Waterworks Company. The population of the town in 1861 was 6,810, it is now about 10,000. The Neath Water Company commenced to supply the town in 1863.

Year.	Receipts.	Dividends paid.
1864	£664 9 4	4 per cent. per ann.
1865	656 0 2	4 „ „
1866	659 17 9	4½ „ „
1867	836 17 11	5 „ „
1868	1,067 10 7	6 „ „
1869	1,086 0 5	7½ „ „
1870	1,086 10 4	8 „ „
1871	1,103 15 0	8 „ „
1872	1,222 12 2	8 „ „
1873	1,524 1 11	8 „ „
1874	1,591 2 9	10 „ „

Great Grimsby commenced a supply in 1866. The dividend in 1869 was 6 per cent., and in 1874 7½ per cent. Pontypool, with a population of 10,000, pays 10 per cent. Bristol and Cardiff both pay 10 per cent. Newport pays 8 per cent., being limited by their Act of Parliament.

The value of the Birmingham Waterworks in 1865 was about £400,000; at the present time the market value is £1,010,400.* Yet, notwithstanding these facts, very little of the capital for local companies is subscribed in the places themselves, but by what are termed foreigners—*i.e.* persons without the district—those most eager to invest being shareholders in similar companies.

It has been stated that public authorities have power to lease or purchase waterworks from private companies by agreement. It is thought by many that where it is desirable that public authorities should possess the waterworks the better plan is to purchase them when they are well established and paying a good dividend, than to make the works themselves. In the former case, although they have generally to pay much more than the original cost of the works, yet they are able to borrow money on their rates at a low interest, and the increasing value of the water-rates enables them in ordinary cases to pay off the loan, whereas to construct works they would not receive any income during their construction.

Few, if any, classes of works show more prominently the ill effects of false economy than gas and waterworks. In designing waterworks not only should they be made to give the maximum supply to the present population, but they should be capable of meeting the wants of an increase of at least 50 per cent.; and in some exceptional cases provision for double or more than that of the original number would not be too much. Arrangements should also be constructed so that future extensions may be made with the least possible inconvenience and expense. It is more important to make the works of ample size in gravitating than in pumping schemes, for it is obviously less expense to put down an extra engine and appurtenances than to enlarge the bank of an impounding reservoir, and to increase the diameter of what is frequently a long length of main between the impounding and service reservoirs. The mains also should be of ample size. The value of the old mains when taken up is often little more than that of old iron, and with the smaller sizes it scarcely meets the cost of recovering them. Many companies that have fallen into this error find when they are fairly established and paying a good dividend—perhaps the full 10 per cent.—that the increased consumption of water requires a remodelling of their mains and works at a great cost, and that in consequence the dividends decline to probably the normal 4 or 5 per cent., at which they remain for some time, and it may be for years. Public bodies, acting under the pressure of the ratepayers, or perhaps of their own penurious inclinations, are particularly liable to cut down the cost of works, with a view to borrow as small a sum of money as possible, and therefore to keep down the rates, and hence their failure to maintain efficiently the undertaking. Their reluctance to make any extensions may also be traced to the same source.

* See 'Journal of Gas-lighting,' December 8, 1874.

ADDENDA TO CHAPTER XV.

The Laws and Economy of Waterwork'

Since Chapter XV. has been in print, 'The Public Health Act, 1875' (38 & 39 Vict., c. 55), has been passed. It consolidates the whole of the Sanitary Acts relating to Water Supply, as far as regards England (exclusive of the Metropolis), and the following comparisons, taken from a document recently issued by the Local Government Board, will be of value.

The main object of the Act is consolidation; but certain amendments have been introduced, many of them to clear up doubtful points of construction, and to harmonize the provisions of the various Acts consolidated, and the effect of others is to extend the powers.

The Acts thus consolidated are repealed: and those clauses which refer to Water Supply will be found in Clauses 51 to 70, inclusive; and as to Purchases of Land, Clauses 175 to 178, inclusive; and as to Borrowing Powers, Clauses 233 to 244, inclusive, of the said Act. Those clauses in which any alterations and extensions are made are given below.

Water Supply.

Section 51, in conformity with the recommendation of the Royal Sanitary Commission, requires that the sanction of the Local Government Board should be obtained before any waterworks or water rights are purchased by a Local Authority.

By 'The Public Health Act, 1848,' Section 75, Local Authorities were placed under certain restrictions in the construction of waterworks within the limits of supply of any water company; and a question having arisen whether these restrictions were confined to cases where the company is empowered by statute to supply water, Section 52 removes the doubt, by expressly limiting such restrictions to cases where the water company has acquired Parliamentary powers.

Before constructing any reservoir to hold more than 100,000 gallons, Local Authorities are required, by Section 53, to give notice of their intention by advertisement; and in case of objection on the part of any person interested, the Local Government Board are empowered, after local inquiry, to allow the proposed work, with or without modifications, or to disallow it.

Section 54 confers on Local Authorities the same powers for carrying water mains without their district as they have for carrying sewers, and imposes on them the like restrictions.

Where the Local Authority have constructed or purchased waterworks, Section 55 imposes upon them the obligation of keeping the supply of water pure and wholesome.

The provisions of the Sanitary Acts with reference to the supply of water by Local Authorities having been found in some respects inadequate, Section 55 incorporates the provisions of the Waterworks Clauses Act, with regard to communication pipes, the waste or misuse of water, the fouling of water, and the payment and recovery of water rates. The effect of this incorporation will be to give Local Authorities supplying water the benefit of such of the provisions of the general Acts relating to water companies as are applicable to their circumstances; and in consequence of such incorporation, some of the provisions of 'The Public Health Act, 1848,' have been omitted as unnecessary.

Sections 58, 59, and 60 enable Local Authorities to supply water by measure, and contain such provisions with respect to meters as are usually found in special Water Acts.

In cases where a Local Authority have more water than is required for the supply of their own district, and the Authority of an adjoining district are willing to take the surplus, Section 61 enables the necessary arrangements to be entered into for that purpose, subject to the sanction of the Local Government Board. It is believed that this provision will not infrequently be found useful in cases where a Local Authority obtain their supply from sources outside their district.

Complaints have often been made, that in attempting to enforce a compulsory supply of water to houses in districts where no Local Act is in force, the limited charge, viz. 2*d.* a week, is insufficient to enable a proper supply to be furnished. The Local Government Board are now empowered by Section 62, on the application of any Local Authority, to extend the limit of charge to such amount as the Board may, under all the circumstances of the case, deem reasonable. The same section, by expressly enabling the Local Authority to enter into contracts with a water company, removes certain difficulties which had arisen under the Sanitary Act, where the Authority enforced a supply of water in a district within the limits of a water company.

