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THE IMPACTS OF SEWAGE ON THE ENVIRONMENT

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ABSTRACT

Over the years and ages, the environment has experienced a rapid growth with respect to population and advancement in technological facilities which in return have resulted to much impact on the present-day environment. This paper critically examines the impacts of sewage on the entire environment in which man and other living things inhabit. It is indubitable to say that the impacts of sewage on man and his environment are indispensable and quite dynamic in nature. The impacts may be negative or positive. Constructive or destructive depending on the knowledge of Sewage; its treatment and pollution control in the Environment. On the other hand, the Environment is very important to man, hence, the need to make it sanitary. This paper revealed the physical, chemical and the biological tests as parts of the parameters used for determining the organic matter in waste water (sewage) .The physical test includes: Temperature, Colour, Odour and turbidity parameters while the chemical test includes test for PH, Sulphides, Chlorides etc Principal Parameters such as: Dissolved oxygen (DO), Bio-chemical Oxygen demand (BOD) and Chemical Oxygen demand (COD) were also highlighted. This paper unfolds that sewage is indispensable and unavoidable in the environment as long as people demand and utilize water for various purposes: domestic, industrial, institutional etc.

Keywords: Sewage, Environment, Sewage treatment plant etc.

INTRODUCTION

Sewage as the term implies is a very important subject matter to consider. It is indispensable in its study and nature. It is connected to water-which can be described as highly essential and central to the sustainability of man and his environment. According to Park (2009), the key to man's health lies largely in his environment. In fact, much of man's ill health can be traced to the adverse environmental factors such as :water pollution, soil pollution, air pollution, poor housing condition which is tied to poverty, animal reservoir and insect vector which altogether poses a constant threat to man's health. However, man is responsible for the pollution through

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urbanization, industrialization and other human activities. The environment without any iota of doubt is very important and dynamic .Therefore, it is imperative to protect and preserve the environment from negative impacts that can further destroy the environment. This is possible by incorporating Engineering skills and the technical know-how in solving many environmental problems. It is noteworthy that Engineering and the Environment are directly related to each other. Without the Environment, there is no Engineering since Engineering is a tool for national and sustainable development. Interestingly, Man cannot do without the environment and the environment also needs the impacts of man to enhance its growth and fortification using Engineering and Management skills as essential tools. Besides, the environment comprises important constituents or components which also have contributory impacts on the environment. From the basic knowledge of Geology, it is understood that the solid earth and its interior is known as "**Lithosphere**" while the gaseous layer surrounding the earth at a distance of about 500Km is made up of what is collectively referred to as the "**Atmosphere**". The atmosphere is further sub divided into: Troposphere, Stratosphere and Thermosphere. Moreover, other components include: the "**Hydrosphere**" which is the entire collection of water and the "**Biosphere"** which is referred to as that particular zone of the earth; where other layers such as: the lithosphere, hydrosphere and the atmosphere come into contact with one another. In a nutshell, the Biosphere is that portion of the earth where life is in existence. The resultant effect is that there is a continuous exchange of matter between the three other layers or elements which are: lithosphere, hydrosphere and atmosphere. For example, plants draw their food from the nutrients and moisture found in the soil layers of the Lithosphere. Similarly, plants use the Carbon dioxide (CO_2) from the atmosphere and sunlight for their growth. Dead plants and animals are decomposed by bacterial and become soil nutrient. This description implies a symbiotic association taken place in the environment. Furthermore, the Environment is divided into: **Physical and Biological**. In these two types of environment, there are four major elements which include: Land, Water, Air and Living organisms (plant and animal). All these as enumerated constitute what is known as the '**Environmen**t or the **Ecosystem**'. The Physical environment (Land, Water and Air) is essential for the existence of life in diverse forms. In respect of water, according to a postulated slogan "Water is life" This assertion is factual because water is a useful, reliable and an indispensable resource for all ages and generations. Its usefulness cut across: domestic, industrial, commercial and agricultural purposes. Not only that, geographically, about seventy-five percent (75%) which is three-quarters of the earth is made up of water (W.G Stone 1975). Besides, the map of the world also revealed that the largest percentage of the earth is surrounded by water bodies. In fact, improper sewage disposal leads to substantial negative environmental impacts such as: pollution of air, soil and water as well as the generation of greenhouse gases such as: Carbon dioxide (CO2), Methane (CH_4), Nitrogen (IV) Oxide, Ozone (O_3) etc.

