

# Wastewater/Sewage Treatment Plant

CEVONS WASTE MANAGEMENT

2019



*"The Greatest Threat To Our Environment Is The  
Belief That Someone Else Will Save It"*

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## Abstract

The Co-operative Republic of Guyana has been constantly developing, and with the oil boom looming, development is set to increase at a rapid rate. Growth, expansion and development in any economy directly correlates with an increase in the activities of everyday life. As a result, one such activity is the inevitable increase in domestic waste.

In Guyana, wastewater from all sources is currently pumped or dumped directly into the Atlantic Ocean. Our concern should be, "*How do we correct this?*". To curb this practice we have to provide an accessible facility capable of treating the capacity of wastewater being generated in and throughout the areas affected.

The realization of such a system, how it will function, what systems and technology will be employed and what parameters it will satisfy is given in detail throughout this document.

## Introduction

Guyana, "A Green State Economy". To maintain this title we must deter from irrational and indiscriminate dumping of wastewater. Fundamental to the longevity of a "fertile" environment is the belief that there must be a sustained supply of potable water. Marine life and ecosystem services cannot be polluted by continual discharge of wastewater. To resolve this problem, key stakeholders must reflect a significant change in knowledge, attitude and practices regarding the generation, collection, treatment and disposal of wastewater.

Our National Development Strategy chapter XVIII highlights sewage pollution as a major concern and identifies wastewater management and pollution control as a priority. This interest resonates across the Caribbean with small island developing states and larger island territories both working to realize the obligations of the Convention for the Protection and Development of the Marine Environment in the Wider Caribbean Region known as the CARTAGENA Convention.

Since Guyana's accession to the convention in June 2010, our country is expected to be proactive with our efforts to comply with the parameters outlined in the four Annexes of the Convention, more so to have treatment facilities and infrastructure in operation by year 2020.

Thus, the catalyst of this whole initiative to design, build and operate a wastewater treatment facility in Guyana is in keeping with the development goals of our nation.

## **Project Concept**

This project deals with the design of a wastewater and sewage treatment plant and its major components. These include receiving chamber, screening chamber, grit removal chamber, skimming tank, sedimentation tank, clarifier active sludge tank and sludge drying beds.

The project will cater for sewage and wastewater collected from households in Georgetown and its immediate environs for the next twenty (20) to thirty (30) years.

The soil in the proposed area for construction of the facility is mainly dense clay and is surrounded by over growth vegetation, a landfill site and housing schemes.

Aspects relating to climate, population growth, topography and effects on the environs have been taken into consideration in the designing of this plant.

Once properly executed, this plant can serve the entire Georgetown and its environs effectively and efficiently.

## Definitions

Sewerage – The infrastructure that conveys sewage or surface runoff using sewers.

Sewage – A liquid consisting of any one or a mixture of liquid waste from urinals, latrines, bathrooms, kitchens or sewerage systems of domestic, commercial or institutional buildings.

Wastewater - Any water that has been adversely affected in quality by anthropogenic influence

Influent - Flowing in; wastewater or sewage entering the treatment plant.

Effluent - Flowing out; liquids being discharged from the plant into the environment.

Activated Sludge – The active biological sludge produced in activated sludge plants. It consists of mainly saprotrophic bacteria, protozoan flora (amoebae) and a range of other filter feeding species.

Inorganic - not consisting of or deriving from living matter.

Mixed Liquor Suspended Solids – The amount of suspended solids in a mixture of raw sewage and activated sludge.

Return Activated Sludge – The activated sludge extracted from the system and mixed with raw incoming sewage to form the mixed liquor.

Waste activated sludge – this is excess activated sludge from the treatment process that is extracted and sent to the sludge treatment and or drying beds.

Sludge Age – The average time the sludge has been in the system. This can determine the average lifespan of bacteria in the system.

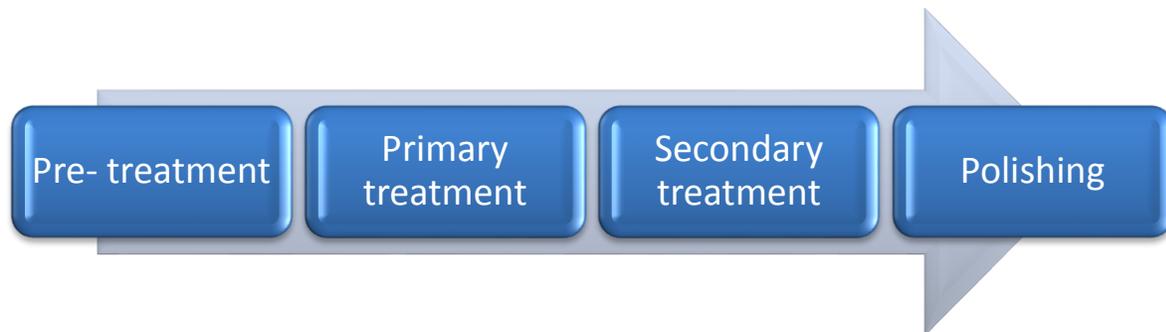
Over flow rate – The discharge per unit of the plant. This is key in designing the settling tanks.

Food to Microorganisms Ratio – Ratio between daily BOD load applied to aerator system and total microbial mass in the system.

## How is Sewage Treated?

Sewage treatment consists of a number of complex functions. The amount and extent of treatment depends on the characteristics of the influent raw material as well as the required effluent quality for discharge as set out by the local Environmental agency, in this case the EPA (Environmental Protection Agency).

Treatment can be classified into four main stages that are progressively sequential namely;



### Pre Treatment

In this stage most foreign objects are removed, this includes all heavy and floating objects and in the case of this project, a large amount of inorganics. It also includes removing oils and grease and has proven to reduce the BOD by almost fifty (50) percent in the initial stage.

Under this stage the processes include;

- Screening (removes floating papers, rags, clothes, solid objects, etc.)
- Grit Chamber (removes grit and sand)
- Skimming (removes oils and grease)

Pretreatment is also essential to prevent scum formation and to hinder excess solids and garbage from entering the other stages of treatment.