The Sanitary Acts required the consent of three-fifths of the shareholders of a water company to the transfer of their undertaking to a Local Authority. By Section 63, the consent of three-fourths is required where the company is not registered under 'The Companies Act, 1862,' but in the case of companies so registered the consent must be expressed by a special resolution passed in the manner provided by that Act. The object of this amendment is to assimilate the law to the requirements of the Standing Orders of the House of Lords in similar cases.

The power of Local Authorities under the 50th Section of 'The Sanitary Law Amendment Act, 1874,' to institute proceedings for the closing of polluted wells, cisterns, and tanks, has been extended by Section 70, so as to include the case where the water is used for the manufacture of aerated or other drinks for human consumption. The section further enables proceedings to be taken against the owner as well as the occupier, and empowers the Authority, if an order of justices under the section is not complied with, themselves to carry it into execution, and to recover the expenses in a summary manner from the person on whom the order is made.

Borrowing Powers.

Doubts had been expressed (1) as to whether loans under the Sanitary Acts could properly be repaid by equal annual instalments of principal and interest combined; (2), as to the precise amount required to be set aside and invested annually, when provision was made for repayment of the loan by means of a sinking fund; and (3), as to the mode in which the sinking fund was from time to time to be applied towards the discharge of part of the loan. Section 234 therefore expressly authorises loans under the Act to be repaid by equal annual instalments of principal, or of principal and interest combined; it enacts that where the repayment is by means of a sinking fund, the annual amount to be set aside is to be such as will, with accumulations, be sufficient to repay the loan at the end of the term; and it provides that the whole, or any part of the fund, may at any time be applied towards the discharge of the loan, but until the loan is discharged the interest which would have accrued on the amount withdrawn must be paid into the fund, in addition to the other payments.

Local Authorities are exempted (Section 238) from responsibility to the transferee of any of their mortgages, until an entry of the transfer has been made in the register kept by them; and by the same section a penalty not exceeding £20 is imposed on the Clerk of the Authority if he wilfully neglects or refuses to make any such entry in the register.

The powers of borrowing conferred by the Act on Local Authorities are extended by Section 244 to Joint Boards, Port Sanitary Authorities, Local Boards of Health, of Main Sewerage Boards; and the Public Works Loan Commissioners may make any loan to any of these Authorities in the same manner and upon the same terms as to Urban or Rural Authorities under the Act.

The Public Works and Local Loans Acts.

In connection with the borrowing powers of Local Authorities under the present statute, it is desirable that their attention should be called to two Acts passed during the last session, viz. (1), 'The Public Works Loans Act, 1875' (38 & 39 Vict., c. 89); and (2), 'The Local Loans Act, 1875' (38 & 39 Vict., c. 83).

(1.) The first Act consolidates with amendments the law relating to loans by the Public Works Loan Commissioners; and Section 13 requires that every intending borrower shall send to the Commissioners on or before the 31st of December in every year a statement of the loans likely to be required during the ensuing financial year, commencing with the first of April following; and the Public Works Loan Commissioners are prohibited from granting any loan which has not been included in the statement above referred to, except with the consent of the Treasury, which can only be expected under very exceptional and pressing circumstances.

Although the Act does not come into operation until the first of April, 1876, Section 54 provides that the first statement of the probable requirements of loans shall be sent to the Commissioners on or before the 31st of

December, 1875; Local Authorities therefore who are desirous of borrowing from the Public Works Loan Commissioners will see the necessity of sending in the requisite statements within the prescribed time.

It should be added, that when any loan is advanced by the Commissioners on the security of a rate, Section 36 imposes on the Local Government Board the duty of satisfying themselves that the loan is applied to the purpose for which it has been advanced. The Board are empowered to make with this object such examination as they may think necessary, and to appoint an officer to conduct the examination.

(2.) The Local Loans Act enables Local Authorities to borrow sums which they are authorised to raise upon debentures, debenture stock, or annuity certificates; and Section 26 empowers them when they propose to raise a loan by the issue of securities under the Act to apply to the Local Government Board to authorise the issue of such securities under official sanction, and this sanction will be conclusive evidence that the Local Authority had power to issue the securities, and that the same are in conformity with the Act. It should also be stated that the Act enables Local Authorities to reborrow in the manner prescribed by it any sums required for the purpose of discharging existing loans (see Section 31). This Act comes into force the first day of January, 1876.

CHAPTER XVI.

CONSTANT AND INTERMITTENT SUPPLY.

Intermittent Supply: Characteristic Feature; Reasons for Adopting; Regulation of Service; Complaints against the System; the London Water Companies and the Small Houses; Waste; Purity of the Water; Extinction of Fires. Constant Supply: Definition; Great Advantage of the System; Associated with High Pressure; Liable to be Rendered Inconstant by Mishaps, &c.; Consumption; Cases of Changing from Intermittent to Constant and from Constant to Intermittent; Increase in Consumption with the Present Fittings; Experiments with the Constant Service in London; Great Waste under the Constant Service at Glasgow, Edinburgh, Croydon, Brighton, &c.; Success of Constant Service at Cambridge, Newcastle, Sheffield, &c.; Importance of Strict Regulations; Regulations at Cambridge with regard to Fittings; Rules and Regulations of the Norwich Waterworks Company; Inspection by Waterworks Authorities; the Change from an Intermittent to a Constant System; the Two Systems Compared.

THE characteristic feature of the intermittent system of water supply is that the supply is turned on at intervals only, and the consumer has therefore to provide for his wants by catching and storing, in one way or another, a quantity of water sufficient to last him until the service is again on. This method of distributing the water is adopted partly to avoid the waste which it is supposed would result if the consumers were able to draw *ad libitum* for twenty-four hours of the day, and if the leakages which are almost sure to follow with imperfect fittings under pressure were to continue uninterruptedly. Another reason for adopting this system is, that it can be arranged to admit of the use of smaller mains than would be necessary in a system where the latter are liable to an excessive draught at certain periods of the day, from the varying wants of the consumers. For this excessive draught may be made a tax upon the domestic reservoirs which are necessary under the intermittent system; and the main can thus be left to deliver the water at a uniform rate. This uniform delivery is generally effected by dividing into sections the district supplied by any main, and then serving only one of those sections at a time. In this way is the service in London and many other intermittent-system towns regulated, the water being turned on to the consumer for from half an hour to three hours, and the whole service lasting from about twelve hours in some cases to about sixteen or eighteen in others. The mode adopted in London for regulating the service, although perhaps the most general, is not universal. Many places are served twice a day—for a few hours morning and evening. Waterford and Sheerness, on the other hand, are each supplied only upon alternate days; but this is exceptional; in the majority of cases the service is daily. In not a few towns the mode of supply is regulated by the levels in different parts, the high-service district being supplied for a few hours each day, during which time the supply to the low-service district is shut off. Frequently the high-service districts only are supplied intermittently, the remainder being constantly supplied. In many places the supply is discontinued only for a few hours of the night, no house cisterns being used; while, again, many towns have intermittent service only during the summer months, when the supply is not so capable of meeting the demand.