STATEMENT OF THE PROBLEM

It is palpable that sewage if not controlled, properly treated and managed as expected poses a lot menaces to public health which in return is hazardous to human beings living in a particular environment. A lot of people due to poverty and ignorance with respect to Sewage and its impacts on the environment have fallen as victims. Therefore, the need to curb the problems generated as a result of the negative impacts of Sewage on the environment.

OBJECTIVE

The objective of this paper is to unveil the possible impacts (positive and negative) of sewage on the entire environment and to also suggest possible solutions to the problems.

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MULTIFARIOUS DEFINITIONS OF SEWAGE.

Sewage is the end product of water utilized in a community. Sewage may be defined in diverse ways with respect to different researches, views and understandings. However, these definitions may be referred to as the same as they revolve around the same orbit. From web research, Sewage may be defined thus:

- Waste matter carried away in Sewers or drains.
- The main liquid waste containing some solids produced by humans which typically consists of washing water, faeces, urine, waste and other materials which go down the drains and toilets from households and industry.
- A suspension of liquid, solid wastes and water runoff transported by sewers to be disposed off or processed.
- The used water and water-carried solids from homes that flow in sewers to a waste water treatment plant.
- The waste water from community including all fiscal matters, urine, household and commercial waste water that contain human wastes.
- Any liquids containing animal or vegetable matter in suspension or solution including liquids containing chemicals in solution.
- The spent water of a community.

In a nutshell, from the definitions above, Sewage may be referred to as **"waste water**" from homes, industries, commercial centres and institutions.

TYPES OF SEWAGE.

There are different types of sewage depending on the sources and locations. Classically, there are these types of sewage viz:

- Industrial Sewage which is mainly generated from the industries and factories.
- Domestic Sewage which is waste water from homes due to domestic uses such as: washing, bathing, flushing, etc.
- Institutional Sewage from Institutions such as: hospitals, schools (Primary, Secondary and Tertiary).
- Commercial Sewage which is usually generated from commercial centres such as: shops, market places etc.

COMPOSITION OF SEWAGE

Sewage contains ninety-nine percent (99.9%) of water and one-tenth percent (0.1%) of Solids usually referred to as **"Sludge"** The one-tenth percent (0.1%) of solids in sewage is made up of partly organic and inorganic matter. Besides, they are partly in suspension and partly in solution. The offensive nature of sewage is mainly due to the organic matter which it contains. Sewage is charged with numerous living organisms derived from faeces, some of which are agents to diseases. Moreover, it is estimated that one gram of faeces may contain about 1,000 million of E.coli,10 to 100 million of faecal streptococci. The average adult person defecates daily about 100 grams of faeces.

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CHARACTERISTCS OF SEWAGE (WASTE WATER)

In addition to the impurities found in water supply, waste water contains a large quantity of impurities added as a result of industrial, commercial and domestic uses of water.

The characteristics of wastewater are classified into: physical, chemical and biological. The principal physical characteristics of wastewater are: the solid content, colour, odour and temperature. The chemical and biological characteristics of wastewater are also briefly outlined.

PHYSICAL CHARACTERISTICS

Solid content: The total solids in wastewater consist of the insoluble or suspended solids and the soluble compounds dissolved in water. Suspended solids content is found by drying and weighing the residue removed by filtering the sample. When this residue is ignited, the volatile solids are burned off. Significantly, about forty-percent (40%) of the solids in an average waste water are suspended. These solids either floating or settleable may form objectionable sludge banks if discharged into a river. Conclusively, settleable solids are those that can be removed by sedimentation.

Colour: is a qualitative characteristic that can be used to assess the general condition of waste water. If light brown in colour, the waste water is six (6) hours old. A light to medium grey colour is a characteristic of waste water that has undergone some decomposition in the collection system for some time. Lastly, if the colour is dark grey or black, the waste water is typically septic; having undergone extensive bacterial decomposition under anaerobic (i.e in the absence of oxygen) conditions.

