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Thème:

The study of "system O)) enviro-septic" for wastewater treatment application at Tiguentourine rig camp

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DEDICATION

Every challenging work needs self-efforts as well as guidance of elders, especially those who were close to our hearts.

We dedicate this modest work to our parents with all our love, to our familys, friends and teachers.

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We extend our heartfelt appreciation to our supervisor, Prof. Kherrat for his exceptional mentorship throughout our research. His expertise and knowledge have been instrumental in the successful completion of our thesis. We are truly grateful for his unwavering commitment to our academic growth and development.

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Finally, we would like to thank our collegues in school for their support and camaraderie. Their encouragement have made our academic journey more enjoyable and memorable.

ABSTRACT

Our study aimed to find a sustainable solution for the wastewater generated in the rig camp located in TIGUENTOURINE (TG) field of the Regional Direction IN AMENAS. It is important to treat wastewater before releasing it into the environment to prevent pollution. After careful consideration, we propose the use of System O)) Ensito-Septic treatment, which is an environmentally friendly solution for individual sanitation systems. This treatment involves a primary treatment (septic tank) and a secondary treatment (lenvireseptic pipes) and filter sand. Enviro Septic Systems are made of recycled plastic items and function as passive systems that do not require energy, chemicals, or expensive maintenance procedures to operate. Additionally, these systems do not require quarterly servicing, making them a simple, effective, and affordable option for wastewater treatment.

Enviro Septic is a highly effective system that creates a protective eco-system for bacteria to thrive. This system is adaptable to any residential or commercial setting and is able to determine the appropriate size based on the amount of wastewater generated. By digesting harmful septic contaminants before effluent is released into the surrounding soils, the result is treated wastewater that is significantly safer for your family and the environment. Additionally, this treated water can be used for irrigation, which helps to reduce water usage and conserve this precious resource.

Keywords: Wastewater, Enviro-Septic system, septic tank, bacteria

RÉSUMÉ

Notre étude visait à trouver une solution durable pour les eaux usées générées dans le camp de forage situé à TIGUENTOURINE (TG) domaine de la Direction Régionale D'AMENAS. Il est important de traiter les eaux usées avant de les rejeter dans l'environnement pour éviter la pollution. Après mûre réflexion, nous proposons l'utilisation du système de traitement Ensito-Septic System O)) qui est une solution respectueuse de l'environnement pour les systèmes d'assainissement individuels. Ce traitement comprend un traitement primaire (fosse septique) et un traitement secondaire (canalisations lenvireseptiques) et filtre à sable. Les systèmes septiques Enviro sont faits d'articles en plastique recyclé et fonctionnent comme des systèmes passifs qui ne nécessitent pas d'énergie, de produits chimiques ou de procédures d'entretien coûteuses pour fonctionner. De plus, ces systèmes ne nécessitent pas d'entretien trimestriel, ce qui en fait une option simple, efficace et abordable pour le traitement des eaux usées.

Enviro Septic est un système très efficace qui crée un écosystème protecteur pour que les bactéries se développent. Ce système est adaptable à tout environnement résidentiel ou commercial et est capable de déterminer la taille appropriée en fonction de la quantité d'eaux usées générées. En digérant les contaminants septiques nocifs avant que les effluents ne soient rejetés dans les sols environnants, le résultat est des eaux usées traitées qui sont nettement plus sûres pour votre famille et l'environnement. De plus, cette eau traitée peut être utilisée pour l'irrigation, ce qui contribue à réduire la consommation d'eau et à conserver cette précieuse ressource.

ملخص

هدفت دراستنا إلى إيجاد حل مستدام للمياه العادمة المتولدة في معسكر الحفارة الواقع في حقل TIGUENTOURINE (TG) التابع للاتجاه الإقليمي في AMENAS. من المهم معالجة مياه الصرف الصحي قبل إطلاقها في البيئة لمنع التلوث. بعد دراسة متأنية ، نقترح استخدام النظام Ensito-Septic (O) ، وهي حل صديق للبيئة لأنظمة الصرف الصحي الفردية. يتضمن هذا العلاج معالجة أولية (خزان للصرف الصحي) ومعالجة ثانوية (تنفيس أنابيب) وتصفية الرمل. تصنع أنظمة الصرف الصحي Enviro من مواد بلاستيكية معاد تدويرها وتعمل كنظم سلبية لا تتطلب طاقة أو مواد كيميائية أو إجراءات صيانة باهظة الثمن للعمل. بالإضافة إلى ذلك ، لا تتطلب هذه الأنظمة خدمة ربع سنوية ، مما يجعلها خيارًا بسيطًا وفعالًا وبأسعار معقولة لمعالجة مياه الصرف الصحي.

Enviro Septic هو نظام فعال للغاية يخلق نظامًا بيئيًا وقائيًا للبكتيريا لتزدهر. هذا النظام قابل للتكيف مع أي بيئة سكنية أو تجارية ويمكنه تحديد الحجم المناسب بناءً على كمية المياه العادمة المتولدة. من خلال هضم الملوثات الضارة قبل إطلاق النفايات السائلة في التربة المحيطة ، تكون النتيجة معالجة مياه الصرف الصحي التي تكون أكثر أمانًا لعائلتك والبيئة. بالإضافة إلى ذلك ، يمكن استخدام هذه المياه المعالجة للري ، مما يساعد على تقليل استخدام المياه والحفاظ على هذا المورد الثمين.

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LIST OF ABBREVIATIONS

FAO: The Food and Agriculture Organization

HSE: Health, safety and environment

JORA: Official Journal of the Algerian Republic

TG: Tiguintourine

STEP: Station d'épuration des eaux usées

CRD: Research & Development Center

CRDT: Research Center on Territorial Development

WHO: World Health Organization

AES: Advanced Enviro-Septic

ES: Enviro-Septic

WWTP: Wastewater treatment plant

MBBR: Moving Bed Biofilm Reactor

MBR: Bioreactor membrane

SBR: Sequential Bio Reactor

PLC: Programmable logic controller

RAS: Return activated sludge

DN: Nominal Diameter

pH: Hydrogen potential

MVS: Volatile matter in suspension

TN: Total Nitrogen

NTK: Nitrogen Kjeldahl

TSS: Total Suspended Solids

NH_4^+: Ammonia nitrogen

SO_4^- : Sulphate ion

NO_2^- : Nitrites

NO_3^- : Nitrates

Cl^-: Chlorides

NO_3^-: Nitrogen

HCO_3^-: Bicarbonate

P t: Total phosphorus

Pb: Lead

Cr: chromium

Mn: Manganese

Co: Cobalt

Cu: Copper

Zn: Zinc

Ni: Nickel

CD: Cadmium

Fe: Iron

Hg: Mercury

N: Nitrogen

P: Phosphorus

NAES: Minimum number of advanced enviro-septic pipes

SE: Minimum evacuation surface

SSR: Minimum area for spacing requirements

Q: Total nominal daily wastewater flow in liters

T: Percolation time of the underlying native soil

ECC: Center to Center Spacing

EL: Lateral extension

EE: End extension

LSR: Reference Surface Length

WSR: Width of Smallest Region

Nr: Number of rows

SSR: Raw Sewage Sludge

LR: Row length

LSystem: Length of the system

WSystem: Width of the system

Vseptic: Volume of the system

CE: Electrical Conductivity

SAR: Sodium adsorption ratio

PE: Population Equivalent

EH: Inhabitant equivalent

LPM: Liters per minute

COD: Chemical Oxygen Demand

BOD: Biochemical Oxygen Demand

BOD5: Biochemical oxygen demand after 5 days

MES: Suspended solids

D-Box: Distribution Box

SS: Suspended Solids

MDT**:** Matières dissoutes totales

T: Temperature

°C: Degree Celsius

i.e or e.g: example

N.T.U: Nephelometric Turbidity Unit

mg: Milligram

L: Liter

cm: Centimeter

mm: Millimeter

m: Meter

m^2 : Square meter

m3 : Cubic meter

g : Gram

d : Day

KG : Kilogram

km : Kilometer

µS : Microsecond

ds : Decisiemens

min : Minute

GENERAL INTRODUCTION

It may come as a surprise that wastewater treatment is a relatively modern practice. While ancient Rome had sewers to remove foul-smelling water, it wasn't until the 19th century that large cities realized the importance of reducing pollutants in used water. Despite an abundance of fresh water and the natural cleansing ability of surface waters, concentrated populations by 1850 led to frequent outbreaks of life-threatening diseases caused by pathogenic bacteria in polluted water. Wastewater treatment plants accelerate the natural cleansing process that occurs in oceans, lakes, rivers or streams. The techniques used in wastewater collection and treatment have been developed and perfected, incorporating biological, physical, chemical and mechanical methods.

