KNOW HOW THE SYSTEM WORKS

Meghalaya is a land with verdant hills and fast flowing streams. Most of the villages are situated on the top of the hills and the sources like streams and rivers flow at the bottom of the hills. In some places, springs at higher altitudes are available, but due to vagaries of rainfall and deforestation in the catchment area as also due to shifting cultivation, the yield of the springs is decreasing gradually. Ring wells or Shallow wells are not successful in hilly areas. Ground water potentiality of the state has not been explored fully. Some deep tube wells and hand tube wells sunk along the plain areas adjoining Assam and Bangladesh border were found to be successful. With the increase in population and man made activities, the quality of water is also degrading continuously.

In Meghalaya, the task of providing safe drinking.. water supply is almost entirely rested with State Public Health Engineering Department.

Ideally, the approach is to tap underground water, which is more or less found to be free from any harmful objects and does not require any treatment except chlorination. These are cheaper both in terms of capital and recurrent cost. The various methods of ground water, as practiced in the state are :-'

(i) Ring Wells
(ii) Dug Wells/Drinking Wells
(iii) Spring Tapped Chambers (STC)
(iv) Shallow Hand Pump Tube Wells
(v) India Mark-II Hand Pump Tube Well
(vi) Deep Tube Well with Power Pump

While (i), (ii), (iii) are preferred, these are not feasible in many places. The next in the order of preference will be to go for Shallow hand pump tube well, which can be used if the suction lift of the pump is within the recommended value,as below, based on altitude of the place:

SIno	Altitude	Maximum Practical Suction Lift of Pump (Metres) Sl.No.
1.	1194 metre above sea level	6.40
2.	1584 metre above sea level	6.10

Generally, in the state ground water is available at depths in excess of 6.00m below the ground surface. In such cases, India Mark-II hand pumps are put to use, where pump is lowered into the well. The cylinder is located below the working water table at least 1.2 - 1.5m below to keep it always under submerged condition, so that it works with a positive suction. India Mark-III hand pump are the improvements over Mark-II hand pump, when water is available at greater depths, requiring lots of energy to pump out water manually through Mark-II hand pump. In the state, generally India Mark-II hand pumps are installed.

When the quantity of water required is more and the ground water is available at greater depths (ranging from 100ft to 600ft), deep tube wells with power pumps are installed. Bore size in such cases are 6"/8" and diesel/electrical driven vertical turbine pumps or submersible pumps are used for pumping out the water.

The surface sources are tapped through:

(i) Gravity scheme
(ii) Pumping scheme

Except for spring sources, treatment of water is generally necessary for such schemes. When we talk about water treatment, the term 'filtration' comes automatically. Water treatment is a physical-chemical process for separating suspended and colloidal impurities from water by passage through a granular material. Over the years, the meaning of the word 'filtration' as used by the water works industry has changed. In 1800s, the slow sand filter was dominant. It incorporated sand with an effective size of 0.2mm. This very fine sand produced good quality water from applied water of low turbidity at rates on the order of 0.12 to 0.32 m/h of bed area.

Because of the low surface rates, slow sand filters required large areas of land. The removal of impurities takes place by following mechanism:

1. The attachment and absorption of particles preset in water to the surface of sand grains.
2. Retention of particles larger than the pores of the granular medium, known as staining.
3. Formation of a layer of organic materials and other nutrients present in water at the top of the sand bed, known as 'Schmutzdecke', that efficiently strains very minute particles.

When the quantity of effluent water becomes very less due to deposit of excessive impurities, it is cleaned generally once in 2-3 months, by scrapping top 2-3 cm of schmutzdecke manually.

In early 1900s under the stimulus of epidemic water borne disease, the rapid sand filter came into general use and it largely replaced the slow sand filter. Rapid sand filter media might vary in effective size from 0.35 to 1.00mm with a typical value being 0.5mm with an uniformity co-efficient of 1.3 to 1.7. This type of media has demonstrated the ability to handle applied turbidity of 5 through 10 NTU at rates up to 4.88 m/h. Sand being bigger in size than the slow sand filter, rate of filtration is much higher (approx. 20 times) in rapid gravity filter requiring less space than the slow sand filter in treating the same quantity of water. The pore opening in a rapid gravity filter ranges from 0.1 mm to 0.2mm in size. In the water applied to the filter, floc size ranges from 2mm to less than 0.1 mm. It follows from these dimensions that the large floc particles can be removed by simple staining of the filter surface, but that much of the flocculated matter will pass into the filter bed and lodge within it largely in the top 10cm of the sand bed. The rapid sand filter requires cleaning generally once in 24 hrs. as against 2/3 months for a slow sand filter.

Rapid sand filters are cleansed by reversing the flow through the filter and backwashing the trapped particles from the bed. After back washing, the very fine sand accumulates at the top of the bed and the coarser particles lie below. More than 90% of the particles removed are taken out in the top few cm of the bed. Once a suspended particle has penetrated this top layer of the fine sand, its chances are greatly increased for passing through the entire bed, because the void spaces become larger and opportunities for contact decrease, as the particles travel downward. This is a well recognized limitation of the rapid sand filter.

