Analysis of the evidence in favour of the constant supply system : given before the Health of Towns Commissioners, with remarks thereon / by Thomas Wicksteed.

ANALYSIS

OF THE

EVIDENCE IN FAVOUR

OF THE

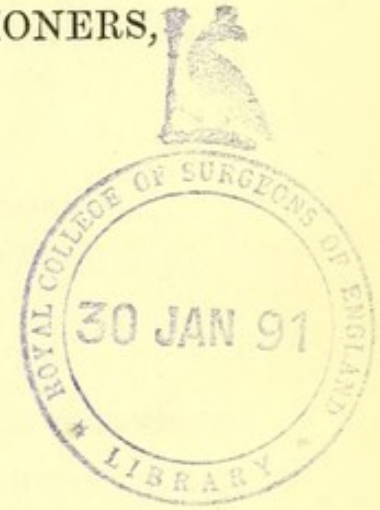
CONSTANT SUPPLY SYSTEM,

GIVEN BEFORE THE

HEALTH OF TOWNS COMMISSIONERS,

WITH

REMARKS THEREON.



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CONSTANT (?) SUPPLY SYSTEM OF WATER.

To the Chairmen of the Water Works Committee of the Corporation of Hull, of the Directors of the Wolverhampton Water Works, and of the Directors of the Liverpool and Harrington Water Works.

OLD FORD, NEAR LONDON,
March 25, 1846.

GENTLEMEN,

Having been called upon at different periods by your Boards to report upon the advantages or disadvantages of the system of constant supply, and finding that the notion of constant supply, as applicable to *all* Water Works, is still very prevalent, it has occurred to me, (the limits of a report having hitherto restricted me to a mere expression of my opinions,) that something more is required; I have, therefore, taken the liberty of addressing you, and propose in the following pamphlet, not merely to give my *opinion* only against the universal adoption

of a constant supply, but to analyse the published evidence of its advocates; and thus I trust prove it to be so contradictory, that no reliance ought to be placed upon it. In doing so I shall endeavour to avoid personality; and am perfectly aware that my *published* evidence, as an advocate of what is termed *intermittent* supply, (but which I contend, practically approximates more closely to a *constant* and *equal* supply than what is termed "constant supply,") is also open to analysis and comment.

In adopting this mode of addressing you, I shall have to go over the same ground that I have travelled before in addressing your respective Boards; but I have thought it better to publish the following remarks as emanating from myself, than, by addressing it as a report to either of your Boards, give the impression to the public that they might be considered as partizans of any particular system, and thus lead to the assumption that they were not open to listen to any proposition which might benefit the public, to whom they are bound to give every advantage that *improvements* in the mode of supply will enable them to do.

In order to a clear understanding of the point at issue, I will shortly state the advantages of the mode hitherto adopted for the supply of water, and the disadvantages of the mode proposed by the advocates of a constant supply.

The advantages of the first-named method are—

1st. Its practical convenience, tested by long experience.

2nd. The provision of an equal distribution of water throughout all districts, however extensive, or however great the inequalities of surface.

3rd. The power of concentrating the whole force of water at one spot in case of fire.

With regard to the second, or constant supply, I contend—

1st. That its adoption would be attended with an enormous additional expenditure, and with so many practical difficulties, as to render it almost impracticable except in the case of *small level* towns, and that the evidence in support of it is insufficient and contradictory.

2nd. That the advantages claimed for it, do not exclusively belong to it, but can be more surely and more economically realized by the present plan.

It is scarcely necessary to mention that the chief cause of the attention which the question has excited, exists in the prominent position which is occupied by it in the Report of the Health of Towns Commissioners, and that whatever evidence can be found in support of it, or whatever arguments can be brought forward to establish it, must be sought in the evidence obtained and published by the same Commissioners. The shortest mode of arriving at a fair conclusion, will, therefore, be to examine the evidence and arguments before referred to, and if I can prove the soundness of my reasons against the plan, from an analysis and examination of the reasons alleged in favour of it, no objection can be raised against the fairness of the mode, and no question can be urged against the soundness of the premises. It should be premised, that, however zealously the

Commissioners have laboured to draw from the witnesses a good case for the "constant supply" system, and however strongly their favourable disposition towards it is developed, yet it is entirely omitted from those portions of their report which are printed in italics, *as their recommendations*, i. e. as the result of the varying evidence that had passed before them, and as the dicta which, under all circumstances, they consider it *safe* to issue on *their authority*.

Now in making a comparison as to the *cost* of any article, the *quantity* forms an essential element, and it may be well to show here, though not perhaps strictly the place for it, the quantity of water given per house where the constant supply is in operation—and the quantity given per house upon the plan which the adoption of that system would supersede.

Constant Supply.
Gallons per house per diem.

	Gallons.
Nottingham (80 or 90 gallons) say	85
Preston	76
Greenock, 2 cub. ft. per individual, say per house	80
3)241	
Mean supply	80

Intermittent Supply.
Gallons per house per diem.

	Gallons.
New River	129
East London	153
Grand Junction	213
3)495	
Mean supply	165

The above comparison will show, that either the tenants under the constant supply system, receive a very stinted supply, or that the water available for

cleansing sewers and for public purposes, must be lamentably deficient, where that plan prevails.

That this is a fair inference, the reports of the Commissioners show, in answer to the questions forwarded to various towns by the Commissioners, as to the state of their sewerage.

Nottingham says,—

"Inferior parts neither drained or paved."—"Sewers very defective and unsystematic." "No local regulations." "No service of scavengers—the *poorest* parts entirely neglected." "Refuse of courts and alleys allowed to accumulate."

Preston says,—

"No regulations, drainage very insufficient." "There are sewers in *some* streets." "The house drains are few in numbers." "There are many stagnant pools which evaporate or are absorbed by the subsoil." "The courts and alleys and undedicated streets, are *not* cleansed."

If these towns had been well provided with sewers, and a good system of drainage, the *demand* for water would have been much greater; as they are, a greater quantity would be injurious, rather than beneficial.

Great stress is laid upon the *saving* to the poor tenant which would be effected by the absence of the necessity for providing butts or tanks. Now it appears that a wine-butt holding 100 gallons, will cost 17*s.* 6*d.* or thereabouts, and if 5 per cent. is allowed for repairs, and 5 per cent. upon outlay, this will amount to 1*s.* 9*d.* per annum, *and will represent the actual saving*, as the cost of pipes, cocks, &c., will be on the constant supply plan, at least equal to that on the present plan.

In reply to Question 5,872, as to what the extra cost of the proposed mode of supply would be per tenement weekly, in the Southwark district, the answer is, "three-halfpence weekly in addition to what they now pay."

In reply to Question 5,877, it is stated that the present average charge for a tenement of 2 rooms is 6*s.* per annum: from this it would appear that 6*s.* per annum is the charge for the present supply, and that 12*s.* 6*d.* would be the charge for the proposed supply instead of 7*s.* 9*d.*; namely, 6*s.* rate, and 1*s.* 9*d.* annual cost of tank.

