Frequently asked Questions on WASTE WATER

Compiled by S.S.Ranganathan

http://www.indiawaterportal.org/

What is Waste Water? How is it generated?

Waste water is the water that emerges after fresh water is used by human beings for domestic, commercial and industrial use. This document will restrict itself only to the waste water generated due to domestic use.
By and large,it is fresh water that is used for a variety of domestic uses such as washing, bathing & flushing toilets. Washing involves the washing of utensils used in cooking, washing vegetables and other food items, bathing, washing hands, washing clothes. The water that emerges after these uses contains, vegetable matter, oils used in cooking, oil in hair, detergents, dirt from floors that have been washed , soap used in bathing along with oils/greases washed from the human body. This water is referred to as " Grey Water" or sullage. Water used to flush toilets to evacuate human excreta is called " Black Water" or Sewage.
Grey water is easier to purify as compared to black water, i.e sewage. However, the practice predominantly followed in India is to combine these two wastes to discharge into a public sewer or into a sewage treatment plant in a residential community/building that has no access to a public sewer.

How much waste water is generated in a residential complex?

As per standards laid down by the CPHEEO (*Central Public Health Environmental & Engineering Organisation)*, the fresh water consumption per day per person should be between 135 to 150 litres per day. It is officially expressed as "litres per capita daily" (lpcd). By and large public water supply and sewerage bodies/authorities all across the country use the former figure to work out probable water consumption. When water is consumed by people living in a residential complex without access to an underground sewerage/drainage system , the amount consumed is estimated to be 135 lpcd. The total quantity (No. of residents X 135 litres) comes into a sewage treatment plant(STP) in the premises, and , this total volume has to be treated by the STP.
In a vast majority of cases, the actual waste generated exceeds this figure comfortably leading to overloading of the STP. This happens routinely because almost all residential complexes do not install water meters or similar water volume and flow measurement devices to keep track of water consumption in a residential complex/gated community. Consequently, when a device is installed and readings monitored, consumption has been found to be double and some times triple the suggested figure of 135 lpcd.

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Waste generation in a commercial complex:

Human occupation of this kind of building is only during “duty hours”,i..e for approximately 8 to 10 hours per shift if there is more than a single shift. In this case water consumption is considered as 50 lpcd per person per shift.

What are the constituents of waste water (sewage) ?

Waste water contains all the dissolved minerals present in the fresh water that was used and which became waste water as well as all the other contaminants mentioned above. These are proteins, carbohydrates, oils & fats. These contaminants are degradable and use up oxygen in the degradation process. Therefore, these are measured in terms of their demand for oxygen which can be established by certain tests in a laboratory. This is called Bio Degradable Oxygen demand(BOD). Some chemicals which also contaminate the water during the process of domestic use also degrade and use oxygen and the test done to establish this demand which is called Chemical Oxgen demand (COD).Typically a domestic sewage would contain approximately 300 to 450 mg/litre of BOD and COD on an average. Sewage also contains coliform bacteria (e coli) which is harmful to human beings if water containing such bacteria is consumed(drunk). E coli is bacteria that thrives in the intestines of warm blooded creatures such as humans, animals and birds. Another feature of sewage is the high level of Total Suspended Solids (TSS). This is what gives the sewage a black colour ,hence the name “ black water”. If sewage is allowed to turn septic, it then also has a strong, unpleasant odour.

Why treat waste water?

Much of the water used for domestic purposes does not require potable (suitable for drinking) water quality. For instance, water used for flushing toilets or for washing floors, yards or roads & gardening does not require to be potable. In a scenario where fresh water is getting increasingly scarce and when enormous volumes of sewage generated in the country are not being treated ,but goes unchecked to pollute fresh water from lakes, rivers and the ground water table, it must be treated. Discharging untreated sewage into any drains other than an underground sewerage system, or into open land , is an offence and invites prosecution under the laws of all Pollution Control Boards in the country. Sewage must necessarily be treated correctly and then re-used/re-cycled for various uses that do not need potable water quality. Recycling/re-using treated sewage can reduce fresh water requirements very substantially, by almost 50 to 60%.In a scenario where fresh water availability itself is increasingly in doubt this is critical.