### Primary Treatment

This usually entails the removal of large suspended organic solids. This is accomplished mainly by sedimentation with time, in settlement tanks or basins. This process is often preceded by a short period of aeration to add some oxygen into the mix, so as to maximize the amount of large suspended solids that is removed in this stage.

The liquid effluent from this stage still contains a large amount of smaller suspended organic material and can carry a BOD of almost fifty (50%) to sixty (60%) percent that of the raw material.

## Secondary Treatment

In this stage of treatment, biological decomposition of the influent organic material is accomplished by one of three (3) means depending on the owners' choice. These are, Aerobic conditions, anaerobic conditions, or a combination of both.

Aerobic units are units that allow air to be mixed with the material so as to supply same to the existing bacteria which will in turn feed on the organic matter in the sewage.

These units include;

- Oxidation ponds
- Aerated lagoons
- Activated sludge plants (recirculation of sludge, secondary clarification and aeration tanks)
- Filters (sand bags/box, trickling filters)

Anaerobic units allow decomposition of organics to occur in the absence of air. Most of the decomposition occurs in accumulated sludge at the bottom of the tank/pond.

These units include;

- Anaerobic lagoons/ponds
- Septic tanks

The effluent from either one of these secondary treatment methods contains very little BOD, which is about five (5%) to ten (10%) percent, that of the raw material and may even contain a small amount of dissolved oxygen (DO) depending on type and rate of aeration.

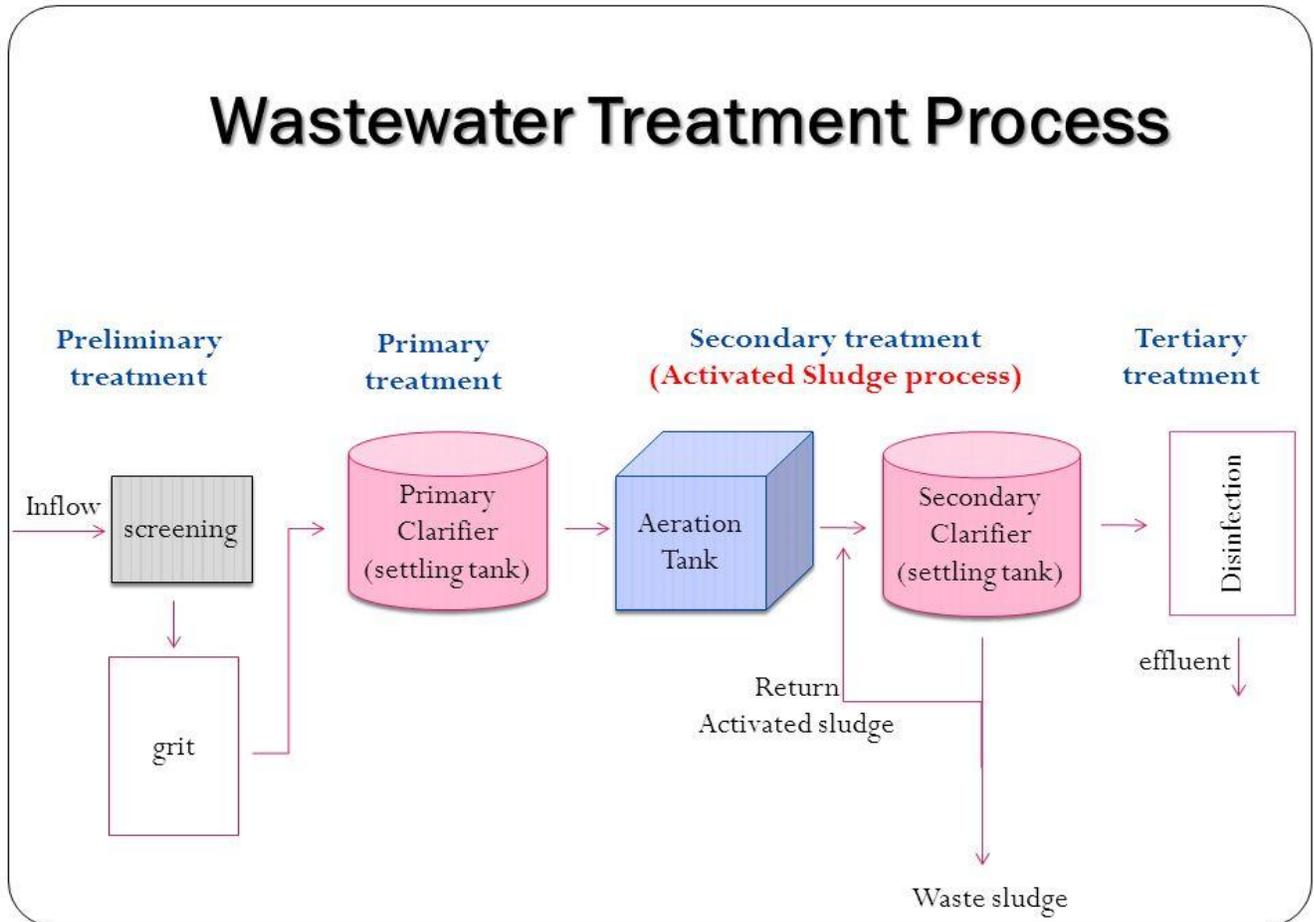
For this project, a combination of both conditions will be used, in order to maximize on existing conditions and at the same time reduce construction and operation costs. This however will not affect the quality of the effluent.

## Polishing

This provides a final stage of treatment before release into the receiving environment. A number of processes can be instituted at this stage. Coagulation and or flocculation, added aeration or disinfection and filtration are just some examples of the processes that can be instituted at this stage, but the chosen process depends highly on the required effluent quality. Disinfection if practiced at the plant, however must be the final stage before discharge.

Another name for the process at this stage is 'effluent polishing'.

(The flow diagram below depicts the simplified sequential stages of the Wastewater Treatment Process)



## Effluent Quality, Parameters & Guidelines

Raw sewage contains many types of contaminants and disease bacteria. This raw sewage if not properly treated before disposal can propose a serious threat to the environment and aquamarine life. It is therefore imperative that parameters be established to determine the quality of effluent allowed to be discharged in a particular medium.