In reply to Question 5,504, it is stated that the charge for water at Hyde, near Manchester, for labourers' houses, (320 in number,) is 3*d.* per week, or 13*s.* per annum, being a charge of 20 per cent. upon the rental.

In Dr. Lyon Playfair's Report, given in the Appendix to the Report of the Commissioners, Part 2, he states that in Liverpool, the cost of supply to the lowest class of cottages is 5 per cent. upon the rental, and in Manchester and Salford 5*s.* per annum. In these towns the proposed mode of supply has not been adopted; but in Preston, Bury, Ashton, Rochdale and Oldham, where it *is* in operation, the cost of supply for the same class of houses is respectively 7*s.*, 12*s.*, 6*s.*, 10*s.*, and 12*s.*, being an excess beyond the former rate, of from 20 to 140 per cent.

Thus the comparative cost of water in the foregoing towns will be as follows:—I have added 1*s.* 9*d.*

per annum to the annual rates in the cases of intermittent supply.

Constant Supply.

	s.	d.
Southwark	12	6
Hyde	13	0
Preston	7	0
Bury	12	0
Ashton	6	0
Rochdale	10	0
Oldham	12	0
7)	72	6
Mean rate	10	4

Intermittent Supply.

	s.	d.
Southwark	7	9
Liverpool	6	9
Manchester and Salford	6	9
3)	21	3
Mean rate	7	1

Or, the *constant* supply in these towns costs 45 per cent. more than the *intermittent* supply in the other towns quoted.

Mr. Anderton, of Preston, states in evidence, that, taking one house with another, the cost of *tanks* is about £2 per tenement, so the cost upon 5,300 tenants at Preston, if they had had tanks with their necessary appurtenances of balls, &c., would have been £10,600 instead of £1,590, as by their present arrangements.

And again, that 80 cottages belonging to Mr. Smith cost, in taking in water according to their present arrangements, £24; but if tanks, balls, &c., had been used, the cost would have been £160.

According to these statements it is made to appear that each tenant would have to pay for fittings, (allowing, as before, 5 per cent. for capital, and 5 per cent. for wear and tear,) 4*s*. per annum for the

intermittent, and only $7\frac{1}{4}d.$, per annum for the constant supply.

At Question 5,220, Mr. Hawksley, of Nottingham, states that the expense of the tank or butt will, *in general*, be more than half the tenant's expense, considered *exclusively of the cost of the communication-pipe used in the street.*

At Question 5,222, he says the cost of each of the Company's branches (communication-pipe used in the street) may possibly average 15*s.*, but this may be reduced to less than one-half, by several being laid from the same pipe; and he observes, by the bye, that the Water Companies have no objection to lay these communication-pipes if properly remunerated,—as if any one could object on such a condition.

At Question 5,224, the expenditure at Nottingham for the supply of 8,000 houses, is stated to amount to about £30,000. The witness *apprehends* that the cost of butts or cisterns, fitted with a ball-cock and other appurtenances, would also amount to £30,000 at the least, if each of the 8,000 tenants were provided with a separate cistern capable of containing two days' supply, and that of more than half this cost, the public is *disburdened* by the adoption of the system of constant delivery, viz. £15,000.

According to this statement, it is made to appear that each tenant would have to pay for fittings, (allowing, as before, 10 per cent. for interest and wear

and tear,) 3*s.* 9*d.* per annum extra, if the constant supply were not adopted at Nottingham.

Now, it is very difficult to reconcile statements founded upon the cost of materials in different localities, and also depending upon the mode that various individuals may adopt to attain the same end.

The following estimate is that of one of the most respectable contractors in London, who has been employed for years in pipe laying, and who has invariably given satisfaction, both in the metropolis and in the country, to those employing him.

1st. The cost of a ½-inch ferule, 24 feet of ½-inch lead pipe, and a ½-inch ball cock, will amount to £1. 1*s.* 9*d.*

2nd. The cost of a wine butt, holding 100 gallons, will amount to 17*s.* 6*d.*

3rd. The cost of a ½-inch ferule, 24 feet of ½-inch lead pipe, and two ½-inch common cocks, will amount to £1. 1*s.* 9*d.*

The cost, therefore, for fittings, upon the *intermittent* plan, will be £1. 19*s.* 3*d.*, and upon the *constant* plan, £1. 1*s.* 9*d.*, or 17*s.* 6*d.* less for the constant supply; and this at 10 per cent. is equal to 1*s.* 9*d.* per annum, or $\frac{4}{10}$ths of a penny per week, or of less than a ¼ of a farthing per diem for each tenant supplied; and this is the amount of which the public are *to be disburdened* by the introduction of the system of *constant* supply. It has, however, been shown that the average rate for water in several towns in Lancashire was 3*s.* 3*d.* per

annum greater for the *constant* than the *intermittent* supply.

It may, however, be necessary to give some further explanation of the estimates I have adopted. That the work can be executed at the prices stated, is certain. I have assumed $\frac{1}{2}$-inch pipes in *both* cases, because I have also assumed a $\frac{1}{2}$-inch pipe to *each* house: when $\frac{3}{4}$-inch pipes are laid, generally two, and sometimes three, tenants are supplied from the *same* pipe.

I have also assumed two cocks upon the *constant* supply system; for, if only one is used, in case of a breakage, the whole of the inhabitants in the street in which the fracture occurs, must remain without a supply of water until this pipe is repaired; but by introducing a stop-cock between the house and the main, then (so long as the fracture is *in* the house) the repair may be effected without stopping the supply to other houses; if, however, it should happen between the stop-cock and main, then there is no alternative, and the houses in all the streets that may be supplied from this main, must have their supply of water stopped until the repair be effected.

The next question is, as to the comparative cost of works established upon the *constant* and the *intermittent* systems, and the points involved are the quantity of water supplied, the pressure under which it is supplied, and the size of the mains; because it has been deduced from the evidence, that there is less waste of water, and less water used—a greater pressure ensured, and that pipes of less diameter are

required,—in other words, greater advantages are obtained at less cost, by the adoption of the *constant* than by the *intermittent* system. As I do not think the evidence given authorizes any such deduction, I shall now proceed to analyze it on these points.

The evidence to which the greatest importance seems to have been attached, is that of Mr. Hawksley, who was, at the time, Engineer to the Trent Water Works Company, one of the three Water Companies established in Nottingham ; and as this town is continually referred to, as a place in which the principle of constant supply *has* been carried out with great success, I shall examine his evidence closely and in detail.

In his replies to the queries of the Commissioners he states—

"The Nottingham Old Water Company supplies from 12,000 to 16,000 of the population."

"The Trent Water Company supplies upwards of 36,000 of the population of Nottingham, and of the adjoining village of Sneinton."

