTIONS WITH DISTRICT METERING*

BY E. D. CASE
Vice-President, The Pitometer Co., New York City

HOW to control waste of water in city distribution systems is a problem that is becoming of greater importance each year. The old idea that water should be as "free as air" is now obsolete. The increase in cost of extensions which are necessary if waste is not curtailed, due to high price of pipe, building material, labor, etc., has made it imperative that every water works manager who desires maximum efficiency in his plant, take steps not only to reduce waste to a minimum, but to make such a reduction permanent.

Water waste may be said to come under two general heads: (1)—Underground leakage; and (2)—House waste. While the first item exists to a greater or less extent in all water works systems, it is usually smaller by comparison to the second, especially in unmetered plants. The item of house waste may be further divided into three sub-heads:—(1)—Wilful waste; (2)—Leaking services; and (3)—Leaking fixtures.

Development of Deacon System

The most obvious and effective means of controlling waste of this kind is to place meters on all services. The owner will not run water for cooling purposes in summer, or allow his faucets to run continuously to prevent freezing in winter, if he knows that every cubic foot of water wasted will appear in dollars and cents on his next water bill. Furthermore, when paying for water on such a basis, he loses no time in repairing leaks in his fixtures or services as soon as they make themselves evident.

Unfortunately, however, local conditions make universal metering impossible in a great number of places. Either sentiment is against this method of selling water, or the first cost of installation is prohibitive and the manager must look about for some other method of controlling waste. Fortunately, there is one at hand which when properly applied will prove quite as effective as universal metering. This system may be described briefly as house-to-house inspections under the supervision of a district meter. It is by no means a new idea, as it is simply a development of the "Deacon Meter System," originated by George F. Deacon, engineer of the Liverpool (England) water works. The scheme in general at that time was as follows:—

New Portable Flow Meter

The distribution system was divided into districts by valve operation, and a meter especially designed for the purpose, called a "Deacon Meter," was placed in a vault on the main supplying each district with water. By cutting a block out of the district, or by shutting off the service, the amount of water used or wasted in this block, or through this service, was recorded by the meter. Inspectors were then sent into blocks where flows were abnormally high, and the cause of the high flow located and the leaks repaired.

This system was almost universally adopted throughout Great Britain, with the result that the per capita consumption in British cities at the present time is remarkably low. The accompanying table shows the per capita in some of the larger cities in Great Britain.

The "Deacon Meter System" was adopted by the city of Boston in 1881, with considerable success, but its use did not become very popular in the United States owing to the large cost involved in installing the district meters, also due to the fact that they deteriorated very rapidly and repairs and replacements were constantly needed, which made the cost of maintaining them very high. These drawbacks were overcome about 1900 by the development of a portable flow meter, called the "Pitometer," an application of the principle of the Pitot tube. Practically the same methods were used, but instead of permanently setting a

*From a paper read at a recent convention of the Southwestern Water Works Association.