Mr. G. W. HEMANS said, he gathered from the Paper that the daily water supply for the whole population of Paris, amounted to only 21 gallons per head, and that more than one-half of that total supply was devoted to public purposes, in such a manner that a great quantity ran to waste. If he were not mistaken, as much as 54,000,000 gallons per day were bestowed upon the public fountains and conduits of the city, and if that quantity were so applied, the proportion utilized must be much below the supply furnished to other great cities, and the scheme must be considered to be an instance of failure.

Mr. VIGNOLES said, the Institution had been indebted to the Author on several occasions for bringing forward interesting subjects, of which this was not the least. He remembered former instances, in which Mr. Burnell's assiduity and attention to particular points of foreign engineering had given rise to very profitable discussions. The point which most struck him in connection with the present subject was the leading fact, that with a limited supply of water, one half went for ornamental purposes, at the expense of the public health. All the poorer classes of Paris, who inhabited the upper stories of the houses, were imperfectly provided. It was the same in other towns on the Continent, great displays were made in fountains and embellishments, while the health of the community was neglected; and that must be the case where the government attempted to do everything, and where a spirit of self-reliance was wanting. He considered the water supply of Paris at present a failure, and he was glad that the Author had stated it to be so, commercially, though successful as an engineering operation.

Mr. ROBERT RAWLINSON, C.B. remarked that the question of water supply was of the utmost importance, and he would preface the few remarks he proposed to make, by stating that it behoved speakers in this Institution to consider carefully the force of any words they used; because, to the credit of the Institution be it said, the opinions of its members on questions of engineering were looked to by foreign nations, and the technical laws laid down were attempted to be carried out by foreign peoples; and, consequently, if false notions were promulgated, mischief would result in other quarters, just as the enunciation of true principles was calculated to do good. The water supply in Paris appeared to be similar to that in London. In both cases water was drawn from various objectionable sources; for London the principal one being the Thames, and for Paris, the Seine, and in the case of Paris from below the city, where the water was necessarily impure. French engineers, and he supposed he might also say French medical men, appeared to have arrived at the erroneous conclusion, that water which contained 16 degrees of hardness, or 16 grains of bi-carbonate of lime per gallon of water, was more wholesome than purer water. That doctrine had also been promulgated in this country, but it had also been most earnestly controverted. To take a practical view of the matter, those who had to study animal life, and whose duty it was to develop it to its highest degree of perfection, looked upon hard water as poisonous; for instance, a trainer of race-horses would not attempt to get an animal into racing condition with water of 16 degrees of hardness, experience having taught him that such a course would end in failure. Horses must be trained on soft water, and care must be taken not to change the source of supply. In the town supplies of this country there were many examples, on a great scale, that soft water was not injurious, but the contrary. Glasgow was supplied with the soft and very pure water of Loch Katrine; then there were Manchester, Whitehaven, Keswick, Lancaster, and other places, as Falmouth, having very soft water below 4 degrees of hardness. In fact, hard water, far from being necessary to human health, was, if possible, to be avoided. He believed a great amount of mischief was done by invalids drinking hard water, as there was scarcely a watering-place along the eastern and southern coasts of England, from Scarborough to Brighton, which was not supplied with hard oolitic or chalk water.