"The Minor Works supply, together, probably 5,000 inhabitants."

"The Old Company has *received no dividend for near* 20 *years.*"

"The Trent Water Company paid *no dividend* for five or six years, and although this Company now divides 6 per cent. on the *nominal* capital, it does not obtain more than 5 per cent. on the *actual investment.*"

The Northern Water Works Company receives *little or no remuneration* for its outlay."

"And the Minor Works, I am given to understand, scarcely recompense the owners for the trouble and attention bestowed upon them."

"It is not possible to say into how many houses the water is *separately* laid, but I conceive the number to be between 4,000 and 5,000.

"*All* the houses in Nottingham are supplied very *efficiently*, either in the houses, or by *cocks in the courts*, excepting about 800, who are necessitated by the *parsimony* of the landlords to beg or *steal* from their

neighbours. The large *houses* originally supplied by the old Company have *very extensive brick cisterns, capable of holding* several weeks' supply. All the other houses are, with few exceptions, served from pipes *directly communicating with the water mains,* in which the supply is *constantly maintained.*"

"The poorer classes are supplied chiefly from water cocks placed in the courts in which they reside. The *proprietors* of small tenements provide the pipes and apparatus, and discharge the water rent."

"The water from the Trent Water Works is forced along a main into a reservoir, situated near the Park, at an *elevation of* 135 *feet.*"

"This portion is *elevated from* 50 *to* 200 *feet above* the adjacent valley of the Trent, and comprises the *best and most respectably* inhabited part of the town, *together* with numerous densely-populated places of very inferior description, inhabited by the *working classes.*

"The natural facilities for drainage are exceedingly good, as the town stands, with trifling exceptions, upon inclined ground rising 196 feet in little more than one mile."

"*The principal and district mains are never tapped for branches.*"

The only conclusions I can arrive at, upon a perusal of the foregoing statements, are—

1st. That with so many competing companies in a town whose population does not exceed 60,000, it would be impossible that a remunerating price could be obtained by *all* the companies; and this appears to be the fact.

2nd. That as out of 12,000 houses, only 4,000 or 5,000 have a *separate* supply; that as the poorer classes are *chiefly* supplied by common cocks placed in the courts; and as 800 houses steal the water,—the mode of supply in this town is not superior to that in others.

3rd. That if the elevation of some of the most respectably inhabited portions of the town, is 200 feet (or 230 feet to the tops of the houses), and if "the *principal* and *district mains* are *never* tapped,"

it is impossible, if the water is raised to an elevation of "135 feet" only, that

. . . "all the other houses, with few exceptions," can be "served from pipes *directly communicating with the water mains*, in which the supply is constantly maintained."

I think the foregoing will show that Nottingham should not be held up as a town where the system of constant supply, *has been* proved to be successful; and this is an important conclusion to arrive at, as we may then more easily account for the contradictory evidence afterwards given. If it *had been* proved, the evidence would have shown clearly the results, and how they had been arrived at; but as it would appear, that it is a suggestion for what is supposed to be an improved mode of supply, the evidence must be *speculative*, and that may account for its being contradictory.

As to waste of Water.

At Question 5,229, the witness is asked for his opinion upon the following portions of my evidence.

"Suppose a supply of water to be required for 20,000 houses, and the height to which it was raised at the works was such that a 20-inch main would be sufficient to give the supply according to the system hereinbefore explained, it would not be so if the water were constantly on in all the pipes, both mains and services; for example, suppose the size of the lead pipes to supply the houses to be upon an average half an inch in diameter, then the aggregate areas of 20,000 half-inch pipes would be equal to 27¼ square feet, and it would require a main of 71 inches diameter at the source to supply the town, instead of 20 inches, and for side streets containing 100 houses each, it would require pipes of 5 inches diameter instead of 3 or 4 inches. *This is an extreme case*, but one that it would be necessary to provide against,

because if the water is always on, the houses may be all at one time supplied; and even trusting to the chances of *only one half the number of houses taking water at the same time*, the main must then be 48 inches in diameter at the source. In addition to the necessity for this extraordinary outlay in the first instance, the quantity of water that would be used would be enormous; and, consequently, the expense of raising a sufficient supply would be increased in proportion, and the object sought, that of having a strong pressure of water in the mains, would be defeated by the very means proposed to ensure it; for inasmuch as the water in the pipes would be always on, so would the draft by the houses be constant, and the present power of shutting off the supply from the side streets, and applying the full force of the supply to the particular locality requiring it, would be destroyed.

Question.—Taking a large town as an aggregate of several towns, may you not do for a large town what is actually done for several provincial towns? Answer.—The objection is this, that if your water is always on, you would have to supply a much larger quantity of water than is now necessary to give an abundant supply, and you must have a great many extra officers to prevent improper use of the water. If you can insist upon every inhabitant having a ball-cock, and if you can be satisfied that there would be no unnecessary waste, and no unfair dealing in the houses, then the objection to having all the pipes charged is removed. But if you cannot do that, you are very likely at the time when you have a fire, instead of having the water concentrated at the place where you want, to find the water drawn off in different parts of the town."

The witness answers, that there cannot be much waste, because the "supply at Nottingham is not more than 80 or 90 gallons per day per house;" which includes Breweries, Dye-works, Inns, and other large consumers.—I do not see how the fact of there not being much waste at Nottingham, where the sewage is "defective and unsystematic," and the supply of water very inadequate, can prove that any statement in respect to other towns, where the sewage is good, and where a much larger supply would be required, whether the system be constant or in-

termittent, is incorrect. In fact, this is *not* an answer to the question.

At Question 5,235, in which the Commissioners allude to my strongly-expressed opinion, as an *apprehension* merely, that if the system of constant supply (without reference to high pressure, which has no necessary connection with it) were adopted, much larger mains would be required—the witness is asked, What is the evidence of *fact* and *experience*? and the answer is—"*Directly the reverse of the hypothesis.*"

At Question 5,279, the witness is asked if

"The saving in the size of the service-pipes, the mains, and so forth, would compensate for the cost of throwing up by engines an *additional quantity* of water to meet the *apprehended waste* and *additional* consumption, and *keeping it constantly on*?"

And replies—

"Yes; and the management is much more easy, and the number of men necessary to superintend the distribution of the water becomes much fewer; in fact, it demands very little attention indeed where the water is constantly running through the pipes; but where the water is given at intervals, many persons are put to great inconvenience; then they are complaining, and must be attended to, and the cocks, when they go down, will stick very frequently, and there is, consequently, a *great waste of water*, so that a great quantity of water is not well applied. The *waste is very great on the intermittent supply*, much more, I am satisfied, than most engineers are aware of. We have found, in many instances, where our supply has been turned off in a particular street for a short time, the ball-cock of a cistern has gone down, and the water run to waste after being again turned on. That happens in all towns where the supply is intermittent; and I believe the *waste* from this and some other causes is *much greater* than that which occurs in a *constant supply*."