One of the complaints against this system is the liability of the consumer to be deprived of water through accident, carelessness, or emergency, at least for a time. It is not an infrequent occurrence for the contents of the cistern to be exhausted before the day is over, perhaps from waste caused by some defect in the taps, the water-closet apparatus being out of order—some foreign substance preventing the proper closing of the valve; or water wilfully left running to waste from this tap and from that, or maybe some unusual demand for water in the household; or the ball-cock may be stiff, requiring an adjustment by the hand each time, neglect of which, until it is too late, will deprive the house of its supply for the day. These are evils attendant upon house storage as we find it, but they are not essential to the system; and those of them which are mere matters of mechanical detail could easily be avoided when introducing a system of water-supply into a town for the first time. Those which are brought about by carelessness or wilful motives of waste, should, where they do not entail the Water Companies in expense, be allowed to teach their own moral lesson. So long as the storage-vessels are of sufficient capacity to last the consumer well between the intervals of service, there ought to

be no room for complaint on the score of the quantity accessible to the consumer against an intermittent supply where the mechanical details can lay any claim to efficiency. . On the whole, the cisterns of the existing intermittent systems are of fair and even ample dimensions; the exceptions being confined principally to the poor neighbourhoods, and here the landlords are in the way. Speaking of the New River Company district, Mr. Muir says:—'There are a few groups of houses in very poor localities, which the landlords have left entirely without cisterns, and they have left the poor tenants to depend upon a pipe placed in a court, coming through a wall, where they have to go out and draw the water, which is a most imperfect arrangement.' 'We have no power to interfere in these cases.' There is not a sufficient supply of water to the inhabitants. A very large proportion of houses in the Southwark district are of the poorer class, and Mr. Quick has made several suggestions to the landlords from time to time, but there is always difficulty in getting them to lay out money for the improvement of their cisterns, or storage of water for the poor. One of his suggestions was the use of a cistern as a supplementary supply for the service of all the houses, leaving their present tanks or butts. This plan was communicated to all the vestries in the Southwark Company's district, was approved of, and thought an excellent plan, but no one would find the money ; the expense would be about £7 or £8 for the group of houses. This plan brings vestries as well as landlords into the question, and seems to have been a matter of money, because under Section 27 of the 'Metropolitan Water Supply Act,' churchwardens and overseers, upon seeing that any house is improperly supplied with water, have the power to compel them to take a supply. With respect to this, Mr. Muir says:—'No full action has ever been taken under that clause ; inquiries have been started which have been replied to and met, and an intimation has been given that the Company would use their influence in every way beneficially, in seeing that the clause had operation; but without the thing being adversely used, arrangements have always been made, and the parties have been induced, I believe, in all cases, to put up the cisterns which were wanted; in fact, the clause is not a bad one. The right of putting the clause in operation has acted sufficiently well.' But it must be asked, how often generally, and with what result? Speaking again of the poorer localities, Mr. Muir says:—'In some cases the cisterns are unequal to the supply of the numbers of the occupants of houses, because the supply was originally intended for one family, and there may be often four or five families in one house ;' and he further bears testimony to the great want of cisterns generally in the eastern part of the metropolis. Mr. Morris also says there is very defective provision of cisterns by the owners of the smaller class of houses in the district of the Kent Company. With regard to the introduction of one large cistern for a block of houses, Mr. Simpson says:—'We have several cases of that kind, and it does answer to some extent, but sometimes the parties quarrel, and let the water run to waste. Generally speaking, it is a good mode of supplying houses,' meaning, of course, the houses of the poor. So far, we have asked only whether the consumer does or does not, under the intermittent system, get enough. Scarcely less important is the question—Does he not consume more than he really uses? Most undoubtedly he does. We have already seen that his wilful or negligent waste frequently brings upon him the inconveniences of a temporary drought. But the fear of this is more than counterbalanced by the desire to secure the freshness and comparative purity of the water in the cistern by frequently drawing off its stale contents. Such motives, at least, bring about a careless habit of using water, and moreover suggest the wasting of large quantities, while the water is 'on,' by leaving or fastening open the supply to water-closets and elsewhere during such times. The liability of ball-cocks to get out of order may, and very frequently does, lead to considerable waste by the cock not closing properly when the cistern is full ; on the other hand, the consumer is sometimes by the same cause prevented from receiving his proper supply, which inconvenience he remedies either by fastening the ball-cock down, or removing it altogether. In all these cases vast quantities of water pass uselessly down the overflow pipe—then truly a 'waste' pipe. These are some of the elements which make up the difference between the intermittent-service towns and those constant-service towns where special measures are taken to prevent waste. The remedy for the consumer likely to be occasionally 'short of water,' from causes other than his own carelessness or wilful waste, is to be found, as already stated, in proper attention to mechanical details; and it may be seen that this same attention will also protect the Companies against a certain amount of waste. To protect the Companies from the remainder of the waste—the wilful and careless waste—would require the introduction of appliances, the expense of which, added to that of the large storage vessels necessary with the intermittent system, would scarcely be justified by the end attained. We have now to enter upon the question of purity under the intermittent or house-storage system, and this is viewing the case perhaps in its most important aspect. The cisterns, as a rule, and especially so in the poorer districts, are placed in situations where they are liable to contract impurities of all kinds, close to the water-closets, ready to absorb the noxious vapours rising from those places. Not satisfied with this, a direct communication is, generally speaking, afforded between the closet pans and the cistern by means of the waste-pipe from the latter. Very frequently, too, are the cisterns placed by architects in positions where they are most inaccessible for cleansing, and this is almost as influential a cause of their neglected foulness, as