With regard to quantity, Paris and London appeared to be similarly provided. The latter, with its population of 3,000,000, was supplied with about 100,000,000 gallons per diem, and Paris, with a population of about 1,600,000, had a supply of nearly 50,000,000 gallons per diem. In both cases, however, much of the water was wasted. Public companies and free institutions in this country were supposed to do a great deal better than the Imperial Government of France, but he was sorry to differ from that opinion. He must express his belief, that if the two cases were fairly and fully analysed, mismanagement and great waste of water would be found both in London and in Paris. In the ornamental fountains of Paris, an enormous quantity of water was wasted, while the poor in their houses were left to starve. In London, through mal-administration, defective services, and other causes, a waste was permitted of probably one-half or even two-thirds of the water brought in by the companies. He had seen valves and stand-pipes leaking for months together, causing the loss, in some instances, of as much water as would have supplied a small district. Throughout London the supply was intermittent. Frequently the ball-cock was unscrewed and the service was left open, so that every time water was turned on large quantities ran down the overflow-pipes and into the sewers. The water was supplied in the east of London by stand-pipes having no taps, it was not taken into the houses; and the complaint was that the poor in London, like the poor in Paris, were destitute of water, and yet the daily supply to London and Paris was said to be upwards of 30 gallons per head, men, women, and children. The only true method of giving a supply, was to carry a service-pipe and tap into every building; but to do that the supplies to houses in London and Paris must be organized on a different principle to any yet attempted. In the existing mains there was a pressure active, for injury, of something like 100 or 200 feet, while the pressure for useful service was not more than 3 or 4 feet. The water, when drawn from the street and used for fire service, would not rise in many places 3 feet from the pavement, because the great lengths of mains and the friction destroyed the head. Up to a recent period in London, for fire service, the old, effete method of a plug driven into the main was the only one in use, and that plug had to be drawn, to allow of the insertion of the stand-pipe before the engines could be supplied. Neither London nor Paris could have an efficient and constant service without the intervention of service reservoirs. The two-storied reservoirs in Paris, as described in the Paper, he had no hesitation in saying, without seeing the section, would be difficult to execute, difficult to maintain in an efficient state, and must have been exceedingly expensive, and in his opinion were not worthy of imitation. It was stated that the fall of the new aqueduct to bring water into Paris, was 1 in 10,000. The fall of an aqueduct must be in proportion to the depth and volume of water which it had to deliver. The fall of the New River in London was 1 in 10,000, or about 6 inches to the mile; but with so large a volume and an unpaved channel it was necessary to form a weir and give the water a vertical fall of a few inches at certain points of its course. He found that plan was adopted in the East. In laying out a line of aqueduct two principles were involved. If it were graded, as the Romans graded some of theirs, from 5 feet to 15 feet per mile, there would be difficulty in stopping the water at any point. It was practicable, however, to grade an aqueduct having a fall of 15 feet or 20 feet per mile, if vertical falls were introduced at intervals, alternately with level or nearly level lengths. This mode enabled an Engineer to fix the velocity, so as to prevent undue 'washing.' The vertical falls tended to aërate the water, and this in itself constituted an additional advantage. All covered aqueduct conduits should be abundantly ventilated; and there should be side entrances, stop-gates, overflows, and washout-valves.

Rev. J. C. CLUTTERBUCK would not attempt to follow the Paper through all its details; but there were two points on which he would offer a few remarks. One was the partial supply from the Artesian wells, and the other, the way in which the French

Engineers proposed to augment the flow of water from the head sources of the rivers. First, as to the supply from the existing Artesian wells; the way in which the Grenelle well at Paris was carried out by M. Mulot, at a heavy expense, and under serious discouragements and difficulties, was a matter of history.[1] The other great work at Passy had not long been completed.[2] Those who were well informed as to the state of things, admitted that the Grenelle well was affected by the discharge of water from that at Passy, to a certain extent. It was to this fact he wished to draw attention. He ventured to remind the Institution that in his published letter to Sir John Sebright in 1841,[3] he said, "There is reason to believe that a practice which has lately obtained of sinking wells into the chalk in London for the use of large establishments, may, if extended, produce serious consequences." Though this statement was received with incredulity at the time it was made, and though, in Papers, read at the Institution in 1842 and 1843,[4] similar statements were made, and were called in question, it was demonstrated in a Paper read in 1850[5] that those anticipations were correct. Since then the supply from that source had been given up by many large breweries and other establishments, and recourse was again had to the water companies, except in some cases for the purposes of refrigeration. Though the well at Grenelle derived its water from the lower green sand, the same principle might be applied to both cases, and he had been able to calculate the height to which water would rise in the Artesian wells of the London Basin, viz., the mean between the highest source of supply, and the ultimate outfall. He applied the same rule to the Paris Basin, the extreme points being the height of the water in the green sand at Lusigny, and the sea level at Havre; the rule stood good, and a line drawn from Lusigny, 131 mètres above the sea, and 100 mètres above Paris, gave the exact height that the water rose at Grenelle, and also at Elbeuf. He mentioned that fact, because, if, as had been observed, what was spoken in that room went all over the world, he would seriously warn those interested in the two wells in Paris, to which he had referred, not to draw too freely on the source whence their water was derived, viz., the lower green sand. A most extraordinary well, the Warren well, had been sunk to the same stratum near Brighton. He had calculated the

