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Design and Detailing of a Waste Water Treatment Plant for a Small Community

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Abstract
The water supplied to a community receives a range of chemical substances and microbial flora during its use such that the waste water acquires a polluting potential and becomes a health and environmental hazard. Communicable diseases of the intestinal tract such as; cholera, typhoid, dysenteries and water borne diseases like infectious hepatitis etc. can be spread from uncontrolled disposal of waste water and therefore, prevention of communicable diseases and protecting public health attracts the primary objective of sanitary waste water disposal. Little is known about the viability of WWTP. Therefore this research paper has been undertaken to provide a comprehensive study to establish guidelines for their application. In the context it is not pre-requisite to find the best sanitation technology for a given problem but to list the conditions where WWTP represents an efficient alternative to either conventional sewage or on-site wastewater treatment/disposal technologies. Design and detailing of such a waste water treatment plant has been undertaken to avoid a breach of polluting environment for a small community of 7000 people approximately.

Keywords: *Wastewater, grit chamber, primary settling tank, aeration tank*

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INTRODUCTION
Wastewater may be defined as a combination of liquid or water-carried wastes removed from residences, institutions, and commercial and industrial establishments, together with groundwater, surface water and storm water as may be present. When untreated wastewater accumulates and allowed to go to septic tank; the decomposition of the organic matter it contains will lead to nuisance conditions including the production of mat odorous gases.

In addition untreated wastewater contains numerous pathogenic microorganisms that dwell in the human intestinal tract. Wastewater also contains nutrients, which can stimulate the growth of aquatic plants and may contain toxic compounds or compounds that potentially may be mutagenic or carcinogenic. For these reasons, the immediate and nuisance-free removal of wastewater from its sources of generation, followed by treatment, reuse, or dispersal into the environment is necessary to protect public health and the environment.

METHODOLOGY
Methods of treatment in which the removal of contaminants is brought about by chemical or biological reactions are known as unit processes (Figure 1). At the present time, unit operations and processes are grouped together to provide various levels of treatment.

In preliminary treatment, gross solids such as; large objects, rags, and grit are removed that may damage equipment. In primary treatment, a physical operation, usually sedimentation is used to remove the floating and settleable materials found in waste water. For advanced primary treatment, chemicals are added to enhance the removal of suspended solids and to a lesser extent dissolved solids.

In secondary treatment biological and chemical processes are used to remove most of the organic matter. In advanced treatment additional combinations of unit operations and processes are used to remove residual suspended solids and other constituents that are not reduced significantly by conventional secondary treatment. Every community produces both liquid and air emissions.

The liquid waste-wastewater is essentially the water supply of the community after it has been used in three varieties of applications. The basic methods like screening, grit removal, primary sedimentation, aeration, secondary clarification, disinfection as it is a Small Scale Wastewater Treatment Designed for 7000 people. Advanced methods may be applied but for a small community. The step by step process in the wastewater treatment method with design is discussed below:

Treatment Level	**Description**
Preliminary	Removal of wastewater constituents such as; rags, sticks, floatables, grit, and grease that many cause maintenance or operational problems with the treatment operations, processes, and ancillary system.
Primary	Removal of a portion of the suspended solid and organic matter from the wastewater.
Advanced primary	Enhanced removal of suspended solid and organic matter accomplished by chemical addition and filtration.
Secondary	Removal of biodegradable organic matter (in solution or suspension) and suspended solid. Disinfection is also typically included in the definition of conventional secondary treatment.
Secondary with nutrient removal	Removal of biodegradable organics, suspended solids, and nutrients(nitrogen, phosphorus, or both nitrogen and phosphorus).
Tertiary	Removal of residual suspended solids (after secondary treatment), usually by granular medium filtration or micro screens Disinfection is also typically a part of tertiary treatment. Nutrient removal is included in this definition.
Advanced	Removal of dissolved and suspended materials remaining after normal biological treatment when required for various water reuse applications.