If the quantity of untreated sewage in concentration is more than that of the receiving medium, then this medium will become polluted. To avoid such circumstances, treatment becomes necessary, so that the effluent material can be accepted in the immediate environment without causing any harm to it.

The treatment processes to be employed usually depends on the analysis of the impurities present and the quality of effluent required.

**For this project, the waste stabilization pond, and activated sludge method will be employed.**

(Generally the parameters and effluent quality that would be permissible for discharge into the environment are listed in the Table 1.1 below)

<b>PARAMETERS</b>	<b>EFFLUENT QUALITY (expected)</b>
pH	5 – 9
BOD	≤20mg/l
COD	≤250mg/l
Oil and Grease	≤5mg/l
Total Suspended Solids	≤30mg/l
Nitrogen	≤5mg/l
Ammonia	≤50mg/l
Total Phosphorous	≤5mg/l
Total Coli form	≤1000 no/100ml

**The extent of treatment needed will be decided and or guided by the regulatory guidelines set out by the Environmental Protection Agency (EPA), and based on the intended use of the final product.**

**All treatments adopted will adhere strictly to these standards and will take into consideration maximum use of the final product.**

# **Project Lifespan, Location & Plant Layout**

## **Lifespan**

The design of this treatment plan is aimed to produce and maintain a smooth and efficient flow of materials and to maintain a high quality of effluent. The expected lifespan of the project is at minimum thirty (30) years. This allows for a longer time by which the operator can get back his returns, while providing a pristine service.

## **Location**

The treatment plant will be located just south of the Haags Bosch Sanitary Landfill Site, and about five hundred meters (500m) from any other habitation.

There are no water intake facilities or ground water wells in close proximity to the location of the plant site. The effluent of the plant will be discharged into a drainage canal just north of the plant site. The canal is an existing drainage canal used by the landfill operators.

## **Plant Layout**

The plant will be laid out in order of sequence of the treatment process, so as to allow a smooth flow from one treatment stage to another. Consideration will be given to the topography of the land in order to allow the flow to be done by gravity from one process to the other.

Care will be taken during the design to utilize the minimum possible space for the plant while ensuring that the capacity of the units can accommodate the expected loading. Facilities for staff and operators will be constructed at strategic points in close proximity to the plant so that operators can monitor the plant easily.

All units will be constructed with bypass lines and overflow weirs so as to reduce the possibility of overtopping of a unit due to a blockage or for a unit to be serviced, cleaned or repaired.

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## **Plant Design**

The processes about to be explained in detail will represent the systems to be employed in the Wastewater Treatment Facility being built.

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The processes are explained sequentially; from influent discharge to final effluent disposal and dilution.

## Step 1. Receiving Chamber "The BEAST"

The receiving chamber is generally a structure designed to receive the raw sewage, it can be constructed underground or above ground, and should have the capacity to hold at least twice the daily intake of raw material. It is usually a rectangular shaped tank constructed at the entrance of the treatment plant. Trucks pump their spoils directly into this tank.

However, for this project, a specialized piece of equipment called "The BEAST" will be purchased to handle all pre-treatment of raw material. This piece of equipment removes all inorganic solids (heavy and floating) objects from the raw sewage, and a large amount of organics, thus reducing the initial BOD by almost fifty (50%) percent.

"The BEAST" contains a rotating internally fed drum-screen and a high pressure wash press. Inorganics exiting "The BEAST" will be deposited onto the drying beds to further remove any moisture before landfilling.

(The pictures below gives a representation of what "The BEAST" looks like on the exterior)



This robust piece of equipment is specialized to handle all pre-treatment requirements, which includes **screening (course and fine), grit removal** and **skimming**, however, additional measures will be put in place for further pre-treatment after the sewage has exited "The BEAST".

## Step 2. Primary Sedimentation Pond

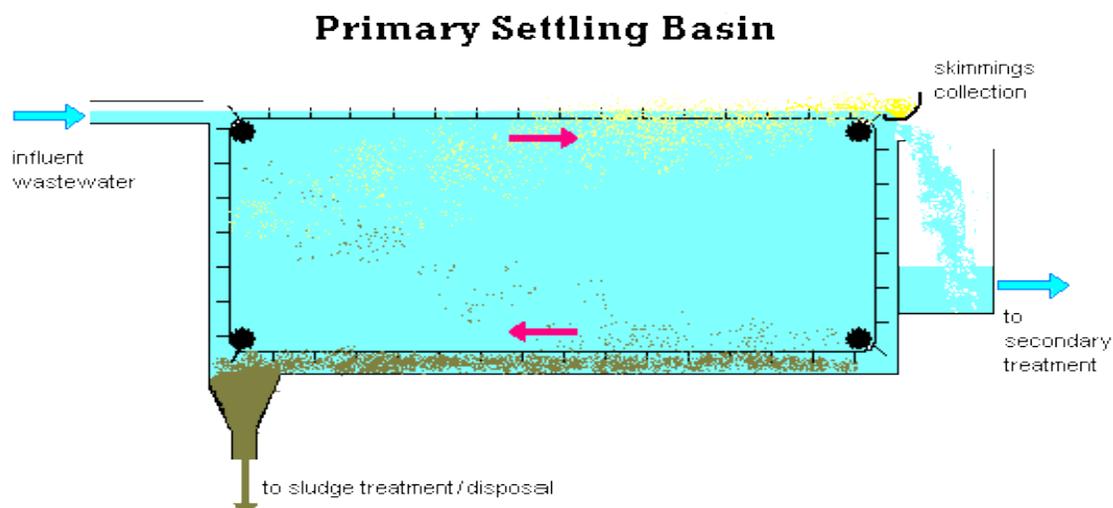
This POND is used for the settling of most organic solids which are too small to be removed by the screens but too heavy to be removed by other means. This includes particles of lesser size than 0.2 mm and specific gravity of about 2.65. This pond also caters for the removal of scum since some amount of floating materials can reach to this pond.