ignorance, indifference, and laziness. Moreover, in vast numbers of cases, they are without covers, exposed to the sun, the dust, and the smoke, and the stench, and liable to be fouled by the accidental or wilful introduction of foreign matters which need not be here detailed. Vegetation is fostered; and, indeed, the cisterns of the eastern part of the Metropolis, viewed from the railway viaducts which have intruded upon the privacy of so many hundreds of houses in these districts, present the appearance of a series of ill-placed aquaria. 'In some of the poor neighbourhoods,' says Mr. Muir, 'the inhabitants have no cisterns; they store the water in tubs in their bed-rooms or wherever they can, so that the water becomes warm, and polluted, and offensive. This arises from the general bad adaptation of the residences of the lower orders. They have not sufficient back-courts or proper places for putting their water in. The landlords will not erect for them the proper means, and they steal from one another. Their tubs and other receptacles are frequently stolen, and the only way they can store the water is by putting it under their beds, or anywhere they can. It is one of the most lamentable things which can be seen. He (Mr. Muir) would not say that the present system is as bad as it can be, but it could not be much worse.' With regard to the probability of the cistern becoming foul, supposing the people in these poor neighbourhoods had them, he says, 'Even in the houses of the rich they become so.' 'I think that the people who are well off are just as careless in those matters as the poor; we know hundreds of houses where the covers are never lifted for years together.' Dr. Letheby states that 'Very frequently the water is much contaminated by matters which have either fallen into the cistern or have entered by the service-pipe which delivers the water from the main to the cistern. I may give an example of what happened some ten days ago. Some water was put into my hand for examination, received from a cistern in one of the houses of the City, and I found it largely charged with drainage impurity, and upon inquiry I found that one of the service-pipes which carried the water from the main to the cistern passed through a dung-heap, and a little hole had been made in the pipe by oxidation, and the drainings of the stable manure had entered the pipes, and every time this water was delivered to the cistern, that which had oozed into the pipe was delivered to the cistern also. I have found dead animals frequently in the cisterns of the poor, and the water often charged with decomposing organic matters.' As to the accumulations of dirt, generally, in cisterns, he had found, 'Almost always, the bottoms of the cisterns of almost all poor people's houses, unless they are cleansed every month or six weeks, have a deposit of filthy matter. Generally speaking, the cisterns are uncovered, and they are placed in situations admitting of the access of filth of all descriptions.' If they were covered, 'they would take the covers away immediately and chop them up for fire-wood; we do not know how to deal with those cases. The matters falling from the atmosphere would not do very much injury.' 'We have examined the rain falling in London, and also snow, and we find there is a good deal of carbonaceous matter in it, but that would not pollute the water to any great extent; that which goes into the cistern is generally grosser matter than that.' The 'blacks' and dust of London, falling into a cistern, would, if over a long period of time, 'form an accumulation at the bottom of the cistern, but not in the course of a moderate time; in the course of a month or six weeks I believe it would not.'

This question of purity is of the utmost importance. What security for freshness and wholesomeness does storage offer? A daily draining off of the contents of the cistern by the ordinary means would not effect the removal of most of the impurities of which we have been speaking. Almost all parties, rich and poor, are careless as to the cleanliness of their cisterns. What remedy is there for this? The Companies deliver good water into the cisterns, and in them it becomes more or less polluted; this is not the fault of the Companies, but of the consumers. It is the interest of the consumers to keep the water from contamination; it is their concern, but they do not do it, and nothing but a general enlightenment as to the evils arising from drinking contaminated water, and a very strong feeling of the necessity of keeping receptacles for it in a clean state, could make them give the requisite attention, and when will they come to that state of mind and feeling on this matter? Nothing but inspection and the enforcement of penalties in cases where the cisterns are foul can remedy the evil, and then who are to inspect? The Companies lose nothing through their water being spoiled in the cisterns—the consumers do not care.

The intermittent system is considered to present disadvantages in connection with the extinction of fires, as there is a difficulty, at times, to secure a prompt and efficient supply of water. This difficulty, however, is mostly confined to roads or streets in which a 'main' is not laid, for in most towns the 'mains' are constantly charged; and only from the 'services,' or branch pipes supplying subdivisions or districts, is the water shut off at intervals. If the fire occur in a part to which water from a 'main' can be conveniently applied, the conditions of the intermittent system offer certain advantages not to be found where there is no house-storage for general purposes. The advantage is, that the entire pressure may be concentrated to the mains in the locality of the fire, by closing any of the cocks commanding the neighbouring services, which may be open at the time. The houses on these services will suffer no special inconvenience from this unless their cisterns be exhausted and the replenishment of them be due. If, however, the fire occur in a part of the town where a 'service' only

is available, and if, moreover, the service be not charged at the time, the cock which commands the service will have to be opened ; and until all the cisterns on this particular service are filled, the full pressure will not be available for the extinction of the fire. The delay in the arrival of the turncock and the filling of the cisterns is often a considerable loss of valuable time. Thus we see that when the fire supply can be conveniently drawn from a main that is always charged, house storage affords an advantage; but the case is reversed when the supply has to be drawn from a 'service' or pipe by which a district is supplied intermittently. True it is that in some towns even the mains are not always charged, or at least not with the full pressure ; in such cases, the intermittent system stands at considerable disadvantage. On the other hand, the intermittent system is sometimes blamed for a deficiency of fire-pressure in the mains in cases where it is really a question of absolute initial head and not one of hydraulic pressure. This is of course an injustice to the system as such ; for the constant system would under the same circumstances be liable to even greater disadvantages, as we shall presently see, when again referring to this subject.

Before entering upon the enquiry into the working of the constant system, it is as well to define clearly what is meant by 'constant supply' in the sense in which it will be used in this chapter, and in the sense in which it should be, and is generally, understood. Constant supply should be understood to mean not only a supply that is constantly available to the consumer, but one constantly presented by the waterworks at all times of the day and night, and indeed without any reasonably avoidable interruption whatever. In one sense, the system in which large house cisterns are replenished once a day with a quantity sufficient to last the consumer until the water is again turned on, is a constant system; and Mr. Bateman, one of the leading advocates for constant service as it ought to be, recently went so far as to say before a Committee of the House of Commons, that 'the intervention of the large cistern accommodation obtains, in the best houses in London, a supply which is now practically constant.' But this is not constant service by the waterworks, although it may in one sense be a constant supply to the consumer—that is, constant until he has withdrawn the limited contents of his cistern, if he have occasion so to do, after which he must wait until the water is again turned on. Constant supply to the consumer means properly constant delivery by the waterworks—that is, a state of things in which the mains and all other pipes of the waterworks are constantly charged, and the consumer is at all times able and at liberty to draw from them water for his legitimate use. This is one of the great advantages which the constant system is considered to afford to the consumer ; but that which is regarded as the most estimable benefit is the avoidance of storing the water in cisterns and other receptacles where it is so very liable to be contaminated, as we have already seen. It is not here necessary to enlarge further upon the desirability of avoiding even the chance of these evils ; and, indeed, on the ground of the water being more fresh and wholesome, a second thought is not necessary to establish the superiority of the continuous supply over the house-storage system. There are, however, many practical considerations affecting the question, as will be seen directly.