[1] *Vide* Minutes of Proceedings Inst. C.E., vol. xxiii., p. 459.

[2] *Ibid.*, p. 460.

[3] *Vide* "Letter to Sir J. Sebright, Bart.; On the Effects which will be produced by taking a supply of Water to the Metropolis from the Valley of the Colne, by the proposed London and Westminster Water Company." Tract, 8vo., vol. lxxviii. Watford, 1841.

[4] *Vide* Minutes of Proceedings Inst. C.E., vol. ii. (1842), p. 155, and (1843) p. 156.

[5] *Ibid.*, vol. ix., p. 151.

height to which the water would rise, and had expressed an opinion that no great quantity of water would be found; the facts confirmed his anticipations. Judging from what he had seen of the yield of water in the lower green sand in England, which corresponded, geologically, with that of the Paris Basin, he believed the present supply would be endangered if any large demand was made on it by boring additional wells. His anticipations, expressed twenty-five years ago, had been realized as to the wells sunk into the chalk in London; and if the advice he now gave as to the wells sunk into the green sand at Paris was neglected, the same disastrous effects would be realised there also. In all cases he had protested against any tampering with underground water, especially at the sources of rivers, as was proposed, for instance, in the project for supplying Cheltenham with water, from Cerney, on the Upper Thames. As he understood from the Paper, the French Engineers contemplated an increase of flow to the rivers supplying Paris, by some operations at their sources. That he considered a most dangerous experiment; it would produce the effect which, he feared, might now be traced to land drainage, especially in the oolitic formations of the watershed of the Upper Thames, where thin seams of oolitic rock alternated with beds of clay. Where those beds were drained for agricultural purposes, the water, instead of oozing from the hill sides throughout the year, was carried at once into the river, and reduced its perennial volume. He hoped that the Engineers, as the guardians of the water of England—for so he regarded them,—would do all they could to discourage any such interference with underground sources of water, but would be content to take it when it appeared above ground, as that course, he believed, would tend to the economy of the water supply of England, the value of which was daily increasing, and which, if once injured, could never be restored.

Mr. JOHN MURRAY said, respecting the fall and length of the New River, that from its source at Chadwell Spring near Ware, to the 'head' in the parish of Clerkenwell, the length was originally about 39 miles, and the fall throughout was, on an average, about 4½ inches per mile. There was originally, and now existed, a stop-gate at Bush Hill, to regulate the sudden fall, which varied at that point, in recent times, from 18 to 24 inches. The opening of the sluice varied from 15 to 18 inches in height, and it was 4 feet 6 inches wide, discharging, by calculation, about 3,100 cubic feet per minute. A great number of bends, some of them very circuitous, originally existed in the course of the river, as it followed the contour of the country. Many of those had been taken off, by making the channel straight, through cuttings, and by embankments; and he believed the course had been shortened by these means about 6 or 7 miles. In consequence of the shortening of the distance, the fall had to be regulated, otherwise it would have been in some places too great, and would have torn up the bottom, or injured the banks. For that purpose two additional stop-gates had been provided, one at Hornsey, and the other at Highbury. The fall of the water surface, deducting the stop-gates, varied from $3\frac{3}{4}$ inches to 4 inches per mile. Those stop-gates acted as regulators at certain periods; for, by partially closing the openings of the gates, the water accumulated in the pens above, and then, by raising the gates to their ordinary height, the extra body of water was allowed to pass along the channel to the reservoirs at Stoke Newington and the New River Head.