The pond is usually about three (3) to five (5) meters deep and should be capable of holding a minimum of twice the daily intake of sewage. This pond allows settling by gradual means in the direction of the flow. These ponds use gravity in conjunction with projected natural settling so as to effect a high percentage of suspended solids removal.

These ponds have the capability to remove sixty (60) to sixty-five (65) percent (%) of the suspended organic solids and approximately fifty-five percent (55%) of the BOD.

Apart from achieving settlement, this pond also encourages anaerobic digestion in the accumulated sludge at the bottom of the pond. This allows for treatment of the sludge simultaneously with the liquid purification process.

(The illustration below is a visual depiction of what happens inside a Primary Sedimentation Pond).



### **Step 3. The Activated Sludge Process**

This is a biological treatment process for sewage in the presence of air. It uses dissolved oxygen to promote biological matter that contributes to the digestion/removal of organic material in the settled out sewage.

In all activated sludge facilities once the sewage is aerated enough it is then sent to a settlement pond where the live bacteria will settle to the bottom to assist with digestion and the dead bacteria floats to the top. In this stage protozoa are also digested.

The process requires contact aeration, secondary settling, sludge storage and sludge drying.

This unit will combine all the requirements of the activated sludge process into one compact pond so as to minimize land use and initial startup cost. This however will not affect the quality of final effluent. The design of this pond will take into consideration required flow (influent and effluent) and retention time needed for sufficient treatment of the settled sewage.

Retention time varies from pond to pond, a standard assumption based on practical experience pins retention time as follows;

- Aeration (contact) pond – four (4) to eight (8)hrs
- Settling pond – five (5) to thirty (30) days

In the combination of the two ponds for the process, the retention time will be pinned at five (5) to thirty (30) days.

The process allows atmospheric air to be bubbled through primary treated sewage combined with organisms (contained in sludge) to develop a biological matter (floc), and this in turn reduces the organic content of the settled sewage.

A combination of raw settled out sewage and biological mass is formed and this is referred to as Mixed liquor.

After the mixed liquor is treated, it is then sent to a secondary settling tank, where the settled sludge is sent to the return sludge holding basin and the excess is sent for further treatment. For this project the two will be combined into one pond to facilitate this aspect of the process. The percentage that is sent to the holding basin is called return activated sludge. The excess that is sent for further treatment is known as waste activated sludge.

This waste activated sludge can be further treated by digestion or then sent to drying beds.

In this process the moving organisms oxidize the organic matter, thus allowing it to settle in the secondary sedimentation pond.

The settled sludge (activated sludge) can then be recycled to the beginning of the aerated pond and mixed with the new entering effluent from the primary sedimentation tank.

All excess sludge from the activated sludge process is termed waste activated sludge and is disposed with primary treated sludge after digestion is completed.

The activated sludge unit of the plant can result in almost ninety-five percent (95%) BOD and bacteria removal once properly operated.

Some steps to proper operation of this unit includes;

- Sufficient supply of oxygen to the plant
- Continuous mixing of sewage with activated sludge
- Keeping return sludge flow constant throughout the process
- Avoiding over oxidizing the liquor.

## **Step 4. Aeration**

This is the first step in the activated sludge process and consists of usually a rectangular shaped pond ranging from one (1) to three (3) meters deep and calculated surface area depending on influent rate and retention time.

The length can extend as long as is required, depending on Hydraulic retention time (HRT) and Solids retention time (SRT).

Volume required is therefore the sum of the expected flow per day plus return flow of solids (if necessary).

Air is mixed with the wastewater at this stage so as to increase the DO (dissolved oxygen) content of the waste water thus enhancing treatment. Note however, that over aerating can negatively hamper the treatment process.

Aeration is done by either diffused air aeration, mechanical aeration or combine aeration, for this project combined aeration will be employed.

Diffused air aeration is when air is mixed with water /waste water through a diffuser, it consists of three main parts, namely

1. Air compressor
2. Air hose
3. Diffuser (plate or tube)

Mechanical aeration is the use of machinery to mix the air and water/waste water so that oxygen can be absorbed into it.

Examples of mechanical aerators are;

1. Paddle wheels
2. Mixers
3. Rotating brushes to agitate the surface
4. Pumps to create fountains
5. Pumps to create cascades (waterfalls)

(Pictorial representation below of Aeration taking place)



**Activated Sludge Aeration Tank**

## **Step 5. Secondary Sedimentation**

This is a similar pond to the primary sedimentation pond except that no provisions is needed for the removal of scum.

However, the surface area should be designed for both overflow rate, retention time and solids loading.

In this pond the already settled and activated liquid is allowed to further settle thus removing the remaining organic matter and getting the liquid ready for the next stage.

## **Step 6. Stabilization**

This is a simple pond where the excess sludge is allowed to settle before being pumped to the drying beds. This pond is optional, since the sludge once allowed to digest in the settling ponds can be pumped directly to the drying beds.

It is usually designed to accommodate three (3) times the amount of expected waste activated sludge.

The actual capacity is a direct relation to the length of time the sludge takes to dry on the drying beds.

## **Step 7. Sludge Drying**

Sludge drying is usually done on open beds known as sludge drying beds.

The digested sludge from the stabilization ponds still contain lots of water, so it is necessary for it to be dewatered before being disposed of at the landfill site. Most of the moisture gets evaporated into the atmosphere in hot weather.

Bad weather conditions often affect the effective drying of sludge on open beds. However, additional means of dewatering will be taken into consideration.

This include the construction of a drainage layer beneath the drying bed so as to allow liquid to be drained from the sludge by gravity into collection troughs. This liquid is then added to the aeration pond for further treatment.

The sludge is usually spread to a thickness of twenty (20 to thirty (30) cm. Actual thickness however, is based on seepage ratio and permeability of drainage layer.

By using a combination of the two methods, sludge drying can be done in a minimum of three (3) days in hot weather and as much as twelve (12) days in bad weather.

The dried sludge cakes are then removed and taken to the landfill site or used as manure for plants, since it can still contain a small percentage of nitrogen, phosphorous and potassium (NPK).