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How can treated sewage be re-used/re-cycled?

This requires plumbing to be laid so as to serve two sets of storage tanks on the roofs of any residential/commercial building. One set of storage tanks will be used to receive and store fresh water which will flow through plumbing laid to take it to bathrooms and kitchens where it can be used for drinking, cooking, washing & bathing. The second set of tanks will receive treated sewage which will be connected by plumbing to all the flush tanks in toilets and to other points where the water can be used for washing yards, floors and also for gardening.

How is waste water treated?

Sullage (grey water) which is mentioned above, if collected in a storage tank separately can be treated by aerating it to prevent it from turning septic, and then dosed with a coagulant, chlorinated and then subjected to filtration by pressure sand filtration followed by activated carbon filtration and stored in a separate overhead tank or tanks from which it can be used for flushing toilets and other uses where fresh or potable water is not required. However, the current practice is to combine sullage and sewage (black water) and treat the mixture in an STP (Sewage treatment plant). This practice has come in predominantly to reduce the cost of construction of two separate plants and because space is now at a premium in any building.

Why not consider grey water treatment seriously in spite of the extra space it requires?

From the point of view of a resident it is worth considering as it enhances the water security of the resident. A builder's priority is totally different, since the space taken up by the treatment system can not be 'sold' to a buyer, he will just not consider it, instead the builder will combine greywater with sewage in an STP. This enables the builder to save costs. However if looked at from the residents' view point, a seperate grey water treatment system being easier to operate provides a facility to 'fall back on' when the STP fails. Why STPs fail becomes clearer as you read on.

Sewage Treatment

Treatment of sewage is based on a method provided by nature, i.e by using microbial action. When a steady consistent supply of air is pumped into a tank containing sewage which has been screened to remove all floating debris and non soluble contents in sewage, microbes which are present in it get activated. These

microbes are present in the sludge which makes up a substantial part of sewage, and they consume the pollutants in the sewage while the air supply brings them to life and keeps them alive and multiplying.
This is a time tested system called the world over as the " Activated Sludge Process"(ASP). It is the oldest system world wide and is the most used process world over. An STP based on this aerobic process will consist of the following major stages of treatment :

- *Primary Treatment:*
  In this stage, raw sewage is screened to remove floating debris/ insoluble impurities such as plastic bags, leaves, twigs, paper,etc.
- *Secondary Treatment:*
  In this stage, oxygen(air) is mixed into the sewage to activate the microbes which consume the pollution load and which then become sludge(biomass) . Aerated sewage and sludge are than separated so that the sludge can be removed and de-watered/ dried for disposal. The sludge can be used as compost in a garden. The water free from sludge is sent to a clear water tank(also called clarified water tank).
- *Tertiary Treatment:*
  Clarified water is filtered through a pressure sand filter and an activated sand filter to remove any remaining suspended impurities and a substantial portion of the BOD & COD present in it. Finally it is disinfected to kill all the bacteria present in it by either chlorination or ozonation or with ultra violet light. This tertiary treated water is then pumped into a dedicated set of storage tanks from where it is used to flush toilets, wash roads, yards and for gardening.
  A majority of the STPs in India are based on this ASP system in its most basic form. Such STPs are highly susceptible to input fluctuations(a frequent feature in India) and this results in a lot of untreated sewage and other related problems.

Are there any other processes available to treat sewage?

- A fairly recent system called the MBR system (membrane bio reactor system) which is a superior system is becoming very popular. It is a very compact waste treatment system that combines biological decomposition with membrane separation of the sludge(biomass).The membrane compacts & concentrates the sludge making for a far more compact design than the ASP system described above(it combines the secondary and tertiary treatment in one single step). Further it produces far less sludge too. Best of all ,it is not so sensitive to input load fluctuations like the ASP system.