Mr. W. ATKINSON remarked, it had been stated that in laying out an aqueduct there was an advantage in constructing a great portion of it on a flat gradient, and in acquiring the velocity by the introduction of rapids at different points of the course. In the canal of Isabel II., from the Guadarama range to the city of Madrid, the gradients, in open cutting and earth-works, were 1 in 5,000; in tunnels 1 in 1,500; and for aqueducts 1 in 1,000. The object in that was to reduce the cost of the works by increasing the velocity, and diminishing the sectional area. The same plan had been adopted in the Canal de Marseille, at the celebrated bridge aqueduct of Roquefavour, where the sectional area was reduced one half; and the velocity, by the increase of gradient to 1 in 250, was doubled. Great stress had been laid upon the benefit of supplying towns with soft water, on the ground that hard water for drinking purposes was not equally conducive to health. But a high authority on that subject, Professor Johnston, had expressed an opinion apparently at variance with that view. He had said:—

"It by no means follows in all cases, perhaps not even in the majority, that the purest of water is the best for the health of a given family, or for the population of a given district.

"The bright, sparkling, hard waters, which gush out in frequent springs from our chalk and other limestone rocks, are relished to drink, not merely because they are grateful to the eye, but because there is something exhilarating in the excess of carbonic acid they contain, and give off as they pass through the warm mouth and throat, and because the lime they hold in solution removes acid matters from the stomach, and thus acts as a grateful medicine to the system. To abandon the use of such a water, and to drink daily in its stead one entirely free from mineral matter, so far from improving, may generally injure the individual or local health.

"The human body requires a certain proportion of lime to be contained in or mixed with its food. If the common diet do not contain a sufficient proportion of this mineral ingredient, the common water of the country may supply the deficiency; and thus a national mode of living may spring up, the salutary properties of which depend partly upon the food, and partly upon the water."

If the question of absolutely pure water, with regard to its distribution in houses, were considered, the effect of the water on the lead must be taken into account; for, though lead cisterns were not much used, lead service pipes were generally employed. Lead in small pieces, when placed in distilled water, was rapidly dissolved: it was established by eminent chemists, that where lead pipes were used, the most dangerous impregnation was when the water was the purest, and that so large a proportion of salts as a 4,000th part would be insufficient, if those salts were chiefly chlorides. Now, the 4,000th part was about 17½ degrees of hardness, and was nearly the same as the standard of the French Engineers. So that, whether the question was viewed physiologically or with regard to the danger from solution of lead, it did not appear advantageous to use very soft water.