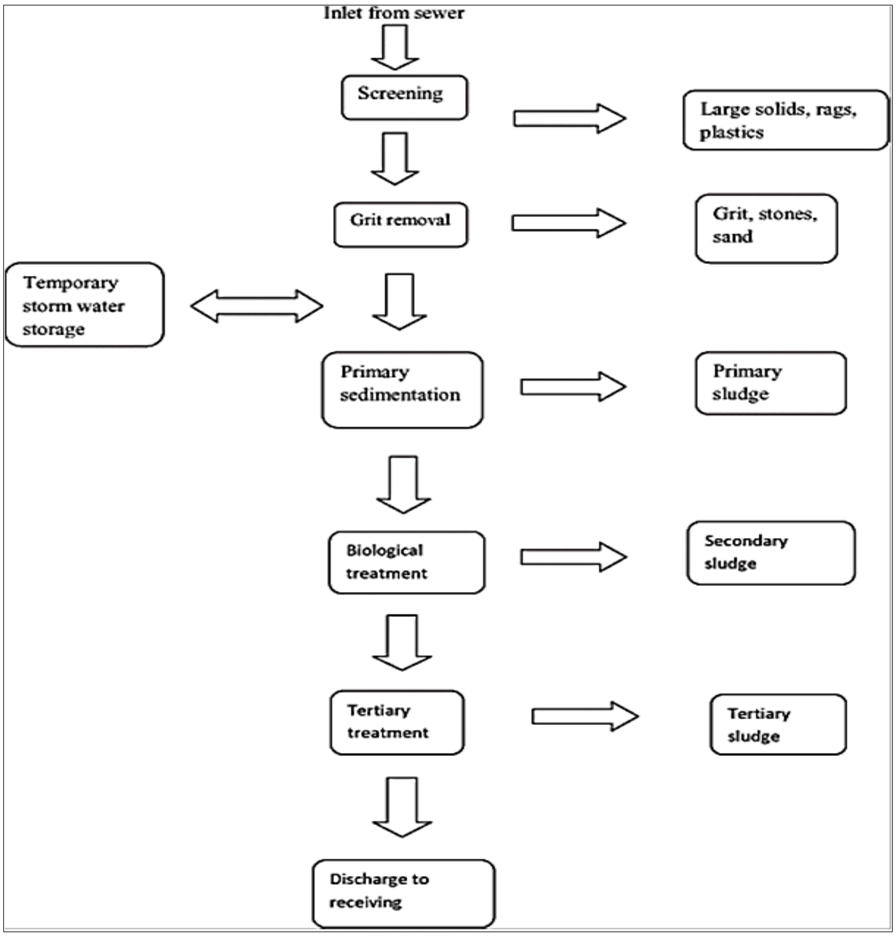

Fig. 1: *Flow Chart for the Processes of WWTP.*

Waste water treatment parameters may be classified into groups of processes according to the function they perform and their complexity.

Preliminary Treatment: It includes simple processes that deal with debris and solid material. The purpose of preliminary treatment is to remove those easily separable components. This is usually performed by screening (usually by bar screens) and grit removal. Their removal is important in order to increase the effectiveness of the later treatment processes and prevent damages to the pipes, pumps and fittings.

Primary Treatment: This is mainly the removal of solids by settlement. Simple settlement of the solid material in sewage can reduce the polluting load by significant amounts. It can reduce BOD by up to 40%. Some examples of primary treatment are septic tanks, septic tanks with up flow filters, Inhofe tanks.

Secondary Treatment: In secondary treatment the organic material that remains in the waste water is reduced biologically. Secondary treatment actually involves harnessing and accelerating the natural process of waste disposal where by bacteria converts organic matter to stable forms. Some examples of secondary treatment are UASB, reed bed systems, trickling filters and stabilization ponds. Wastewater treatment can encompass a number of steps, which filter, clarify and clean wastewater from start to finish Preliminary treatment screens out coarse solids (rocks, rags, plastics, etc.) and grit (sand and gravel) which are normally sent to landfill. Wastewater is screened down to 6 mm sized particles where preliminary treatment is currently in effect. The screened waste water then continues unimpeded to outfalls. Primary treatment screens wastewater, and performs some rudimentary treatment to remove crude solids and skim off grease, oil and fat. Wastewater sits in settling tanks, which are designed to hold the wastewater for several hours. During that time, most of the heavy solids fall to the bottom of the tank, where they become thick slurry known as primary sludge. The material that floats is also skimmed from the surface of the tanks. Both the primary sludge and skimmed material are typically pumped or trucked to a solids treatment processing plant. Secondary (or biological) treatment removes dissolved oxygen-demanding organic substances by using bacteria to convert degradable organic matter into bacterial cells. The wastewater is then clarified by separating treated liquid from grown bacterial cells using gravity. Bacteria and sludge is then either processed onsite or sent to a separate solids treatment facility.