Wastewater treatment is a crucial process that involves the removal of contaminants and pollutants from wastewater and converts it into an effluent suitable for reuse or returning to the water cycle.

Enviro-Septic system is an environmental friendly wastewater treatment system developed by Presby Environmental, Inc. This system is an excellent choice for those seeking a reliable and effective wastewater treatment solution. It is designed to enhance the natural contribution of bacteria in treating pollutants in a more efficient way. It can also function for extended periods without any attention. The media inside the system does not clog or become saturated, and the bacteria that breaks down the waste are self-regulating and naturally occurring. Enviro-Septic is highly adaptable and can be customized to meet the needs of residential, commercial, and industrial sites.

Chapter 1:

Wastewater and wastewater treatments

CHAPTER1

1.1 Introduction

The very fact that water is used means that it will become polluted. Water pollution has become a major source of concern and a priority for both society and public authorities, but more importantly, for the whole industrial world (Sonune and Ghate 2004; Crini 2005; Cox et al. 2007; Sharma 2015; Rathoure and Dhatwalia 2016). The pollution of rivers and streams with chemical contaminants is a crucial environmental problem. Waterborne chemical pollution can cause significant destruction, making it essential to treat wastewater before discharge into the environment. In this context, a constant effort must be made to protect water Resources (Khalaf 2016; Rathoure and Dhatwalia 2016; Morin-Crini and Crini 2017).

Industries rely on water for various purposes, however, most of the supplied water ends up as industrial wastewater. Discharging these streams into the environment can cause soil contamination, water pollution, and air pollution. Therefore, it's crucial for industries to treat these wastewaters within their premises or eliminate them at the source to prevent environmental damage.

1.2 Types of effluents

Four categories of water are typically distinguished: rainwater, domestic wastewater, agricultural water, and industrial wastewaters. The latter can be further divided into cooling water, washing effluent, and manufacturing or process water. Process waters, or wastewaters, generally pose the greatest problems due to their biodegradable and/or potentially toxic nature. Unlike drinking water sources, which are typically rivers, lakes, or reservoirs, wastewaters have significantly higher levels of contaminants, depending on their industrial origin. Their toxicity also varies based on their composition.

1.3 Treatment of wastewater

Wastewater treatment is a common form of pollution control .To use naturally occurring water for domestic, industrial, commercial, agricultural, or recreational purposes, adequate treatment is necessary.It is crucial for maintaining a healthy environment, preserving natural resources, and preventing water pollution. The extent of treatment required depends on the end use of the treated water. In the past, sewage was dumped into waterways, which began a natural process of purification. However, with today's higher populations and greater volume of domestic and industrial wastewater, communities must give nature a helping hand.

The treatment's objective is to eliminate pollutants from wastewater and make it suitable for safe discharge into the environment. Merely relying on end-of-pipe treatment is not sufficient for pollution control due to the increasing demand for water and its decreasing availability. Therefore, reuse, recycling, and by-product recovery must be incorporated into the treatment plan. Experience proves that this goal can be achieved without incurring heavy expenses. Moreover, recycling wastewater is starting to receive active attention from industry in the Context of sustainable development, improved water management (recycling of waste water) and also health concerns (Kentish and Stevens 2001; Cox et al. 2007; Sharma and Sanghi 2012; Khalaf 2016; Rathoure and Dhatwalia 2016; Morin-Crini And Crini 2017).

1.4 Stages of wastewater treatment

Purification process consists of five successive steps :preliminary, primary secondary, tertiary and treatment of the sludge formed (Anjaneyulu et al. 2005; Crini and Badot 2007, 2010).

1.4.1 Preliminary stage

This involves screening and grit removal to remove large objects and debris from raw wastewater, including wood, cloth, paper, plastics, and fecal matter. This process also removes heavy inorganic solids such as sand, gravel, metal, and glass as well as excessive amounts of oils or greases.

1.4.2 Primary stage

Uses sedimentation and flotation to remove organic and inorganic solids. It involves solids being removed from the wastewater by allowing them to settle. It only eliminates approximately 25-50% of the incoming BOD, 50-70% of the total suspended solids , and 65% of the oil and grease. It also removes some organic nitrogen, organic phosphorus, and heavy metals associated with solids.

1.4.3 Secondary stage

It aims to further treat the effluent from primary stage. it uses biological processes to further purify the wastewater. In some cases, these stages are combined into one operation. A grit chamber is particularly important in communities with combined sewer systems where sand or gravel may wash into sewers along with storm water.

1.5 Wastewater treatment technologies

Elimination of pollutants is done in several ways: Physical Methods, Chemical Methods, biological methods and Energy Intensive Methods.

1.5.1 Physical methods

Include solid-liquid separation techniques, with filtration being the dominant player. Filtration can be conventional or non-conventional and is an essential component of drinking water and wastewater treatment. However, it is just one unit process within a modern water treatment plant scheme, with numerous equipment and technology options available depending on the treatment goals.

1.5.2 Chemical methods

These methods rely on the chemical interactions of contaminants and the application of chemicals to remove or neutralize them. They can be used alone or in combination with physical methods.

1.5.3 Thermal methods

They are energy-intensive and have a dual role in water treatment. They can be used for sterilization to produce high-quality drinking water, or for processing solid waste and sludge generated from water treatment applications. Thermal methods can be used to sterilize sludge contaminated with organic contaminants and for volume reduction in water treatment operations. This is important as there is a tradeoff between polluted water and hazardous solid waste. Electrochemical techniques are energy intensive and are mainly used for drinking water applications to achieve sterilization and conditioning for palatable quality.

1.5.4 Biological methods

It is a modern technique that uses microorganisms to treat wastewater instead of chemicals. This method prevents adverse effects caused by chemical treatment, such as chemical accumulation in water bodies or algal blooming. The process uses aerobic and anaerobic microorganisms to reduce pollutants and BOD of water.

1.6 Purification process in Algeria

1.6.1 Main processes

The main biological treatment methods include:

1.6.2 Extensive processes

They use solar energy for photosynthesis to produce oxygen, allowing operation without electricity.

They are divided into:

a. Extended "Natural lagoon" processes

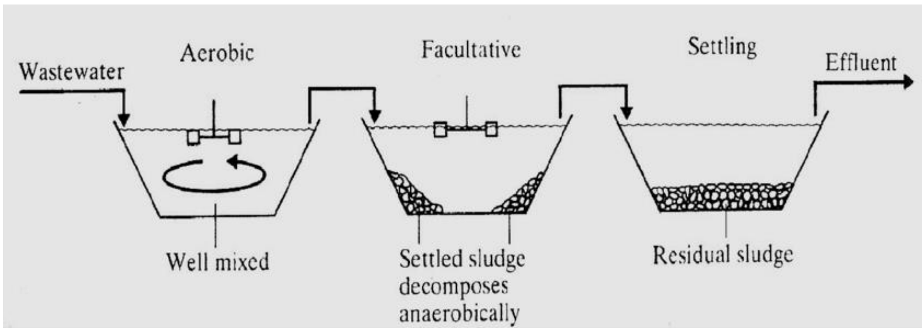

Figure 1: General view of the lagoon station

Purification is carried out through a series of watertight basins where a long residence time is ensured. Typically, three pools are used. The process relies on photosynthesis, allowing the existence of algae which produce oxygen for aerobic bacteria. These bacteria are responsible for breaking down organic matter. Carbon dioxide and mineral salts in wastewater allow algae to multiply, creating a self-sustaining cycle. Anaerobic bacteria at the bottom of the pond degrade the sediments resulting from the settling of organic matter. This process depends on solar energy and organic matter. A release of carbon dioxide and methane occurs at this level.