Mr. J. F. Bateman thought the necessity for the presence of carbonate of lime in water, for the purpose of preserving health, was far from being proved. The great characteristics of the people who inhabited the soft-water districts of England and Scotland, were size of bone, and strength; whereas those who lived where there was the largest proportion of lime in the water were, in general, physically inferior. The people of the granite districts of Aberdeen, of the highlands of Scotland, those of the Silurian districts of the lowlands, and of the Lake districts of Westmorland and Cumberland, as well as the inhabitants of the backbone of England, between Yorkshire and Lancashire, drank soft water because they could get no hard; and they were among the finest men to be found in the kingdom; whereas in those districts in which there was abundance of lime in the water—Dorsetshire and Wiltshire, for example—the race was much smaller. He had hoped that the erroneous theory of chalk in the water being necessary for the formation of bone in the animal frame had been exploded. Again, there was the unfounded apprehension of the action of soft water on lead pipes being deleterious. The city of Glasgow had expended no less a sum than £4,500 to investigate that particular question. The water of Loch Katrine acted very powerfully indeed upon lead. On putting a piece of bright, pure lead into a vessel filled with it, its effects were seen in less than half an hour: the water became opalescent. It was declared that the health of the inhabitants of Glasgow would be seriously affected by lead-poison if the Loch Katrine water were supplied to them. But the water had been supplied without any apparent ill effects. He had in his possession, for twelve years, lead pipes through which the water of Loch Ness—which acted more powerfully on lead than that of Loch Katrine—had passed for fifteen or twenty years. Those pipes were completely coated inside with an oxide of lead, which was insoluble in water, firmly adhered to the pipes, and perfectly protected them. There was no doubt that at first, if the pipes were pure and bright when introduced into a house—an unusual condition—the water would, for a short time, act upon the lead, but the ultimate oxidation of the surface afforded an insoluble lining, and afterwards no further danger was to be apprehended. As to the effect of soft water upon the health of those who drank it, the town of Paisley was formerly supplied with water of a very hard description, and gravel and stone was the common malady among the inhabitants. Now that they had soft water that disease had disappeared. Manchester was at one time supplied with hard water, and during that period the same disease was prevalent there. Soft water was now supplied to that city, and beneficial results had followed. As an instance of the tendency of soft water to prevent, or destroy calcareous accumulation, he might mention, that when he first began to construct the Manchester Water Works, he found the whole interior, not only of the reservoir, but of the pipes—large and small—coated with myriads of small mussels. No doubt the material of which their shells were formed was derived from the lime contained in the water; for upon introducing soft water the mussels, no longer able to obtain the lime necessary to their existence, died, became detached, and were carried by the current of the water to the lower end of the pipes; many of the smaller pipes becoming, in consequence, choked with them. The effect was, that the soft water gradually dissolved the shells, and ultimately all were absorbed, and disappeared. During the process of absorption, the water delivered in the city varied from $1\frac{1}{2}$ degree to 7 degrees of hardness; the variation being, no doubt, due to the presence of the mussels. Now the water was uniformly delivered in its normal state of from $1\frac{1}{2}$ degree to 2 degrees of hardness. He believed there had been no case of lead-poisoning properly attributable to the soft water, in Manchester. In the older parts of the town there were, however, multitudes of lead cisterns deriving their supply from the rain falling upon the roofs of the houses, which were covered with the salts and acids issuing from the chemical works and tall chimneys of the neighbourhood. Those salts, or acids, being carried away with the water, acted powerfully upon the lead, and cases of poisoning were the result: but there were none where the water was conveyed in lead pipes directly from the street mains into the houses. He thought the importance of that branch of the subject was such that it never ought to be overlooked. The introduction of the Loch Katrine water into Glasgow produced an immediate saving in domestic establishments of £40,000 a year. In his own household, where he had introduced water of only $\frac{6}{10}$ths of a degree of hardness, in the place of the hard water previously used there, he calculated the economy at 5*s.* per head per annum. It was not hardness, but aëration and coldness which gave freshness and pleasantness for drinking. Those were the characteristics of the hard water from the old and new red sandstone, from the millstone grit, from the gravel detritus of granitic and most primary rocks; and of the soft water from the lower green sands. Where water had passed through the gravel or porous rock of such formations, it became aërated, and it was that, and not the lime, which made it so pleasant and wholesome. The same might be said of the Ennerdale water, and of that of the Lake districts generally. All those waters, with the exception of Loch Ness, were derived from the clay slate, or Silurian formations, which contained no lime. The clay-slate waters were exceedingly soft, but generally more vapid than many other waters. Loch Katrine water was much aërated. The water of Loch Ness was derived from the granite; and its more powerful action upon lead was attributable to the large amount of oxygen it contained, and the absence of lime. Pure, brightly-scraped lead, exposed in that water, would, in a few days, make the water look thick and milky, and yet it was drunk without the slightest injury to health.

Referring to the falls in aqueducts, he might state, that in the Loch Katrine aqueduct of the Glasgow Water Works, the fall was 10 inches to the mile throughout, except where the water was carried by syphon pipes across deep valleys which, in one instance of a hollow of 250 feet, was done for a distance of 3½ miles, and in these cases there was a fall of 5 feet per mile, to economise the size of the pipes. In the city of Paris, it would seem, that with only half the population of London, the anticipated supply of water would be greater than the latter city now had.