Human waste or more technically referred to as ‘excreta’ the useless matter discharged by animal alimentary, animals being humans in this context. Excreta are made up of a solid matter, faeces, and a liquid matter, urine and are essentially an organic compound. The constituents making up the compound are carbon, nitrogen, phosphorous, sulphur and hydrogen. Also present are fats, carbohydrates, enzymes, proteins, trace elements, pathogens and many different bacteria. It is necessary to treat human waste or excreta for many reasons, but the most important reason is to preserve health. Untreated human excrement contains a variety of pathogenic organisms, which include protozoa, bacteria, viruses and eggs of helminthes that are disease-causing organisms. The presence of these in the environment transmits various types of diseases. They could be:

- Water borne where pathogens are present in water supplies.
- Soil–based where the excreted organism is spread through the soil.
- Insect-vector borne where the pathogen is spread by insects that feed or breed in water e.g. flies and mosquitoes.
- Faecal-oral transmission routes by which pathogens from faeces reach the mouth by hand, clothes, food etc.

Once excrements have been produced, it is necessary to decide what to do with the waste and determine the wastewater treatment option. There is a general distinction: Waste being treated on-site via various treatment options e.g. VIP latrines, water seal toilets, composting toilets etc. or by the use of water to carry the waste off-site to be treated someplace else either not too far from the compound as with septic tanks or to specialized treatment plants through sewer lines. This form of waste often is referred to as wastewater or sewerage.

The total management of wastewater can be separated into four categories: waste water collection, waste water treatment, treated wastewater disposal and sludge management.

The term treatment means separation of solids and stabilisation of pollutants. In turn stabilisation means the degradation of organic matter until the point at which chemical or biological reactions stop. Treatment can also mean the removal of toxic or otherwise dangerous substances (for e.g. heavy metals or phosphorous) which are likely to distort sustainable biological cycles, even after stabilisation of the organic matter.

General Parameters to Measure Organic Pollution: Biochemical Oxygen Demand (BOD_5) and Chemical Oxygen Demand (COD) are the most commonly used parameters for the characterization of wastewaters. COD (Chemical Oxygen Demand) is said to be the most general parameter to measure organic pollution [1]. COD describes how much oxygen is required to oxidise all organic and inorganic matter found in the wastewater sample. BOD (Biological Oxygen Demand) describes what can be oxidised biologically, with the help of bacteria and is always a fraction of COD. Usually BOD is measured as BOD_5 meaning that it describes the amount of oxygen consumed over a five-day measurement period. It is a direct measurement of the amount of oxygen consumed by organisms removing the organic matter in the waste. SS (suspended solids) describes how much of the organic or inorganic matter is not dissolved in water and contains settleable solids that sink to the bottom in a short time and non-settleable suspended solids (Figure 2). It is an important parameter because SS causes turbidity in the water causing clogging of filters etc. The mentioned parameters are measured in 'mg/l'.

Methods of treatment in which the application of physical forces predominate are known as unit operations. Methods of treatment in which the removal of contaminants is brought about by chemical or biological reactions are known as unit processes. At the present time, unit operations and processes are grouped together to provide various levels of treatment known as preliminary, primary, advanced primary, secondary(without or with nutrient removal), and advanced (or tertiary) treatment.