b. Aerated lagoon

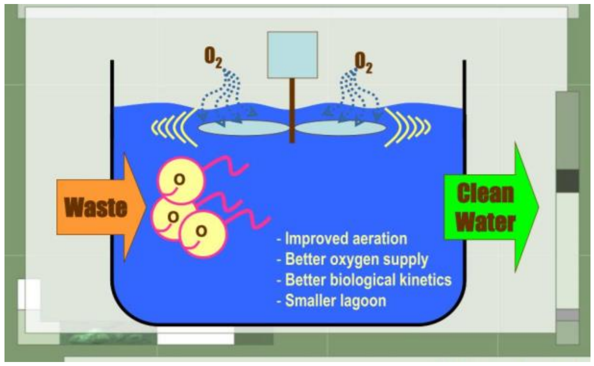

Figure 2Diagram of an aerated lagoon system

The aerated lagoon is a biological purification technique that uses micro-organisms to degrade wastewater and assimilate nutrients. This process is similar to activated sludge, but with a lower bacteria density and no recirculation. Oxygenation is carried out by a surface aerator or by air blowing, with an electrical consumption similar to that of activated sludge. During settling, the suspended solids agglomerate into sludge, which must be regularly extracted. Cleaning is facilitated by the presence of two basins that can be bypassed separately. However, since sludge flocculation is not very pronounced, the settling lagoon must be oversized. The aerated lagoon is distinguished from activated sludge by the absence of maintenance of a fixed concentration of micro-organisms (no recirculation). This leads to providing longer residence times, more favorable to good adaptation of the system to variations in the quality of the effluent to be treated. This process behaves well with respect to diluted effluents or if the flow rates are not.

c. Vertical flow planted filter

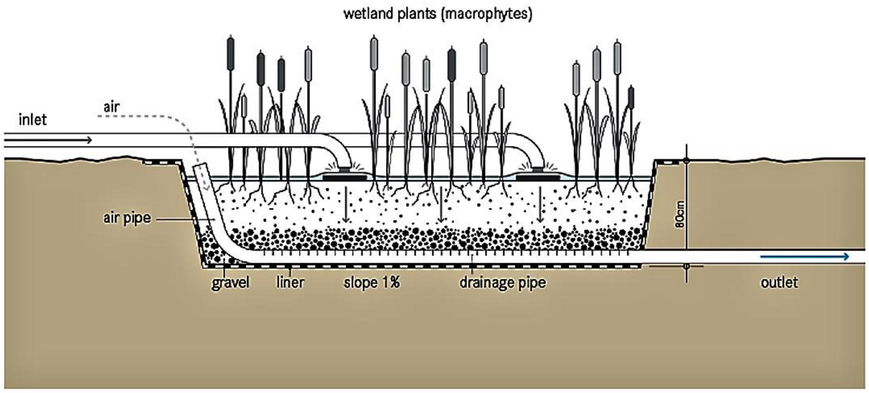

Figure 3. Cross section of a vertical flow planted filter

The filters used for wastewater treatment are sealed excavations on the ground. They are filled with layers of gravel or sand of variable grain size depending on the quality of the wastewater. Unlike infiltration-percolation, the raw influent is distributed directly to the surface of the filter without prior settling. The water undergoes physical, chemical and biological treatment inside the filter. The treated water is drained, and the filters are supplied with raw wastewater per tank. The filtration surface is separated into several units, allowing periods of feeding and rest. The principle of purification is based on the development of an aerobic biomass fixed on a reconstituted soil, the oxygen being supplied by convection and diffusion. The supply of oxygen by the rootlets of the plants is negligible compared to the needs.

The sizing of the vertical filters was established empirically by defining the acceptable daily organic loads (20 to 25 g BOD5 m-2.d-1 of total planted area). The first stage is designed to receive approximately 40 g BOD5 m-2.d-1, representing 60% of the total surface area, i.e. approximately 1.2 m2/pe. When the network is unitary or partially unitary, the dimensioning of the first floor is increased to 1.5 m2/EH (Agence de l'eau, 1999). This stage is compartmentalized into a multiple of 3 filters, which allows rest periods of 2/3 of the time. The surface of the second floor is generally 40% of the total surface, or approximately 0.8 m2/PE. At this stage, the rest time required is equal to the operating time, requiring the installation of a multiple of 2 filters and equal to 2/3 of the number of filters used for the first stage.

d. Filters planted with horizontal flow reeds

In horizontal flow filters, the filter bed is fully saturated with water and the effluent is distributed evenly through a distribution system. The flow is mainly horizontal and the feeding is generally continuous due to the low organic load. Evacuation is via a drain at the opposite end of the bed, connected to a siphon for adjusting the overflow. The water level must be maintained at 5 cm below the surface so as not to short-circuit the treatment chain and prevent the proliferation of insects. There is no free water in this process.

1.6.3 Intensive processes

The principle of these processes used for the transformation and destruction of organic matter is to locate on small surfaces. They are classified into:

a. Classic activated sludge

Figure 4 Activated sludge treatment plant

The activated sludge treatment process involves the development of agglomerated microorganisms in the form of flocs suspended in a basin fed with wastewater. The aeration tank is a crucial part of the treatment plant, responsible for meeting oxygen requirements and controlling nitrification and denitrification. It represents 60 to 80% of the total operating energy expenditure and is generally considered to be one third of the total operating cost. The design of the aeration tank, including mixing and aeration facilities, is essential to ensure that the exchange conditions between substrate, active biomass and oxygen are optimal for effective biological performance.

A good quality mix is essential to homogenize the sludge in the reactor, avoid deposits and reduce the risk of string organisms. These organisms can negatively impact the quality of treated effluents and the mechanical quality of biological sludge. Efficient mixing of the various fluids, including effluent to be treated, recirculated sludge and mixed liquor, is also ensured. In addition, it contributes to the micro-mixing of the sludge, bringing the active biomass into contact with the substrate, the nutrients and the dissolved oxygen. Rapid resuspension of settled sludge can be achieved through proper mixing. Aeration is necessary to supply oxygen to microorganisms in an aerobic environment, allowing the breakdown of organic matter in the wastewater.

b. Activated Sludge (Compact Solution – Conditioning Stations)

i. MBBR process

Figure 5 MBBR-type STEP

The MBBR system is an advanced biological process used for wastewater treatment, including municipal and industrial applications. It is very effective in removing BOD, nitrification and denitrification.

The activated sludge process has four main specific uses which are the elimination of carbon pollution (organic matter), nitrogen pollution, biological elimination of phosphorus and stabilization of sludge.

The MBBR unit utilizes numerous biofilm reactors in the aeration basin, which triggers microbial productivity and allows for the growth of heterotrophic and autotrophic organisms. This results in high density bacteria that facilitates rapid biodegradation while ensuring process security and ease of operation.

The technology is cost-effective and requires minimal maintenance as the MBBR processes maintain an optimal level of productive biofilm. The biofilm attached to the mobile carrier bios reacts automatically to load fluctuations. MBBR technology offers several advantages over traditional activated sludge treatment process, making it the most popular technology. The MBBR reactor can remove 60-85% of BOD and reduce the load on the downstream activated sludge treatment process.

Advantages

- It produces less solids without the need for polymer, making it more efficient and reducing operational costs compared to traditional water treatment systems.
- It has a small footprint, requiring only 1/3 the space of other systems.
- It is cost-efficient with affordable operation and maintenance expenses.
- The system is flexible and easy to use with controllable operating systems. However, automatic management is essential as the whole process is done in a single basin.

Disadvantages

- The increased power requirement for aeration leads to an increase in operational costs.
- The cost of media used in the process is high.
- High oxygen concentration is necessary for the process to be effective.