Mr. S. C. Homersham said, at the present time the inhabitants of Paris received, by means of the recently-constructed Dhuis aqueduct, a daily supply of 8,000,000 gallons of pure spring water, and he thought a greater boon could not have been conferred upon any city. Further, when the intended Vanne aqueduct was finished, another 22,000,000 gallons of the same kind of water would be conveyed to Paris. It was satisfactory to find, that M. Belgrand, the Engineer of the Paris Water Works, had succeeded in inducing the authorities to construct the Dhuis covered conduit 80 miles in length, in order to bring into the city pure spring water from the chalk, instead of taking the new supply from the River Seine, a short distance above Paris, and filtering it, as was once proposed. Commencing at a distance of about 60 English miles east from Paris there was an area of 4,780 square miles of chalk rising in hills, the tops of which were from 500 to 600 feet above the level of the sea. Not only was the rainfall of that district, or the greater portion of it, absorbed by the chalk, as it fell, but there was a large drainage ground at a higher level, and beyond it, having an area of about 9,500 square miles. So that the chalk not only received the rain-water that fell on its own surface, but also received and absorbed a portion of the water that fell upon those 9,500 square miles beyond it. Calculating, however, that a depth of only 10 inches per annum of the rain was absorbed on the chalk area, which was a reasonable calculation, there would be a supply of water into the chalk equal to one billion six hundred million gallons per day for every day in the year. He mentioned this because a hope had been expressed, by a previous speaker that the water of the chalk would not be tampered with; but Mr. Homersham knew, that at the point near where the Dhuis aqueduct received the spring water, 40,000,000, or 50,000,000 gallons per day of spring water might be obtained by underground works with the greatest ease, without injury to any interest whatever. At the present time, that water flowing through subterranean channels in the chalk escaped into the sea, and was wasted. If the proposition for taking the Seine water, filtered, had been carried out, the result would have been that the inhabitants of Paris would have had supplied to them water containing from 12 to 13 grains of saline or mineral matter to the gallon, whereas the water of the chalk contained 22 grains of saline or mineral matter; but in addition to the mineral matter, the Seine water contained a large quantity of impure organic matter and living animalcules. Even if the river water were filtered, first, through sand, and afterwards through a Lipscombe filter, the animalcules and the other impurities would not be removed, so that if the water were used without being boiled, it might cause many diseases. The avowed object of M. Belgrand was to get spring water, free from impure or organic matter.