In conventional filters, narrated above, water is passed from fine to coarse sand grains, leaving a lot of void space unutilized. If the filter media could be fully utilized, the filter run would have been more, the filtration rate would increase, improving both quality and quantity of filtered water.

First attempt of coarse to fine filtration was by reversing the flow of water from bottom to top in Up Flow Filtration. This removed the shortcomings of conventional filters, but if the adequate attention is not given for timely cleaning, previously removed particles trapped in the bed could escape in the- effluent, giving rise to quality problem.

It was not until early 1940s, the development of coarse to fine principle of filtration took place, resulting in introduction of mixed media filter units, where three materials coal, sand and garnet/ilmenite having specific gravities of 1.4, 2.65 and 4.5 with coal at the top, sand at the middle and garnet/ilmenite at the bottom are placed. The particles are sized in such a way that after backwashing, controlled intermixing of these materials occur and no discrete interface exists between them. With applied turbidity of less than 15 NTU, dual media filters can operate under steady state condition at 9.76 to 12.2 m/h with production of high quality water. Thus the filtration rate in mixed media filter is approx 2 to 3 times higher than the rapid gravity filter and 40 to 60 times higher than the slow sand filter. However, if the raw water contains excessive amount of finer particles, quality problem of filter effluents is encountered. Such type of filters have been constructed in the state with modification in simplified water treatment plants.

Some of the major Water Supply Schemes, where Slow Sand Filters and Rapid Gravity Filters have been constructed for drinking water purposes are :

SLOW SAND FILTERS

(i) Umkhen W.S.S. (for Shillong Area)
(ii) Dalu W.S.S. preceded by a UPFLOW FILTER
(iii) Baghmara W.S.S. preceded by a UPFLOW FILTER
(iv) Rajasimla W.S.S.
(v) Chibonga IN.S.S
(vi) Wage Asi W.S.S.

RAPID GRAVITY FILTERS

(i) . Greater Shil!ong Water Supply Scheme (G.S.W.S.S.) Phase-I, Capacity-7.5 MGD.
(ii) Tura Phase-II W.S.S, Capacity-3.6 MGD.
(iii) Jowai W.S.S., Capacity-1.50 MGD.
(iv) Mawlai W.S.S., Capacity-0.75 MGD.
(v) Simsanggiri W.S.S., Capacity-O.75 MGD.
(vi) Baghmara Civil Sub Divn. Complex W.S.S.
(vii) Nongpoh W.S.S.
(viii) Mairang W.S.S.
(ix) Maulakandi W.S.S.

The simplified treatment plant is a new technique, developed by Dr. J.N. Kardile of Nasik, Maharashtra, which is used in the state also. Few schemes namely Goramara W.S.S., Konarchar W.S.S. and Goiragiri W.S.S. , Nongstoin WSS, Greater Mawiong WSS have been commissioned with such type of treatment plants. Here crushed coconut is used as a media along with sand. This media enables a very high rate of filtration compared to conventional filters. Raw water with high turbidity can be treated very well. This is also economical in the long run, as the crushed coconut shell media has a longer life of about 10 years and need not be replaced soon. Water can be treated directly with the filter, provided turbidity of raw water is less than 1 NTU for Slow sand Filter and less than 15 NTU for rapid gravity and mixed media filter. The raw water in the state generally conform to this for most of the period in a year, except for rainy season, when turbidity can go as high as 1000 NTU. The process of removing turbidity to make water ready to be used in the filter is. known as Clarification/Sedimentation. Turbidity arises due to presence of suspended and colloidal materials. Turbidity of raw water is reduced by removing these materials.

In plain sedimentation, water is allowed to pass through a rectangular tank. The tank is so designed that most of the suspended materials are deposited at the bottom, before water leaves the tank. It has been established that the efficiency of a sedimentation tank depends on the surface area of the tank and the rate of flow of water. More the surface area, more the efficiency of the sedimentation tank in removing turbidity. This principle has been utilized in recent development of tube/plate settlers for removing turbidity. In plate settlers, a series of inclined plates are placed at an angle in a small tank increasing the surface area of flow of water, thereby removing the turbidity to a great extent.

The shortcoming of the Plain Sedimentation Tank is that the very fine particles do not settle down in the tank, which can be economically constructed, due to their small size. To arrest the smaller particles, Coagulation is done, which is the process of joining smaller particles with the addition of Alum, whose chemical formula is AI2(S04h 18H2O, the most commonly used coagulant, so that bigger flocs form and settle at the bottom of the tank. In such a case, instead of a rectangular tank, circular tanks are used, known, as Clarifier, instead of a rectangular tank, for slow mixing of particles/flocs, so that they grow in size and deposit at the .bottom of the tank. However, with the addition of the alum, 'pH of the water decreases, making it acidic. To bring pH to the range of 6-8, generally lime is used in the treatment of water, after Coagulation.

In the state, plain rectangular sedimentation tank generally precedes slow sand filters, whereas Clarifiers precede Rapid Gravity Filters and Tube Settlers precede simplified filters. In some cases, sedimentation is also done in a pebble bed filter.