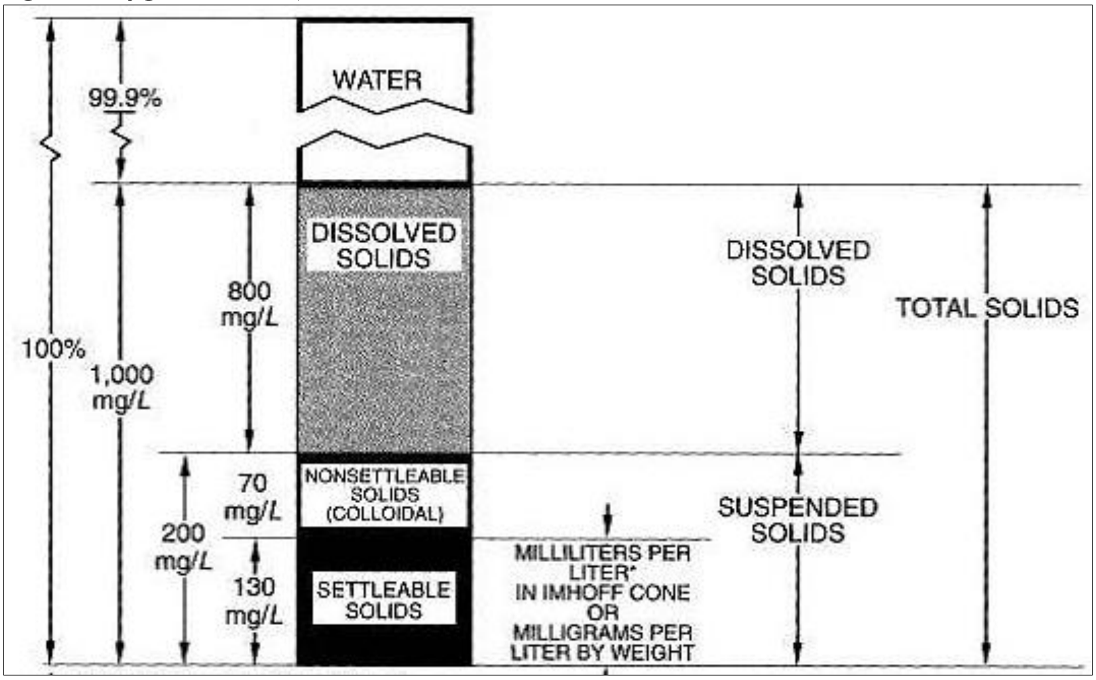

Fig. 2: *Different Parameters of Treatment Processes.*

In preliminary treatment, gross solids such as large objects, rags, and grit are removed that may damage equipment. In primary treatment, a physical operation, usually sedimentation is used to remove the floating and settleable materials found in waste water. For advanced primary treatment, chemicals are added to enhance the removal of suspended solids and to a lesser extent dissolved solids. In secondary treatment biological; and chemical processes are used to remove most of the organic matter. In advanced treatment additional combinations of unit operations and processes are used to remove residual suspended solids and other constituents that are not reduced significantly by conventional secondary treatment.

But in this project we will emphasize the basic methods like screening, grit removal, primary sedimentation, aeration, secondary clarification, disinfection as it is a Small Scale Wastewater Treatment Designed for 7000 people.

RESULTS AND DISCUSSION

One of the primary considerations in evaluating an existing wastewater plant is in the area of plant operation and Control [2]. The entire scenario of waste water treatment depends on the design aspects on which each treatment tank is to be constructed basing on the small community of 7000 people residing in a locality.

Design for Screening

Mechanically screened bar screen will be provided with 2.5 cm clear opening between the bar. Assuming the velocity of flow at the time of maximum hours flow as 80 cm/sec [3].

Net effective area of screens = (From maximum flow of grit chamber) = 0.0607625×1.4/0.80 = 0.106334 (Maximum flow/average flow =1.40 constant)
Providing the depth of the flow as 1.2 m [3].
The required effective width = 0.106334/1.2
= 0.0886 m
Providing 5×1 cm flat cast iron bars [3].
Overall required width = 1.0+ (1.0×100/2.5)×0.1+0.01 = 5.01 m
The screened will be fixed inclined at an angle of 30° to the vertical and with a drop of 10 cm will be given to the floor on the screen chamber on just stream side of it [3].

Design of Grit Chamber

Average quantity of sewage = 300 l/d/c
= 7000×300=2100000 l/d
= 1.4583 cum/min
Assuming the maximum flow = 2.5×1.4583
= 3.64575 cum/min
= 0.0607625 cum/sec
Keeping the horizontal velocity of sewage inside the grit chamber as 20 cm/sec [4].
Detention period = 1 min
Depth of the water as 1.0 m
Length of the grit chamber = V×T
V = velocity of sewage inside the grit chamber
T = detention period = 20×60
= 1200 cm = 12 m
Capacity of the chamber = Q×T
Q = discharge of flow
T = detention period = 0.0607625×60
= 3.64575 cum
Area of flow = (Q×T)/L
= (0.0607625×60)/12
= 0.3334 m
Width of the chamber = A/D
A = area of flow
D=depth of water = 0.3334/1
= 0.3334 m
= 0.34 m
We provide grit chamber of length = 12 m, width = 0.34 m, breadth = 0.64 m
Providing 30 cm as free board at top.