Odour*:* The odour of fresh wastewater is usually offensive. A variety of odourous compound are released when sewage (wastewater) is decomposed biologically under anaerobic conditions. The principal odourous compound is Hydrogen sulphide (H_2S) which smells like a rotten egg. From the knowledge of chemistry, Hydrogen sulphide is responsible for acid rain which has negative impact or effect on buildings and the environment at large. However, special precaution should be taken in the design of sewage treatment plant facilities in order to avoid the conditions that will allow the development of odour which is unfriendly to the environment.

Temperature: The temperature of waste water is higher than that of water supply because of the addition of warm water from municipal uses. The measurement of temperature is important because most wastewater treatment schemes include biological processes that are temperature dependent. The temperature of wastewater varies from season to season and also with respect to geographic location.

CHEMICAL CHARACTERISTICS

The principal chemical test for wastewater includes: freeammonia (NH_3), organic nitrogen, nitrites, nitrates and organic phosphorus. Nitrogen and phosphorus are important because these two elements have been identified most commonly as being responsible for the growth of aquatic plants. Other tests such as: Chloride, Sulphides, PH and alkalinity are carried out to assess the suitability of re-using treated wastewater as well as controlling the various treatment processes.

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BIOLOGICAL CHARACTERISTICS

The biological characteristics of wastes are sometimes of importance. Tests for "COLIFORMS" in plant effluent are sometimes made to assess the efficiency of the treatment processes in reducing bacteria and the determination of the suitability for discharge into recreational waters. Several types of bacteria found in wastewater are dangerous because they produce disease e.g Salmonella typi (causing Typhoid fever) Salmonellaparatypi (causing fever), Schistosoma (Schistomiasis), Vibrio cholera (Cholera), Mycobacterium tubeculvis (Tuberculosis) etc. However, most bacteria found in waste water are important aids in the process of organic decomposition.

SEWAGE STRENGTH

The sewage strength is determined by the principal parameters which are used to characterize organic matter in waste water. These major parameters are:

- Biochemical Oxygen Demand (BOD)
- Chemical Oxygen Demand (COD)
- Dissolved Oxygen

Biochemical Oxygen Demand (BOD): The strength of sewage is expressed in terms of Biochemical Oxygen Demand (BOD).It is the most important test done on sewage. It is defined as the amount of oxygen absorbed by a sample of sewage during a specified period, generally 5 days at a specified temperature, generally 20^0C for the aerobic destruction or use of organic matter by living organisms. Therefore, BOD of sewage gives the amount of biologically active matter present in sewage. Generally Sewage may be classified as strong or weak. Strong if it ranges between 200-500 milligram/litre but weak if is less than or equal to 100 milligram/litre.

Chemical Oxygen Demand (COD): The organic matter present in water can be measured in a number of ways; volatile solids determination being crude measure of organic matter. Actually, Chemical Oxygen Demand (COD) is the measure of total organic matter (biodegradable as well as non-biodegradable) present in sewage. The Chemical Oxygen Demand (COD) of a raw water or waste water is determined by performing a laboratory test on the given water with a strong oxidant such as dichromate solution. The theoretical computations of COD are only performed on water solutions prepared with the known amounts of specific organic compound in laboratory situations to compare the theoretical test results which further help to establish the limitations of the test procedures.

Dissolved Oxygen (D.O): The determination of dissolved oxygen present in sewage is very important. While discharging the treated sewage into some water bodies e.g rivers or streams, it is necessary to ensure at least four parts per million(4ppm) of D.O in it; otherwise ,fish and some other aquatic organism may likely be mutilated or killed, thereby creating nuisance near the vicinity of disposal. Furthermore, the D.O test performed on sewage before treatment helps to indicate the condition of sewage. It is well known that fresh sewage contains some dissolved oxygen which is soon depleted by aerobic decomposition. Moreover, the dissolved oxygen is inversely proportional to temperature; that is if the temperature of sewage is more, the dissolved oxygen content will be less. Specifically, the D.O content is generally determined by the Winkler's method which is an

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oxidation-reduction process carried out chemically to liberate iodine in an amount equivalent to the quantity of dissolved oxygen present originally present.