Filters produce a clear effluent, virtually free from any organic matter. Pathogenic bacteria removal is between 99 to 99.9%. Cysts, helminthic ova are removed even to a higher degree. Significant reduction in colour takes place. Viruses are virtually completely removed. Effluent from a filter may be bacteriologically unsafe, if a single pathogen remains in the water. Water after filtration is invariably disinfected with the objective of destroying or inactivating pathogenic organisms, more precisely bacteria of intestinal origin. Disinfection is done by adding Chlorine in the filter effluent. If the drinking water contains residual chlorine of 0.2-0.3mg/1, the water is considered to be bacteriologically safe. In the state, disinfection is generally done through addition of bleaching powder, whose chemical formula is Ca(OC1)C1, in a solution form in the water, which approx. contains 30% Chlorine. Dose of bleaching powder required to be provided is found out by actual test, so that minimum residual Chlorine is maintained at the farthest consumer's point. In European countries, 0zone is gradually taking the place of Chlorine, as disinfectant, but in India Chlorine in gas and solution form is the dominant disinfectant.

It needs a mention of rain water harvesting structures, constructed under Technology Mission in the West Khasi Hills District of the state. In this system, polythene sheets are placed over the thatched roof and the rain water is collected through a gutter system to a tank via a pre-fabricated filter unit. The water in the tank is used for drinking purpose through an ordinary hand pump. Some of the disadvantages of such structures are as below:

- The water available is limited by rainfall and roof area. Supplementary water sources are therefore needed.
- Mineral free water has a flat taste, while people prefer the taste of mineral rich water.
- Mineral free water may cause nutrition deficiencies in people, who are already on mineral deficient diets.

However, where there is no other feasible source of drinking water exists, such structures can be put to use. The Department is presently contemplating taking up rain water harvesting structures in a big way where stress will be more on community rain harvesting structures.

When Meghalaya was carved out of the erstwhile state of Assam in January, 1972, only 60 nos. of villages were provided with safe drinking water supply. Garikhana, Nongpoh, Umsning, Naya Bunglaw, Cherrapungee, Lawsohtun, Mawsynram, Madanriting, Sohkha, Darran, Muktapur were some of the gravity feed schemes completed during that period. Since then number of schemes has been implemnented by PHED in order to provide safe drinking water supply to all the population. The details of which has been indicated in the functioning of completed schemes part, which has been put elsewhere in the site.

Of late, water quality problem, mostly the presence of excess iron (more than 1 mg/I) has been causing concern in the state. The problem is mostly present in those habitations, where deep tube well/hand pump have been installed. This is attributed to solution of rocks and minerals chiefly oxides, sulphides, carbonates of iron in the presence of carbon-di-oxide. The presence of excess iron imparts water a bitter characteristic, metallic taste and cause coloration of water apart from staining of plumbing fixtures and laundered materials. The coal extraction in different parts of the state is also giving rise to water quality problem.

The affected habitations are mostly in West Garo Hills, West Khasi Hills, Jaintia Hills district of the state. Quality affected habitations have so far been provided with safe drinking water supply in West Garo Hills District, by installation of Iron Removal Plants (IRPs). The principle of iron removal in IRPs involves transformation of iron present in dissolved Fe++ form in the ground water, due to absence of oxygen and presence of carbon-dioxide, to precipitate in the form of Fe+++ with the "help of oxygen present in air. This is affected by allowing water to pass through a spray aerator. Water falls through six number *oft* rays , placed one above the other containing sand and lime, in the form of spray, so that drops of water having large surface area are formed thus facilitating easy mixing with atmospheric oxygen. Lime is placed over the trays to increase the teaction rate about 100 times. The following reaction takes place :- .

$Fe_{++} + \frac{1}{4} O2 + 2 (OH_{-}) = Fe(OH)_3$

The precipitated iron is removed from sedimentation and filter tank. The name of few schemes where IRPs have been successfully commissioned in the state are PUTAMATI W.S.S., TIKRIKILLA ZONE-A W.S.S., DOMAPARA W.S.S., AMPATI W.S.S., PAHAMPATARKATA W.S.S., BAINAPARA W.S.S., PHERSAKANDI W.S.S., HARIPUR W.S.S., MARAKAPARA W.S.S etc. In Borato W.S.S. of Jaintia Hills District, old source has been discarded due to presence of excess iron and new source has been tapped for safe drinking water.

CONCLUSION

Water Supply is a continuous process. The supply level goes below the designed level with increase in population and decrease in discharge of the source and improvement/augmentation schemes are necessary for this. The water supply schemes are designed for 15 years, after which renovation/reconstruction of these are required. Further with the improvement in quality of life, requirement of quantity of water will be more. Urbanization/Industrialization has given rise to pollution of drinking water sources, which were earlier free from that. Massive investment is thus necessary. Assets so far created needs also to be maintained properly to maximize benefits. It is also necessary to motivate, educate and involve the beneficiaries, especially the women, for proper upkeep.

Government investment alone is not sufficient. A sense of willingness needs to be developed in the community to pay for the assets created as well as for its maintenance.