The constant system is frequently associated, in name, with high-pressure service, and as a rule the pressure in constant-service towns is high. To a certain extent, the association between constant service and high pressure is an essential one ; and in order to render this clear it will be necessary to anticipate somewhat the points that must presently be discussed. With a given system of main and distributing pipes, the pressure in the pipes will vary with the volume of water that has to be passed through them in a given time. Under the constant system the demands will be much greater at certain parts of the day than at others. The maximum rate of discharge will in some towns be found to rise to nearly three times the average rate for the twenty-four hours. Now, in towns supplied on the intermittent system, it is customary, as we have seen, to spread the 'service' over twelve or fourteen hours of the day, so that the maximum rate of delivery from the mains is about twice the average. The greater rate of discharge which is thus obtained under the constant system necessitates, *cæteris paribus*, a greater initial head of water; and if this head be not capable of adjustment to suit the draught upon the mains, it will result in a considerably increased and sometimes rather inconvenient effective head in the distribution pipes at the times of the day—and especially the night—when the consumption of water is reduced. If, on the other hand, the initial head be capable of adjustment—as when distributing engines are pumping directly into the mains—the effective head need not be allowed to rise to an undue height. From the foregoing, it may be seen, in high-pressure constant-service towns, unless there be some provision for regulating the pressure such as that just mentioned, it cannot be said that the pressure is constant, although the service may be ; indeed, the service or supply would in such case be rather continuous than constant. And this variation in the pressure, in the case of 'constant-service' towns, is one of the characteristics of the system; in fact, one of its weak points. For instance, in districts of which certain parts are elevated considerably above the remainder, the higher parts are liable to have their effective pressure reduced to a useless amount; indeed, they are liable to be entirely deprived of their supply when the mains are being taxed by rapid consumption

in the lower parts of the district. Under the intermittent system a simple remedy would be found in concentrating the 'services' into the higher parts at certain times in the day; but where it is obligatory that the whole district shall be continuously served, this would be out of the question; so that to afford to the high parts the uninterrupted supply which under the circumstances they could claim, either special arrangements would have to be made for them, or the whole district must be subject to the excessive pressure which the case would demand. Of some other inconveniences resulting from the variations in the pressure of constant-service towns, there will be occasion to speak presently in connection with the extinction of fires.

The constant system is liable to be rendered inconstant by mishaps and irregularities of one kind and another. Should any of the mains or distributing pipes require repair or removal, all the houses depending upon such pipes for their supply must have their supply discontinued until the repairs are effected; and if the consumer be not prepared for his emergency by a temporary storage of water, he will necessarily suffer some inconvenience. In the course of his evidence upon the 'Metropolis Water Bill (1871),' Mr. Muir stated that in the New River Company's district there had been during the past year no less than 2,472 lead-pipe repairs under the roadway, most of which, if not all, would, under the constant system, have necessitated the temporary discontinuance of the supply to from thirty to fifty houses. And yet there do not seem to be any serious complaints on this score from the numerous towns now under the constant system; and this is partly, no doubt, because, in constant-service towns, the services and communication pipes have to be made much stronger, and failures of the kind referred to above are far less frequent. The repairs of communication pipes, of which Mr. Muir seemed to have had an extraordinary number, might have been effected without any inconvenience to the consumers had a stop-cock been inserted at the junction of the connecting pipes with the service, which is a very general practice in constant service towns. But even where it is imperative to shut off the water for the execution of minor repairs, removals, and alterations, these could in most cases be conducted before 6 A.M., when but little inconvenience would be caused.

It has not unfrequently happened that in some towns boasting of constant supply the service has in times of drought been confined to two or three hours of the day, in consequence of the water in store in the reservoirs running short. But this cannot be said to be the fault of the constant system, unless the latter is responsible for an undue consumption of water per head, which remains to be seen; such occurrences are rather due to an over-estimate of the capabilities of gravitation schemes, with which, in most cases, the constant system has been and is associated.

Next to be considered is the question of consumption; and much has at times been urged against the constant system, with regard to the excessive use and misuse which might be reasonably expected where the inhabitants were free to consume water *ad libitum*.

It has been stated in a previous chapter that, under the intermittent system, the consumption averages 20 to 25 gallons per head per day. Of course the consumption will vary with the class of the inhabitants and their habits, and much again will depend upon whether there are water-closets or not. Where water-closets are common, a large portion of the consumption is due to the very prevalent habit of letting the water run with a view to flush the pan and the drains, and thus 'sweeten' them. Of course, no restraint is felt so long as the contents of the cistern are not exhausted before the time for its replenishment returns.

In order to form an idea of the effect of an imperfectly regulated constant service, we will, firstly, review a few cases in which a change has been made from the intermittent system. Mr. Bateman states that in Chester 'they wished to introduce the constant supply, and they gave notice of their intention; but, having taken no special measures to provide for it, the waste was very considerable, and after some time they abandoned it, and they now give a very continuous supply, but they do not deliver during the night. I have no doubt that, if they had been resolute enough, they might, as it has been done in other towns, have reduced the supply, or kept it in bounds, by proper vigilance and determination.' 'Folkestone,' Mr. Simpson states, 'is one of the towns that have gone back to the intermittent system; the quantity of water used when placed at the command of the people without control was so great, that they had not water enough to do it; and in many cases they had good evidence that parties had filled baths three or four times from the taps, and, because they did not like the appearance of the water, they had let it run to waste again, so they came to Parliament, and got controlling clauses, and they gave them a supply for two hours in the morning and two hours in the afternoon.' Much has been said of the increased consumption of water under the constant system, in the metropolitan districts, when trials have been made to compare the two systems. Mr. Muir states that the constant supply could not be afforded, 'as the fittings now are; and I can give an instance from actual experiments lately made in proof of the assertion, that, with fittings as they are now, the consumption would be so much increased that the proper supply of the inhabitants would be quite impossible. Lately, the New River Company placed upon one of their

district mains a meter, and tried what the consumption of water was under the existing intermittent system. It was then found to be something like ten gallons per head, and after a month's trial in this way the supply was left on so as to be what is called constant. The result was that sixteen times the quantity of water was taken under the constant system than had been taken under the ordinary intermittent system.' He also states, in answer to the question as to whether the fittings would be at all capable of sustaining or bearing that constant supply, that 'they would not, because in that case to which I have alluded, of 121 houses on which the experiment was made, eighteen of the lead pipes were burst by the additional pressure that took place during certain hours of the day, and various leakages occurred.' The houses ' were taken purposely of a very average class, the rental being about £36 a year.' As to number of inhabitants, ' we only took an estimate of the number of inhabitants, knowing from experience what is generally the average in houses of that class.' An experiment was made by the Southwark and Vauxhall Water Company in St. George's. It was an experiment made by Mr. Quick, the engineer to the Company, on his own property:—' The second year after the pipes had been properly laid on, they began to fail. The taps were all being destroyed or taken off the pipes, and it became such a nuisance, not only to the adjoining tenants but the adjoining property, that I was obliged to take the pipes away.' Mr. Morris, engineer to the Kent Waterworks, has given the results of some experiments:—' The object of making the experiment was, what the worst would be if the public were at liberty to waste any quantity of water they chose; and for that purpose I placed, in 1857, the town of Woolwich, for six weeks, under constant service, giving them an unlimited supply, to see what they would do. It added to the Company's consumption 1,000,000 gallons per diem, which, spread over the houses supplied in Woolwich, would give them 148 gallons per head per diem.' The parties did not have notice that they were to be on the constant supply system, and it was given for six weeks. In 1856 an experiment was made upon a small block of newly-constructed houses. ' I had an opportunity of applying the constant supply to about twenty houses. I inspected the fittings, and provided at that time everything that I thought was necessary, and placed them under the constant service, with a meter attached to the supply-pipe for the whole. They were under no inspection for the whole of that time; they did as they liked with that water, but at the end of the year I took the meter again, and I found that they had used just upon 2,000 gallons per house per diem, which would give about 285 gallons per head.' ' This was at Morden Grove, Greenwich. They were houses of seven or eight rooms. I should think they were worth near upon £30 per year.' This supply lasted one year. Mr. Morris also carried out some experiments at Plumstead, with similar results. The reader will now be referred to Glasgow. A report was prepared, from careful observations and measurements made by Mr. James M. Gale, in the Gorbals district, in 1850, with respect to kitchen taps and water-fittings generally, and on this report Mr. Bateman makes the following remarks:—

