Graduating Thesis

Subject

Water Supplies from a Sanitary Point of View

by

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Contents

Introduction
Growing Interest in the Subject
Importance of Quality
Classification
Spring Water
Rain Water
Running Water
Its Source of Contamination
How Effected by Plant and Animal Life
Temperature
Ground Water
Artesian Water
Filtration
Importance of Filtration
Aid of Chemical Action
Contaminating Substances
Mineral Matter
Organic Matter
Animal Matter
Conclusion
Improvements of Systems

Public water supplies for the smaller towns are gradually growing in favor. They are becoming a common necessity and at the hand of the skillful engineer water is being placed at the door-way of all classes of people. Quality is attracting greater public attention and cost is being reduced to a minimum. Water has long been known to be the bearer of desease and the present attention that is being given to it places more emphasis upon the need of a more pure and wholesome article. Sanitarians and health officers are condemning the use of surface wells, streams, and drainage waters that have under any possible condition come in contact with matter thrown off from the animal body or been seriously polluted with decayed vegetable matter. The surface well is the source from which many families obtain their water, little heed- the danger there is connect- ed with it. These wells receive their supply from the rain- fall in the immediate lo- cality and the kitchen slops, privy valts, cess pools, and stock yards are subject to their drainage. Public systems are less subject to such contamina tion when properly located and cared for. Besides this the conven- ence of an abundant supply, the watering of streets and lawns, and protection against fire are important advantages.

A good quality of water is one of the essencial things to the health of a community. Poison ous matter both in suspension and solution may be present, as well as bacteria in innumerable numbers. Special diseases germs which cannot be distinguished from the harmless forms by the biologist may be scattered among the bacteria and find their way into the water supply of the community. Cases where typhoid fever, dysentary, cholera, and diphtheria have become prevalent may be cited where the water is known to be the only cause of the contagion.

Quantity is the most essencial thing in a water supply with quality second in the order of importance. The ocean is the great source of supply and as the water from it goes through the process of evaporation or distillation it reaches its purest state, and from this point it is gathering up or throwing off impurities until it is again evaporated. Water as it is winding its way back toward the sea can be classed under two general heads, namely, surface waters and ground waters, the former including rain, streams, lakes, and ponds; and the later springs, wells, and artesian waters.

Spring water is the purest natural source. It is often so pure from an organic point of view that it is difficult for the chemist to prepare a purer one. It is, however, subject to the collection of more or less mineral matter that may render it too hard for the best laundry purposes but which generally makes it more palatable. Being cool and so nearly free from organic matter and microscopic life it has been pronounced the best source of supply when sufficient quantity can be obtained.

Rain water is largely used for domestic purposes. Cisterns and small reservoirs are the chief methods by which it is stored, though the great water sheds of some of the large cities afford a perplexing question. Impurities are collected in either case and have to be contended with. In a clean atmosphere and an uncontaminated drainage surface it affords a very pure quality of water, but the collection of dust, germs, smoke, and waste material from upon the roofs and animal and vegetable matter from the drainage areas have to be guarded against. New Orleans has a large amount of contaminated ground water within a few feet of the surface and any leakage in a cistern connects it with contamination; also reservoirs in her more densely populated parts are placed in the back yards and alleys that are hemmed in on all sides by buildings and with so much decaying waste material and filth in them that it is disagreeable to enter. Under such conditions water is collected, stored, and used. Is it any wonder that epidemics break out in our large cities, when such desease brooding conditions are so closely connected with the people's source of living? Public supplies are troubled in keeping a water shed that is clean and uncontaminated. Few cities, if any, own their entire drainage area, and no law enable the city council to control the territory not in their possession. New York controls about one sixth of her drainage area and other cities a similar proportion. The lands are used by their owners as they choose and the impurities are washed down into the reservoir from which the water of the city is taken.

From the streams comes the surest supply but the most doubtful in quality. In densely habitated districts streams are often so badly contaminated that they are pronounced unfit for use especially where they have received the sewerage from a large city. In our Western Districts farmers are accostomed to building their feed lots and throwing their stable cleanings on the banks of tributaries so the washings will find their way to the principle water courses. Carcoses of dead animals are often thrown into the streams, and it is a common practice to build pig pens so the pigs can wallow in the mud along the edge of the stream, and the filth and excrement are washed into the course. Organic matter is washed in by the rain to a greater or less degree from the surrounding country. Mountain streams which would be supposed to be free from organic matter have been found to be dangerously contaminated. Both free and albuminoid ammonia are found in large quantities presumably from the vegetable growth that is left there to decay and be washed down, becoming mixed with the then pure water. Streams just after they have left the mountains have been found to contain more ammonia than when they reach the more thickly populated country.