THE IMPACTS OF SEWAGE ON THE ENVIRONMENT

The impact of sewage on the environment is quite indispensable and inexorable. It is mainly negative and to a small extent positive. The positive impact is revealed in some countries of the world, e.g Indian and Nigeria where sewage is used for what is referred to as **sewage farming or Broad Irrigation**; a practice in which sewage is fed into the furrows intermintently and crops are grown on the ridges. The crops that are found suitable to grow are those which do not come in contact with sewage and are likely to be eaten raw e.g fodder grass, potatoes, plantain. But sugarcane, tomatoes, onion etc should not be grown. However, important precaution should be taken as the farm should be under the direction of a competent agricultural expert. On the other hand the negative impacts are more and enumerated thus:

- Creation of nuisance as shown in figure 1, unsightliness and unpleasant odours.
- Breeding of flies and mosquitoes which are potential vectors of diseases such as: Malaria, Cholera, Typhoid e.t.c.
- Pollutions of soil and water which implies a great deal of environmental pollution.
- Contamination of food.

Figure1: Domestic solid waste in part of Auchi typical of sewage creating nuisance to the environment.Source: Galaxy Motion Pictures 2018.

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Figure1: Domestic solid waste in part of Auchi typical of sewage creating nuisance to the environment.

Source: Galaxy Motion Pictures 2018.

THE PROBABLE SOLUTIONS

As long as man uses water in the environment for various purposes viz: domestic, industrial, institutional etc, sewage will always be generated. From the previously outlined negative impacts sewage posed to the environment, it is important to proffer probable solutions which will help to attenuate the negative impacts of sewage on the environment.

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The probable solutions lie in the detailed study and design of a typical Sewage treatment plant. Fig 2 shows a section of an existing but abandoned Sewage Treatment plant located at a particular industrial area in Ibadan.

Fig 2: A typical Sewage Treatment plant with various components.

SEWAGE TREATMENT METHOD

Sewage Treatment is the process of removing contaminants from waste water and household sewage; both runoff (effluents) and domestic. It includes: physical, chemical and biological processes which help to remove physical, chemical and biological contaminants. Generally, there are three methods viz: Primary treatment, Secondary Treatment and Tertiary treatment methods.

PRE-TREATMENT

Pre-Treatment removes the materials that can be easily collected from the raw waste water and disposed off. The typical materials that are removed during pre-treatment include fats,

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oils and greases (also referred to as Fog), sand, gravels and rocks (also referred to as grit), large settle able solids and floating materials (such as rags and flushed feminine hygiene products). In developed countries, sophisticated equipment with remote operation and control are employed. The developing countries still rely on low cost equipment such as manually cleaned screen etc.

SCREENING

The influent sewage water is strained to remove all large objects carried in the sewage stream, such as rags sticks, tampons, cans, fruit etc. This is most commonly done with a manual or automated mechanically raked bar screen. The raking action of a mechanical bar screen is typically paced according to the accumulation on the bar screens and /or flow rate. The bar screen is used because large solids can damage or clog the equipment used later in the sewage treatment plant. The large solids can also hinder the biological process. The solids are collected and later disposed in a land fill or incinerator.

SEWAGE TREATMENT PLANT

The sewage treatment plant is an essential structure built with the sole purpose of treating the sewage conveyed and discharged from different buildings in a particular community (commercial, institutional and industrial) via sewer networks. In reality, the Sewage treatment plant consists of the pump house, the aeration chamber, the Sedimentation chamber, the effluent chamber and the digester chamber where the treated effluent is made ready for discharge via the outlet sewer connected to the sewage treatment plant. Besides, each of these chambers consists of manholes which are also referred to as assess points or chambers for the inspection or observation and maintenance. In summary, one of the major probable solutions to the negative impacts posed to man and his aesthetic environment is to put in place a well-designed and adequately constructed Sewage Treatment Plant.

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DESIGN PROCEDURES

The proposed area or location of the sewage treatment plant (S.T.P) must be studied. This can be achieved using a detailed topographical map showing the elevations as well as the nature of terrain (i.e. Flat or Sloping). Besides, the population data must be known as this is an important factor for a properly designed sewage treatment. Subsequent to this is a detailed survey which aid in the design of the sewage treatment plant and the establishment of the network between sewers and the Sewage treatment plant. The operation of the Sewage Treatment is in connection with Sewers (sewage conveyance structures) with different sizes; ranging from a minimum of 50mm to 300mm or more depending on the purpose for which it is designed.