' From these it appears that the average daily waste by 135 families from badly constructed or imperfectly fitting kitchen taps alone, amounted to 108 gallons per family, or 20 gallons per head per day. In one case while one careful fellow wasted nothing, another negligent fellow ran down his sink stone, for no useful purpose to himself, no less than 850 gallons per day. This waste is principally caused by the universal custom in Glasgow of using the common ground-tap, the worst description of tap for water under pressure which can be adopted, and which has long since been exploded in all improved and well-regulated waterworks in England.'

On the 6th of June, three months after the introduction of the Loch Katrine water, Mr. Bateman made the following report:—' I must draw your attention to the present consumption of water, which is increasing so rapidly as to be really alarming, and quite warrants the apprehensions I felt, and the pains I took to guard against it, when writing my report on the city piping, 1858. Referring then to the habits of waste which existed, and to the imperfect state of the fittings, I observed that, should the same state of things continue under a constant supply, and at high pressure, the waste would be enormous, and even Loch Katrine would be found inadequate to meet it.' At the time I wrote this, the consumption on the north side of the river was a little under 13,000,000 gallons a day. In November last, eighteen months later, it had increased to 14,000,000, and in the beginning of March of this year, after the whole of the city, on this side, was supplied with the Loch Katrine water, it was 15,000,000 gallons per day. It has gone on increasing since then, till it now amounts to 18,000,000 gallons per day, being an increase of 3,000,000 gallons per day in three months. The consumption by the city was measured at the Muggdock Reservoir every hour for twenty-four hours consecutively in the beginning of this week. The greatest draught is about 1 o'clock in the day, when it is at the rate of 22,000,000 gallons a day, and the least at 2 o'clock in the morning, when it amounts to about 14,000,000. At this time of the night, nearly the whole of this quantity must be wasted. The total consumption of the city from Loch Katrine and Gorbals together is 22,000,000 gallons a day, being at the rate of 50 gallons per head, and just twice, in gross quantity,

as much as Manchester and Salford take for a larger population.' Upon this statement, Mr. Gale, the resident engineer, was instructed to institute such an examination as would lead to the discovery of the cause of the excessive waste of water. He found that from badly-constructed and leaky taps alone the waste amounted to 7,200,000 gallons per day, equal to 20 gallons per head, the value of which, if sold for trade purposes, would have been about £50,000 per annum.

There are other further particulars as to the great consumption in Glasgow, but a few other places must be referred to. Mr. Bateman describes the waste through waste pipes from cisterns and baths in Edinburgh as enormous and incalculable; the cisterns are generally placed in out-of-the-way corners, where nobody can reach them except a chimney-sweep or a plumber, or somebody like that; they are allowed to run there, the ball cocks remaining on, for weeks and months continually. At Croydon, in May 1868, Mr. Baldwin Latham concluded that water was being wasted at the rate of about 30 gallons per head per day, the total consumption being about 56 gallons per head. In Brighton, Mr. Easton stated that the quantity consumed from 1863 to 1866 had crept up in the following proportions—87, 90, 91, and 98, and that he could only account for the increase by supposing that the inspection was not so good. From a report, dated 1864, in reference to Boston, in America, Mr. Simpson gives the following extract:—'This was immediately carried out' (whatever it was), 'and the result has proved that nearly half the water that has been brought into the city has been wasted. For the first ten days, and including about one-third of the city, there were reported 531 cases where water was running to waste, and 1,353 cases where fixtures were out of order, and water was leaking on that account;' and there is a great deal more of that kind. 'This shows a consumption of 97 gallons per head, an amount believed to be without parallel in the civilized world.'

What do these extracts on waste show? Do they show that there is in this system any positive radical defect, any insuperable obstacle to its application? Are they not rather all instances of want of proper fittings, of proper supervision, and, in some instances, of want of legal powers to control. With respect to the experiments made by the London Companies, they were made (with the exception of the one in St. George's, Southwark, where Mr. Quick states that the pipes had been properly laid) without any precautions for security against waste, and they simply show the enormous increase of waste, under the same given condition as to fixtures, when the water is running all the twenty-four hours instead of, say, two; and, in fact, the enormous increase of the loss from all the causes previously contributing to the waste, principally the water-closets, as, improper fittings, carelessness, abstraction of water for the purpose of watering gardens and for other purposes.

Let us now see what may be actually obtained with regard to consumption in constant-service towns.

It is essential to give detailed evidence as to quantity, as the opponents to this system insist that the waste must be enormous with constant pressure. So it is without proper precautions, but a few facts as to what can be done with them will soon show how really economical it is. Mr. Bateman gives the following facts, for which he says he is indebted to Mr. Tomlinson:—'In Cambridge, where the supply has always been constant, but where precautions against waste were neglected till recently, the following facts are exhibited. In the first half-year of 1865, at which time no preventative measures had been introduced, the gross consumption per day was 31·2 gallons, and the domestic consumption, after deducting water sold for trade purposes, 23·1 gallons per head. A house-to-house inspection was then carried out—all bad cocks were replaced by those of the best construction, and water fittings of every description were put into proper repair. The result was that in the first half-year of 1866 the gross daily consumption was reduced to 19·56 gallons per head, and the domestic consumption to 11·1, being less than one-half of what had previously been obtained.' Referring to Newcastle, where in some of the districts the consumption amounted to as much as 80 gallons per head per day, Mr. Muir says:—'In order to stop so flagrant a waste we set on a staff of men to examine every water-closet and tap, and report them, leaving a notice that if not put in order within three days, the supply would be stopped. After the lapse of three days, another set of men followed, inspecting only those places reported as leaking, and shutting off the water where the notice had been disregarded. In this way we stopped an immense waste, the effect being immediately apparent in increased pressure throughout the town. But that measure was only for a temporary purpose, and could not be relied upon to effect any permanent saving, and for upwards of twelve months we have been going on systematically replacing the present water-closets with Guest and Chrimes' double-valve cistern, and Thomson and Murray's valve cistern, neither of which can be propped to cause a continuous run. In this way, we have reduced

'No. 3 district from 55 to 34 gallons per head.
5 „ „ 60 to 39 „ „
6 „ „ 61 to 25 „ „
7 „ „ 62 to 26 „ „'

When the town of Sheffield was first put upon the constant supply, the consumption rose from 21½ to 40

gallons per head per day. Proper regulations have now reduced it to a total of 29 gallons per head, of which 3 gallons are for trade purposes.

