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EVERY HOUSE ITS OWN WATER SUPPLY.

BY SHIRLEY HIBBERD, ESQ., F.R.H.S.

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POURING UNTO US FROM THE HEAVEN'S BRINK."
Keats' Endymion, I. 23.

LONDON:
EFFINGHAM WILSON, ROYAL EXCHANGE.

MDCCCLXXIX.

PRICE ONE SHILLING.

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AMONG what are called the "burning questions" of the day is that of Water Supply. The newspapers are crowded with reports of commissions and conferences, analyses of blue books, letters of complaint and inquiry, and editorial leaders on the various points of the great controversy. The ratepayer groans when the water rate is demanded, and the grounds of this groaning are that the supply is bad and the price exorbitant. Amongst the many proposed remedies for the scarcity, badness, and dearness of the water are the transference of the system of supply from the hands of trading companies to those of municipal councils, and a very bold enlargement of the field from which the water is collected. Glasgow has given a bold example in drawing its supplies from Loch Katrine; Manchester proposes to tap Thirlmere; and London, which needs no less resources than those of the whole world to keep life and soul together, is seriously considering the cost of obtaining water from Bala Lake, to begin with, and from any or all of the mountain streams and lakes that constitute the chief scenic glories of North Wales and Cumberland. Millions have been expended on public water supply, but the results are unequal to the requirements of the case, and the supply must be increased by the expenditure of more millions, so that the present wail of the water-consuming citizen, who in the end must pay for the performance, is likely to be augmented in loudness and dolefulness, for in truth, water, which he must have or perish, is rising in the market, and he must pay handsomely to obtain a reasonable share of the precious article. The object of this pamphlet is to persuade him that he may, if he pleases, make an end of his obligations to the water company by establishing a supply of his own—a supply that will cost him absolutely nothing, and that will continue as surely as seedtime and harvest, for himself, and his children, and his children's children. It is a perfectly new supply, because practically it is unknown, and therefore neglected, but nevertheless it is as old as the hills that fill the lakes, and is the ultimate source of every possible water supply. It will not be the privilege of the writer of this to develop a discovery; his object is to give new faces to old facts, and bring them home to every household wherein there is somewhat of the spirit of self-help.

It may be assumed that the Water Companies have done and are doing the best in their power to meet the wants of their customers. It is their interest to render opposition powerless and disarm the clamour raised against them. They certainly must rank among the greatest benefactors of mankind; and, although they represent only a commercial response to a loud demand, they may nevertheless be regarded as true pioneers of civilization. They have done for the people what the people would not do for themselves. The tendency of humanity is to pollute and waste water at every opportunity. The brightest brawling trout stream becomes a mere kitchen midden when it passes near a village, and the noblest navigable river has to bear, not only the burdens of commerce, but the refuse of manufactories and the sewage of towns. The Water Companies step in between the destroyer and his prey, they save a certain amount of water in a better state than would be saved without their agency, and they place it at the service of those who, without such aid, would perish of thirst or poison. If for this service they demand to be paid well, they do but prove thereby they are like other people, and have wrought out in their own interest the commercial doctrine of buying in the cheapest and selling in the dearest market.

Whatever may be the course of legislation on this subject, or the policy of the companies to avert legislation and keep affairs safely in their hands, it is certain every man has at his command, to a very great extent, the means of securing an abundant and perfect supply of water by the simple process of utilizing the rainfall. In this year of agitation on the subject the rainfall has been more copious than has been known for many years, and has been almost wholly allowed to run to waste. There has been "water, water, everywhere, but not a drop to drink." Nor is the wanton waste in rainfall the only sin society has to answer for in the presence of a bountiful Providence. The cost of its removal by means of channels and drains is enormous, and the addition of the rainfall to sewage proper renders the utilization of sewage impossible by reason of its unmanageable bulk and excessive dilution. Thus the rain that we refuse to catch and keep adds to the burden of the ratepayer by every drop that falls, and is made the means of conveying to the sea, to be lost for evermore, those constituents of the soil that are the causes of fertility. We are prospecting among the hills and boring into the depths of the earth in search of water, while if we would but look to heaven we should have plenty, and the Divine assurance of heavenly drink for evermore. The rainfall in London averages twenty-five inches. One inch of rain falling on an acre of ground is 22,622 gallons, and, if there are twenty-five houses on that acre of land, the total annual rainfall is exactly that amount for each of them. Suppose only one-tenth of the total fall is caught and saved for household purposes, that is 2,262 gallons per house. The rainfall of the present year will greatly exceed the average, but exceptional circumstances should not be brought into the present consideration.

The proposal to use rain water for any but the roughest purposes will surprise a few, and annoy many. Rain water is in bad repute, more especially in towns. Here and there we meet with an ill-looking water butt, from which may be drawn a sooty fluid that is less remarkable for its sootiness than for its offensive odour, and sometimes for the plenitude of mysterious life it contains in the shape of wriggling and jerking creatures, whose activities indicate that the water must contain something substantial for their sustenance. It might be better to be content with the water supplied by the companies than to drink such filth as this, but the filthiness is profoundly instructive. The companies travel far and incur great expenditure to discover springs and wells; they construct great engines and filtering beds, and in various ways make a business of obtaining and preparing water for domestic use. But when the householder enters into the business for himself he sticks up a second-hand rum puncheon, without a cover, in the full sun, exposed to all weathers as a contemptible thing, and in due time complains that it stinks! Well, a leg of mutton would do the same thing. If water is worth having it is worth respectful and reasonable treatment, and when rain water obtains this treatment it is better in appearance, better in flavour, better for cooking, washing, and all other domestic uses, than any other water, no matter from what source obtained. This subtle element acquires contamination of some sort the instant it touches the earth, and the contamination is in exact proportion to the nature and solubility of the earth that constitutes the watershed, the watercourse, the bed of the lake, and the reservoir. Hence, indeed, the endless diversities in the characters of waters, for wherever we travel we meet with water characteristic of the place—often too characteristic, so that it becomes a serious question, how best to die with it, or live without it. The immense use of aerated waters and "mineral" waters generally affords testimony to the unsatisfactory nature of the prevailing supplies. But it is a grave question whether these conduce to the health of those who consume them. This, however, is beyond dispute, that many forms of disease, not the least of the number being urinary calculus and goitre, are direct results of the habitual use of waters impregnated with mineral substances that are never properly eliminated from the frame. The danger of mineralization is made manifest in the constant endeavours of all concerned to obtain *pure* water, and the scrupulousness with which the percentage of organic and mineral matters in any particular water are noted and commented on. And when the purest water obtainable is obtained, it is but rain water with the least contamination possible. What else is the water of Loch Katrine? The reason of its purity is that it is fed from a rock which yields but infinitesimally of its mineral constituents to the solvent powers of water.