It will be observed, that the Commissioners appear to think that there is some ground for appre-

hending waste and additional consumption in keeping the water always on, and propose to compensate for the expense thereby incurred, by the savings to be made in reducing the pipes (the fact being, that if there is to be waste and greater consumption, the pipes must be increased); and when the question is put as to whether this will be the case, the witness, without hesitation, says, Yes!

From the foregoing it would appear, that the witness had formed a strong opinion that there is greater waste and consumption of water where the intermittent supply, than where the constant supply system is adopted: the question has been one of fact, is there or is there not more water or consumption of water in one plan than the other? and *experience* would have given a simple answer: from the following, however, it would appear that there is more waste upon the constant than the intermittent supply, or exactly the reverse of the previous statements.

To Question 5,280—

"In stating *generally* your view that the supply of a town by the medium of a constant supply and high pressure is quite as cheap or cheaper than under the other system of an intermittent supply, do you take into consideration, that, in the one case, of *constant supply and high pressure* there would be greater advantage to the people, and a *greater supply of water?*"

The witness replies,—

"I did *not* take that into consideration, in the *first* instance; but I think the saving in the number of officers, and in other respects, would more than compensate for the cost of pumping *that* quantity of water; for the mere cost of raising the water is but a trifling portion

of the expenses of a Water Company; a great many expenses are permanent standing expenses; the greater proportion are in a great degree independent of the quantity of water lifted."

The Commissioners would seem here to have some doubts of their witness's judgment; for they say, "In stating *generally* your view," that the supply of a town is "quite as cheap or cheaper," when you said so, did you consider the greater advantage to the people, and the *greater supply* of water?

The witness replies he did not take that into consideration *in the first instance*, and as he has been telling the Commissioners over and over again, that there will be less waste and less consumption of water, it appeared hardly necessary to ask the question again; however they were right, for the witness says that he *thinks* the saving in the number of officers and in other respects, would more than compensate for the cost of pumping *that* quantity of water. The witness could not have come to this conclusion without forming an estimate of *that* quantity; but the *expense* will be *trifling*; that there are many other greater expenses incurred by a Water Company than *that* of raising water, and the greater proportion are in a great degree independent of the quantity of water lifted; but unless the witness is prepared to state what greater consumption he *now* calculates as likely to result from the adoption of the constant supply, his statement of the cost being trifling must stand as a mere assertion, and be valued accordingly.

In Question 5,282, he is asked whether he thinks he can supply cottages and houses at the same ex-

pense on the constant supply, as could be done by the intermittent supply; and he replies,—

"Certainly: we have tried the experiment for *a month*, and we found, that *though there was an economy to a certain extent, as far as the supply of water went*, the cost of attendance, irrespective of the inconvenience to the people supplied, was far more than would compensate for that trifling advantage."

In answer to a question put a few minutes before, the witness says, he believes the waste to be much greater on the intermittent supply, and now states, that, on making the experiment, he found there was an *economy to a certain extent, as far as the supply of water went.*

A little further on, in answer to Question 5,293, the witness says, that in changing tenants from the intermittent to the constant supply, there might, at *first*, be some additional waste; and further on he says, *the Water Companies know that the waste is not so great when the water is only on for a short period, as it would be if kept on constantly;* and he adds, that they pay *great attention* to this matter in Nottingham, and, *in consequence*, are able to keep the water on constantly, without *great* loss to the Company.

It is very difficult to know what the witness means to say—whether that there is less waste, or more waste; whether there is a greater consumption, or a less consumption; for it first appears to be one, and then the other, but he admits that they are obliged to pay great attention to prevent waste, although he states that, "the attention paid is not expensive."

As regards the "cost of attendance," upon which the witness lays great stress, I do not think it is one of so much importance: the cost of turn-cocks, in the East London Water Works district, in the year 1844, was less than 4*d*. per tenant, and this added to 1*s*. 9*d*., the charge for a butt, taken together, will make a total charge of 2*s*. 1*d*. per annum, while, as before shown, the average extra charge for the constant supply was 3*s*. 3*d*. per annum.

As to Greater Pressure ensured.

At Question 5,215, the witness states that—

"The *greatest* pressure at Nottingham is about 120 *feet*;"

and that

"The average pressure may be stated at about 80 feet, there being in Nottingham great variations of altitude."

If the greatest is 120 feet, and the average is 80 feet, it may be inferred that the least is not more than 40 feet.

To Question 5,216, "Is the *high* pressure kept up on all classes of pipes and at all times?" the answer is in the affirmative; but the witness should have added, that he considered pressures of 120 feet, 80 feet, and 40 feet, *all* to be high pressures.

In answer to the next question, as to whether in the communication-pipes of the tenants, the common or constant *high* pressure is kept on night and day, he says—

"Yes, we have no use for the term *high* pressure. It is the ordinary state of the water within the pipes. The pipes are charged so as to deliver water at the *tops* of *all* the houses *which are within a proper distance beneath the head of water in the superior reservoir.*"

No use certainly for the fixed term "*high* pressure" where it varies from 120 feet to 40 feet, and where it will *not* reach the tops of all the houses.

To the next question he says,—

"There is but *one* pressure in Nottingham,—that is the same at all times, and is found to be economical."

What can possibly be meant by this statement, and what can possibly be understood by it, after the evidence immediately preceding, showing so great a variation in the pressure?

From the evidence just referred to, it would be inferred, that throughout the district supplied by this Company, the water was at all times conveyed to the tops of the houses; but in his Report, replying to query 41, and speaking of the advantages of having water at high pressure as a protection against fire, the witness states that *those* parts of the towns situated on the *low* or *medium levels* derive this advantage, but *those parts* of the town more nearly on the level of the upper reservoir, *of course* cannot command this advantage. It would have added to the value of the information given to the Commissioners, if it had been stated how many houses were so situated, and how many were at 40 feet, how many at 80 feet, and how many at 120 feet pressure respectively, because the general impression from the evidence would be, that the town is all under "*one pressure*," and this impression is much strengthened by the table given in the same Report, in reply to Question 34, where the charge for water delivered by pipes of various sizes from $\frac{1}{2}$ inch to

$1\frac{1}{4}$ inch for the supplying of large consumers, is stated. Now the witness should have been aware that this table is calculated to mislead unscientific persons, who are not aware, as he is, that a consumer whose premises are situated at 120 feet below the level of the reservoir, will receive through a $\frac{1}{2}$ inch pipe, for which he is to pay £5, double the quantity of water received by one situated at 30 feet only below the reservoir, who is to pay the same sum. This mistake would be confirmed in the minds of these persons by the evidence previously given by the witness, that—

. . . "there is but one pressure at Nottingham,—that is the same at all times;"—

they would suppose from this, that the same quantity of water would be received through the same sized pipe, and that *therefore* the charge was the same.