'It appears,' says Mr. Bateman, 'that in the manufacturing towns of Lancashire and Yorkshire the consumption is from 16 to 20 or 21 gallons per head per day for all purposes, including trade, and of course all the waste that is taking place. In Manchester the quantity consumed by about 600,000 persons, and by the trades demanding water within the district supplied, varies from 12 to 13 millions gallons per day. Of this quantity it is estimated that one-third is supplied to manufacturers, leaving the net quantity consumed for domestic purposes, including waste, 14 gallons per day. The experience of Preston, Blackburn, Bolton, Stockport, Halifax, Warrington, and almost all the other towns in the North of England, is nearly identical with that of Manchester, and if this be compared with the consumption in towns supplied under the intermittent system, it will be found that scarcely in any case does the supply fall to so low a point as under the constant system.' 'We have shown that in the manufacturing towns, with an unlimited and unstinted supply, 14 gallons per head per day are all that are taken for domestic use. In Preston, careful observation and measurements, continued during many years, proved that 10 or 11 gallons were sufficient, but in these towns generally the number of water-closets is small.' The latest returns* give for Leeds, 23 gallons per head per day, being 18½ for domestic and 4½ for trade purposes; Manchester, 14 for domestic and 7 for trade, or a total of 21 gallons per head; while Norwich is satisfied with a total consumption at the rate of only 14½ gallons per head per day, being 10·8 gallons for domestic and 3·7 gallons per head for trade purposes.

Thus we see that, while without proper and strictly enforced regulations as to fittings, &c., the constant service entails enormous loss by waste, quite unknown to the intermittent system, with such regulations, on the other hand, an advantage is gained, in point of reduced consumption, to which the intermittent has not yet been able, perhaps indeed could not be made, to attain. The case of Norwich is truly a most exemplary one, and prominently shows that economy may be effected under the constant system.

We must now enquire into the nature of these regulations which we have seen to yield such favourable results. In point of detail, they naturally vary for different places, but they are framed on common general principles, which Mr. Tomlinson, writing from Cambridge, epitomizes as follows :—

'Proper sizes and weights of lead pipe, tinned inside, if desirable, and laid at proper depths. The best ball-cocks, screw-down stop-cocks, and draw-off cocks, made to gauge, and tested.

Waste-preventing cisterns for water-closets, with stated sizes of down-pipes and spreaders satisfactorily fixed.

No waste-pipes to cisterns allowed, unless in a position where, any waste occurring, the closet could not be used, or where the waste would be annoying and easily observable.

No connection to be made with any fittings until examined and approved by the Company's representative.

All supplies, where there is a liability to waste water, to be served by meter.

The Company to execute any work and repairs desired by their customers, plumbers also being allowed to do work under the Company's regulations.'

First, with regard to the strength of the pipes. The full pressure from the mains is constantly upon them, and at night, when there is but an insufficient draught from the mains, they are subject to the entire hydrostatic pressure from the service reservoir. Should these pipes burst in the houses, not only would there be a considerable waste, but, what in this case is more important, the consumer would be subject to an inundation, the consequences of which would be inconvenient if not disastrous, so that in this regulation the interests of the consumer are as much guarded as those of the waterworks.

Some of the waste and other inconveniences resulting from the employment of inefficient ball-cocks in cisterns have been already noticed in this chapter. That this part of the domestic water apparatus should have its liability to derangement reduced to a minimum is an obvious necessity, if the water is to be constantly on, and economical results are aimed at. The same may be said of all the other cocks in the house. To the common ground plug-tap, which ought long ago to have been considered obsolete, there are numerous objections. It is liable to become soon leaky, partly from the unavoidable intrusion of grit which chases grooves in the plug, thus affording the water an 'illegal' means of escape. The only way to repair it is to have it re-ground in; whereas the screw-down tap is set right in a few minutes without any difficulty. But perhaps the most serious objection to the ground-tap is that it can be instantaneously closed; and the column of water in the pipes, moving in all probability at a very high velocity, being suddenly arrested, its *vis viva* must be expended somewhere—on the pipe, of course, which is thus but too frequently ruptured by the sudden strain. With the screw-down tap, on the other hand, it is impossible to arrest the column of water otherwise than gradually.

* Evidence of Dr. Pole, 'Metropolis Water (No. 2) Bill, 1871.'

The remaining clauses speak for themselves. To allow to the consumer the means of running to waste a constant stream of water under high pressure, simply with the view of flushing soil-pans and drains to correct a nuisance which ought not, and, with proper arrangements, would not, exist, would be simply suicidal on the part of the Waterworks authorities, as some of the experiments recorded in an earlier part of this chapter show. In the kitchen or the scullery there are no such inducements for waste, and nothing but the most wanton and vicious motives would permit its continuance. The waste-preventing cisterns here referred to are not for storage, but are simply regulators, as it were, and of course have nothing to do with the supply drawn for drinking, culinary, and general domestic purposes—which is drawn direct and fresh from the mains.

The following are the regulations now in force at Norwich *in extenso*:—

CITY OF NORWICH WATERWORKS COMPANY.

RULES AND REGULATIONS.

1. The Company will, at their own cost, lay down and maintain all the lead or other branches extending from their main to the side of the public highway in which such main is situate; and will, at their own cost, carry the pipe through the frontage wall (if there be one), and six inches beyond, or otherwise equivalently allow fifteen inches in length for the owner's or occupier's plumber to connect his work to.

2. The owner or occupier must, at his own expense, lay down and maintain all the pipes and apparatus upon his premises, or for his use, and of the strengths and descriptions, and subject to the rules following, that is to say:—

A. Such pipes must, unless otherwise agreed, be of lead, and of not less than the following weights, namely:—

⅜-inch	5 lbs. per yard.
½-inch	7 „ ditto
⅝-inch	9 „ ditto
¾-inch	11 „ ditto
1-inch	16 „ ditto
1¼-inch	22½ „ ditto

Note.—Owners and occupiers, before laying on the water or making alterations in their apparatus, are requested to inquire at the Company's offices the sizes of the pipes proper to be used, that such sizes may be duly proportioned to the pressure of water in the Company's mains in the district, and thus useless expense be prevented.