This grand natural illustration of the true principles of water supply will suggest that the mode of catching and keeping rain water must in a very great degree determine its value for domestic use. An illustration, perhaps still more to the purpose, may be derived from the management of a successful aquarium. Here, unless the water is managed on scientific principles, ruin is as sure as the coming of night and day. In the early experiments the water in the tanks often became as offensive as the rain water that we occasionally hear of as caught and kept in the dirty little water butt in a sunny corner of the back yard. In due time it was discovered that small quantities of water, which are necessarily stagnant, are soon rendered impure by the mere action of light upon them. Hence we now find the tanks so placed that but little light reaches them, and there is kept for the refreshment of those tanks a reserve of water in cool, dark, underground reservoirs, wherein, though clouded when admitted, it soon acquires a crystal clearness, and becomes perfectly adapted for sustaining the delicate creatures that are preserved in the tanks. There is nothing accomplished without trouble, and a little trouble must be incurred in the preservation of rain water. For the supply from the companies we provide (that is, we pay for) costly conduits, capacious tanks, that are well covered in, and pipes and cocks for distribution. Even then, the water intended for drinking is passed through a filter, which, of course, only removes mechanical impurities, for it cannot remove the mineral salts that are perfectly dissolved and invisible, but which, nevertheless, the delicate organization of the frame will discover, and register in the shape of disease some day or other. A very simple arrangement will suffice for the preservation of rain water ; but, that being secured, the result will be a bright and beautiful fluid, soft and sweet and refreshing, for while it is under process of purification from soot and other inevitable impurities, it absorbs atmospheric air, and becomes naturally aerated, while its purity at last is such that it may be likened to distilled water.

The main requisites of the business before us are three in number. Firstly, the rejection of the first supply, or its separation for rough purposes, because contaminated with washings of the roof. But the roof being washed by the first flush of the storm, the water that follows will be comparatively pure, and will improve by subsidence. Secondly, the saving of the bulk of the best water, in a cool situation, and in complete darkness, but allowing a current of air to pass over the surface. The darkness prevents the appearance of any kind of life in the water. As a matter of fact, healthy vegetation is rather beneficial than otherwise to water, but people do not like to see it, and as we can have pure water without it there can be no need for a conflict with a silly prejudice. It will not cost much to secure darkness with coolness and ventilation, and a considerable bulk of the water may be kept in open tanks anywhere, and the only grand point will be to have tank room enough and to spare, so that a wet season shall carry the supply through a dry season, and the water in any given tank shall be allowed to stand some time before being used. Thirdly, the best water should be passed through a filter before being supplied to the table, to render it perfectly bright and completely aerated. A large filter, kept in constant use, will be found one of the best friends of the family, for it makes an end of all suspicion of the smoky flavour of rain water, which, however clear through subsidence, is sometimes slightly tainted with sootiness, until it has passed through the filter, when, without any exception, save the filter itself being in fault, the taint is entirely removed. Were it not so, there would be less harm to health in the absorption of an infinitesimal dose of pure carbon than in the absorption of salts of lime, alumina, magnesia, soda, arsenic, and other minerals, that are common constituents of commercial waters.

The practical matters that lie before us are of an extremely simple nature.