Design of Primary Sedimentation Tank

Population = 7000
Assuming water consumption = 150 l/capita day
Detention period = 2 h
Considering 80% will contribute to sewage flow
Average discharge Q = A×V = 7000×150×0.8 = 840000 l/d
Capacity (C) = (2×840000)/24 = 70000 litres = 70 cum
Provide depth of the tank = 3 m
Surface area = capacity/depth = 7000/3 = 2333.34 litres = 23.34 sq m
Provide 2 tanks of 2 m diameter each
Provide hopper bottom at the slope = 80 mm/m [4].
Total fall in slope = 80×2/2 = 80 mm = 0.08 m
Surface loading = Q/A

= 840000/23.34 = 35989.717 l/sq m/d
Weir loading Q/total periphery of 2 tanks
= 840000/(2×23.34×2) = 8997.42l/m/d
Sludge produced at 4 cum/M L flow [4].
= (4×840000)/100 = 33600 l/cum/d
= 3.36 cum/d
We provide dimension of the primary sedimentation tank (Figure 3).
Depth = 3 m and Diameter = 2 m

Fig. 3: *Equalisation Tank.*

Fig. 4: *Aeration Tank.*

Fig. 5: *Secondary Clarifier.*

Fig. 6: *V Notch.*

Design of Aeration Tank

Population = 7000
Sewage flow = 300 L/c/d
BOD per capita = 0.777 Kg
Return sludge = 30%
Detention period = 6 h
35% of BOD being removed on primary settling tank
Discharge (Q) = 7000×300 = 2100000 L/d
Total volume = (2100000×1.3×6)/24×1000
= 682.5 cum
Providing the tank dimension (Figure 4).
Length = 10 m, Width = 2 m, Depth
= 3.5 m [4].

Normally arrangement of air supply should be so made that for each 15 g of BOD, free air supply of 1 cum should be available [4].

BOD = 7000×0.077×0.65 Kg/d
= 350.35 g/min
Air supply = 350.35/15 = 23.356 cum per min

Design of Secondary Clarifier

Population = 7000
Assuming average flow rate = 33 m/d
MLSS-mixed liquor suspended solids = 2860 mg/l
Flow of secondary clarifier = 0.300 cum/sec [5].
Area=Q/V (Davis Cornwell, 2012)
Q=discharge of the clarifier
V=average flow rate= (7000×0.150 cum/d)/33 m/d = 31.81 sqm = 32 sq m
Diameter of the tank = $\pi D^2/4$ =>32 = $\pi D^2/4$ =>28 = πD^2 =>D^2=128/π =>D^2= 40.7643 =>

D = 6.384 m i. e. required depth of the tank [5].

If diameter of the tank < 12 m side water depth is recommended as 3.4 m
Hence, diameter taken will be 3.4 m
Weir loading for a single weir located at the2/3rd of the radial distance
W.L = .150×86400s/d)/(π×2/3×6.384)
Surface loading = Q/A
Q = discharge
A = area of the tank
S.L = (2860 g/cum×0.300 cum/sec)/(π× D^2/4)
= (2860 g/cum×0.300 cum/sec)/(3.14× 6.384^2/4
= (858 g/s)/31.009 sq m = 26.80× 10^{-3} Kg/g×86400 s/d = 2315.52 Kg/d sq m
Providing the diameter of secondary clarifier = 6.384 m and Depth = 3.4 m (Figures 5 and 6).

Fig. 7: *Chemical Dosing Tank.*

Disinfection
Characteristics of an ideal disinfectant: An ideal disinfectant would have to poses a wide range of characteristic. Although such a component may not exist, the characteristics set forth should be considered in evaluating proposed or recommended disinfectants. It is also important that the disinfectant are safe to handle and apply and that its strength or concentration in treated waters be measurable (Figure 7). The latter consideration is an issue with use of ozone and UV disinfection where no residual is measured.

Disinfection methods and means: Disinfection is most commonly accomplished by the use of:
1. Chemical agents
2. Physical agents
3. Mechanical means
4. Radiation

Chemical Agents
Chemical agents that have been used as disinfectant includes:
1. Chlorine and its components
2. Bromine
3. Iodine
4. Ozone
5. Phenol and phenolic compounds
6. Dyes
7. Soaps and synthetic detergent
8. Quaternary aluminum compound
9. Hydrogen Peroxide
10. Parasitic acid
11. Various alkalis
12. Various acids
13. Alcohols
14. Heavy metals and related compounds

Of these the most common disinfectant are the oxidizing chemical and chlorine is the one used most universally, though bromine and iodine have been used for waste water disinfection. Ozone is highly effective disinfectant and its use is even though it leaves no residue. Highly acid and alkaline water can also be used to destroy pathogenic bacteria because water with a pH greater than 11 or less than 3 is relatively toxic to more bacteria.