At Question 5,299, the witness confounds the question of *high pressure* with *constant supply*, in respect to the sizes of the pipes, and, consequently, is puzzled how to answer, while, had he confined himself to the question, there could have been no difficulty in replying, that the greater the elevation to which the water is raised, the greater will be the velocity of its passage, the smaller may be the pipes, and, consequently, the less will be the cost; but this would prove nothing for constant supply.

He afterwards states—

"At Notttingham we never speak of high pressure."

There is no reason why he should not speak of it in the *lower* parts of the town; but, in the *upper* parts of the town it would certainly be prudent to say nothing about it, and especially as, in answer to the 2nd Question forwarded to him by the Commissioners, he states (as before quoted)—

"Three-fourths of the town is based immediately upon red sandstone."

"This portion is elevated from 50 to 200 feet above the adjacent valley of the Trent, and comprises the best and most respectably inhabited part of the town, together with numerous densely-populated places of very inferior description, inhabited by the working classes.

"The natural facilities for drainage are exceedingly good, as the town stands, with trifling exceptions, upon inclined ground rising 196 feet in little more than one mile."

The evidence shows that the greatest pressure at Nottingham is either 135 feet as stated in the answers to the Commissioners, or 120 feet as stated in evidence—that the variation in the levels of the different portions of the town is from 50 feet to 200 feet, and adding 30 feet for the height of the houses, it would be 230 feet. If these statements are correct, as most probably they are, who can come to the conclusion, that

"There is but *one* pressure at Nottingham,—that is the *same at all times?*"

The fact is, that whether the supply be constant or intermittent, the pressure of water in the mains *must* vary according to the level of the different streets and houses above the source of supply, and the number of tenants drawing off water at the same time; the fewer tenants that are drawing off

water at one time, the greater the pressure, and *vice versâ*. Hence, the effect of constant draft would be constant diminution of pressure; and, therefore, in towns where the system of *mains* and *services* is adopted, the *mains* are much more likely to be under high pressure in case of fire, than when no distinction is made, and, consequently, no *certainty* of high pressure insured.

As to Pipes of less Diameter being required.

At Question 5,230, the witness is asked,—

"Does the system of constant supply equalize comparatively the rate of delivery?"

The answer is,—

"It diminishes the rate of delivery in the *service-pipes* and *sub-mains very materially*, distributing over a *greater number of hours* the quantity of water which *otherwise* must be delivered in a *very short period*."

And he further states that—

"The word equalize does not apply, because the *current of water* in the *great leading mains* is but *little affected*."

To the Question 5,231,—

"It is spreading the supply over the 12 hours of the day?"

the witness replies,—

"Yes, and with the advantage, that as the *water travels more slowly through the pipes, smaller* pipes will *be equivalent to larger*."

This evidence would give the impression that the constant supply possesses some advantage as regards the size of the pipes.

To prove that the system of constant supply has nothing to do with the size of the mains, unless

indeed in the case quoted by the same witness, which I shall hereafter refer to, I will state a case: In both the *intermittent* and *constant* supply system, a fixed quantity of water is raised and passed through the pipes for the supply of a certain number of houses in 12 hours. Now, as far as the size of the pipes is concerned, it matters not how this quantity is taken: the varying pressure in the town of Nottingham, stated to be from nothing to 120 feet, will determine the velocity of water through the various communication pipes, and when a half-inch cock is opened, whether it be kept for 5 minutes to fill a pail, or for an hour to fill a cistern, during the time it is open the velocity of water through that cock will be the same for that period, therefore the friction of water through the pipe will be the same, and, consequently, *the size* of the pipes and main required must be the same; but if it be assumed that the quantity of water supplied is less, or the time of delivering the same quantity greater, *then* the pipes may be smaller; *but this would apply equally to the constant and intermittent supply.* The only way, therefore, to give the appearance of an advantage, and the only case in which, *assuming it to be a possible one*, the branch services and mains might be made smaller, is to suppose that each inhabitant is *constantly drawing* water at an uniform rate during the whole 12 hours, or one-tenth of a gallon per minute; but as this involves the necessity of some one in each house being always drawing water during the whole 12 hours, the supposition is mani-

festly absurd. If it were possible to regulate the size of the pipes for each house, and thus to limit the supply to a given quantity during the 12 hours, or if the public would submit to it, then the constant supply might be considered not impracticable. This illustration, however, shows an extreme case, and you cannot reduce the sizes of the side mains, whether for a constant or intermittent supply, unless in case of a reduced *quantity* to be delivered, or an extended time in which to deliver it; the latter militates against the views of the Commissioners, which are to save time and labour in obtaining water, and the former militates against common sense and public convenience.

In the next question, 5,232, the witness is asked whether he requires an extra number of men to prevent the waste of water. The witness says— that in his works the fact is exactly the reverse. He then mentions that he tried the effect of shutting off the water during *seven* hours of the *night*, and found that it would be more expensive for extra turncocks, &c. &c., and therefore he did not follow out this plan. Here I must beg leave to call attention to the period at which the water was shut off. I presume the inhabitants would be at rest between the hours of ten p.m. and five a.m., and therefore not likely to be using water; and this, I dare say, will not be disputed; as the witness says, in reply to Question 5,277,—

"I consider that nearly the whole of the water will be consumed in

the *four or five hours elapsing between breakfast and dinner.* To err on the safe side, I assume the delivery to take place *in four hours.*"

If such is the case, then, how could the witness find that

· · · "it would be more expensive to keep extra turncocks, do extra repair to valves, draw plugs, to cleanse the pipes, and attend to complaints."

But, nevertheless, this constitutes the whole of the *experiments* which the witness states he tried to prove the superiority of one system over the other.

In answer to Question 5,235, the reasoning of the witness, that if smaller pipes suffice for tenants' communication-pipes, smaller pipes will suffice for the mains at high pressure, is deceptive, because it confounds two questions which are really distinct. If you increase the pressure, there is no doubt that the same quantity of water can be passed through smaller pipes, in proportion to the square root of the increased pressure. But my "apprehension," or, to speak more correctly, my *conviction* is, that if all the tenants of the Water Companies in London, were to be *put upon the main*, which is literally the constant supply proposed, and which will be well understood by many persons besides engineers, the consumption of water would be much greater than it now is; there must also be an increased capital expended to supply the increased demand, and this must be paid for in some shape. Whether the tenant is to pay for it directly in rates, or indirectly in increased rent to his landlord, or

whether it is to be paid for by the government; in some way or other the burden will fall upon the public.