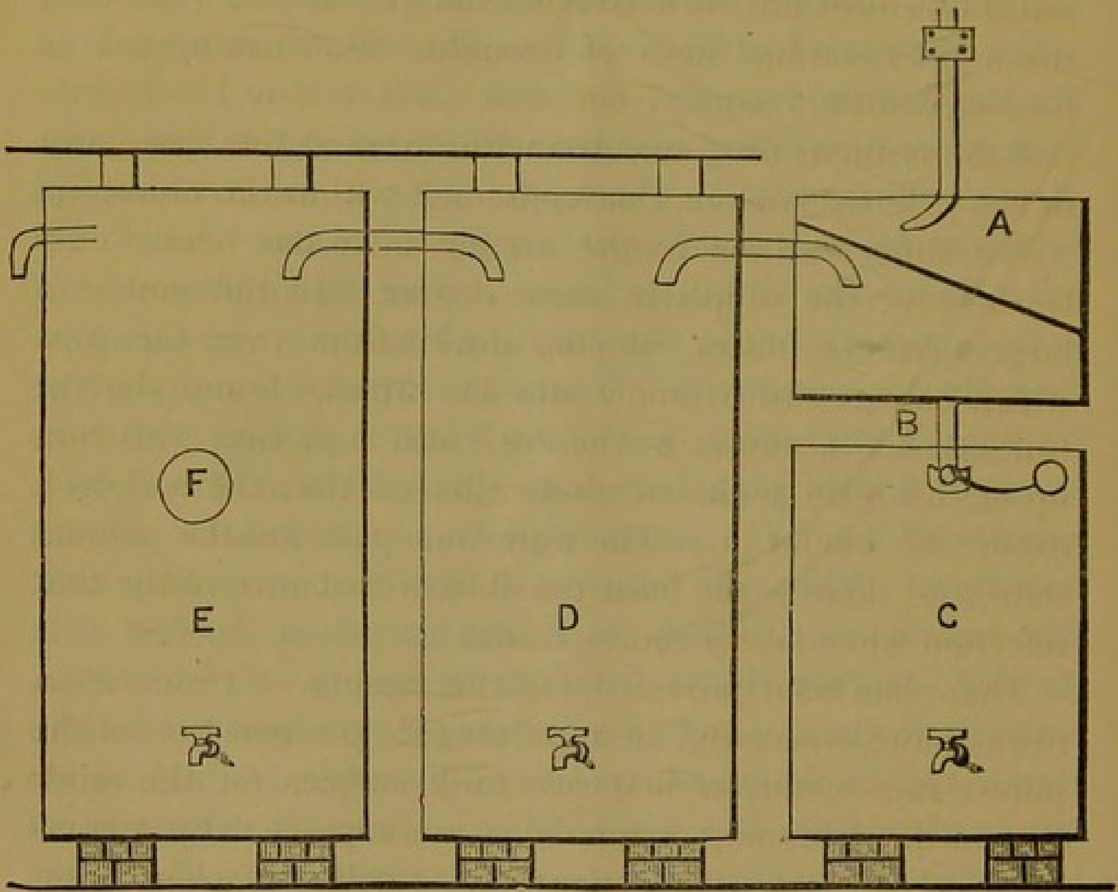
From illustrations, therefore, we pass to examples, and from arguments to facts. We will instance a country house of somewhat antique pattern, completely isolated in the midst of meadows, and lacking many of the conveniences that are found in modern town houses. This house had been for many years supplied with water direct from a river by means of pipes carried through grass land a considerable distance, and discharging into an underground tank. The water was pumped up as required, and in one respect, therefore, the supply was no better than if obtained from a well. At this place gardening was pursued with some degree of ardour, and consequently there were slate roofs, and glass roofs, and roofs of other kinds from which rain water could be collected, and iron tanks of considerable capacity were fitted in various places to collect it. The object of these arrangements was solely to advantage the garden, save that one tank was reserved for the household, and proved invaluable when soft water was required for washing and other purposes. Thus, there was hard water secured for cooking and drinking, and obtainable by pumping; and the garden was abundantly supplied with soft water for the benefit of melons, cucumbers, strawberries, cauliflowers, and the like. With no more warning than a mysterious gush of water in the grass land, one part—and the supposed principal part—of the water supply suddenly collapsed, and it was found that there was an end for a time of the flow of water from the river and the working of the familiar pump. To lay down a fresh service of pipes was a matter not only costly, but difficult, and must of necessity extend over some months. It was spring time, and the skies were clearing for hot weather, and the summer that followed was one of the hottest that had been known in our time. The case seemed desperate, and it was seriously contemplated to fit up a water cart for periodical conveyance of water a distance of about half a mile from the river, whence the supply had until then been derived. But before this plan could be carried into effect, sheer necessity compelled resort to the rain-water tanks. The water from the largest tank was filtered for daily use, and a great change occurred in the economy of the establishment. The inmates of this house had expected smoky tea and ill-looking vegetables, but were agreeably surprised to find the tea more delicately flavoured than before, and the vegetables—that in this house had never been badly cooked—greener and more savoury than ever; while as to water for drinking, it was remarkable for brightness, softness, and sweetness of flavour; for pure water has a flavour, although it is reputed to have none. This surprise was a deathblow to the water cart, and the pony designed for the drudgery was permitted to follow his old trade of trotting easily along the lanes on short journeys with light weights. It will not interest the reader to learn what was done in respect of the disused pipes and the old supply; but it is needful, to complete the story, to add that this entire dependence on tanks that were never intended for the supply of the house, and with no special arrangements whatever for the substitution of rain for river water, continued about nine months, and was thoroughly satisfactory from first to last.

During the long drought of a hot summer the supply several times appeared on the verge of failing ; but one smart storm would refill the tanks, and it was very soon discovered that a little management was needed to make the best of things. One point in the management consisted in allowing the first rush of water to run waste, or rather, to be more particular, means were taken to divert it into tanks and tubs for the service of the garden ; so that only when the roofs had been well washed was there any saved for the domestic supply.

A more interesting case than this occurred in the same house. There was on the upper floor a water closet for which there was no proper supply of water. The only solution of the difficulty seemed to be the employment of a force pump ; but in the end, this, like the water cart, was happily dispensed with. There was fitted, close under the ceiling of the closet, a shallow tank, and into this was brought a rain pipe from one side of the roof, and, as a matter of course a waste pipe was provided to prevent overflow. When rain occurred it was not surprising that the tank was well filled, but it was surprising to find that in dry weather the tank was never empty. It was like a miracle to those who had not learned to observe ; but in truth the explanation was not only simple, but as audible as words spoken in plain English. Towards the dawn of morning during the hottest weather there occurred a trickling of water from the roof to the tank, which tided it through the intervals of showers, and this trickling was the result of the condensation of dew on the slate roof. Here, then, is a source of water supply, small indeed, but constant, and in the case of an isolated country house by no means despicable, provided that to obtain water is attended with any degree of difficulty.

Another and a better example may be submitted to the reader, from a London house, where the rain water is decidedly sooty, and needs more scientific treatment than the simple subsidence and subsequent filtering in the case just described. Here, however, the arrangements are neither complicated nor costly, as the description will show.