Physical Agents
Physical disinfectants that can be used are heat, light and sound waves. Heating, water to the boiling point for example:-will destroy the major disease producing the non-spore-forming bacteria. Heat is commonly used in beverage and dairy industry, but it is not the feasible means of disinfecting large quantities of waste water because of the high cost. However, pasteurization of sludge is used extensively in Europe.

Sunlight is also a good disinfectant due primarily to the ultraviolet (UV) radiation portion of the electro- magnetic spectrum. The decay of microorganism observed in oxidation ponds is due, in part to their exposure to the UV component of sunlight, special lamps developed to emit ultra violet rays have been used successfully to disinfect water and waste water. The efficiency of the process depends on the penetration of rays into water. The contact geometry between the ultraviolet radiation source and the water is extremely important because suspended matter dissolved organic molecules and the water itself will absorbs the radiation in addition to the microorganism.

Mechanical Means

Bacteria and other organism are also removed by mechanical mean during waste water treatment. The first four operation listed may be considered to be physical. The removals accomplished are byproducts of the primary function of the process.

Radiation

The major type of radiation is electromagnetic, acoustic and particle. Gamma rays are emitted from the radio isotopes such as cobalt-60 because of its penetration power. Gamma rays have been used to disinfect both water and waste water. Although use of a high energy electron beam device for the irradiation of waste or sludge has been studied extensively there are no commercial devices or full scale installation in operation.

Disinfection with Chlorine: As we know from all the chemical disinfectants chlorine is the one used most commonly all over the world. A review of chlorine chemicals and a break point chlorination, and analysis on the performance of chlorine as a disinfectant and the factor that may influence the effectiveness of the chlorination process a discussion for the formation of disinfection byproducts (DBP_s) and a consideration of the potential impacts of the discharge of DBP_s to the environment. Disinfection with chlorine oxide chlorination dechlorination and the dechlorination facilities are considered in the following three sections, respectively.

Dechlorination: In case where low level chlorine residuals may have potential toxic effect on the aquatic organism, dechlorination treated effluent is practiced. Dechlorination is accomplished by reacting with the residual chlorine with a reducing agent such as sulpherdioxide, sodiummetabisulphite or by adsorption of activated carbon. The design of dechlorination system is considered in the following section.

Need of Dechlorination: Chlorination is the most commonly used method for destruction of pathogenic and other harmful organism that may endanger human health. As noted per the previous section however, certain organic constituent in waste water interface with the previous section and with the chlorination process. Many of these organic compounds may react with the chlorine to form toxic compounds that can have long term adverse effect on the beneficial use of the water to which they are discharged. To minimize the effect of this potential toxic chlorine residual on the environment, dechlorination of waste water is necessary. Where effluent toxicity requirement s are applicable or where the dechlorination is used as a polishing step following the break point chlorination process for the removal of ammonia nitrogen, sulphur dioxide is used as most commonly for de-chlorination. Other chemicals that have been used are sodium sulfite (Na_2SO_3), sodium bisulfate ($NaHSO_3$), sodium metabisulphite ($Na_2S_2O_5$), sodium thiosulphate ($Na_2S_2O_3$). Activated carbon has also been used for de-chlorination.

Storage: In many reclaimed water reuse applications, storage facilities for reclaimed water have become an integral part of the water recycling facilities. In golf course watering and landscape irrigation, reclaimed water is applied in the evening or early morning hours. Because of low flow during these time periods, reclaimed water produced during the daytime hours must be stored to meet the irrigation demand. Because of increasingly restrictive discharge standard to streams and rivers, many communities are moving toward applying treated effluent to land, with ultimate objective of zero discharge to water bodies. In some location treated effluent must be stored during the summer months, because of low-flow conditions in streams, and discharged during the winter high-flow months.

Operation of Storage Reservoirs

Given the above applications, a number of operating schemes are in use for both open and enclosed reservoirs including:

(1) off-line storage of peak flows during the day time hours for night time use,
(2) flow –through In-line storage,

(3) long term storage of winter flows for summer discharge, and
(4) Long term storage of summer flows for winter discharge.

Off-line storage is common in water reuse applications to
(1) meet the off-hour irrigation water requirements, and
(2) Minimize the pumping costs associated with meeting peak water use demands.