Many small plants and animal are found in the surface waters some of which are a sign of the presence of organic matter while others act as purifiers. Fish are considered an advantage rather than a disadvantage to water and the only instances recorded of cases when they were injurious are those of epidemics which destroyed them. Aquatic plants are a source of contamination similar to land plants. The smaller ones are seen to collect on the surface of the water as film and when in reservoirs may readily be removed. These plants offord a hiding place for aquatic insects where they can take air down and store it among the plants enabling them to remain under water for a considerable time. Bubbles may often be seen escaping to the surface where the air has not been sufficiently protected or something has disturbed it. Insects by this means bring air in contact with the water and assist in the oxydation of the organic matter. The plants themselves as long as they are alive and in the water are not considered injurious. It is in case of their decay that they accasion any trouble, and then the water must be very warm and circumstances favorable for their growth and development that a sufficiently large amount of them will be produced. And then the temperature of the water has a greater effect upon the health of the community than the plants contaminating it. Statistics from the Rivers Pollution Commission of England show that the death rate from diarrhea in London increases with the increase of the temperature of the Thames River after it reaches sixty two degrees. The death rate in different parts of the city varies with the difference in temperature of the water supplied in that part of the city. American authority claims that after water has reached sixty degrees there is danger of a marked increase in epidemic deseases.

Ground water is the surest source of a pure supply. Water that has percolated through the ground for a long distance has gone through a process of natural filtration. It is bright, clear and crystal like and all suspended matter and most of the other impurities have been removed. The liability of contamination in surface wells has already been spoken of, but water from the sand or gravel beds when separated from shallower water by an impervious strata or layer is the most reliable source. Many cities get their supply from this source and great expense is gone to in building filtering galleries and laying percolating pipes for it's collection. It is of a more even temperature and supply, and more thoroughly filtered than the water nearer the surface, as well as having the advantage over the ~~d~~waters found deeper down in the opening of the rocks, of meeting with less mineral mattar and coming in contact with more air and oxydizing material. Contamination is less likely than in other water although it is sometimes found to be connected with a source of pollution, and when such is the case it is as objecttionable as that of polluted water from any other source. River beds are generally impervious and afford but little opportunity for the mixing of impure water with underground flow, but it is considered advisable not to seek a supply too close to a running stream. The bottom of the stream becomes covered with sediment and decaying material brooding organisms and acting as an unclean filter to the water that enters the ground.

Artesian water is found in a great many places and is generally a cheaper source of supply, but it is usually quite hard and is more subject to the collection of mineral matter, besides frequently being of a high temperature, that often renders it injurious to vegetable growth and less valuable for household purposes.

Filtration has become a valuable factor of a pure water supply. The removal of suspended matter renders it more acceptable to the eye as well as less injurious to the health. It is only the utilizing of natures processes and until the last few years it has not come into any very prominent use. Cities are now filtering hundreds of thousands of gallon daily at a very little expense and with the assurance that they are receiving a pure quality of water. The sand filter, the most successful one now in use, was introduced near London some fifty years ago, but the great importance and usefulness of it has been left for the American Engineer to make prominent. Their arrangements are being perfected so they can be readily cleansed with but little time and labor, eliminating the once difficult problem of destroying the brooding places of germs and micro-organisms in the filth of the filter. Large settling basins are use to remove the heavier material and layers of animal charcoal or coke are placed beneath the layers of sand to assist in aeration and oxydation. The rapidity and thoroughness of the filter depends upon the sand's degree of fineness.

Chemical action has long been known to assist filtration and now under the extensive use of the filter it is preforming an important part. Much soluble matter that would find it's way through the sand with the water, when placed in contact with some other soluble matter forms a precipitate that is readily removed. As for instance the water in the Mississippi at St. Louis has a white milky tint and repeated filtration does not remove it, but by adding a slight amount of alum and then filtering, the water is bright and clear. The reagents most frequently employed for this purpose are Metallic iron and iron salts, such as chlorides, permanganate of potassium, and alum, the latter perhaps being the most commonly used. It requires only a very small amount of the reagent to purify a gallon, and when properly added there are no chemicals that remain in the water. Bacteria in connection with the foreign matter are thrown down as they are also with the suspended matter; statistics of many of the improved filters confirm this by showing an almost perfect removal of the germs and organisms. Atlanta Georgia has one of these large and well regulated filters that has been successfully operated for several years with the best of results. It supplies nearly four million gallons daily of a clear, fresh, wholesome water that gives but a very slight response to the test for organic matter, and ninety eight per cent of the bacteria are claimed to be removed. Atlanta's health statistics show a decided improvement since the building of her filter and the expense of filtering is but three dollars and eighty three cents per million gallons. About a half a grain of alum is used per gallon with the best results, and it is claimed that not over two grains is needed for the worst of water.