The rainfall is in this case conducted to a tank which separates the first supply for rough purposes, and directs the second supply into large tanks for subsidence and filtering, whence is drawn the best water for the house. This collecting tank is marked A in the diagram. When it is



empty the ball cock, B, ensures that water coming into it will pass into the tank below, marked C. Thus the first supply is separated. The filling of C lifts the ball, and A then fills and overflows to D and E. In these tanks, which are of great capacity, and from which light and dust are excluded, the water being already selected by the action of the tanks A and C, very soon acquires such clearness as to be suitable for most household purposes. But a second selection is made by the insertion in the tank E of a filter F, which is connected with a pipe inside the house, and thus a pure and sparkling water is obtained in plenty. The filter is of a well-known construction, the water having to pass through its substance to the outlet within the house, and never requiring to be cleansed or interfered with. From each of the tanks, save the first, water may be drawn, as shown in the diagram.

As a matter of course the Filter should be as low as possible, consistent with convenience, in order to prolong the supply during times of drought. But every tank is furnished with a cock, from which water may be drawn; and these might be connected with filters in the same way as the pipe that delivers water from F within the house.

A trifling addition to the arrangement has been found to improve the supply in some degree. In the tank A a large slate is placed, sloping down from over the pipe which carries the overflow into D. It was found that at times during heavy rains the rush into A caused a stirring up of the little sediment that collected after the ball cock came into operation. The water now falls on the sloping slate, and there is the least possible disturbance of the first selection when heavy rains occur.

There has been provided, for the benefit of residents in towns more especially, an apparatus for the selection of the purest rain water, so that one tank suffices for the work that in the foregoing example is accomplished by a combination of three. The apparatus is called Buck's Patent Percolator. It is attached to the ordinary rain water pipe, and it effects a separation of the first supply by mechanical action, the first supply being directed into a reservoir provided for the purpose, or wasted, at the discretion of the householder. The second supply is directed into the reservoir intended for it, and at this point the arrangement of tanks shown in the diagram may advantageously come into operation where a large supply of the purest water is required. Between the first fall of rain and the separation of water by Buck's Percolator a period of about fifteen minutes will elapse; during this time the water is directed to the waste storage, or worst quality tank, or is lost altogether. At the end of about fifteen minutes the Percolator cants over, and a new action commences, the water passing through it being now directed to the clean storage tank, from which, as a matter of course, it can be directed into other tanks ad infinitum, and find its way, if needful, through any number of filters. The apparatus aims directly at the removal of the one weak point in the employment of the roof as a watershed for domestic purposes. After a term of dry weather, the roof, whether in town or country, is covered with dust, dead leaves, and various kinds of light debris, that will, as soon as steeped in water, undergo fermentation, and render the water offensive, as we find it to be in the little sour rain water butts that are planted in yards in aid of the laundry. The Percolator is a kind of box with two chambers, and it is fitted into the stack pipe on a swivel or pivot. A slight shower causes no action of the apparatus, and consequently the water that runs from the roof is lost, or goes into the waste storage. But a rain of some duration brings the apparatus into play. In the first instance the water from the roof passes through one of the chambers as waste. After from ten to fifteen minutes the second chamber, which is larger than the first, becomes filled with water through the action of a perforation provided for the purpose, and its weight causes it to overbalance the smaller chamber, and the whole affair then moves on the swivel, and the outflow takes a new direction into a pipe which conveys the water to the proper storage for supply of the household. The apparatus requires no attention, for its action is purely mechanical, not a drop of water being able to reach the storage until the rain has continued from ten to fifteen minutes. The result is water saved from a well-washed roof and a well-washed atmosphere ; and a clean slate roof is as good a watershed as can be desired. A recent inspection of the apparatus and the water saved by it proved in a striking manner its effectiveness. A house situate about the distance of a bowshot from the Kilburn Station on the London and North-Western Railway is provided with the apparatus, which is connected with a capacious reservoir. The water as it first flows from the roof is as black as ink, but as taken from the reservoir, without the aid of filtering, it is as clear as the most fastidious could desire. This house is supplied with water in the usual way by a company, but the rain water is greatly valued as supplementary, and is almost exclusively employed for cooking, the making of tea and coffee, as well as for laundry purposes. In this particular case the water supply to one house is just doubled in amount, and one half of it is absolutely perfect in quality for certain purposes. Were all London houses so situated there would be no need for prospecting at Bala, and perhaps but very small occasion for anxiety as to the constant needs of a thirsty population.

Receptacles for rain water are usually placed on the ground level, but they may be fitted close under the roof by simply providing suitable supports, and then the advantage of pressure—of which the companies seem to have a monopoly—will be secured, and the water will find its way to any part of the premises as the tanks and pipes may direct it. Indeed, the roof itself may be a tank with a perforated ridge-and-furrow water-catch on Mr. Ormsby's plan, instead of the pitched roof of slate. Thus, protection against fire would be secured in addition to a constant water supply at high pressure, for water is never wanted higher than the roof. In building a house this point is worth considering, because a roof promenade could be secured around the margin, and the roof itself being hidden from view, there would be greater scope afforded the genius of the architect.

It often happens that in the endeavour to provide villages with water the benevolent projectors turn their eyes to distant hills, and lose themselves in calculating the cost of obtaining what, at almost no cost at all, might be obtained on the very spot. An instructive instance of the kind is recorded by Mr. Chitty, of Stamford Hill, in the *Gardener's Magazine*, of September 17th, and October 1st, 1870. In that year of heat and drought the village of Knockholt, in Kent, suffered great distress. Amongst other plans projected for the relief of the villagers one was well carried out. A subscription was started, and the result was an expenditure of eight shillings per day in carrying water from Otford to Knockholt, a distance of four miles. The villagers secured thereby about a gallon each per day of water that was by no means of the purest.

When the season of distress was past its lessons were well taken to heart by some in Knockholt, and underground tanks were provided for the storage of rain water, the roofs being made contributory to the utmost possible extent. At the Grange there are six of these tanks: one for the dwelling house, 20 ft. by 8 ft.; one at the stable, 12 ft. by 6 ft.; one for washing carriages, 11 ft. by 20 ft.; one for cattle, 12 ft. by 6 ft.; one for workmen at the wood shed, 12 ft. by 6 ft.; and another for the gardener, 15 ft. by 11 ft. All are closed in from light and air, and the water is lifted by pumps as required. But in this village, as in many more, we may see the people dip water for culinary purposes from little mud holes that are crowded with live stock, through the influence of light and contact of the water with earth, although, in any case, a very trifling outlay would suffice to ensure an inoffensive, even if imperfect supply.