- The MBBR technology requires an increased level of pretreatment with fine screening, which can be time-consuming and costly.
- The process is also sensitive to sustained peak hour flow, which can lead to inefficiencies.
- The replacement of media is required, adding to the overall cost of the process.

ii. SBR process

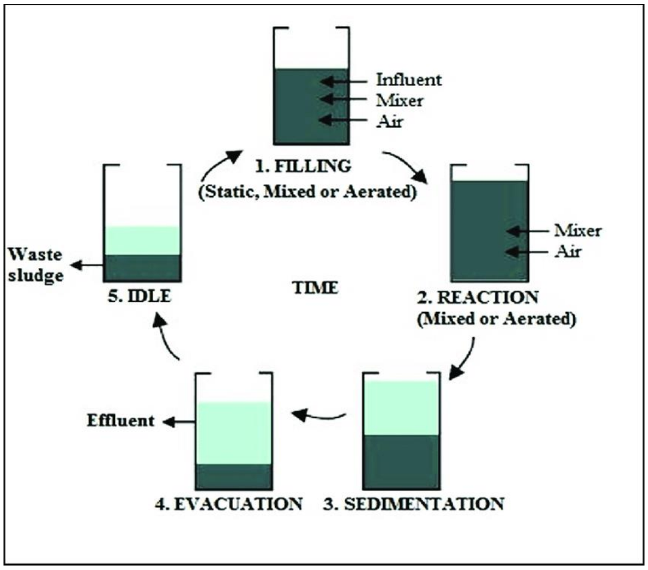

Figure 6 SBR system working principle

The SBR process is an aerobic biological process which operates in a discontinuous manner, with feeding, aeration, sedimentation, sludge purging and evacuation taking place in a cyclical manner. The treatment steps are the same as in any other aerobic biological process, including pre-treatment and sludge line.

The principle of the activated sludge process is the elimination of carbon and nitrogen pollution, the biological elimination of phosphorus and the stabilization of sludge.

Advantages

- It has the ability to adjust process timing via PLC in the reactor for specific processes such as aerobic, anaerobic and anoxic.
- It can achieve high quality effluent when operated properly.
- It has a smaller footprint than conventional activated sludge and does not require secondary clarifiers and RAS pumping.

Disadvantages

- It has discontinuous discharge which can have negative effects on downstream processes.
- It requires relatively large reactor volumes.
- Advanced nutrient removal is difficult.
- Batch discharge may require post-equalization.
- High peak flow may disrupt performance, therefore influent equalization should be considered in design.

iii. MBR process

The MBR process is a pre-engineered system for wastewater treatment that combines biological treatment with membrane filtration. This technology allows a high concentration of biomass and a high quality of effluents, making the treated water suitable for reuse for irrigation, cleaning or supplying a fire-fighting circuit.

The operating principle of membrane bioreactors is based on a combination of biological and physical separation treatments using ultrafiltration or microfiltration membranes. In addition, the system includes sludge stabilization.

Figure 7 MBR-type STEP, Sontrach

Advantages

- Has a smaller footprint.
- Has a consistent high-quality effluent.
- No need for a final clarifier or filter.
- It is also resilient to fluctuations in solids loading.
- Has a high degree of automation.
- Requires no settling of sludge.
- Has a short reactor hydraulic retention times.
- The membranes function as a positive barrier.

Disadvantages

- Higher capital and energy costs, as well as the cost of membrane replacement.
- Maintenance requirements are higher.
- Membrane fouling can be a major drawback caused by scaling, biofouling, particle fouling, or chemical fouling.
- The system's performance is sensitive to pretreatment processes, and some form of influent equalization is required.
- High flow events can lead to increased membrane maintenance.
- The system has a hydraulically limited capacity through membranes.

iv. System O

Figure 8 Sonatrach Repsol Regane

To optimize bacterial growth, a 3.05 m long and 30.5 cm diameter high density polyethylene pipe is used. The water enters the plastic pipes where it undergoes cooling and further fat separation. The bio-accelerator distributes water evenly while the bacteria adhere to the synthetic bacterial medium. The pollutants are consumed by the bacteria, leaving the water ready for infiltration. Finally, the treated water is filtered through sand and discharged into the natural soil.

The system removes a significant amount of nutrients, including phosphorus and nitrogen, and effectively removes harmful pathogens. It also withstands large variations in hydraulic load, and its construction is simple and does not require any permanent structure.

Advantages of enviroseptic system

- Eliminates a large part of the nutrients e.g phosphorus and nitrogen and pathogenic germs
- Adapts well to strong hydraulic load variations;
- Good landscape integration;
- Absence of noise pollution;
- Low operating cost
- installs more easily and quickly
- adapts easily to sites of any size

- It increases system performance and longevity, tests environmentally safer, and recharges groundwater more safely than conventional systems.

Disadvantages [2]

- Exposed pipe caps on turf at field location.
- Exposed vent pipe (0.9 m high).
- Can sometimes generate odors when there is an imbalance of pressure in the plumbing.
- May require the formation of a mound in clay or unsuitable soil.
- Limited excavator choice.
- The footprint of the process, i.e. ~40 m^2, remains too large in many cases where the space is very small.
- The ministerial approval of the Enviro Septic prohibits its installation in the presence of a water table.

1.7 CONCLUSION

The principal objective of wastewater treatment is to dispose of human and industrial effluents without endangering human health or causing unacceptable damage to the natural environment.

New treatment technologies are necessary in certain systems to remove nutrients from wastewater. To achieve this, advanced wastewater treatment plants use sophisticated processes and equipment. To ensure the protection of the water body that receives the discharge, careful management of wastewater treatment processes is required. Trained and certified treatment plant operators measure and monitor the incoming sewage, the treatment process, and the final effluent. The ultimate goal of wastewater treatment should be managing wastewater effectively, economically, and ecologically.

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CHAPITRE 2:

SYSTEM O))

“Enviro-Septic”

CHAPTER2

2.1 Introduction

Residential septic systems are the largest source (by volume) disposed to the land [1]. Enviroseptic system offers an effective way for treating residential wastewater to an acceptable level for reintroduction into the environment. It is designed to purify wastewater that has undergone primary treatment in a septic tank and disperse it into the underlying soils. The system uses both aerobic and anaerobic bacteria to treat water. It distributes, treats, infiltrates wastewater in a single system, and is adaptable to various residential or commercial applications due to its versatility in shape and size. The system is designed to excel in this unique eco-system, offering greater efficiency and longevity.

2.2 COMPONENTS OF ENVIROSEPTIC SYSTEM [2]

2.2.1 Septic Tank

Its an underground chamber made of concrete, fibreglss or plastic through which domestic wastewater flows for basic treatment. Acts as the primary treatment of wastewater. It settles heavy solids and evacuate wastewater allowing the wastewater to flow into the enviroseptic pipes for further treatment.

Figure 9 Septic Tank

2.2.2 Effluent filter

Is a cylindrical device installed on the outer baffle of septic tanks. They protect the drain field and prevents solids from passing out of the septic tank.

2.2.3 Distribution device [3]

A device made of polyethylene used to distributes the effluent evenly in the rows of enviroseptic pipes. It can carry a maximum load of 460KG. It contains one entry and 6 potential outputs.

Figure 10 DISTRIBUTION BOX

Figure 11 The inside view of DISTRIBUTION BOX

2.2.4 Advanced Enviro-Septic pipe

Consist of a 30cm diameter, high density plastic pipe which is corrugated to increase surface area of heat transfer and perforrated to let the effluent flow out. A randomly oriented fibre mesh covers the pipe to facilitate circulation of effluent. A non woven polypropylene geotextile is sewn over the fibrous membrane preventing sand from entering the pipe.

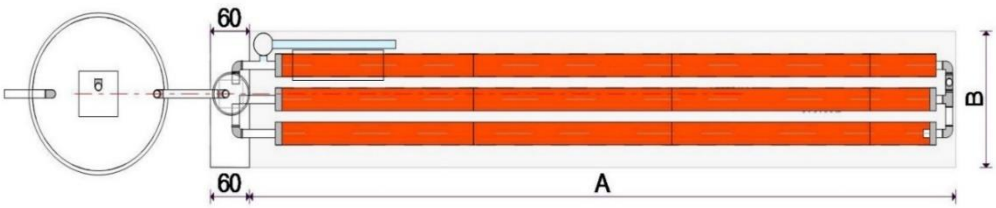

Figure 12 ENVIROSEPTIC PIPES

2.2.5 Sampling Device

Is a device used to collect samples of the effluent from the system for testing purposes in order to verify treatment performance of the ES system.