- An MBR system requires skilled operators. However, it can be automated to cut out operator error and poor operation.
- Another interesting development is a system developed in Germany, called DEWATS (Decentralised Water Treatment System). It is a combination of anaerobic treatment with aerobic treatment. It is a low cost system and requires no Operator intervention unlike the ASP. This process has no moving parts and it can even provide methane gas from the anaerobic part of the system which can be used for cooking. The DEWATS system was developed keeping in mind the needs of developing economies where it is difficult to get skilled operating personnel for conventional ASP based STPs. Treated water from DEWATS will still require tertiary treatment for re-use/recycle,and this part of the system (tertiary treatment) needs operators.
- Reed Bed Sewage Treatment System. This is an extremely eco friendly system where sewage is allowed into a constructed water body where certain kinds of aquatic plants are planted which absorb atmospheric oxyen and let this out through their roots thereby providing the oxygen to feed the microbes which will clean up the sewage. This system does however require a tertiary treatment system if the treated sewage is required for anything more than gardening. Its drawback is that it requires a lot of land to function and this is a major disadvantage in a world where space is at a premium. One major advantage is that it requires virtually no electricity to operate if the flow of raw and treated sewage is by gravity.

What is the difference between " Aerobic" and " Anaerobic" processes in sewage treatment?

The aerobic process as explained above is one where the microbes which clean up the sewage need to be supplied with air(oxygen) to function and multiply so that the sewage is 'cleaned up'. An anaerobic process is one where a different kind of bacteria comes into action. It is a bacteria/microbe that does not need air and operates in an atmosphere without air (hence the term 'anaerobic').This kind of bacteria produces methane and in the waste/environmental engineering industry, they are called " methanogens".
Mostly, anaerobic treatment is usually followed by the aerobic process and this combination is used where the waste water has very high values of BOD and COD. In such situations, the anaerobic system reduces the BOD & COD down to a level where the aerobic process completes the job of reducing it down to the levels where a tertiary treatment stage can do the final 'polishing' of the treated sewage as stated above.

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What are the problems that can be expected with an installed STP?

The most common problems encountered are listed below and are based on an informal survey of STPs (including Water Treatment plants also) carried out over the last 4 years.

- **Initial Start up of an STP failing to treat sewage**
  An STP is normally designed for the total sewage that can be expected when a building or premises is fully occupied. Full occupation in most cases usually takes up to a year or more. During this period when occupancy can be as low as 30% or so and gradually increases over a year or more, consequently the sewage that comes in initially does not provide the minimum load needed for satisfactory operation of an STP. It results in a situation which can only be called “sewage in sewage out”. Many STPs which face this situation take a long time to stabilize and provide treated sewage, very often, due to poor or wrong operation, STPs do not stabilize.

- **Poor design/underdesign of the STP**
  Often STPs which initially ‘struggle’ to overcome the first problem described above also can not function because a) the balancing tank is undersized or b) aeration tank is undersized or clarifier is badly designed or c) the total inflow of sewage is higher than the volume the STP was designed to handle. The tanks mentioned in a) & b) above are part of the primary and secondary treatment portions of an ASP system.

- **Consistent mal-operation of the STP**
  Another very common feature is that a majority of plant operating personnel employed by agencies that take on Operation & Maintenance(O&M) contracts are illiterate, un trained and supervised by people with little or no knowledge of what O&M involves. Such agencies generally charge O&M charges that residents’ associations consider affordable. Companies with well trained operation personnel and experienced supervisory staff charge for services an amount that reflect their skill and expertise which residents’ Associations are reluctant to pay and thereby lose out on a well run/operated water infrastructure. They often do not realize that even the charges which they consider as cheaper/lower are going to waste if the sewage is only partially treated.

- **Strong smell/odour from the STP**
  This is a very common complaint from numerous housing communities and even commercial buildings which have an STP in operation. The smell is often very strong and quite often unbearable. It is caused by any one or all of the problems(1 to 3) listed above.

- **Very high noise levels from the STP**
  Quite often residents of an apartment building have sought help from experts to minimize the very high noise levels from their STP which they find unbearable throughout the day and more so at night, thereby preventing the residents from sleeping in peace.