The exhibition illustrative of water supply at the Alexandra Palace, Muswell Hill, contains but few contributions towards the direct use of rain water. It is perhaps too strongly seasoned with the commercial element to grasp the whole subject in its social and scientific aspects. But there is one contribution of immense value and importance from Mr. A. Ormsby. This is a model showing how a special watershed may be created on any small spot of cheap land for the supply of a town or village, or any particular district even of London itself. An open elevated spot is preferred for the purpose, but in truth any spot on which rain falls could be made to answer at a pinch. The site is fenced in to exclude cattle and two-legged trespassers, and the area is covered with a ridge and furrow of concrete pierced all over with funnel-like openings. While rain falls, the water runs through these openings into pipes which communicate with a reservoir placed preferably underground, and being thus collected, may be passed on to the consumers by the ordinary appliances. The merit of the invention consists in the mode of collecting. An open reservoir might occasionally become the resort of water fowl, and would certainly be more or less peopled with the wriggling larvæ of innumerable flies, as well as with lively beetles, frogs, and the lower forms of vegetation. The larger animals are excluded because they cannot pass through the funnels, and of course have no desire to try the experiment. The smaller kinds of life are excluded by the light without which they cannot live.

The bearing of all this on the sewage question must be too obvious to need elaboration. Boards of works and engineers and chemists and ratepayers are alike paralyzed by the sewage problem. We know it to be absurd and wasteful to discharge sewage into the sea, and worse than absurd and wasteful to pollute rivers and poison wells by its agency. But the enormous bulk and increasing flow of the dark stream are sufficient to sweep swiftly out of sight every proposal of reform, and it seems the more money we spend the farther away are we from the end of our troubles. But suppose the overplus of half-a-dozen great lakes added to the sewage of London, Manchester, Liverpool, and other great towns, and what then will be done with the sewage? Its present unmanageable bulk is wholly due to the admixture with it of the rainfall, which ought to be caught and reserved for many uses, and the remainder guided into channels apart from the sewage. It is strange, indeed, that while in London we have had an almost continuous deluge of rain since the year began, the first sunny day that occurs witnesses the watering of the roads with water supplied at a high rate by water companies. We are an unthrifty lot, and it is fortunate the sea protects us, for if we happened to promote a war, and suffered consequent invasion, and had to pay a great indemnity, we should in all probability reach our end as an independent people. For the present, at all events, an Englishman's main ambition appears to be to attain to the perfection of wastefulness, even to the employment of the blessed rain from heaven to wash the fertile earth away from under his feet!

It will possibly occur to the reader that such plans as are here proposed are not well adapted for small houses built in blocks, or for country cottages that are widely separated. Such an objection would be perfectly just, but perhaps may be easily disposed of. Not, indeed, that any amount of argument or of demonstration will render our artisans and labourers thrifty of means and studious of health. They will seek and consume bad food and bad water through many a generation yet to come, and our towns will continue to be crowded with attenuated people, careless of the conditions of life that make men strong. But the primary principle of separating the bad rain water from the good rain water may be very fairly carried out by means of a couple of water butts and a little watching of their action, care being taken to get rid of the sediment periodically, and to waste or appropriate to garden purposes the first washings of every shower that occurs after a time of drought. Town houses, however small, are provided with cisterns and ball cocks and pipes for the supply of hard water, and if these can be paid for by the tenants, they can perhaps in many instances pay something less to ensure a good supply of soft water, which hitherto, except in very rare cases, they certainly have never enjoyed. It needs not to be pointed out that in many instances the produce of many small roofs might be conveyed to a set of tanks appointed for the common use of the inhabitants of the contributing houses, and that the cost of the plant would be as nothing to the value of the water, which would soon be appreciated for the washing tub and the tea kettle if collected in a proper manner.

The worst roof material for water catching is thatch, because of its inherent dirtiness and power of absorption. Tiles are clean, but absorbent, and therefore wasteful. The very best materials are slate and glass. The latter is at present known as a roof material for plant houses only, but it will probably soon come into use as a substitute for slates and tiles. We must not, however, defer water collecting until roofs are perfect, but make the best of them as they are. There is no one of the many necessities of life our poor are in greater need of than water. They are better provided with food than with water, and it cannot be expected of them to provide tanks and percolators, and ridge-and-furrow roofs. But they might be taught the decent and economical use of the rain-water butt, and the means of superseding mud holes. In many villages where thatched roofs prevail, and where water is too costly an article to allow of personal cleanliness, there are many roofs well adapted to afford a supply, but from which there is never a drop derived for the comfort of the people. The church, the schoolhouse, the market hall, and other edifices might be made to contribute to a common stock, and usually the water would be of better quality than the surrounding hills or adjoining rivers would supply, even with the aid of costly engineering. It is of the utmost importance to convince mankind that rain water is better than spring water, better than well water, better than river water, by the very fact that it has not been in contact with the earth, and is therefore neither hardened by minerals nor poisoned by sewage, but is water, and water only, all other kinds of natural water being impure by reason of the addition of something that at the best is superfluous, and, as a rule, is injurious, no matter for what purpose the water is required, whether for drinking, cooking, or washing.

The choice of tanks for storage must be in some part determined by the convenience of the locality. In a slate country slate tanks may be the best, both because of their wholesomeness and cheapness. In a timber country wood may have the preference. But when it happens that no particular material is at hand, then there is nothing so cheap, wholesome, and lasting as the common galvanized iron tanks that have of late years come into use for various purposes. These can be made of almost any size or shape provided the form is rectangular, and there is no difficulty attending their transport by road or rail, for they are light in weight as compared with the size, and rough usage does not seriously harm them. In the event of any leakage occurring after they are filled it will be advisable to clear them out and throw down on the weak place a little Portland cement freshly mixed with water, after which probably there will be no further leakage in the lifetime of the owner and his descendants for a generation or two.