2.2.6 System sand [4]

In an Enviro-Septic system, System Sand is the material in direct contact with all Advanced Enviro-Septic pipes. The proper installation of System Sand is essential to the long-term performance of an Enviro-Septic system. To ensure the system functions correctly, it's important to install the correct amount and type of System Sand. The sand must be clean, granular, and free of organic matter, and it must come in direct contact with all Advanced Enviro-Septic pipes. System Sand must be properly graded to ensure that it provides adequate drainage and does not become compacted over time. The sand must also be installed at a specific depth and slope to promote proper drainage and treatment of the wastewater.

The dimensions of the System Sand bed must meet specific requirements including:

- 12 inches (30 cm) of System Sand below the AES pipe
- 3 inches (10 cm) of System Sand above the AES pipe
- 12 inches (30 cm) of System Sand around the perimeter of the pipes
- 6 inch (15 cm) deep System Sand Extension when required.

The System Sand Extension refers to any part of the System Sand bed that is more than 1 foot away from the AES pipes. Proper installation of System Sand is essential to the long-term performance of the Enviro-Septic system a it provides a large surface area for the treated water to be absorbed by the soil.

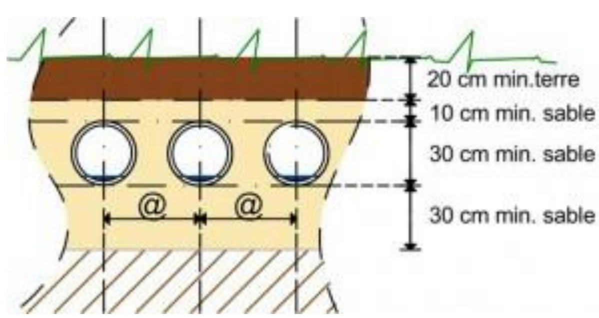

Figure 13 View of a vertical cut of the filter sand

2.3 Working mechanism

Wastewater from the septic tank flows by gravity into the distribution box equipped with equalizers. From there, it is evenly distributed into the rows of Advanced Enviro Septic pipes. The effluent is cooled to a lower temperature thanks to the corrugations of the pipe, which provide a large surface area for heat exchange. This cooling process encourages the separation of greases and some of the suspended solids. Lighter solids float to the surface as foam, while heavier solids end up at the bottom of the pipe to create scum. These solids remain inside the pipe and help prevent the soil from becoming clogged. Finally, the effluent leaves the pipe through perforations found on the entire circumference of the pipe.

The treatment process involves the mat of plastic fibers where bacteria settle to treat suspended solids. Liquid level fluctuations inside the pipe, caused by peak periods of water use, condition the mat of plastic fibers. This encourages the proliferation of bacteria that perform the treatment. The process is similar to the deterioration of a wood picket fence, which always starts at the ground level due to changing humidity conditions and the acceleration of bacteria.

The effluent flows through the geo-textile, where another layer of bacteria forms on the internal surface. Capillary action causes the geotextile and surrounding sand to collect and distribute the effluent on the pipe’s circumference, aiding water evacuation to the surrounding ground. This phenomenon is similar to the wick of an oil lamp, where fuel moves towards the combustion area. The effluent then passes through the system sand surrounding the Advanced Enviro-Septic pipes for further treatment. The sand facilitates the process by wicking the liquid out of the pipes and ensuring that the system receives sufficient oxygen to support a healthy population of bacteria. Upon reaching the receiving soil, almost all contaminants have been removed, allowing for easy infiltration into the ground and evacuation from the site.

The system uses both aerobic and anaerobic bacteria that feed on pollutants in the water; Their Advanced Enviro-Septic pipes create an ideal environment for these organisms to thrive, maximizing surface area. The bacteria control each other to prevent biomass from growing too large and needing removal.

The system's pipe requirement and system sand bed size are adjusted based on the daily design flow, soil characteristics, and site constraints to ensure effective treatment and adequate absorption into underlying soils.

Figure 14 The components of the AES pipes

- It is not intended for the treatment of wastewater for drinking purposes. However, proper maintenance is required to ensure long-term treatment performance.
- 30 years of product existence.
- 300,000 Enviro-Septic Installations.
- 50 years of service life.
- 20 years warranty.

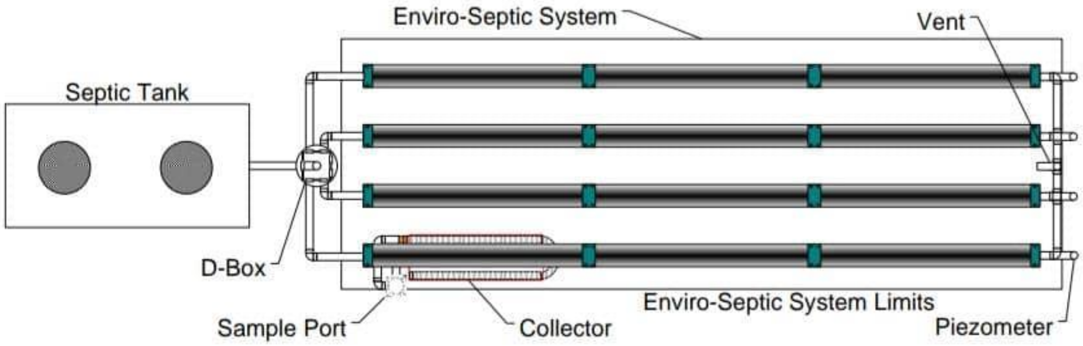

Figure 15 . Enviro-septic system components installed in the ground

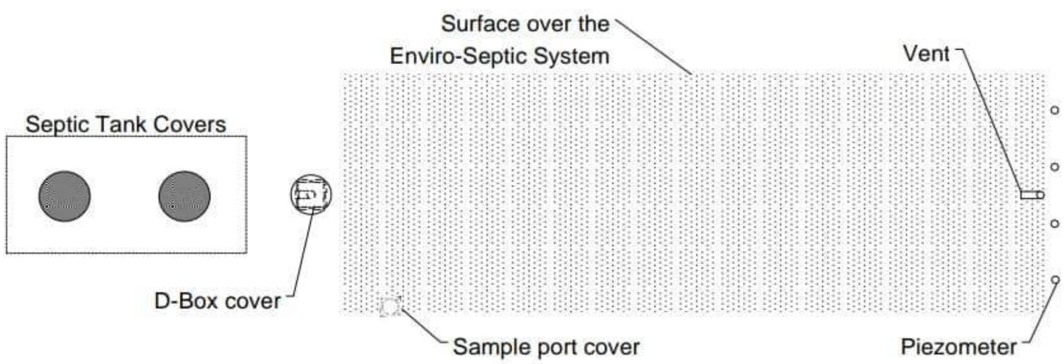

Figure 16 Enviro-septic system components visible

Figure 17 The semi-final installation of the enviro-septic

2.4 MATERIALS REQUIRED

2.4.1 Offset adapter

Is a 12-inch plastic fitting close the rows of pipes. The upstream supply the rows with effluents while the downstream ensure the connection to the bottom vent to guarantee continuous natural ventilation of the system.

Figure 18 OFFSET ADAPTER

2.4.2 Coupling

Is a plastic fitting that connects two pieces of pipe. 1 sleeve to join 2 pipes or sections of pipe. In cold weather, it’s easier to work with couplings if they’re stored in a heated location before use.