Sludge beds are not limited to any specific size, but should be large enough to accommodate the required amount of sludge required for drying. The beds are usually made up of two layers of gravel (15cm at the bottom and 5cm at the top) on top of perforated pipes leading to a catchment area or tank. A drainage filter fabric can be used on top of the gravel to allow for easy removal of dried sludge, and prevent contamination with the gravel bed.

(Picture below showing sludge being poured on a drying bed to be dewatered.)



## Step 8. Effluent Polishing

This is the final stage of treatment before the waste water can be released into existing drainage systems. In this process all remaining BOD, SS, nitrogen, phosphorous, potassium etc. that is left after the activated sludge process is completed is removed or reduced to a safe concentration.

These ponds are point five (0.5) to one (1) meters deep and are usually very long or built in series so as to maximize the treatment. The main way of removal of contaminants in these ponds is photosynthesis.

Through photosynthesis algae and other aqua life releases oxygen into the wastewater and at the same time consume carbon dioxide produced by the respiration of bacteria.

Most of this photosynthesis is driven by sunlight, as such the dissolve oxygen levels are higher during the day and lower during the night. Mixing is usually assisted by wind or aerators if necessary.

Polishing is done by either engineered wetlands or biological wetlands.

In engineered wetlands filters are constructed using a number of different materials, (rocks, sand, activated carbon, activated charcoal, coconut fiber, etc.). These are arranged in such a way that the waste water is thoroughly filtered before discharge into waterways.

In biological wetlands a more natural approach is taken using the reaction of sunlight with algae and other water life forms (grass, fishes, etc.) to treat the waste water through mainly photosynthesis and respiration.

Both methods have been proven to give acceptable results, but for this project, a combination of both methods will be used.



## **Step 9. Disposal**

Unless further treatment for higher quality effluent is required, the effluent can be disposed of in one of two ways;

1. Dilution – disposal into existing water bodies
2. Effluent irrigation – disposal on land (rice farming)

### **Dilution**

This is basically discharging the treated effluent into existing bodies of water, e.g. drains, rivers, lakes, seas, etc.

### **Effluent Irrigation**

The effluent can be evenly spread on the surface of land thus allowing the remaining suspended solids to remain on the surface while the water percolates into the ground.

The remaining suspended solids (while very little in volume) are acted upon by existing bacteria on the ground and are also oxidized by exposure to atmospheric actions of heat, light and air.

# Proposed Site Layout

Site Layout

South View

North View

Sectional View

## Summary of the Treatment Process

Raw sewage and waste water will be collected from domestic and industrial entities as well as existing sewage sumps in various municipalities and NDC's.

Upon arrival at the site, the trucks will be inspected and documented, then directed to the offloading area, where pretreatment will begin immediately.

For pretreatment, the trucks will be hooked up to The BEAST and the raw material will be pumped into this specialized piece of equipment. At this point screening, grit removal and some amount of sludge removal will be done with this piece of equipment.

After exiting the beast, the liquid waste will enter a skimming tank where oils and grease will be coagulated and removed before exiting to the next stage of treatment. All solids will be disposed of at the landfill site on a daily basis.

In the skimming tank a mixture of air and chlorine will be blown through the liquid, the rising air tends to coagulate and solidify the oils and grease, thus causing them to rise to the top of the tank, while the chlorine destroys the colloidal effect of protein which tends to hold the oils and grease in an emulsified form.

After this stage, the liquid is now ready to be clarified. This is done in a primary settlement pond. In this pond the liquid is allowed to settle using gravity and directional flow.

The heavy suspended solids are settled in this pond and digestion is accomplished in the accumulated sludge at the bottom of the pond. (this is usually done in an anaerobic condition, hence the depth of the pond). In this pond as much as fifty percent (50%) BOD removal can be accomplished, depending on the composition of the liquid.

Lighter suspended solids will still be floating in the liquid and this will be removed in the next stage. Treatment in this pond can take between one (1) to seven (7) days depending on liquid composition.

The next stage of treatment is the activated sludge process, which includes aeration, secondary sedimentation, sludge stabilization and sludge drying.

Aeration is needed to activate the bacteria present in the liquid so as to allow it to feed on the organic content of the liquid. Air also collides and coagulate lighter suspended solids allowing them to become heavier and eventually sinking to the bottom of the liquid. Oxygen (O<sub>2</sub>), present in air is also needed to satisfy the high BOD existing in sewage.

If there's not enough bacteria present in the liquid at this stage, bacteria can be added from the stabilization pond so as to effectively remove the organic matter from the liquid.

The biological floc which is now formed is allowed to settle (secondary clarification) for a period of five (5) to thirty (30) days depending again on liquid concentration, after which it moves on to the next stage of treatment. All settled sludge from primary and secondary clarification (once digested will be pumped to drying beds for further treatment.

The drying beds will be constructed with a drainage layer beneath in order to maximize the drying rate of the sludge. All liquid exiting the drying beds will be returned to the secondary settling pond for further treatment.

The next stage of treatment is maturation and polishing. In this stage all remaining contaminants in the liquid will be removed or reduced to a safe concentration for discharge. The liquid at this stage will also be gradually integrated with the existing environs.

This treatment and integration will be accomplished through photosynthesis, engineered filtration and biological integration (use of aqua life). After polishing the effluent will be tested and once safe will be released into the existing drainage canal.

A contingency line will be installed at the exit of the polishing pond. This line will be used to return improperly treated effluent to the secondary treatment stage if further treatment is required.

A lab will be constructed onsite to constantly monitor and test liquid at various stages of treatment so as to ensure a safe product is being drained into the canal.

Other onsite facilities will include Offices for admin staff, washroom facilities, store rooms, conference room and sanitation area for both workers and trucks using the facility.

All run-off water from onsite facilities will be sent to the beginning of the treatment process.

## Conclusion

Since there is no such facility existing in the city of Georgetown and its environs, this project can be seen as necessary to curb the wanton dumping of raw sewage in our waterways, as is practiced presently.

This project intends to combine all aspects, namely environmental, biological, chemical, social and engineering to achieve the best possible treatment facility.

This project also takes into consideration the projected increase of sewage inflow for the next thirty (30) years, since components are designed to have adjacent capacity.