Underground storage is better than aboveground, as regards the keeping of the water, but much less convenient. Puddled wells are not suitable for the keeping of domestic water, for contact with the clay renders the water hard and of an unpleasant flavour. Brick and cement are the best materials for general use. Large butts sunk to the rim and securely covered answer well, and last longer than butts above ground. If they are not covered they are sure to be defiled, and the action of light will be injurious. A handy pump costs so little, and is so convenient in use, that dipping should be prohibited, as a slovenly, wasteful, and dirty way of obtaining water.

A correspondent, writing on this subject, says: "For three years I and my family (six in all) dwelt in a suburb S.E. of London, and obtained all the water we needed without any help from a company, and consequently we never paid a farthing for the supply. We had enough and to spare, and our neighbours were often accommodated out of our abundance. All the rain water that fell on the roofs of the house and out buildings was conveyed to a cistern sunk in the garden. This was nine feet deep and four feet in diameter, bricked and cemented at sides and bottom, and covered with a trap door at top. The water was used in its natural state for household and garden purposes, but for drinking it was passed through a charcoal filter. I could not wish for better water; sweet, soft, and silky; perfection for tea making and washing, and comforting to the mind, because known to be free from taint of sewage and insidious mineral impurities."

The Abyssinian Tube Well has obtained but little attention in this country, although it is a most valuable auxiliary to the rain-water tank or the company's supply. Its simplicity and effectiveness are remarkable. A perforated tube is driven a certain depth—usually a few feet only—into the soil, and a pump is attached, and presently there is a fair supply of water. As might be expected, it is of little use on chalk and sand, because in such soils there is not usually any water near enough to the surface to be caught by such a frail trap. But, wherever there is water within a few feet of the surface, as there is in most heavy soils, and even in sheer sand and gravel occasionally, the tube well will secure it, and the supply may be regarded as inexhaustible. It is of necessity hard water, and more or less bad or indifferent, as may be determined by the circumstances of its origin. Within a certain range of conditions any kind of water is valuable, and the tube well has its place in these economies.

All filters, of whatever kind or shape, should be periodically examined and cleansed. The impurities they remove from the water may accumulate in them or upon them, to the detriment of their action and the injury, in various ways, of the household. It is too much the rule to leave filters to take care of themselves, which they are no more able to do than are the thirsty citizens they endeavour to serve faithfully.

If water supply may be called a "burning question," so also may the same be said of our means for preventing and extinguishing fire. Practically we have no means for either except in great towns. The country house, isolated in the midst of its own grounds, is likely to become a heap of mere charcoal and broken glass and twisted ironwork within an hour of the breaking out of fire in any part of it. But a fire dealt with promptly and with suitable appliances may usually be extinguished with ease and rapidity. A good supply of water on the spot is certainly one of the necessary safeguards, and a light garden engine on wheels is another. When a fire occurs people rush about and waste their strength in cries of alarm, because they are suddenly convinced of their utter helplessness. But in a well-ordered house the case is different, and when a fire happens each one knows what to do. The barrel engine, with its fittings all in perfect order, and the syringes and other such things, should be housed beside the water tanks, and in an emergency every one will know where to find them. A finely-divided spray, consuming a comparatively small amount of water, directed upon the place of the burning, will produce an effect instanter, while perhaps a heavy stream, or water thrown from buckets, would produce no effect at all. If the value of pure water for every day use does not appear a sufficient argument for the storage of rain water, the need of water for the extinction of fire may be urged, for, as the case stands, there is never anywhere a sufficient body of water to render suitable engines and willing hands promptly effectual in extinguishing fire. Hence it is that fires usually continue until there is nothing left tó burn, and the best that can be done is to prevent them from extending beyond the site of their origin, whether it be a house, a corn rick, or a stack of timber. *Bonum magis carendo quam fruendo cernitur.*

The following particulars bearing on water supply are taken from the *Garden Oracle and Horticultural Year Book* :—

FRESH WATER.

One cubic foot weighs 1,000 ounces or 6·25 pounds avoirdupois, and contains 6·2321 imperial gallons.

One foot in depth has a pressure of ·434 lb. to the square inch.

One foot in depth has a pressure of 62·5 lb. to the square foot.

35·84 feet in depth has a pressure of 2,240 lb., or 1 ton, to the square foot.

One cylindrical foot weighs 785·4 oz., or 49·08 lb. avoirdupois, and contains 4·8947 imperial gallons.

One cylindrical foot in depth has a pressure of ·34 lb. on an area 1 inch in diameter.

One cylindrical foot in depth has a pressure of 49·08 lb. on an area 1 foot in diameter.

45·64 cylindrical feet in depth has a pressure of 2,240 lb., or 1 ton, on an area of 1 foot in diameter.

When the atmosphere presses on the surface of the earth with a force of 15 lb. to the square inch, it balances a column of mercury nearly 30 inches, or a column of water 34·56 feet in height.

The quantity of water in 1 inch in depth of rainfall on an imperial acre of surface is 3,630 cubic feet, which is 22622·523 imperial gallons, or 101·28 tons. 3,630 cubic feet of rain falling in 24 hours is 2·52 cubic feet per minute.

NUMBER OF GALLONS CONTAINED IN RECTANGULAR TANKS.