PRELIMINARY DESIGN OF A SEWAGE TREATMENT PLANT.

In general, the method of estimating sewage flows for large commercial/industrial areas is to estimate a population equivalent to the hectarage covered by the development which is then followed by the calculation of the sewage flows. A population equivalent of 85 persons per gross hectare is often used.Besides, it is also necessary to calculate an appropriate peaking factor as well as select a representative unit of peak extraneous flow. However, for individual commercial and institutional uses, the following average daily sewage flow rates are commonly used for design thus:

Shopping centres - (2500-5000L/1000m^2 –day)
Hospitals - (900-1800L/bed-day)
Schools - (70-140L/student-day)

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It is noteworthy that Industrial flows vary with the type and size of industry. Hence, where the specific type of industry is unknown, an allowance of $50m^3$/hectare/day is often used.

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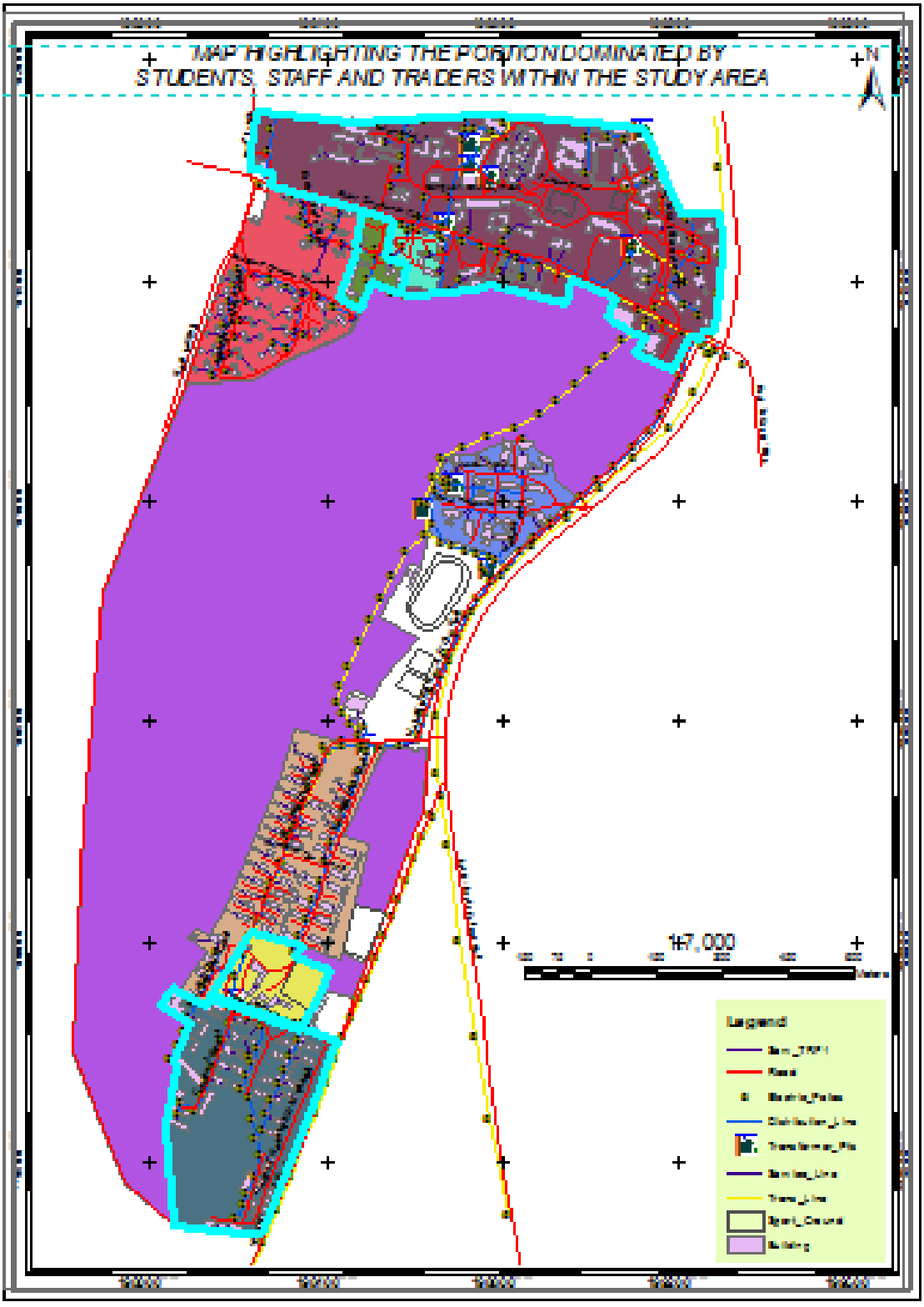