The project consists of a complete design of a sewage treatment plant inclusive of pretreatment area (receiving, screening, grit removal, skimming), primary sedimentation pond, activated sludge process (aeration, secondary sedimentation, sludge stabilization and sludge drying) and polishing area and maturation (maturation pond, engineering and biological wetlands).

Since the facility is going to use natural means of treating the leachate, all components, with the exception of the beast, will be designed and constructed locally. The beast is a specialized equipment, manufactured to handle pretreatment of leachate and has to be sourced from overseas.

A successful project of this magnitude will depend on the involvement of all entities and institutions with the requisite technical expertise in this field.

It is therefore hoped that full cooperation can be had for a successful construction and operation of this facility.

# **EPA Comments**

## **APPENDIX**

(This Appendix includes responses to the comments outlined by the relevant EPA officials.)

## General Comments

- The document lacks a map showing the surrounding land use to the proposed project site (sewage treatment plant). Map depictions will enable a better understanding of how far or close the project will be to surrounding waterways, aquifers, wells etc. The North Arrow should be inserted on the proposed site layout and site layout diagrams. Further, a Description of the site, inclusive of topography and hydrogeology should be submitted for the project.

See Attached

- Given the potential impacts of the project to ground and surface water and to residents, the project should consult Hydromet within the Ministry of Agriculture and central Housing and Planning Authority (CH&PA) seeking No Objection or approval for the project. In this regard, a copy of the same must be submitted to the Agency. ***Please note, the Agency will process the Authorization once information is received that the afore-mentioned Authorities were consulted. However, prior to finalization of the Authorization the No Objection or Approval from the authorities must be submitted to the Agency.***

See Attached

- The project summary mentioned that a number of ponds will be constructed to cater for the treatment of raw sewage. It should explicitly outline all treatment processes to be undertaken and flow diagram should begin at the point of receipt and conclude at release point into the environment. Each pond should be specifically explained on how it will be constructed (size) and materials that will be used for construction (earthen or concrete). The document should be referenced inclusive of figures, estimations, calculations, etc.

See Attached

- The document should include all environmental media likely to be significantly impacted by the operation of the sewage treatment plant, for e.g. surface water, ground water, air, land and should clearly indicate the monitoring of gases, odour, noise, particulate matter, meteorological conditions, etc.

See Attached

- Aerated lagoons require a source of electricity. What are the plans for the power source?

Primary power will be sourced from the Guyana Power & Light and auxiliary power supplied by a generator.

### Air Quality

- The sources of possible air emissions from the transfer, storage and waste treatment processes should be identified. During construction identify the potential impacts on air and including noise emissions from the use of equipment.

<b>Transfer</b>	<b>Storage</b>	<b>Waste treatment processes</b>
Vehicular emissions	Offensive Odours	<ul style="list-style-type: none"> <li>• Production of odorous gases during the anaerobic digestion of organic matter</li> </ul>
		<ul style="list-style-type: none"> <li>• Dust emissions from the sludge drying process and unpaved surfaces</li> </ul>

- Baseline Air Quality Assessment should be conducted at the proposed location of the treatment plant prior to operation based on the possible emissions. The methodology, type of equipment and model number to be used should be stated.

<b>Air quality Parameters to be tested</b>	<b>Methodologies</b>	<b>Instrument</b>
<ul style="list-style-type: none"> <li>• Particulate Matter</li> </ul>	<p>The Gravimetric method will be utilized given that it is a widely used technique for determining ambient concentrations of PM as well as the amount of PM in emissions. It can be used to measure Particles lesser than 2.5 &amp; 10 micrometers.</p> <ul style="list-style-type: none"> <li>• A blank filter will first</li> </ul>	Mettler Toledo 851e Thermo Gravimetric Analyzer

	<p>be weighed on a balance in the laboratory</p> <ul style="list-style-type: none"> <li>• Filters are loaded into labeled cartridges, preconditioned and transported to the test site.</li> <li>• At the test site, the air of gases are drawn through the filter at a known flow rate for a specific duration. Any particulate matter present is retained on the filter</li> <li>• In the laboratory , the loaded filters are conditioned again and reweighed</li> <li>• By subtracting the weight of the blank filter, the mass of PM can be determined (differential weighing). Concentration of PM is calculated using the flow rate of the gas/air sample</li> </ul>	
<ul style="list-style-type: none"> <li>• Methane</li> </ul>	<p>Infrared beams can be used to detect and quantify methane present in the atmosphere since methane is an excellent absorber of infrared energy. How it works is that IR radiation is directed from a light source through the gas being measured to an Infrared detector. A filter located at front of the detector usually prevents wavelengths other than that specific to the measured gas from passing through the detector. The light intensity is then detected and converted into a gas concentration value. IR</p>	

	sensors are generally known to have many benefits. They are stable and highly selective to the measured gas, they have a long lifetime and can withstand high humidity, dust and harsh conditions.	
<ul style="list-style-type: none"> <li>Nitrous Oxides</li> </ul>	The Modified Jacob & Hochheiser Method captures Nitrous oxides by bubbling air through a solution of Sodium hydroxide and sodium Arsenite. The concentration of Nitrite ion produce during sampling is determined calorimetrically by reacting the Nitrite ion with Phosphoric Acid, Sulphamic Acid, NEDA (N-(1-Naphthyl) Ethylenediamine dihydrochloride) and measuring the Absorbance of highly colored azo dye at 540 nm.	

- A monitoring schedule should be developed and maintained for all parameters identified by the company. This should be done to highlight the operating and quality assurance principles under which best engineering practices will be executed

Monitoring will conducted for all the parameters highlighted. Parameters will be tested quarterly to ensure that the project does not significantly impact surrounding Air quality.

- Particulate matter (PM) poses significant health risk to humans. The report did not highlight if the company plans on conducting monitoring of PM (PM 2.5 and PM 10).

The Monitoring of particulate matter will be conducted, PM 2.5 and PM 10. ..

- Company should outline a mitigation plan for odour and air pollutants from the plant and from the disposal of effluent and sludge. Additionally, dust and noise emissions during the construction and operational phases should be included.

Potential/Anticipated Impacts of pollutants associated with the project are listed below.