Size in feet.	Depth in feet. 3 ft.	4 ft.	5 ft.	Size in feet.	Depth in feet. 3 ft.	4 ft.	5 ft.	Size in feet.	Depth in feet. 3 ft.	4 ft.	5 ft.
6 by 3	336	448	560	9 by 5	840	1120	1400	11 by 7	1437	1916	2398
6 ,, 4	447	596	745	9 ,, 6	1008	1444	1680	11 ,, 8	1644	2192	2740
6 ,, 5	558	744	930	9 ,, 7	1176	1568	1960	11 ,, 9	1848	2464	3080
6 ,, 6	672	896	1120	9 ,, 8	1341	1792	2240	11 ,, 10	2055	2740	3425
7 ,, 4	522	696	870	9 ,, 9	1512	2016	2520	11 ,, 11	2259	3012	3765
7 ,, 5	658	872	1090	10 ,, 5	930	1240	1550	12 ,, 6	1344	1792	2240
7 ,, 6	754	1132	1290	10 ,, 6	1116	1488	1860	12 ,, 7	1548	2064	2580
7 ,, 7	903	1200	1505	10 ,, 7	1305	1740	2175	12 ,, 8	1788	2384	2910
8 ,, 4	597	796	995	10 ,, 8	1491	1988	2485	12 ,, 9	2016	2688	3360
8 ,, 5	744	992	1240	10 ,, 9	1677	2236	2795	12 ,, 10	2232	2976	3720
8 ,, 6	894	1192	1490	10 ,, 10	1860	2480	3100	12 ,, 11	2466	3688	4110
8 ,, 7	1044	1392	1740	11 ,, 6	1233	1644	2055	12 ,, 12	2688	3584	4480
8 ,, 8	1194	1592	1990								

NUMBER OF GALLONS CONTAINED IN CIRCULAR TANKS.

Diameter.	When the depth is 3 feet.	4 feet.	5 feet.	6 feet.	7 feet.	8 feet.	9 feet.	10 feet.
4 feet	234	312	390	...	...	...	...	...
5 ,,	363	484	605	...	...	...	...	...
6 ,,	515	700	875	1050	..	...	...	...
7 ,,	720	960	1200	1440	1680	...	...	...
8 ,,	933	1244	1555	1866	2177	2488	...	...
9 ,,	1185	1480	1975	2370	2765	2960	3555	...
10 ,,	1464	1952	2440	2928	3416	3904	4392	4880
11 ,,	1776	2368	2960	3552	4144	4736	5326	5920
12 ,,	2112	2816	3520	4224	4928	5632	6336	7040

ANNUAL AVERAGE RAINFALL.

AVERAGE MEAN ANNUAL RAINFALL AT 144 STATIONS IN BRITAIN AND IRELAND.

Revised by G. J. Symons, Esq.

Aberdeen	31
Aberfoyle	60
Acworth	25
Alderley	33
Alford	38
Ambleside	78
Appleby	35
Applegarth	34
Arbroath	30
Arddarrock	76
Ardnamurchan	49
Arncliffe	58
Aylesbury	21
Ayr	44
Banbridge	29
Barnstaple	40
Bath	29
Bedford	21
Belfast	31
Ben Lomond	91
Berkhampstead	28
Birmingham	31
Bodmin	47
Bolton	50
Boston	22
Bovey Tracey	41
Braemar	33
Bridgewater	29
Bridport	32
Bury St. Edmunds	23
Bushey	24
Buxton	47
Canterbury	27
Castle Toward	55
Cardiff	43
Carlisle	30
Chard	32
Chatsworth	27
Cheltenham	32
Chichester	29
Cirencester	31
Clifton	33
Clitheroe	43
Cobham	24
Coniston	85
Cork	40
Cumbrae	42
Dartmoor	86
Dawlish	32
Derby	26
Dublin	30
Dumfries	41
Dundee	31
Dunoon	77
Dunrobin	27
Edinburgh	24
Elgin	25
Epping	25
Exeter	33
Falmouth	39
Galway	50
Glasgow	37
Glen Quoich	117
Gosport	30
Grantham	21
Grimsby	21
Haddington	28
Halifax	31
Hastings	29
Haverfordwest	48
Hawarden	24
Helston	39
Hengoed	36
Hereford	30
Hertford	25
Holkham	23
Horncastle	25
Inverness	26
Ivybridge	45
Kendal	53
Keswick	59
Klilaloe	48
Lampeter	45
Lancaster	44
Lawrencekirk	32
Leominster	26
Limerick	35
Lincoln	20
Liverpool	35
Llandudno	30
London	24
Londonderry	41
Manchester	36
Market Rasen	22
Monmouth	29
Norwich	24
Oban	66
Orkney	33
Ormskirk	35
Oxford	25
Portree	109
Peebles	29
Penzance	40
Perth	30
Plymouth	40
Preston	39
Retford	23
Rhayader	46
Rochdale	47
Ross	27
Salisbury	30
Seathwaite	140
Selborne	34
Settle	50
Sheffield	31
Shetland	40
Shields	27
Shrewsbury	27
South Molton	47
Southwell	20
Staleybridge	33
Stamford	25
Stornoway	46
Stranraer	47
Torosay	80
Taunton	29
Tavistock	45
Teignmouth	34
The Howe	80
The Stye	165
Thirsk	24
Truro	42
Tyree	85
Uckfield	33
Valentia	60
Ventnor	30
Wanlockhead	65
Waterford	40
Whitehaven	52
Wigan	43
Witham	21
Worcester	28
Worthing	23
Ystalyfera	63

WEIGHT OF CAST-IRON PIPES.

TABLE showing the Weight of Pipes 1 foot long, of bores from 1 inch to 12 inches in diameter, advancing by ¼ of an inch; and of thickness from ¼ of an inch to 1 inch, advancing by ⅛ of an inch.