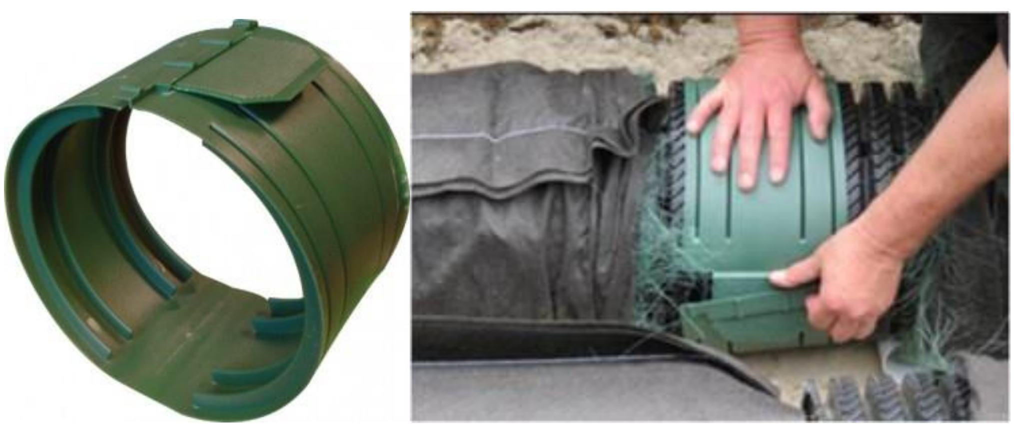

Figure 19 coupling

2.4.3 EQUALIZERS [3]

The distribution box includes several Polylok equalizers made of polyethylene which are adjustable via a rack system to adapt the water levels according to the needs and distribute the effluent equitably to each row of pipes. 1 equalizer / row of pipes and the maximum flow per equalizer varies from 49 to 72 liters per minute (LPM).

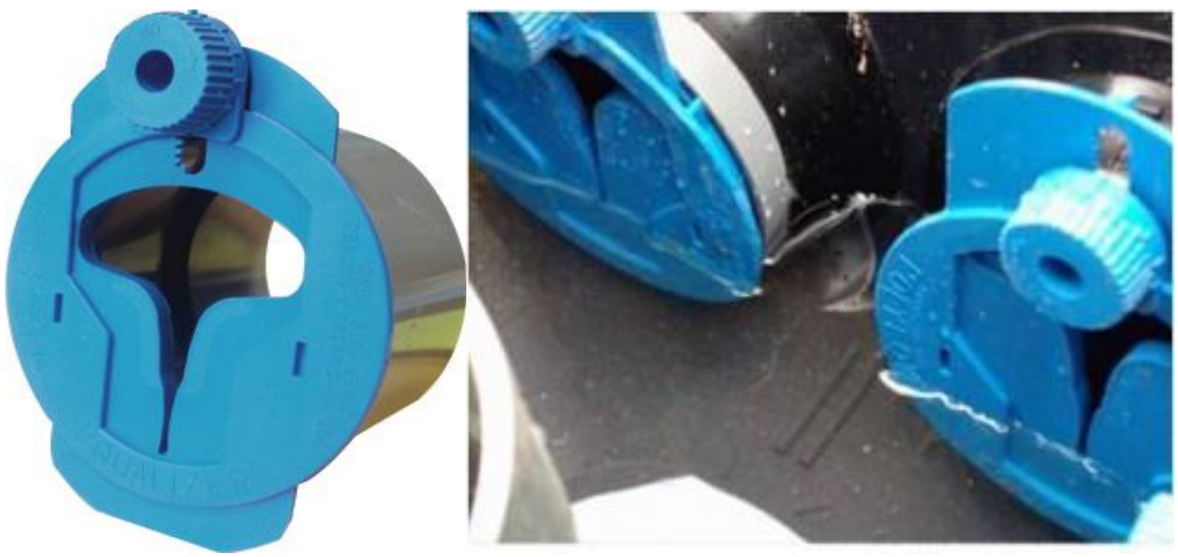

Figure 20 EQUALIZERS

2.4.4 LID

The distribution box is fitted with a polyethylene cover which must be positioned at finished floor level to guarantee permanent access to the distribution box.

Figure 21 . LID

2.4.5 Inspection room [5]

VISIT AND SAMPLING CHAMBER

Figure 22 Inspection room

Composed of an inspection chamber and a sampling tank. This dual device makes it possible to collect a sample of water treated by the ENVIRO-SEPTIC system in order to analyze and control it at any time. 1 chamber and a tank / 100 pipes maximum.

This mechanism ensures the transparency of the system and its permanent access.

2.4.6 Continuous ventilator [6]

Figure 23 VENTILATOR

Continuous natural ventilation is one of the 3 key elements of an ENVIRO-SEPTIC system. It is essential for the oxidation of pollutants, the maintenance of aerobic bacteria and the evacuation of gases.

The bottom vent is installed at the end of rows and acts as an air entry point. The air passes through the pipes, through the distribution box and possibly the septic tank. Exit through the high vent located on the roof or on any other element located high up. The difference in height between the low vent and the high vent (3m min.) creates a natural circulation of air by chimney effect.

2.5 CONCLUSION

Enviro-septic wastewater treatment system is highly adaptable and can be used in a variety of settings including residential and commercial applications. It is a reliable and environmentally friendly solution for wastewater treatment. The system works by utilizing a series of pipes that are filled with specially designed media, which allows for the growth of naturally occurring bacteria that breakdown and treat the wastewater. It is also easy to install and require minimal maintenance.

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[2] Ontario Home Owner's User GuideEnviro-Septic® System

[3] Boîte de distribution | Limpido

[4] Sable filtrant | Limpido

[5] Chambre de visite | Limpido

[6] Ventilation continue | Limpido

CHAPTER 3: ANALYSIS AND METHODOLOGY IN TIGUINTOURINE

CHAPTER3

3.1 Introduction

This study project is an essential element of Sonatrach's policy aimed at implementing HSE standards and complying with international laws and Algerian legislation.The objective is to protect the environment and promote sustainable development, ensuring the preservation of human health and the region's water resources.

The facility has sufficient surface area to install a treatment facility (wastewater treatment plant), upstream of the existing sloughs. Given the unavailability of land inside the living quarters, it was decided to project the future STEP outside the living quarters.This system may include sand filters, ultrafiltration membranes or other advanced treatment technologies. It is important to consider other factors such as site topography, soil permeability, local climatic conditions, etc

3.2 Research problem

At the level of the TIGUENTOURINE (TG) field of the Regional Direction IN AMENAS;

The residence is not connected to the municipality’s sewer system which the wastewater ends up in a collector and join the receiving environment without any treatment. For that we are doing a study for the realization of a purification system.

And also in order to collect the treated water so it will be used only for the irrigation purposes. It is important to note that water quality requirements for irrigation vary depending on the type of crop and soil, which is the consult of the local standards to determine if the treated water is suitable for a specific use.

3.3 Basic project data

3.3.1 Geographical location

The IN AMENAS region is part of the Willaya of ILLIZI. It is located 1600 km south-east of Algiers, 820 km south-east of Ouargla and 220 km north/north-east of the wilaya capital. The average altitude is 500 m above sea level.

The Study area: The rig camp associated with the Production Department, namely: TIGUENTOURINE living base (TG)

The site brings together 50 people working permanently, with a capacity of 80 people. Altitude

Figure 25 Google Earth satellite image - Base camp TIGUENTOURINE

Figure 24 Living base housing

3.4 Origin and constitution of wastewater effluents

The waste water comes from the sanitary facilities, the showers and the canteen temporarily fitted out while waiting for the completion of the new canteen under construction. It is collected via a collector with a diameter of DN 300 mm and ends up joining the receiving environment without any treatment. Prior because the base does not have a purification system for these waste water discharges.

- The corresponding polluting flows are estimated from the average daily flow selected (19 m3/d).

3.5 Methodology

3.5.1 Characteristics of the effluents to be pretreated

The establishment was the subject of a pollution survey in order to observe the operating conditions of the living quarters during the period of activity, as well as the conditions for the use of water and the discharge of effluents into the sewer network.

Figure 26 .In situ of parameters (pH- conductivity, temperature and SS)

The first sampling campaign was carried out from July 23 to 24, 2022, several samples were taken, analyzes carried out in the Berhamoun quality laboratory.

The second sampling campaign was carried out from September 10 to 11, 2022. Analysis carried out in the CRD In Amenas laboratory.

3.5.2 Pollution loads

There are two sampling points chosen for the site located on the rig camp discharge collector.

These sampling campaigns were carried out with the aim of knowing the nature of the water to be treated in order to be able to subsequently consider the appropriate treatment.

Physico-chemical, bacteriological and heavy metal analyzes were carried out in the BERRAHMOUN QUALITY LABORATORY AND CRDT HASSI MESSAOUD LABORATORY

The pollution report carried out over 24 hours in July and September 2022, during normal periods of activity.

The concentrations recorded on the classic pollution parameters (COD, BOD5, TSS and NTK) correspond to average values equivalent to those of an urban effluent.