The witness then makes the broad assertion,—

"That where 20-inch mains are used on the system of periodical supply, 12-inch mains would amply suffice for the system of constant supply; instead of the 7 and 6-inch mains, 5 or 4-inch would suffice; instead of 3-inch service pipes for the occasional supply, 2-inch would suffice for the constant supply:"

or, in other words, the leading mains may be one-third of the area, and the "sub-mains" and services one-half the area; and this arises, he says, from the circumstance of *constant* supply, and not on account of *reduced* supply. But there is here a contradiction; for in answer to Question 5,230, before referred to, he states, that the rate of delivery in the service pipes and sub-mains is very materially diminished, but he excludes the leading-main from the beneficial effect, and states specially that—

"The current of water in the great leading-main is but little affected."

Thus, in answer to one question, he states that smaller services and sub-mains may be introduced, but that you cannot reduce the leading-main; and in answer to only the fifth question after the former one, he states that the leading-main may he reduced much more than either the sub-mains or services.

In answer to Question 5,277, the witness states distinctly, that in proportioning the size of his pipes,

he calculates the whole of the delivery to take place in 4 hours per diem.

His pipes must therefore be three times the area that would be necessary if the same quantity of water were delivered in 12 hours. It must be borne in mind, too, that in answer to Question 5,231, as to spreading the supply over 12 hours of the day, he states the advantage to be, that the water travels more slowly through the pipes, and that, *therefore*, smaller pipes would be equivalent to larger; and yet, immediately after this calculation, for giving the supply in 4 hours, in answer to the very next question (5,278), as to what would be the saving in the size of the pipes consequent on the system of constant supply, as compared with the intermittent system, he states that the diameter of service pipes and sub-mains is diminished about one-third. These statements are somewhat inconsistent: first, (5,230) The service-pipes and sub-mains are to be reduced, but not the leading-main,—then (5,231) the supply is spread over 12 hours of the day, and, *therefore*, smaller pipes may be used; but, afterwards, (5,232) it appears that this supply is spread over a longer period, for the tenantry suffer great inconvenience when it is shut off for 7 hours in the night, so that, having it on for 17 hours instead of 12 was not sufficient, but it was required for the remaining 7 also; then (5,235) the size of the leading mains, which before could not be touched (5,230), may be reduced to one-third of its former capacity, but the sub-mains can only be reduced one-half: they have

thus changed their relative positions since they last met at Question 5,230.

Then, in Question 5,277, the mains, instead of being *reduced* to *one-third* or one-half, are to be *increased* to *three times* the capacity, because, although it would appear, from the evidence generally, that it was a great advantage to have the water on for 24 hours, yet the witness states, as the result of his experience, that *nearly* the whole (and to determine the size of his pipes, he calculates the *whole*) is delivered in 4 hours out of the 24.

Then, at 5,278, the sub-mains and service-pipes are neither diminished one-half, nor increased to three-times the size, but are to be diminished about one-third only, while the leading-main, which at first was not to be touched, then was to be diminished to one-third, and then to be increased three times, is now not to be touched at all, and is not even noticed. But so little has the contradiction struck the Commissioners, that in the very next question (5,279), they ask—

"The *saving in the size of the service-pipes, the mains, and so forth,* would compensate for the cost of throwing up by engines an *additional quantity* of water to meet the *apprehended waste* and *additional* consumption, and *keeping it constantly on ?*"

The answer to which is hereinbefore quoted, wherein the witness states that there will be—

"A saving in the size of the service-pipes, the mains, and so forth."

He afterwards reverts to the water running constantly through the pipes, but does not state whether

by " constantly" he means 4, 12, 17, or 24 hours, so that it would appear, when capital is to be raised, and the pipes to be reduced in size, the water goes constantly for 24 hours, (on *paper*) ; but when the witness is asked as to what sized pipes he really would lay, he calculates the supply to be taken in 4 hours. How is it possible, however, to determine the size of a main, without knowing the quantity of water that is to pass through it in a given time?

It is utterly impossible, from the foregoing data, to determine that, by the adoption of the constant supply system, smaller pipes may be used instead of larger; on the contrary, if it be a fact that the greatest portion of the water is taken in 4 hours, instead of being distributed over 12 or 24 hours, then there can be no doubt that the pipes must be very considerably increased beyond the usual size. And if so, then the cost of the works must be greater.

In answer to Question 5,227, Mr. Hawksley states that amongst the " conveniences and economies attendant upon such an arrangement,"—

. . " there is the saving of the room occupied by the tank, in some districts a matter of *much importance;* there is the avoidance of the damp from the *evaporation* of a *body* of water in the house; the saving of accidents and of leakage, and of the inconvenience from having the tank sometimes empty: in many houses where there is no convenience for a tank in the upper part of the house, it is placed in a lower apartment, and the water must be borne up stairs for use; the labour incurred necessarily restricts the free employment of the water for many purposes

to which it might be beneficially and healthfully employed. In such cases too the expense of a force-pump to charge tanks for water-closets, and of waste and warning pipes, is sometimes necessary. This apparatus for the middle and higher class houses is not only very expensive, but liable to be very often out of repair, constantly bringing the plumber into the house.

"Another and a very serious inconvenience affecting the habits and sanatory condition of the population attendant on the system of partial or occasional supply is that it creates an inconvenience and obstacle to the use of *baths*."

I think there can be no doubt that the impression intended to be conveyed to the public in the foregoing statement is, that *all the conveniences* mentioned belong to the system of *constant* supply, and *all the inconveniences* to the *other* system. It will be well, therefore, to examine the statements a little more closely. First of all, if the saving of the room for a tank is of importance, (and it should be borne in mind that this butt or tank is generally outside the house, for, if this were not the case, wherefore the apprehension of soot or dust getting into the butts,) where is it intended to place the *bath?* which it appears to me, if it is to be really useful, must be of much larger dimensions than a butt.

As to the damp caused by the evaporation of water, it would be very difficult to calculate the amount of vapour arising from a butt, or to prove that it was more than is actually necessary for health, as everybody knows you *may* have the air in a house too dry.

As to accidents and leakage, I do not think a pipe with the water "*always on*," "*at high pressure*,"

can be less liable to accidents and leakage than the present pipe and butt.

With regard to the tank being *sometimes* empty, this may be an inconvenience, but it is one easily remedied, unless your neighbour has been equally careless: supposing, however, under the system of constant supply, a main should burst in the street, the whole street would then be without a supply of water, unless the inhabitants had taken the precaution to have a cistern in their houses as a provision against such accidents, to which the constant supply is liable, and against another accident, more frequent and regular in its occurrence, viz., frost, during which, if no provision is made for reserving water, the inconvenience may probably be found greater, even, than that of the occasional occurrence of a tank being empty.

As to the labour of carrying water up stairs in a cottage, this is really a refinement too subtle for examination; and in a large house, I presume, room might be found for a tank.

With respect to the necessity for force-pumps to charge tanks on the tops of houses, and the inconvenience and expense attending the plumber's constant visits, I cannot see what they have to do with the question.