With regard to the action of soft water upon lead, it was quite true that Loch Katrine and other lake waters dissolved lead; but that was not the case with pure chalk spring water when softened down by Dr. Clark's process to as low as 2½ degrees of hardness. The latter had no action of any kind upon lead; but lake and surface waters were never found to be pure; that was to say, although the inorganic, or mineral matter, might not exceed 2 grains or 3 grains to the gallon, yet, if an examination with the microscope were made, the water would be found highly charged with living animalcules, nourished by the impure organic matter contained in the water. It was that which made lake and river water dissolve lead and be so unwholesome. The Registrar-General's late returns showed that in Glasgow, which was supplied with the soft Loch Katrine water, the death-rate was as much as 38 per thousand; in Birmingham it was 30, and in Sheffield 33 per thousand; but at Hull, where, within the last two or three years, pure spring water from the chalk had been supplied to the town, instead of filtered river water, the death-rate, after the change, fell as low as 23 or 24 per thousand The examination of water was not merely a case for the chemist, but also for the microscopist and physiologist. A short time ago Mr. Homersham had the water from the lake of Orta, in the north of Italy, analysed; it was found to be only $\frac{6}{10}$ths of a degree of hardness, and to contain only 3 grains of mineral matter per gallon, but when examined with the microscope, it was found to contain many kinds of living animalcules, so that if taken it would undoubtedly prove noxious. At a lecture, recently delivered by Dr. Thudicum, before the Society of Arts, it was stated, that in the lake districts of Switzerand, the propagation of entozoa among the people was caused by eating fish taken from the lakes. If really pure wholesome water for domestic use was wanted, uncontaminated subterranean springs must be resorted to, and if the water was too hard naturally, it might readily be softened by artificial means. Chalk spring water might easily be brought down to $2\frac{1}{2}$ or $3\frac{1}{2}$ degrees of hardness. So treated, it was much approved for domestic use. It was not only soft, but did not contain any organic matter, and had no action on lead. The mud from the bottom of Loch Katrine, and from some large artificial reservoirs used for town supplies, would be found to be of the most disagreeable kind, being composed of decayed leaves, the exuviæ of fish, and other impurities, yet such lakes and the reservoirs were never cleaned out, and yet the water was supplied to towns for drinking purposes. He could refer to a reservoir at Todd's Brook, in Derbyshire, at the head of the Peak Forest canal. The water was of remarkable softness, and contained only 2 or 3 grains of mineral matter to the gallon. He had sent samples of that water to two eminent chemists, and each of those gentlemen required as much as 3 gallons to make a reliable qualitative analysis. Notwithstanding this, he had frequently taken a tumblerful of that water direct from the reservoir in the autumn, and had counted in it, without the aid of a magnifying glass, twenty different living insects. It was said that such water should be filtered. The larger insects might be removed by filtration; but the smaller ones, together with their eggs and larvæ, and other impurities, would go with the water through a sand filter, first, and then through a Lipscombe's filter, and afterwards the organisms would still live, breed, die, and putrefy in the water. He therefore thought the authorities in Paris had done wisely in acting upon M. Belgrand's advice, and in going the long distance of 80 miles with one conduit, and 105 miles with another, to obtain spring water from the chalk hills, instead of taking their supply from the River Seine, or from other surface water. The Dhuis spring water could be easily reduced to about the hardness of 2½ degrees, if that was required. As to the wholesomeness or unwholesomeness of chalk dissolved in water, he believed it was of little consequence whether there was lime in the water or not; but he held it to be indispensable that water for domestic use should be free from all organic impurities.

Mr. C. B. LANE said, that a quarter of a century ago it was proved from statistics, by the late Dr. Prout, an eminent chemist and physician, that calculous diseases were more rife in the districts of England where chalk-water was drunk than in others.

Mr. FLEEMING JENKIN remarked, that this Paper was one of peculiar interest to him, inasmuch as he was engaged, with Mr. Forde, in carrying out water works of considerable extent in the town of Rouen. The method of supplying the private consumers in Paris had not been touched upon; it might therefore be interesting to the Institution to be informed of the system pursued in most French towns. There were no water rates in Paris, or in any other town in France; but the water was subscribed for, and the charges were based upon two plans not in use in England. One might be called the gauge-cock system, and the other the system by estimation. By the former plan the water, where it went into the houses, was regulated, so that the average pressure on the pipes would not deliver more than a certain quantity per day, which quantity was taken as the basis of the subscription. Thus, if a subscriber wished for 1 cubic mètre of water, or 220 gallons per diem, the cock by which the water was supplied was 'throttled,' so that if the water ran into the house the whole day, he could not get more than the 220 gallons subscribed for. Besides this, there was a cistern with a ball cock, which shut off the water when full. Under that system much waste was prevented. That was the plan proposed to be adopted in Rouen, and actually used in most other large towns in France. By the other system it was estimated that a certain quantity of water was consumed per day, on the following scale:—

	Gallons.
For each person	4·4
„ horse	16½
„ two-wheeled carriage	8¾
„ four-wheeled carriage	16½
„ square mètre of garden	⅓

In Paris, the price for filtered water ranged, from 2*s.* 4½*d.* per 1,000 gallons for small subscriptions of 55 gallons per diem, to 1*s.* 2½*d.* per 1,000 gallons for large subscriptions of 220 gallons per diem. The water from the canal de l'Ourc was charged for at the rate of 7¼*d.* per thousand to subscribers who took quantities of between