Waste management facilities are generally known to generate atmospheric emissions and liquid effluent, which may be hazardous to human health and the environment (in the form of ecosystem imbalance).

It is anticipated that the project is likely to impact the surrounding environment (e.g. surface water and ground water sources, land/soil, and air quality) and as such practical preventative measures will be implemented so as to minimize or completely eliminate these impacts.

### **Anticipated Impacts on Air quality**

- **Offensive odours:** The release of offensive odours may also cause a nuisance to people in the surrounding areas. Odors constitute the principal air contamination problem at sewage treatment plants. This is caused due to the anaerobic digestion of organic compounds sewage which leads to the production of obnoxious chemicals such as, skatole, cadavarine, mercaptans, amines and sulfides. Amines and mercaptans contain sulfur or nitrogen, producing odors that are detectable by the human nose at extremely low concentrations. Products like hydrogen sulfide (H<sub>2</sub>S) in particular, is released into the atmosphere due to its low solubility in wastewater, producing an offensive odor. Weather conditions can also intensify odors for e.g. Odors are generally worse at higher temperatures. (Factor to be taken into consideration: will the operation be located upwind or downwind of residential areas, use of chemicals to control odour). At which stage of the waste treatment process will these chemicals be added.

### **Mitigative Measures**

- **Ensuring odour producing processes are located downwind of residents.**  
Wind velocity, and wind direction contribute to how far odor emissions drift. By planning the layout for each step in the treatment process, odour producing stages can be laid out downwind or can be isolated in order to reduce the impacts on surrounding residents.

- **The use of Chemicals to help eliminate odours.**  
Oxidizers, Bactericides, and pH modifiers can also be used to help eliminate odours. Oxidizing chemicals are known to eliminate odours by oxidizing odour causing compounds into more stable and odour free compounds. Chemicals that raise the oxidation potential will prevent the reduction of sulfates to hydrogen sulfide. pH modifiers work by raising the pH of the wastewater which prevents the off-gassing of hydrogen sulfide. In addition, it acts as a bactericide and kills the slime that grows on sewer piping surfaces.
- **Use of covers.** Covers not only reduce odor emissions but also help contain harmful greenhouse gases and minimize evaporation so that less water and chemicals need to be used in the wastewater treatment process. There are a wide variety of to choose from for e.g. they can be inflatable, retractable, made from flexible geomembranes, and made from rigid materials such as aluminum, fiberglass, or steel.

## **Dust Pollution**

This is likely to occur during the sludge drying process. The weight and size of particles influence how far the particulate matter can travel. The smaller the particles, they are more likely to stay suspended in the air for longer periods of time and can be transported over longer distances.

## **Mitigative Measures**

- **Covering of sludge drying beds.**  
By covering sludge drying beds can significantly reduce the emissions of particulate matter into the atmosphere especially on windy days. This can be done using materials that will not significantly reducing the amount of sunlight needed for drying beds.

## **The release of GHG emissions and Nitrous oxides.**

Green House Gases such as methane, carbon dioxide, and Nitrous oxides are released during the biological breakdown of organic material in waste treatment processes. This is Likely to occur during the pre-operational and operational phases of the project; vehicles transporting waste to project site and onsite generators.

## **Anticipated Impacts to Water Quality**

## Water Pollution

It is the poor quality of wastewater effluents that is often responsible for the degradation of receiving surface water bodies. If not treated properly it can often lead to both long-term and short-term effects on the environment and human health.

- ***Eutrophication***

Eutrophication can result when nutrient-rich wastewater effluents are discharged into water courses. The influx of nutrients such as nitrites, nitrates, and phosphorus into water bodies can induce eutrophication. The inadequate treatment of these compounds can lead to their introduction into receiving watershed with their attendant consequences. This can result in the growth of algae blooms and plants in aquatic ecosystems. When this happens, the turbidity of the water increases, plant and animal biomass increases, sedimentation rate increases, species diversity decreases, and anoxic conditions may develop, and this could give rise to change in dominant species of the aquatic biota.

## Solutions/Mitigative measures

Water quality parameters such as pH, Ammonia, phosphorous and more will be monitored regularly to ensure that effluent standards are met. It will be conducted at every phase of the project as well at release points so as to ensure that the treatment process is working effectively and that quality effluent is being released into the environment.

<b>PARAMETERS</b>	<b>EFFLUENT QUALITY (expected)</b>
pH	5 – 9
BOD	≤20mg/l
COD	≤250mg/l
Oil and Grease	≤5mg/l
Total Suspended Solids	≤30mg/l
Nitrogen	≤5mg/l
Ammonia	≤50mg/l
Total Phosphorous	≤5mg/l
Total Coli form	≤1000 no/100ml

Table showing the parameters and effluent quality that would be permissible for discharge into the environment

## **Anticipated Impacts to Land/Soil Quality**

### **Release of Heavy metals into surrounding Soils**

When sludge containing significant amounts of toxic materials eg. Heavy metals are disposed of without adequate treatment, they immediately become part of the soil; when these toxic materials and heavy metals become ionized (i.e. in their soluble form), they could be picked up by plant roots and this bio-accumulates in the plant tissues.

### **Mitigation Measure**

- Monitoring of sludge for Heavy metals

### **Erosion**

The clearing of vegetation in order to facilitate the construction of onsite infrastructure. Vegetation removal often leaves topsoil exposed to the elements of erosion (e.g. water and wind). A lack of soil protection leads to erosion and even soils becoming infertile.

### **Mitigation Measure**

- Minimizevegetation removal as much as possible

## **Anticipated Noise and Vibrations Sources**

It is anticipate that the project will generate noise and vibration above existing levels. This is likely to occur mainly during the pre-operational (construction) phase; during hours of operations the noise and vibration levels are expected to be well within permissible ranges. Potential noise sourcesmay include: tools and machinery that will

be utilized in the construction process, onsite generators, the Beast (equipment used in the pre-treatment process) and more. High noise & Vibration levels may result in:

- discomfort to residents
- structural damages to surrounding infrastructure

### **Mitigative Measures/Solutions**

- Retro-fitting existing equipment with damping materials, mufflers, or enclosures
- Erecting barriers
- Routine maintenance of equipment
- Limit Vibration and Noise causing activities to normal working hours (8:00 – 5:00 pm)
- All staff will receive relevant training to ensure noise levels are kept within permissible limits

## Specific Comments

1. What is the estimated volume of sewage expected per day and the expected load? This would be necessary to ensure the size of the plant can accommodate the retention time necessary for efficient and effective treatment.