How can these problems be avoided and/or resolved?

- Modern designs for STPs which are modular are available from reputed companies which are in the field of water and waste water treatment. Such companies have standardized designs where,for instance an STP to handle 150 KLD (150,000 Litres per day) of sewage can be made up of 3 modular STPs each of 50KLD capacity. Such an installation would be able to handle the initial lower load of sewage with one module in operation with remaining modules being commissioned/started up as the sewage volume increases. Such a modular approach also makes it possible to handle sewage in the case of a break-down of the STP as it is extremely rare for all modules to break-down together. In short, there is a stand-by always available. For several years now a few companies have been offering microbial agents which can help overcome these problems if these microbial agents are added to the incoming sewage. **Go in for Modular STPs & use microbial agents regularly.**
- It is equally important to know and be able to control the volume of fresh water used in a community so that it does not exceed the design capacity of an STP. This involves installing water meters at all crucial points to measure water flow(consumption) & thereafter taking action to curb excess consumption of fresh water to prevent overloading the STP**. Control excess consumption of fresh water and thereby prevent overloading of the STP**
- Builders are not expected to be experts in water or sewage treatment plant design, manufacture etc. They can however have tie-ups with reputed environmental engineering companies with sound technical experience and a proven track record, to make up for their lack of knowledge. This seldom happens since a builder's interest ends with selling a completed project and then handing over the project to the Resident's Association as soon as possible, often without even demonstrating actual, successful operation of the water infrastructure. Most builders link up with small, obscure local companies with inadequate knowledge and expertise in waste and water treatment,but will put up something for an extremely low price. The result is poor/ wrong operation of an STP leading to untreated sewage and unpleasant odours from it. **Ensure supply of an STP from a reputed supplier and entrust operation & maintenance to a well trained professional team.**

- One of the major reasons for STPs not working properly is the fluctuations in input loads. Flow of sewage in a residential community is never uniform. It varies with peak flows in the morning (residents getting ready to go to work), very low or almost no flows later in the day with another peak in the evening. Raw sewage is collected in a sewage balancing tank(mentioned above) which should be sized to hold at least 6 to 8 hours flow of sewage. This ensures that the sewage collected in the balancing tank is homogenized, thereby avoiding input fluctuations in input load on the STP. **Do not compromise on the size of a raw sewage balancing tank.**
- High noise levels from an STP are due to the operation of electric motor driven equipment such as pumps, air blowers, air compressors, etc. Old designs/makes of pumps, blowers , compressors , etc are still available at very low prices in the market and these are used in most of the STPs that have been put up. The noise levels of such equipment is very high as compared to modern, world class pumps and rotary motor driven equipment now available in India. These modern makes are almost noiseless and extremely efficient. The old designs are also the cause of high energy consumption in addition to very high noise levels. As per the laws in force in India, the noise level permitted in a residential area is 55 dB (dB= decibels of sound) during day time,i.e from 6:00 am to 10:00 pm and 45 dB during night time(10:00pm to 6:00 am).As compared to these limits, the actual noise levels are likely to be as high as 75 dB or higher. To reduce noise levels and high energy consumption, it will be necessary to replace most of the critical rotary motor driven equipment with the latest noiseless high efficiency equipment. Here it is advisable to choose a reputed company with an established reputation in sewage/waste water treatment to buy an STP. Such companies have constantly improved their designs to reduce the foot prints (space occupied) of their equipment and reduction in the power consumption of power by a very appreciable amount. Unfortunately, residents have no say in this as they face up to this crucial fact when it is too late as the STP has been ordered probably even before the residents bought a home in the property.

What would STPs of different capacities cost?

The prices given here are only indicative and meant to give an idea.All capacities given are in KLD (Kilo litres /day, kilo= 1000 litres).Prices for MBR systems are not given since they involve a substantial import content and hence it would be better to approach companies that offer such a sytem for a price directly.

- 5.0 KLD STP = Rs.5.0 lakhs.
- 10 to 15 KLD = Rs.8.0 lakshs.
- 25 KLD = Rs.15.0 Lakhs.