The same mains that can supply water to the tops of houses constantly, surely could supply the tanks periodically: the point has really no bearing whatever upon the question of constant or intermittent supply, and is merely a question of pressure in the mains.

The householder who would go to the expense of having a force-pump to raise water to his water-closet and tanks, would surely go to the expense of having the water laid on to every floor of his house: if the water in the mains was under high pressure, we might then turn the tables, and ask for a very nice calculation to determine whether the plumber's visits to repair a force-pump, or to repair the pipes and cocks on every floor under the high-pressure system, would be most frequent.

The witness further observes, in reply to the same question,—

. . "with a constant supply of water at sufficient pressure, baths might be supplied in private houses with little difficulty or expense, so little indeed that I believe it to be practicable, and hope yet to see baths introduced into the houses of *labouring* men for the use of themselves or families."

The phrase, "with little difficulty or expense," is unintelligible, unless some definite quantity is stated. The extent to which it is proposed to carry these benefits should be specified: surely it is not meant that all these advantages are to be obtained with 40 gallons per day, or that while the poor man is disburdened of $\frac{4}{10}$ths of a penny per week for a tank, he is to be burdened with a penny per week for a bath and its apparatus; but if it is intended to give 80 gallons instead of 40, or, in other words, double the present supply to the poor, and I suppose therefore to the town, as the rich will expect equal advantages with the poor, about whom so much is talked, and for whom so little done, it will be

found that in spite of all theoretical notions, *practically* it will be necessary to have filter-beds of *twice the size*, engines of *twice the power*, and mains of *twice the capacity*, and this is a question not peculiar to either system of constant or intermittent supply, but equally applicable to both.

In Question 5,233, the Commissioners state, in referring to my evidence,—

"The term waste would imply an excess of expense for the pumping of water."

I would merely correct this by saying, that the *amount* of this expense must be ascertained before it can be determined to be excessive or not. I would remark, with respect to the expense of *raising* water, that if that is the only point considered in forming an opinion as to the expense of supplying a larger quantity, an erroneous conclusion will certainly be arrived at; as I must again repeat, and it is important that it should be understood, that to supply double the quantity, not only the engine-power must be doubled, but also the capacity of filter-beds, reservoirs, and pipage. The Commissioners, having assumed that the term waste would imply excess of expense, then state—and, in so doing, give the appearance of a contradiction in my evidence—that I cite a good expansive engine, that the cost of raising 80,000 gallons of water 100 feet high was 1*s.*; this estimate, they say, included coals at 12*s.* per ton, with labour and stores, and *all* except the interest upon fixed capital. The question

is not put quite correctly, as will be seen by referring to my answer to Question 4,480, where I state that this estimate includes neither repairs of machinery, nor repairs of buildings ; these items, however, with *all the expenses necessary for carrying on Water Works,* and *not merely for raising water,* I afterwards gave in *detail* to the Commissioners, at their request, but they have *not* published them.

The witness is then asked whether his own experience justifies the conclusion that, when the machinery and distributing pipage are fixed, and the supply of water unlimited, the expense of pumping additional quantities is inconsiderable as an element of calculation ; and his answer is—

"*Assuming the possibility of varying our works without cost, the* experience at Nottingham is to this effect, that we could give eight or *ten times* the *present unlimited supply for about a double charge ;* that we could raise all the water now taken fifty feet higher, by increasing the charge five or six per cent. ; and that, were we to lower the head to half its present height, the saving of expense would not exceed six or seven per cent. on the gross charge to the tenant."

The answer may be otherwise given thus :—The Company supply houses at an annual charge of about 7*s.* 6*d.* at any level required, even into the attics of four or five story buildings ; if the supply were afforded to the level of the pavement only, the charge could not be reduced more than 6*d.* per house, or, for the labourer's tenement, not more than 4*d.*

In this answer, the witness commences, "Assuming the possibility of varying our works without cost,"—a possibility which *cannot* be assumed when the cost

is the very thing in question forming the chief element in the calculation. He then states that he can give *eight* or *ten* times the present *unlimited* supply for about a double charge, *putting aside interest upon the capital* necessarily expended in *making filter-beds eight or ten times larger, engines of eight or ten times greater power, and the pipes eight or ten times their present capacity*, which, I presume, is what the witness means by "Assuming the possibility of varying our works without cost."

Then, according to the tabular statement subsequently given by the witness, he might certainly effect it; but as these charges amount to only one-sixth of all the expenses, I do not see the value of such a calculation. It is, in fact, the same as saying that, if we omit the cost of the flour, we could have bread at a very cheap rate. I have no doubt, also, that it is upon the same assumption of omitting the *cost of altering engines, &c.*, that the witness calculates that water might be raised fifty feet higher at an additional charge of five or six per cent., and consequently his statement will give the public no accurate notion of the *actual increase of charge that would be made.* The Company, it is further stated, supply houses *at any level required*, even at the attics of four or five story buildings. I allude to this again, to show that the impression conveyed is, that *all* the houses in Nottingham are so supplied, whether on high or low ground, which, we have already seen, is not the fact.

The Questions from 5,237 to 5,255 relate chiefly to the cost of supplying labourers' cottages. I have already referred to this subject in this Report; but as it is a very important one, and the Commissioners are very properly anxious that the poor should be abundantly supplied with water at the lowest possible charge, I may here advert further to it, remarking that whatever mode of supply be adopted, the cost must depend upon the three following circumstances, and must vary as they vary.

1. The natural facilities, in any locality, for obtaining a supply of water.

2. The experience of the engineer employed to construct the works, as affecting the character of the plan adopted.

3. And, *most important, the number of inhabitants taking a supply in proportion to the whole population.*

But it may safely be asserted that in almost any town of a population of 30,000 and upwards, if the *whole* take a supply, all the poorer houses may receive an *abundant* supply of water (filtered, if necessary,) for a charge of not more than 1*d.* per week.

Some reference is made as to the mode of preventing the water in the pipes from freezing during the winter, and the witness states—

"The tenants also protect the pipes by allowing a small stream of water to run from the tap. This is effectual, but"

he very properly adds, "occasions waste," which certainly would be the case, to a very considerable ex-

tent; for, if each of the 8,000 tenants were to allow a stream of $\frac{58}{1000}$ of a gallon per minute to run through their taps during the twenty-four hours, they would each consume 85 gallons per diem, the whole of the supply provided by the Water Works Company for their tenantry.

The analysis of the evidence herein given, appears to me to be more necessary than it otherwise would be, on account of one of the witnesses, Mr. Thom, a highly respectable manufacturer of Greenock, (who states that "the duties of his own business of cotton-spinning rendered it impossible for him to superintend the details of execution, except in the case of the Rothsay Spinning Mills, the first of his hydraulic operations on a large scale;") assuming that the Commissioners have *recommended* the constant supply.