Long-term storage of winter flows for reuse during the summer irrigation period is quite common. Estimation of the irrigation area and reservoir capacity required for irrigation and storage requirement is illustrated in reservoir capacity required for irrigation.

Problems with Open Reservoirs
Changes in water quality during storage or impoundment can be significant. The most common problems encountered with the storage of reclaimed water in open reservoirs are listed in under the categories of physical, chemical, and biological. In many cases, aesthetic concerns will be the controlling factor in deciding whether the community will accept a proposed water-recycling program. The principal problems with the storage of reclaimed water in open reservoirs are:

- Release of odours, principally hydrogen sulphide
- Temperature stratification
- Loss of chlorine residual
- Low dissolved oxygen resulting in odours and fish kills
- Excessive growth of algae and phytoplankton
- High levels of turbidity and colour
- Re-growth of microorganisms

Problems with Enclosed Reservoirs
The most common problems encountered with the storage of reclaimed water in enclosed reservoirs are listed under the categories of physical, chemical and biological (Figure 8). The principal problems with the storage of reclaimed water in enclosed reservoirs are:

- Stagnation
- Release of odours, principally hydrogen sulphide
- Loss of chlorine residual (much slower compare to open reservoirs)
- Re-growth of microorganisms

Fig. 8: *Dry Sludge used as Manure.*


Fig. 9: *Storage Tank and Reuse of Wastewater after Treatment for Gardening Purpose.*

Application of Treated Water and Biosolids (Sludge)
In the planning and implementation of water reclamation and reuse (Figure 9), the reclaimed water application will usually govern the wastewater treatment needed to protect public health and the environment, and the degree of reliability required for the treatment processes and operations. The seven principal categories of municipal wastewater reuse are listed in descending order of projected volume of use along with potential constraints for their application.

- ❖ The first category, agricultural irrigation, is the largest current use of reclaimed water. This reuse category offers significant future opportunities for water reuse.
- ❖ The second category, landscape irrigation, includes the irrigation of parks; play-

grounds; golf courses; freeway medians; landscaped areas around commercial, office, and industrial developments; and landscaped areas around residences. Many landscape irrigation projects involve dual distribution systems-one distribution network for potable water and another for reclaimed water.

- The third major use of reclaimed water is in industrial activities, primarily for cooling and process needs. Cooling water is the predominant industrial water reuse and, for either cooling towers or cooling ponds, creates the single largest demand for water in many. Industrial uses vary greatly, and to provide adequate water quality, additional treatment is often required beyond conventional secondary wastewater treatment.
- The fourth reuse application for reclaimed water is groundwater recharge, via either spreading basins or direct injection to groundwater aquifers. Groundwater recharge involves assimilation of reclaimed water for replenishment, storage in groundwater aquifers, or establishing hydraulic barriers against saltwater intrusion in coastal areas.
- A fifth use of reclaimed water, recreational/environmental uses, involves a number of nonpotable uses to land-based water features such as the development of recreational lakes, marsh enhancement, and stream-flow augmentation. Reclaimed water impoundments can be incorporated into urban landscape developments. Man-made lakes, golf course storage ponds, and water traps can be supplied with reclaimed water is discussed in Sec. Reclaimed water has been applied to wetlands for a variety of reasons including creation, restoration, and enhancement of habitat, provision for additional treatment prior to discharge to receiving water, and provision for a wet weather disposal alternative for reclaimed water.
- The sixth reuse category, non-potable urban uses, includes uses such as fire protection, air conditioning, toilet flushing, construction water, and flushing of sanitary sewers. Typically, for economic reasons, these uses are incidental depending on the location of the wastewater reclamation plant and whether these applications can be coupled with other ongoing reuse applications such as landscape irrigation.
- The seventh reuse opportunity involves potable reuse, which could occur by blending in water supply storage reservoirs or, in the extreme, by direct input into the water distribution system (i.e., so called “pipe-to-pipe” potable reuse).

While potentially large quantities of reclaimed municipal wastewater can be used in the first five categories, the quantities associated with the sixth and seventh reuse categories are minor at present; particularly potable water reuse.

Solid Sources, Characteristics, and Quantities

To design solids processing, treatment and disposal facilities properly, the sources characteristics, and quantities of solids to be handled must be known. Therefore, the purpose of this section is to present background data and information on these topics that will serve as a basis for the material to be presented in the subsequent sections of this chapter.