BORE.	¼	⅜	½	⅝	¾	⅞	1
in.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
1	3·1	5·1	7·4	10·0	12·9	16·1	19·6
1¼	3·7	6·0	8·6	11·5	14·7	18·3	22·1
1½	4·3	6·9	9·8	13·0	16·6	20·4	24·5
1¾	4·9	7·8	11·1	14·6	18·4	22·6	27·0
2	5·5	8·8	12·3	16·1	20·3	24·7	29·5
2¼	6·1	9·7	13·5	17·6	22·1	26·8	31·9
2½	6·7	10·6	14·7	19·2	23·9	28·9	34·4
2¾	7·4	11·5	16·0	20·7	25·7	31·1	36·8
3	8·0	12·4	17·2	22·2	27·6	33·3	39·3
3¼	8·6	12·3	18·4	23·8	29·5	35·4	41·7
3½	9·2	14·2	19·6	25·3	31·3	37·6	44·2
3¾	9·8	15·2	20·9	26·9	33·1	39·7	46·6
4	10·4	16·1	22·1	28·4	35·0	41·9	49·1
4¼	11·1	17·1	23·4	30·0	36·9	44·1	51·6
4½	11·7	18·0	24·5	31·4	38·7	46·2	54·0
4¾	12·3	18·9	25·8	33·0	40·5	48·3	56·5
5	12·9	19·8	27·0	34·5	42·3	50·5	58·9
5¼	13·5	20·7	28·2	36·1	44·2	52·6	61·4
5½	14·1	21·6	29·5	37·6	46·0	54·8	63·8
5¾	14·7	22·6	30·7	39·1	47·9	56·9	66·3
6	15·3	23·5	31·9	40·7	49·7	59·1	68·7
6¼	16·0	24·4	33·1	42·2	51·5	61·2	71·2
6½	16·6	25·3	34·4	43·7	53·4	63·4	73·4
6¾	17·2	26·2	35·6	45·3	55·2	65·3	76·1
7	17·8	27·2	36·8	46·8	56·8	67·7	78·5
7¼	18·4	28·1	38·1	48·1	58·9	69·8	81·0
7½	19·0	29·0	39·1	49·9	60·7	72·0	83·5
7¾	19·6	29·7	40·5	51·4	62·6	74·1	85·9
8	20·0	30·8	41·7	52·9	64·4	76·2	88·4
8¼	20·9	31·7	43·0	54·5	66·3	78·4	90·8
8½	21·7	32·9	44·4	56·2	68·3	80·8	93·5
8¾	22·1	33·6	45·4	57·5	70·0	82·7	95·7
9	22·7	34·5	46·6	59·1	71·8	84·8	98·2
9¼	23·3	35·4	47·9	60·6	73·6	87·0	100·6
9½	23·9	36·4	49·1	62·1	75·5	89·1	103·1
9¾	24·6	37·3	50·3	63·7	77·3	91·3	105·5
10	5·2	38·2	51·5	65·2	79·2	93·4	108·0
10¼	25·8	39·1	52·8	66·7	81·0	95·6	110·4
10½	26·4	40·0	54·0	68·3	82·8	97·7	112·9
10¾	27·0	41·0	55·2	69·8	84·7	99·9	115·4
11	27·6	41·9	56·5	71·3	86·5	102·0	117·8
11¼	28·2	42·8	57·7	72·9	88·4	104·2	120·3
11½	28·8	43·7	58·9	74·4	90·2	106·3	122·7
11¾	29·5	44·6	60·1	75·9	92·0	108·5	125·2
12	30·1	45·6	61·4	77·5	93·6	110·6	127·6

CEMENTS.

LIME, GYPSUM, CLAY AND CEMENT, MIXED WITH WATER, OIL, OR BLOOD.—For cementing stone and for filling crevices in buildings before they are painted, the masons use a cement made of fresh blood, slaked lime, brick dust, broken-up coal ashes, hammer slag and sand, in all proportions. This excellent cement hardens quickly, and offers great resistance to the action of the weather. *A lime cement* for connecting water pipes, bathing tubes, &c.—A mixture of two-thirds fine brick dust, two-thirds unslaked lime, and two-thirds hammer slag, is made and stirred up with lye or hot oil to a stiff dough. *Another cement*, intended to render Hessian clay retorts impenetrable, is obtained by rubbing freshly-slaked lime into a concentrated solution of borax. The solution is applied with a stiff brush, and allowed to dry, after which it is heated until the glazing begins to fuse. *Clay* mixed with water and fresh warm blood, containing some unslaked lime, is used in Germany to close the joints in stoves. The cement is applied while the stove is hot. Wood ashes, fire clay and salt, mixed with water, is used for the same purpose. Fat and burnt clay, in equal proportions, moulded with water into a dough, is also used. *Plaster of Paris*, mixed with water and a cold solution of alum, is a good cement for stoneware. It sets slowly, but becomes as hard as stone.

IRON CEMENTS.—Their essential constituents are iron filings or borings. By the addition of some common salt or sal ammoniac they are rapidly oxidised, and the escape of carbonic acid increases the volume of the cement and completely fills the crevices where it is put. An excellent luting or cement for the joints and crevices in iron surfaces, and for rendering tight cast iron steam and water pipes and water tanks, is made of filings of cast iron. The filings are sifted to obtain those of the size of a grain of rice, and then rubbed with horse urine and one-half part sal ammonia well worked together, and an equal quantity of flowers of sulphur added. The mass is hammered until it gets warm, and then cold, and, finally, it begins to be brittle. In this condition it is put in the joints, and soon hardens. The surfaces where it is applied must be free from rust. Greasy and oily substances are most readily removed by rubbing with cotton dipped in bensine. The cement keeps best under water. Another good iron cement is made by stirring five parts clay, one part salt, and fifteen parts iron filings together with vinegar to a magma. It will stand heat, and is used for bellows and air pipes.

OIL CEMENTS.—For connecting cast iron water pipes, 12 parts Roman cement, 4 parts white lead, 1 part litharge, and ½ part colophonium are pulverised and mixed ; from 2½ to 3 lbs. of it is triturated with old linseed oil in which is boiled 2 oz. colophonium.

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