- 35 KLD = Rs.18.0 Lakhs.
- 50 KLD = Rs.35.0 Lakhs.
- 75 KLD = Rs.40.0 Lakhs.
- 100 KLD = Rs.30.0 Lakhs. (All civil work for this size to be built by buyer)

Note: The prices given are exclusive of Value Added Tax and excise duties (if applicable)

The supplier will charge a separate amount for installation and starting up the STP. This can cost an additional 5 to 10%

What about the operating costs for an STP?

The operating costs, including maintenance for an STP of 75KLD capacity and above would be 1.2 paise per litre of sewage treated.
For an STP of 50KLD and below would be 1.5 paise per litre of sewage treated.
These costs do not include the cost of plant operating personnel.
If O&M is provided by a reputed company which would use well trained operators with one operator per shift and one supervisor during general shift, they would charge approximately Rs.60,000. per month. Other obscure agencies who take on O&M contracts would charge approximately Rs.20,000.00 to 30,000.00 for providing the same number of personnel, but without the necessary training.

It looks like the treatment of sewage is rather complicated to understand for an average resident/owner of an apartment or villa, yes ?

Yes, unfortunately, it is true.If sewage treatment was simple and easy for all to understand, this entire write up with FAQs would be much smaller and easy to follow.

All right, so, what can a Resident's Association do if it needs expert help to sort out problems with sewage treatment?

Go to the "Ask he Expert" service and you will find that there are several persons with the necessary expertise based in different cities in India. Contact them and ask if they will help and the terms on which they will do so if it involves visiting your location. You will get one of them to definitely offer to help.

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Any important DOs & DON'Ts for sewage treatment plants?

Yes, there are a few. Unfortunately, it is too late for Residents' Associations to do anything about these because they take over a property after it is all over and done. It is the builders who should read this section and hopefully do what is suggested if they have their buyers' interests at heart.

a) Sewage treatment is one of the most crucial features for the residents of an apartment complex/gated community. It needs to be installed in the premises in a location where it is above ground and hence can get all the air it needs for it to function and to facilitate easy maintenance**. Never install an STP in a basement.**

b) Almost all STPs in multi storied apartment complexes are installed as deep underground as possible! From the point of view of an agency that manufactures, installs and probably also operates it, an underground STP is a night mare! If it stops working , emptying the collected sewage so as to be able to repair it is a terribly unpleasant task. Equally important is the handling of sludge which is generated in appreciable volumes during the normal operation of an STP. This sludge needs to be manually handled as it is coming from the basement. Regular maintenance therefore can become a recurring night mare for the Operation & Maintenance team. **More reasons why an STP should not be in a basement.**

c) Something that is extremely important but never done till it becomes too late. A residents' association must insist on the builder furnishing the association with all documentation of what the property has installed on it, eg, As built drawings with criteria used for designing/selecting, as well as detailed technical specifications for the electrical installations, power generation equipment, complete water infrastructure, piping for fresh water and sewage with drawings showing the routings and this must include the piping for the waste water to and from the STP. Details of all the pumps and other motor driven rotary equipment as installed with information on how these have been selected, as, this will have a crucial bearing on the power consumption in the community. **Proper documentation is a must for all the engineering incorporated in a property**

Here, ignorance is not bliss,it is an unmitigated disaster! Without this, maintenance/repairs can become a major problem due to sheer lack of information on all the equipment which is required to undertake planned maintenance.

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It looks like a buyer of a home in any residential complex is going to be a big loser no matter what, what can be done to rectify this and protect the home buyers?

One option is for the Government (either Central or State) to enact legislation to protect buyers of homes. Another option would be for the various associations of builders to themselves evolve a code of ethics that would ensure protection with regard to providing water security in a totally transparent manner. Neither of these is likely to happen in a hurry ,so, it may be necessary for Residents Associations countrywide to come together and put pressure on the governments and builders to ‘clean up their act’ and do things in a more transparent manner concerning the crucial aspect of water security.