Sources

The sources of solids in a plant vary according to the plant and its method of operation. For example, in a complete mix activated –sludge process, if the wasting of solids is accomplished from the mixed liquor line or aeration chamber, the activated-sludge settling tank is not a source of solids.

On the other hand, if wasting is accomplished from the activated – sludge return line, the activated-sludge settling tank constitutes a solids source. Processes used for thickening, digesting, conditioning, and dewatering of solids produced from primary and secondary setting tank also constitute sources.

Characteristics

To treat and dispose of the solids produced from wastewater-treatment plants in the most effective manner, it is important to know the characteristics of the solids that will be processed. The characteristics vary depending on the origin of the solids, the amount of aging that has taken place, and the type of processing to which they have been subjected.

General Composition
Many of the chemical constituents, including nutrients, are important in considering the ultimate disposal of the processed solids and the liquid removed during processing. The measurement of pH, alkalinity, and organic acid content is important in process control of anaerobic digestion. The content of heavy metals, pesticides, and hydrocarbons has to be determines when incineration and land application methods are contemplated. The thermal content of solids is important where a thermal reduction process such as incineration is considered.

Specific Constituents
Solid characteristics that affect their suitability for application to land and for beneficial use include organic content, nutrients, pathogens, metals, and toxic organics. The fertilizer value of the sludge and solids, which should be evaluated where they are to be used as a soil conditioner, is based primarily on the content of nitrogen, phosphorus, and potassium (potash). Typical nutrient values of wastewater biosolids as compared to commercial fertilizers. In most land application systems, biosolids provide sufficient nutrients for good plant growth. In some applications, phosphorus and potassium content may be low and require augmentation.

Trace elements are those inorganic chemical elements that, in very small quantities, can be essential or detrimental to plants and animals. The term “heavy metals” is used to donate several of the trace elements present in sludge and bio-solids.

Application of Biosolids to Land
Land application of biosolids is defined as the spreading of biosolids on or just below the soil surface. Biosolids may be applied to (1) agricultural land (2) forest land (3) disturbed land and (4) dedicated land disposal sites. In all four cases, the land application is designed with the objective of providing further biosolids treatment. Sunlight, soil microorganisms, and desiccation combine to destroy pathogens and many toxic organic substances. Trace metals are trapped in the soil matrix and nutrients are taken us by plants and converted to useful masses. In some cases, a geo-membrane liner is installed below a dedicated land disposal area.

To qualify for application to agricultural and non agricultural land, biosolids or material derived from biosolids must meet at least the pollutant ceiling concentrations, Class B requirements for pathogens, and vector attraction requirements. Bulk solids applied to lawns and home gardens and biosolids that are sold or given away in bags or containers must meet the Class A criteria and one of the several available vector-attraction reduction processes. The application of biosolids to land for agricultural purposes is beneficial because organic matter improves soil structure, tilth, water holding capacity, water infiltration, and soil aeration; and macronutrients (nitrogen, phosphorus, potassium) and micronutrients (iron, manganese, copper, chromium, selenium, and zinc) aid plant growth.

Organic matter also contributes to the cation-exchange capacity (CEC) of the soil which allows the soil to retain potassium, calcium, and magnesium. The presence of organic matter improves the biological diversity in soil and improves the availability of nutrients to the plants.

Nutrients in the biosolids also serve as a partial replacement for expensive chemical fertilizers. Land application can also be of great value in silviculture and site reclamation. Forest utilization has been practiced extensively in the North West, and biosolids application has been recognized as being beneficial to forest growth. Reclamation of distributed land such as superfund sites has also been successful.

CONCLUSION
Wastewater treatment involves a variety of processes performed at different levels of treatment. The basic form of treatment is the breaking down of organic waste by bacteria either aerobically or anaerobically or a combination of both which occurs in secondary treatment. Primary treatment offers the settlement of solids. Tertiary treatment

involves the removal of phosphorus, nitrogen and toxic substances. Pathogen removal occurs throughout treatment but becomes more effective mostly at tertiary levels through the use of UV rays and chlorination. The higher the treatment efficiency the better the quality of effluent produced.

The table ratings were done from the available information. It can be seen from the different ratings that each technology has its strong and weak points and therefore, an effective combination of these treatment technologies together would maximise treatment options. Due to the fact that not all information is presented in the table a conclusive result cannot be made to totally represent all technologies present.

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