Tableau 1 The analysis results of parameters (pH- conductivity, temperature and SS)

Parameters	Variation scale	Tiguentourine rig camp	Rejection standard
Ph	6.5 - 8.5	6.32 - 6.66	6.5 - 8.5
Temperature (° C)	30	37.4	30
My totals (mg/L)	100 – 400	544 – 796	35
MVS		263 – 317	
DBO5 (mg/L)	150 – 500	161.25 - 245.55	35
DCO (mg/L)	300 - 1000	3.26 - 367.5	120
MDT (mg/L)	100 – 300		
N-Total			30
NTK (mg/L)	30 – 100		
N-NH4	20 – 80	13.70	
N-NO2- (mg/L)	<1		
N-NO3- (mg/L)	<1		
SO4-			

Detergents (mg/L)	6 – 13	0.18 - 0.23	
P total (mg/L)	10 – 25	5.5 - 11.2	10
Oil and grease			20
Lead		0.019 - 0.027	0.75
Nickel		0.012 - 0.018	0.5
Chrome		0.012 - 0.018	0.5
Zinc		0.007 - 0.011	3
Manganese		0.004 - 0.005	1.5
Iron		0.19 - 0.29	3

3.6 Results and discussion

3.6.1 pH

The pH values measured are between 6.32 -6.66 for the living quarters effluent (TG). These values fall within the range of values generally observed for urban household wastewater (6. 5 – 8.5). This shows the neutrality of the waste water. It can be seen that these values are located in the right range of microbial activity, which favors the biological treatment.

3.6.2 Temperature

The temperature of the water analyzed is between 31°C and 32°C. These values are less compliant with the Algerian discharge standard which is 30°C (JORA 2006). This promotes the growth of micro-organisms responsible for purification and thus allowing better purification yields.

3.6.3 Conductivity

The values measured are between 3320 µS/cm and 3770 µS/cm for discharges; An electrical conductivity of water greater than 1500 µS/cm, the value set by the WHO, leads to excessive mineralization.

3.6.4 Dissolved oxygen

Dissolved oxygen is the most sensitive parameter to organic pollution, an oxygen value below 5 mg/L is a sign of pollution. The oxygen below could not be measured due to a lack of means of analysis.

3.6.5 Suspended solids

The SS of urban wastewater hardly exceeds -500 mg/L.

The results obtained show that the values are really high for TG discharge waters (796 mg/L).

In the light of the results obtained on the suspended solids, it appears that the waters studied are polluted with solid matter and this pollution is mainly due to the discharge of leftover food from cleaning operations in the restaurant kitchens and the low flow of water. water recorded at the site level (TG).

3.6.6 Volatile matter in suspension

The analysis results indicate that the MVS vary between 56 and 98 mg/l. which confirms that we are in the presence of urban wastewater with a low organic matter content. The fraction of organic matter is between 34% and 39%

3.6.7 Turbidity

The analysis results indicate that the turbidity varies between 54.65 and 90.30 (N.T.U), which shows that the discharges are loaded with colloidal and suspended matter. The water is said to be cloudy.

3.6.8 Biochemical oxygen demand

Urban wastewater has a BOD5 that can vary from 150 to 400 mg/L.

The BOD5 values obtained for discharges are between 161.25 and 245.55 mg/l for waste water discharges (TG), these values show a relatively average content of biodegradable organic matter and this water complies with the characteristics of a urban wastewater.

3.6.9 Chemical oxygen demand

The COD values measured are between 326 and 367.60 for wastewater (TG).In the light of the results obtained on the CODs, it appears that the waters studied are polluted with organic matter, but this pollution remains relatively average and confirms the values found in BOD5.

3.6.10 Ammonium (NH4+), Nitrates (NO3) and Nitrites (NO2)

In this study, we determined the contents of N-NH4, N-NO2, N-NO3. The analysis of these results shows high concentrations of nitrates and low contents of ammoniacal nitrogen and nitrite.The significant quantities of nitrates result mainly from the application of chemical fertilizers during fertilization. The low levels obtained in NH4 + and NO2 - show that these particles come mainly from metabolism.

The presence of NH4+ in water is an indication of organic pollution by micro-organisms, in particular pollution of faecal origin.

3.6.11 Sulphates

The recorded sulfate values are between 451 and 467 wastewater (TG). The maximum sulphate level suggested by FAO in the quality guidelines required for water intended for irrigation is 960 mg/l (According to FAO recommendations 29 rev11988).

The presence of sulphates is linked to the nature of the terrain crossed. It can also testify to industrial discharges.

3.6.12 Total phosphorus

The waters studied meet the criteria in force, The values are very high discharges of (TG) 11.2 but this pollution slightly exceeds the standard (10 mg/l) we can say that this pollution is the use of dishwasher detergents which is high in phosphates and also to malfunctioning and poor maintenance of low flow collectors.

3.6.13 Total nitrogen

Present in excess in natural water, these elements can cause an anarchic proliferation of algae and thereby induce biological imbalances and various pollutions. This is the process of eutrophication. Total nitrogen could not be measured due to a lack of means of analysis.

3.6.14 Heavy metals

In our study, we limit ourselves to the determination of ten elements present in the waste water, namely: Pb, Cr, Mn, Co, Cu, Zn, Ni, Cd, Iron and Hg. The chemical analysis of our samples shows that all of the toxic products are in the form of traces and therefore there can be no inhibition of the purification or a toxic effect on the activity of the purifying micro-organisms. So absence of toxicity by heavy metals.

3.6.15 Oils and fats

The oil and grease contents of the waters analyzed were not measured due to the unavailability of this parameter at the laboratories consulted, for this we will take 20 mg/l considered as the limit value.

3.6.16 Bacteriological parameters

The results obtained show that the discharge is contaminated with total coliforms, faecal coliforms and helminth eggs.The presence of faecal coliforms in this water indicates pollution of faecal origin. These bacteria are commonly used to identify pollution of faecal origin.

3.6.17 Biodegradability and nature of rejection

For domestic wastewater, the COD/BOD5 ratio can reach 2.5 to 3 without any very noticeable drawback. The ratio (COD/BOD5) for TG discharges is included in the interval [1.75-2]. So we can say that the discharges from the base camp (TG) contain biodegradable organic matter.

3.6.18 Required content of nutrients

The N/BOD5 and P/BOD5 ratios have insufficient values to enable the purification processes to be initiated.

3.7 Rejection level after treatment

The level of discharge of treated effluents is conditioned by the Interministerial Order of 8 Safar 1433 corresponding to January 2, 2012 setting the specifications for treated wastewater used for irrigation purposes.

"The size of the storage and distribution system will depend on the area to be irrigated and the water flow required"

Figure 27 Projection site STEP Tiguintourine

3.8 Water collection and reuse

The reuse of treated waste could be one of the main alternative options to expand water resources, especially in dry areas because it represents another source of renewable water. Potential wastewater reuse application include agricultural and landscape irrigation. Irrigation represents the largest treated waste user globally hence this offers singnificant opportunities for water reuse in both industrialized and developing countries.

One of the key features of wastewater treatments is its ability to collect water for reuse. After the wastewater has been treated, the next step is to collect the clean water. This is done through a process known as effluent collection.

The treated water is collected in a number of ways. One of the most common methods is through the use of a collection tank. This tank is designed to collect the treated water and store it until it is needed.

Another method of collecting treated water is through the use of a pump. The pump is used to move the treated water from the treatment system to a storage tank or other location where it can be used. This method is often preferred because it allows for greater control over the amount of water that is collected and the rate at which it is collected.

Finally, some wastewater treatment systems use gravity to collect the treated water. This method involves the use of a series of pipes and channels that are designed to allow the treated water to flow downhill to a collection point. This method is often used in areas where there is a significant amount of elevation change and where the use of a pump would be impractical.

The purified water is collected in a separate tank or chamber within the system. This tank is designed to hold the treated water until it can be reused for irrigation. The tank is conveniently located near the Enviro-Septic system and can be easily accessed for maintenance and monitoring.

However, it is crucial to ensure that the water is free from any harmful contaminants before using it for irrigation. Conducting water quality tests is an essential step to guarantee the safety of plants and soil.