The following extract from a letter written by Mr. Thom to Mr. Gillespie, of Cork, which was read at a public meeting in that city, and published in the local papers, shows that since his evidence before the Commissioners, he considers himself to be the person who has guided the Commissioners in arriving at an opinion, which he states they have expressed, but which opinion, be it ever borne in mind, is not expressed in the "*recommendations*" of the Commissioners.

"You will see by the second Report of the Health of Towns Commissioners, that *they have recommended for general adoption the method I have long practised in supplying towns*, and explained in my evidence before them, which you have referred to. The *plan adopted for supplying New York and other towns was copied from the plan I executed about twenty years ago at Greenock*, and ten years before that in supplying my

own Works, Rothsay Cotton-Mills. *All the late patents taken in France and elsewhere are also founded on my plan of self-acting filters*, first constructed by me about twenty-eight years ago. The Shaw's Water pamphlet, written by me in 1825, for the use of the shareholders of that Work, was soon after translated into French by the then Government Engineer, on roads, bridges, and other public works, and hence my works are much better known in France than in the United Kingdom, where the pamphlet was never *published*, but only privately circulated among the shareholders and their friends.

"You will see by the *plan recommended by the Commissioners* that it is *materially* different from that proposed by Mr. Wicksteed, which is indeed the *old* plan heretofore practised in *London* and *some other towns*."

I may be permitted to make some few observations before concluding this letter, on the practical inconvenience to the public, irrespective of the question of cost, which would inevitably arise from any attempt to introduce the constant supply system to any extent.

1. In towns having any considerable irregularity of elevation, the result would be, that so long as the inhabitants in the lower districts are drawing off water, those in the upper parts would be able to get little or none.

2. In large towns, without any great variation in levels, the houses near the source would receive more water through a pipe of given size, than those at a distance from it, not only on account of the additional friction diminishing the velocity of the current, but because the quantity of water flowing into the pipe at the source, and through its length,

which quantity is fixed and limited, is undergoing a positive diminution at almost every house which it has to supply.

That such would be the case, the engineers who recommend the intermittent supply know, from actual experience, to be a fact.

Any street, or number of streets, now supplied periodically, may be taken as representing a small town, supplied on the continuous system so long as the water is kept on; and it is a fact well known, not only to the engineers but to the tenants of Water Companies, that in the summer time, when two or three taps in the lower part of the street are kept running, the houses in the upper part, instead of obtaining a butt-ful, as they would at other seasons in the course of an hour, with difficulty collect it in the course of ten hours.

Upon this point, on which the reasoning will apply equally to an efficient supply in case of fire, I do not know that I can do better than quote Dr. Arnott's evidence before the Commissioners, in his answers to Questions 3,949, and four following Questions.

"Question 3,949.—Would it not be of great advantage to the salubrity of London, or any other large town, if the volume of water supplied were increased?—There can be no question of the great importance of an abundant supply.

"3,950.—Have you considered the practicability or the advantage, if practicable, of keeping it on always at high pressure?—I think that could not be conveniently done *with one set of pipes, for persons, from negligence or evil intention, might at any time open so many of the cocks in houses, as to lessen or destroy the high pressure. Unless there were some certain means of keeping the cocks closed, except at stated times,*

it would be better to have separate sets of pipes for high and low pressures.

"3,951.—Are you aware of the regulations enforced in Philadelphia, upon that subject?—No.

"3,952.—Or the regulations enforced in New York, where they propose to extinguish the danger of fire altogether?—No; but I think the safer plan would be, to have a separate set of pipes for high pressure, which nobody should touch but the firemen, or other appointed persons. *I think the expense of that would be less than of any contrivance that should give even tolerable security in 'the other way.'*"

These points do not require a scientific explanation, nor does it require any engineering knowledge to show how completely the present arrangements of mains and services remove the difficulties; the various stop-cocks affording the means of stopping the supply at any point when the houses in a certain district have received their two or three days' supply, and allowing the whole quantity which the pipes are capable of conveying, to flow to another district, which otherwise would be almost without water at all.

I may here repeat, that to afford anything like an *adequate* supply on the plan proposed, would involve the necessity of enormously increased mains; and I think a perusal of the preceding observations and quotations will satisfy you that my assertion, that

"The adoption of it is attended with so many practical difficulties as to render it almost impracticable, except in the case of small level towns, and that the evidence in support of it is insufficient and contradictory,"

has been fully proved.

The remaining proposition, viz.:—

"That the advantages claimed for it do not exclusively belong to it, but can be more surely and economically realised by the previous plan,"

will not require any very lengthened arguments for its support; and, indeed, it has been already shown that, in many cases, advantages have been claimed for the constant supply plan, which have no necessary connection with it. It is, consequently, unnecessary for me to do more than touch upon one or two of the leading points.

I have throughout this Report, for convenience, adopted the use of the phrase "constant supply," as distinguishing the plan patronised by the Commissioners, but I cannot admit that it has any exclusive right to it, because, I think, it will be evident, that as far as the tenants are concerned, all that they require is to have a sufficient quantity of water always at hand, and if their cisterns or tanks are of proper size, and tended with ordinary care, they have, while these receptacles are regularly filled, to all intents and purposes, a "constant supply," and much less risk of interruption, than would be the case if every drop of water required, had to be drawn direct from the main, which, on that plan, would, in fact, be the sole receptacle of water for the whole district.

The question of expense, the only real question, has been already treated of; but there is one difficulty connected with it, which I have not hitherto noticed,—I mean, the great and continual loss which would inevitably occur, from the frequent theft of

the cocks and pipes, in low neighbourhoods, if every small house had separate ones.

It has been seen, that even in Nottingham, "the parsimony of landlords" compels the tenants of about 800 houses to "*beg or steal*" their required supplies of water, and it is hardly to be expected that landlords should incur the risk of this peculation, which experience proves would take place.

The truth is, however, that, but for the risk and expense above referred to, a constant supply to the poorer houses may be readily and economically provided by the adoption of the plan of erecting one large tank at the entrance to any court or alley, or for the supply of a row of small houses, and from this tank, separate pipes may be laid to each house. The Companies could supply water daily to these tanks at less cost, without interruption of the supply to larger houses.

By this means, each poor inhabitant might have a separate supply, without the inconvenience of tanks or butts in their houses, but the landlords would still be at the expense of laying pipes and supplying cocks to each tenement.

It must not be forgotten in considering any plan for the supply of the poorer houses, that the burden falls almost entirely upon the landlord: in nearly all cases he has to provide the tanks or whatever means are adopted for giving the supply, and he has to pay the rates to the Water Companies; the tenant pays in the shape of rent.

In conclusion, I may be allowed to state that long

consideration, and fresh and extended experience, confirm my previous convictions, and satisfy me that the plan designated "constant supply" is scientifically untenable, and practically ineffective.

I am, Gentlemen,

Your most Obedient Servant,

THO^{s}. WICKSTEED,

Engineer.

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