Mineral matter plays only a small part in condemning a water, for the total solids are considered of but little consequence in a water examination. The ash constituents of all foods are somewhat similar to this solid solid-matter and the system requires a small amount from some source or other. Sodium in the form of salt only answers the requirements of the system and calcium and other ash products are required in small quantities while a slight excess is simply thrown off as waste matter. Poisonous matter, as the poisonous salts of iron, are sometimes found, but they are in such small quantities and so diluted that they are of but little consequence. Excess of mineral matter renders the water hard and more difficult to use and a large amount of carbonates or sulphates when heated forms a sediment in cooking utensils and steam boiles often cloging up boilers, annoying the engineer and instituting a difficult problem.

Organic contamination is more serious. It effects the health directly, any great amount of it acting upon the digestive organs producing diarrhea and other similar deseases. The amount of such matter allowable in water is a question among health officers and engineers for chemical analysis cannot always be relied upon to determine just to what extent a water is injurious. Water containing about .10 part of albuminoid ammonia to 1 000 000 parts of water has been set by many of the investigators as usable but not without question as to its source of pollution. Local conditions should be thoroughly considered in every case and should bear heavily upon the results of the examination.

Animal matter is the most dangerous pollution we have to contend with. Water that contains filth and dirt from animal life should never be used; and close observation for any such matter is emphasized by every writer. Deseases are known to be scattered over whole communities by the contact of the excreta from a single person with a water supply. There is instance after instance on record where typhoid fever, cholera, and the other deseases the germ of which is carried in the excreta, have been scattered with their fatal effects by carelessly disposing of the waste matter, leakage of sewers or seapage from privy valts or cess pools. Germs multiply rapidly in the decaying matter, and their vitality is simply wonderful often living for months and then producing desease. They are known to have survived in water that has reached the boiling point and that which has gone below the freezing point. Filtration removes a large number of them but no authority admits that water once polluted by animal matter can be made perfectly pure and harmless. An instance is recorded in the health report of a sick patient in one of our Kansas towns who was suffering under extreme prostration when the attending physician noticed the slops from the kitchen were thrown near the well. He prescribed the use of distilled water and the patient rapidly recovered, but on resuming the use of the well water after the patient was almost well a relapse came and the well had to be abandoned before health was completely restored.

Another instance, although considerably more uncertain, will illustrate the spreading of disease as well as the uncertainty of the chemical test. It was at Fort Riley some ten years ago. An outbreak of typhoid fever occured and the health officer soon proceeded to investigate the water supply. A sample on investigation proved the

 194

organic matter to be far below the suspicious point. Further test by the officer in charge showed no suspicious results. The well from which the water was taken was located several hundred feet below the deep ditch that carried off the sewerage from the Fort and drainage from the stables. This, however, was never known to have any connection with the well and the examination of the water seemed satisfactory all through. But the President of the Sanitary Convention that year at Wichita in a paper before that assembly seemed very much inclined to question the purity of the water. It was his opinion that the germs would live in the water on the small amount of organic matter present, that the nidus of the germ was in the digestive organ, and there was where they reproduced and multiplied. It was upon local condition and the favorable circumstances for contamination that he based his suspicion. From the three hundred stationed at the Fort a daily average of twenty four were in the hospital all during the month of November, while only a few cases had accured in the four months previous. The above mentioned paper did not attribute the entire cause of the epidemic to the water supply or condemn the investigators, but it did hold that there was sufficient grounds to doubt the purity of the water and that a chemical test could not always be depended upon.

The need of a pure water supply cannot be too strongly emphasized. It is next to air in sustaining life and because it can hide its injurious effects beneath the ignorance of the public it receives less attention. But Sanitarians are making rapid strides in opening up the subject and adjusting it to more suitable conditions. A double system of water supplies has even been proposed when the demand is large or a pure supply is insufficient in order that a good water may be had for domestic use.

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