220 and 1,100 gallons per diem. For very large quantities it was supplied at $4\frac{3}{4}d$. The smallest subscription allowed for domestic purposes was £2 8*s*. In Havre, the arrangements were very similar; the price ranged between 19*s*. 9*d*. and 11*s*. 3*d*. per thousand; and the smallest subscription was £2 per annum. In Bordeaux the subscription might, at the option of the subscriber, be based on the rent, being about $6\frac{1}{2}$ per cent. on small rents (£12), and a little more than 1*s*. per cent. on large rents, the smallest subscription being 16*s*. There were no means of ascertaining what proportion of the supply to Paris was reserved for the use of private consumers; nor could he find out what the consumption was at the present moment. At Rouen the authorities stipulated for a supply of 30 gallons per head per day; reserving to themselves the right to use one half the supply for municipal purposes, and of that quantity very little was employed for ornament. The water was allowed to run along the gutters for two hours a day in each street; but as this was done at a low velocity, it did not carry away much dirt, and seemed almost to be wasted.

Mr. BATEMAN observed, that in refuting the opinion, that hard water was essential to health, he had instanced the soft-water districts as producing the finest men, merely to show that soft water was not prejudicial to the formation of bone. He agreed that the hardness or softness of water had nothing to do with the disease of gôitre, which was attributable to the close air of the valleys. With respect to the death rate of 38 per thousand, in Glasgow, he would say, in the town of Whitehaven, which was now supplied with water from the Ennerdale Lake, in the four years preceding the introduction of that water, the death rate was 36 per thousand, while in the four subsequent years it was reduced to 24 per thousand, and there was no other cause to which that diminution could be attributed but the introduction of the soft water.

Mr. HAWKSLEY, V. P., remarked, that there was a sequel to that; for after the second period of four years, the death rate returned to what it was previously.

Mr. HOMERSHAM explained, that his meaning was, not that the softness or hardness of water had so much influence upon health, but that pure spring water was perfectly wholesome; while lake or river water was always found to be more or less impure, and in consequence abounding with minute insects.

Mr. G. R. BURNELL, in reply, said he had little to add to the Paper. As regarded the present water supply of Paris, he thought it could not be counted upon. The proportion of the Paris water supply which was intended to be devoted to municipal purposes, and for gratuitous distribution, would be a minimum of about 52 million gallons, or about 50 per cent. of the calculated ultimate supply, which it was estimated would amount to 103 million gallons per day, or commensurate with the increase of the population. The question of the advisability of using hard or soft water had been sufficiently discussed, and he would not offer any remarks upon that point, further than that the instance so often quoted, of Aberdeen and that part of the coast, was a fallacious one, because the inhabitants of all that part of Scotland were of Scandinavian descent, and were therefore a large-boned race. He thought that the neglect with which questions of ethnology were treated might lead to great errors. The Registrar-General's returns of the deaths in those towns where soft water was consumed, as Liverpool, Manchester, and Glasgow, showed a considerably higher rate of mortality than that of London; that, he thought, might be taken *primâ facie*, as presumptive evidence in favour of hard water.

Upon the subject of the wells of Passy and Grenelle, he would say, when the Passy well was first sunk, it considerably affected the Grenelle well, so much so, that the yield of the latter fell off to about 120,000 gallons per day from its former yield of 200,000 gallons, and from its original yield of 800,000 gallons per day. The size of the bore of the Passy well was about 3 feet 4 inches, while that of the Grenelle well was only 8 inches: the yield of the well was, consequently, about in proportion with the size of the bore. The inference he drew from that was, that M. Belgrand had reckoned upon rather too large a yield from the proposed Artesian wells.

Mr. FOWLER, President, said, as that was the last regular meeting of the Institution till November, he wished to say a few words as to the Papers which had not been read. The discussions during the present Session had generally extended to a greater length, and, he thought he might say, had been of greater interest than usual; but the consequence had been that a considerable number of Papers accepted by the Council had been obliged to be postponed. The list embraced many interesting subjects, and he believed there were other communications of equal importance in preparation; at the same time, he must be permitted to say, the Council would be happy to receive further essays on some of the many unexhausted subjects which were suitable for discussion. He would beg to add, that he remembered no period in which the Papers had been prepared with more care, or with more liberality of illustration, than in the present Session.