Figure 3: Base map of Auchi Polytechnic, Auchi, Edo State. Source: Digitized Google Earth Imagery 2014.

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However, the preliminary sewage treatment plant design of three Schools at Auchi Polytechnic; projected for the next ten years. This was done by taken the population of the three Schools thus:

School of Engineering- 5300 persons (students and staff).

School of Art and Design-2800 persons (students and staff).

School of Information & Communication Technology (I.C.T)-6300 persons.

Total population of the three schools is equal to 14,400 persons. (Students and staff).

The population forecast for the next Ten (10) years is estimated using the geometric method of population forecasting which is given as:

$P_t=P_o(1+ r/100)^t$

Where $P_t$is population of persons for a given or projected number of years

P_o is the present or initial population

R is the rate of population growth in percentage (%)

T is the number of years

Therefore, the projected population of the three schools in the next ten (10) years, say year 2025 is calculated thus:

$P_{10}=14,400(1+ r/100)^{10}$ but r=3%

Hence, $P_{10}=14,400(1+ 0.03)^{10}$, $P_{10}=19,353$ persons

Design parameters showing: Sewage flow, peak flow and organic load, air requirement of the estimated population in the next ten (10) years is given below:

Hecterage for the estimated population = 160 hectares which in square metre is given as 160x10,000 which is equal to one million and six hundred thousand square metres (1,600,000 m^2).

Given that the water demand per capita per head on the average =100 litres/day

Total water demand for the projected population = 100 x 19353

= 1,935300litres/day or 1,935.3m^3/day

Quantity of Sewage or Sewage flow = 75% of the total water demand

= 0.75 x 1,935 m^3/day

= 1451.475m^3/day, say 1451.5m^3/day,

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Peak flow= DWF X Peak factor.DWF is taken as the daily water demand as calculated above and the peak factor is a function of the peak factor. Therefore, because the estimated population is less than 100,000 persons,3.5 is taken as the peak factor.

Peak flow= 1451.5 X 3.5

= 5080.25m^3/day

Organic load =0.055kg BOD/person/day

= 0.055 x 19353

= 1064.4Kg BOD/day.

Air requirement = 156m^3 air /kg BOD/day

=156 X 1064.4

= 166046.4m^3 of air /day

Retention Time

Aeration Chamber -24 hours

Sedimentation Chamber -2 hours

Effluent-2 hours

Digesters-5 days (5 x 24)=120 hours.

Moreover, the sizing of the treatment plant is done according the shape of the treatment plant and the british standard code(B.S code), The capacity of the Treatment plant for this the three schools as mentioned above is already calculated per day which is = 1,935300litres/day which is equivalent to 430067 gallons/day.

According to the design guide for a rectangular shape Sewage Treatment Plant, the length is usually twice the breadth i.e L=2B.The depth ranges from1.5 to 2m or more. The retention period is usually not more than twenty-four (24) hours. Note: too long retention will result in undue septicity or toxicity of the effluent while too short period of retention results in insufficient treatment.

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CONCLUSION AND RECOMMENDATIONS

The conclusion for this paper unfolds that sewage is indispensable and inexorable in the environment as long as people demand and utilize water for various purposes: domestic, industrial, institutional etc. Suggested recommendations aimed at attenuating the

negative impacts of sewage on the environment are briefly enumerated thus:

1. Public Health Enlightenments via lectures on proper environmental sanitation, magazines and other information media.
2. Construction of Modern and adequately designed sewage treatment plant.
3. Constant and Consistent maintenance culture with respect to the constructed sewage treatment plant should be inculcated as this will help to prevent the negative/hazardous impacts of sewage in the environment.
4. Provision of sufficient funds by the three arms of government (local, state and federal) and well-meaning philanthropist in the society.

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