B. The drawing (bib) stop and ball-cocks must be strong and of hard brass, and the better to secure water-tightness, of the kinds from time to time sanctioned and approved by the Company; and unless and until due notification to the contrary, the drawing-cocks must be of the best and now approved kind of those called 'screw-down cocks,' as manufactured by Messrs. Guest and Chrimes, and Messrs. Stock Brothers and Taylor, with leather faces, not liable to turn on the seat; and in courts of houses and other exposed places, must be protected by an iron casing, and be made to open with keys; and the ball-taps must be of the best and now approved kind, as manufactured by Messrs. Lambert and Sons, or by Mr. George Watson. Till otherwise notified, no other description of cock must be used without previous and express permission of the Company.

C. Every cistern must be absolutely water-tight, and be provided with a ball-cock and proper means of access and inspection, but must not have an overflow or waste pipe; and if any such should exist, the same must be removed, or effectually and permanently closed before the water is turned on; but nevertheless, as exceptional instances will occasionally occur, in which it will be necessary to provide against the possibility of over-filling, the Company will, in such exceptional instances, allow a detective or warning pipe to be attached to the cistern, provided that in every such case a written consent must be first obtained from the manager of the Company, stating the fact of such consent, and the position in which the detective or warning pipe must be fixed; and in every such case the work must be executed under the immediate superintendence of an officer of the Company, and in manner stated.

On no account whatever can the water of the Company be allowed to communicate with any cistern or place intended or used for the reception of rain-water.

D. *Water-Closets.*—Every pan-closet must be provided with a full and complete apparatus, comprising a ball-cock and a service cistern, fitted with a boot or division to be carried as high as the top of the cistern, and capable of containing not more than one and a half gallons of water when filled within three inches of the top, and two proper valves so arranged as to let down not more than one boot or division-full of water at each pull, or be capable of allowing the water to run to waste either by intention or neglect, and must also have a down pipe of lead from the cistern to the basin of not less than 1¼-inch in diameter, and weighing 9 lbs. to the yard run; and a proper basin, scatterer, weighted lever, pan, trap, and other appliances, needful to prevent such water-closet from becoming a nuisance, and thereby inducing an undue consumption of water; and the valves must be worked by brass rods instead of by wires or chains, Every self-acting or pull-down water-closet must be of a description approved by the Company, and must have either

a lead cistern similar to a pan-closet, or a double-valve cast-iron service-box, of a kind approved by the Company, and fitted with a proper cover to screw on, and internal apparatus in all respects similar to that of the boot of the pan-closet above described, and a similar down-pipe of lead or cast-iron, and must have a proper wide rim flushing basin and trap of a kind approved by the Company. No wire will be allowed to be used in the construction of these water-closets.

The cast-iron double-valve service-boxes must be provided with a ball-tap of the approved kind, and of half an inch diameter where the pressure is less than 40 feet effective head, of three-eighths of an inch diameter where the pressure is less than 70 feet effective head, and a ball-tap of a quarter of an inch diameter where the pressure is more than 70 feet effective head.

Note.—No pipe will be suffered, under any pretence whatever, to communicate directly with the basin or tap, or otherwise than with the cistern or service-box of a water-closet or soil-pan, and the same shall be so constructed and used as to prevent the waste or undue consumption of water, and the return of foul air, and other noisome or impure matter into the mains or other pipes of the Company.

E. Every bath must be constructed without an overflow or waste pipe, and must be provided with a well-fitted and perfectly water-tight apparatus, to prevent the water from flowing into and out of the bath at the same time.

F. No pipe must be laid through, in, or into any slough, drain, ash-pit, manure-hole, or other place, from which, in event of decay or injury to such pipe, the water of the Company might be liable to become fouled, or to escape without observation, or without occasioning the necessity of immediate repair. In every case in which any such slough, drain, ash-pit, manure-hole, or other place as aforesaid, shall be in the unavoidable course of the pipe, such pipe shall be passed through an exterior cast-iron pipe or box of sufficient length and strength to afford due protection to the water-pipe, and so bring any leakage or waste within the means of easy detection.

G. Every pipe and apparatus laid and fixed by or for the use of the consumer must be inspected by an officer of the Company before it is connected with the Company's works; and, if found not in accordance with the Company's regulations, must be forthwith removed or altered.

H. Every meter (unless otherwise specially agreed) must be provided with a separate distinct inlet pipe leading from the main or other pipe of the Company, upon which inlet pipe no stop-cock, or other outlet, leading to or connected with the premises for the supply of which such meter is fixed, will be permitted.

3. The water supplied must not be allowed to run to waste, either wilfully or by neglect, nor must it be used for any other purpose, or to any great extent, than shall have been agreed for.

4. No pipe must be attached to the works of the Company, or to any pipe or apparatus connected therewith; nor must any alteration be made in any existing pipe or apparatus without due notice being given to, and the consent of the proper officer of the Company being first obtained.

5. The supply and use of water for the purposes of trade and manufacture must be open to inspection and admeasurement whenever required, and such information must be from time to time afforded as will be sufficient to enable the Company to obtain a satisfactory account of the quantity of water actually consumed, and of the pipes, cocks, cisterns, and other apparatus and conveniences for delivering, receiving, and using such water.

6. The Company will, if and when so desired, execute all kinds of plumbers' work connected with the supply of water to their tenants, but are nevertheless desirous that the private business of the consumers of water shall be open to all the plumbers of the city; as, however, it is essential to the protection of the interest of the consumers, as well as of the Company, that such work shall be well and strongly executed, and that the directors of the Waterworks Company shall possess a full and satisfactory knowledge of the state of the undertaking in all its departments, it is announced that no plumber or other workman will be allowed to do or perform any work connected with the supply of water, till he shall have been admitted, enrolled, and published by the directors, as 'an authorised waterworks plumber,' and shall have entered into a written engagement to conform to and comply with the rules and regulations of the Company in relation to the construction and management of the works and fittings to which such rules and regulations shall from time to time apply; and all responsible master plumbers, on expressing their willingness to comply with such rules and regulations, will be admitted immediately on signing an undertaking to that effect. If at any time afterwards any such plumber shall be found guilty of wilfully breaking or evading the said rules or regulations, either by himself or his workmen, or shall refuse to communicate any information required of him, in regard to any work done by him or his workmen, or under his superintendence, or on his responsibility, his name will be erased from the list of 'authorised plumbers,' and will be forthwith advertised as having been so struck off.

7. No person is to be employed in or about the Waterworks, or any pipe or apparatus connected therewith, who has not been admitted 'an authorised plumber,' or whose name shall have been struck off the list as aforesaid.

8. The Company shall pay a reward of twenty shillings to any person who will give such information as shall lead to the conviction of any person who shall fraudulently attach any pipe or pipes to the pipes of the Company, or to any pipe, cistern, or apparatus connected therewith, or to or into which the water of the Company shall flow or proceed; or who shall fraudulently use or misappropriate the water of the Company, or who shall knowingly permit the same to be fraudulently used or otherwise misappropriated.