Estimated average volume of sewage per day	16,000 gallons ( 73 m3)
Daily fluctuation rate of ty50 %	24,000 gallons (109 m3)
Allowance for 100% Increase	48,000 gallons (218 m3)

2. Will the plant be accepting sewage from other waste water haulers?
  - Yes. The wastewater treatment facility will be accepting wastewater from other haulers, once compliant with the standard operating procedures onsite.
3. What is the quality of sewage entering the plant, e.g. microbial content e.g. giardia and crytosporidiaorganisms, chemical content e.g. phosphate levels?
  - See Attached (sewage sample results from Kaizen laboratory.)
4. Will the treatment system be able to accommodate the removal/reduction of antibiotics in the waste water?

Provisions will be made to accommodate the removal of antibiotics from wastewater streams. Antibiotics are generally known to bio-accumulate in the environment and possess the ability to affect bacteria colonies (inhibiting their activity) inside wastewater treatment networks. The following method will be used to remove antibiotics from the wastewater at this facility:

Absorption by activated charcoal - As the wastewater passes through the engineered wetland, any form of antibiotics being carried in the effluent will be absorbed in the carbon activated conditions created by the presence of charcoal.

5. Will the landfill be able to accommodate the anticipated solids from pre-treatment? E.g. Large debris, floating papers etc.

- Yes. All solid particles will be accepted at the landfill site.

6. Disinfection if practiced at the plant, however must be final before discharge.” Will disinfection be practiced at the plant? As page XX stated chlorine will be added....

- No. *”In the skimming tank a mixture of air and chlorine will be blown through the liquid, the rising air tends to coagulate and solidify the oils and grease, thus causing them to rise to the top of the tank, while the chlorine destroys the colloidal effect of protein which tends to hold the oils and grease in an emulsified form.”*

NB: De-chlorination will occur as the effluent passes through the biological and engineered wetlands before discharge.

7. “The expected lifespan of the project is at minimum thirty (30) years.” At what rate of loading? What will be the operational hours and how many days per week will the plant operate? What will be the redundancy plan or back-up system in case of malfunctions?

At the beginning of the project the daily average loading rate is expected to be 16,000 gallons per day with an anticipated daily fluctuation of about 24,000 gallons. Operation hours are expected to be from 7 am to 4 pm. The project is also designed to accommodate an increased growth of 100 % (48,000) gallons per day.

The settlement ponds will be built parallel to each other, this is to allow the isolation of one pond to accommodate scheduled maintenance or allow for operations to continue as per norm in instances of malfunctions.

8. Aeration is done by either diffused aeration, mechanical aeration or combine aeration, for this project combined aeration will be employed.” What does the combine aeration process entail?

- The combined process will entail the use of a series of eco-fans throughout the aeration pond and air compressors; these will operate at timed intervals.

9. "This pond is optional, since the sludge once allowed to digest in the settling ponds can be pumped directly to the drying beds". Will a pond be constructed for the settling of excess sludge under the stabilization process?
- No. A stabilization pond will not be constructed.
10. "Sludge drying is usually done on open beds known as sludge drying beds." What will be the dimensions of the sludge drying beds?
- Based on the quantity of wastewater to be treated, sizing of sludge drying bed (SDB) changes. SDB's will be built considering the worst case scenario with dimensions 6-8m width and 6-30m length; with top and bottom gravel layers 5cm and 15cm respectively.
11. "Most of the moisture gets evaporated in the atmosphere in hot weather." What special measures/precautions will be taken with reference to sludge drying during the two expected rainy seasons per year?
- Sludge drying beds will be designed to allow for the recirculation of wastewater being drained from the sludge. During periods of heavy rainfall any excess wastewater drained from the sludge will be returned to the aeration pond, at the start of the treatment process.
12. "A drainage filter fabric can be used on top of the gravel to allow for easy removal of dried sludge, and prevent contamination with the gravel bed." Will a drainage filter fabric be installed?
- Yes. "A drainage filter fabric can be used on top of the gravel to allow for easy removal of dried sludge, and prevent contamination with the gravel bed. Non-woven geotextile fabric will be used a barrier between gravel and collected sludge.
13. Both Methods have been proven to give acceptable results, but for this project, a combination of both methods will be used." How will both these methods be combined with reference to effluent polishing?
- A combination of both engineered and biological wetlands will be utilized in effluent polishing. Both engineered and biological wetlands methods will be utilized to ensure that remaining BOD, SS, nitrogen, phosphorous, and more are removed from the wastewater stream.

14. A lab will be constructed onsite to constantly monitor and test liquid at various stages of treatment. Information on the methods and or instruments used to monitor and test liquid at various stages within the laboratory should be included
- At what phase will water quality will be conducted?
  - What are the water quality parameters that will be tested?
  - How often will testing be done?
  - If the parameter are out of range from the standard, will further treatment be done before discharge?
- Water quality parameters will be monitored using water quality test kits. Test kits usually contain test strips that changes color once exposed to water, based on the water's mineral content. The strip color will then be matched to a color chart.

Additional Questions	Response
At what phase will water quality testing be conducted?	Testing will be conducted at every phase of the project
What are the water quality parameters that will be tested	Some of the water quality parameters that will be tested includes: <ul style="list-style-type: none"> <li>• Phosphates</li> <li>• Nitrogen</li> <li>• pH</li> <li>• Ammonia</li> </ul>
How often will testing be conducted?	Testing will be conducted at every discharge. This will be conducted at least once every week.
If the parameter ran out of range from the standard, will further treatment be done before discharge?	If parameters run out of range from the standard further treatment will be conducted. Effluents will be sent back into the secondary settling pond for further treatment before it is discharged into surrounding surface waterways.