Tableau 2 The limit values of the industrial effluent discharge parameters

	PARAMETRS	Unit	MAXIMUM ALLOWABLE CONCENTRATION
Physical	pH	mg/l	$6.5 \leq pH \leq 8.5$
	MES		30
	CE	ds/m	3
	Infiltration SAR = 0-3 CE	ds/m	0.2
	3-6		0.3
	6-12		0.5
	12-20		1.3
	20-40		3

Chemical	Biochemical oxygen demand (BOD5)	mg/l	30
	Chemical oxygen demand (COD)	mg/l	90
	Chlorides (Cl-)	mg/l	10
	Nitrogen (NO_3^-)	mg/l	30
	Bicarbonate (HCO_3^-)	meq/l	8.5
Elements Toxic	Aluminum	mg/l	20
	Arsenic	mg/l	2
	Beryllium	mg/l	0.5
	Boron	mg/l	2
	Cadmium	mg/l	0.05
	Chromium	mg/l	1.0
	Cobalt	mg/l	5.0
	Copper	mg/l	0.5

	Cyanide	mg/l	0.5
	Fluorine	mg/l	15
	Iron	mg/l	20
	phenols	mg/l	0.002
	lead		10
	Lithium	mg/l	2.5
	Manganese	mg/l	10
	Mercury	mg/l	0.01
	Molybdenum	mg/l	0.05
	Nickel	mg/l	2.0
	Selenium	mg/l	0.02
	Vanadium	mg/l	13
	Zinc	mg/l	10.0

(*): For fine-textured, neutral or alkaline soil types.

To maintain the quality of the treated water, it is important to properly maintain the Enviro-Septic system. Regular inspections and cleanings are necessary to keep the system functioning properly and to prevent any potential issues with the treated water. By properly maintaining the system, Enviro-Septic owners can ensure that their collected treated water is safe and environmentally friendly for reuse.

3.9 CONCLUSION

According to the results of analyzes of the waste water from the rig camp (TG), we can conclude the urban nature and the biodegradability of the pollution of these waters. From where a simple biological treatment will give a good result of reduction of the organic load and a membrane filtration allows a good quality of water can be reused in irrigation.

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CHAPTER 4: SIZING, RESULTS AND DISCUSSION

CHAPTER4

4.1 Introduction

One of the most important aspect of designing an effective enviro-septic system is determining the appropriate dimensions and sizing for the system. This involves calculating the amount of water that will be generated ,its size among other factors. In this discussion, we will explore the dimension and sizing of the enviro-septic systems and how they can be optimized to provide effective and sustainable wastewater treatment solutions.

4.2 Dimensions [1]

The sizing of an Enviro-septic wastewater treatment system for irrigation depends on several factors, including the number of people served, water flow, soil characteristics, and local regulatory requirements. Here are the three main steps for sizing a complete system:

• Determine the size of the septic tank.

• Determine the number of Advanced Enviro-Septic pipes required.

• Determine the dimensions of the Enviro-Septic system and the total area.

4.3 Septic tank sizing [2]

The septic tank must have a minimum of 24hour retention time and a maximumof 48hours retention time for residential wastewater.

For Q = 19 000 L/day,

Vseptic tank = 1 × Q = 1 * 19 000 = 19 000 L

2 x Q = 2 * 19000 = 38000L

4.4 Number of AES pipes [3]

Each section of AES pipe is capable of treating 126 liters of wastewater per day. Each section of pipe is 3.05 m in length. The formula for determining the minimum number of advanced enviro-septic (NAES) pipes required is:

$$\mathbf{N_{AES} = Q/126}$$

$$\mathbf{N_{AES} = 19000 / 126 = 150.7 = 151 \text{ AES minimum}}$$

4.5 Total Length

The total length of the row

$$\mathbf{Tl = N_{AES} * 3.05 = 151 \times 3.05 = 460.55 \text{ m of AES pipe.}}$$

4.6 Number of rows

- Since 10 pipes a row is effective to have a good treatment; so in our case we will work with 10 pipes in each row:

$$\mathbf{Nr = N_{AES} / 10 = 15.1 \text{ rows} = 15 \text{ rows}}$$

4.7 Number of D-box

- Since one distribution box has a potential of 6 outputs[4]; in our case we will work with 5 outputs in each D-box :

$$\mathbf{\text{Number of the D-box} = Nr / 5 = 15 / 5 = 3 \text{ D-box}}$$

4.8 Length of row [3]

$$\mathbf{Lr = Nr \text{ in a row} * 3.05 = 10 * 3.05 = 30.5 \text{ m row}}$$

4.9 Enviro-septic contact area sizing

The ES contact area is determined by the larger of two possibilities:

- Minimum evacuation surface (SE) : The minimum surface required to evacuate water from the system.
- Minimum surface for spacing requirements (S_{SR}) : The minimum surface calculated using the minimum spacing required between and around the length of a row of pipes to properly install the system sand.

4.9.1 Minimum evacuation surface (SE) [3]

SE = QT/400

Where:

SE = contact area in m^2 between the base of the sand layer and the Underlying native soil.

Q = total daily design sewage flow in litres.

T = percolation time of the underlying native soil in min/cm.

“we estimate that the percolation time is 6 min/cm”

SE = (19000 * 6) / 400 = 285 m2

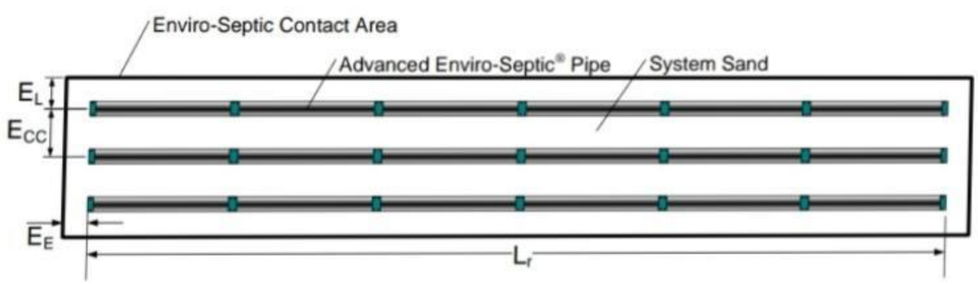

Fig.28. The spacing surfaces

Tableau 3The recommended minimum pipe spacings

Acronym	Description	Minimum horizontal spacing (m)
E_{CC}	Centre to centre spacing from one row of pipes to the next	0.45
E_L	Lateral extension distance from the centre of the last lateral row of pipes to the limit of the enviroseptic system	0.45
E_E	End extension distance from the end of a row of pipes to thelimit of enviroseptic system	0.30

[1]

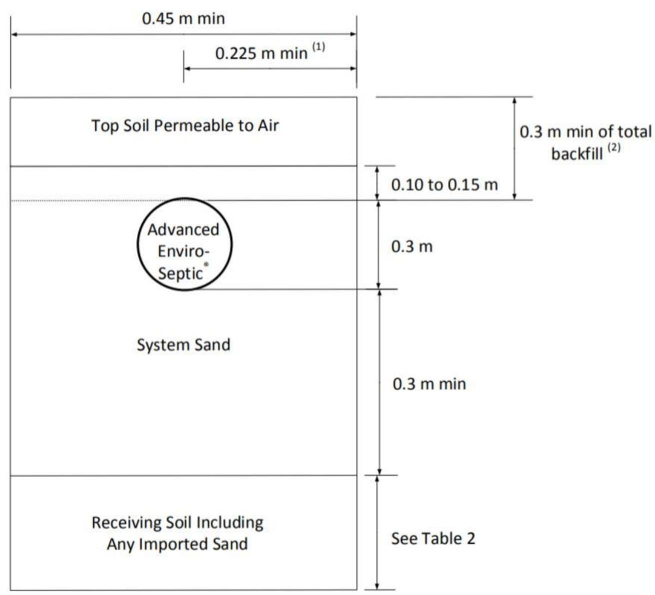

Figure 28 basic profile of an enviroseptic system

[1]

4.9.2 Minimum surface for spacing requirements (S_{SR}) [1]

$S_{SR} = W_{SR} * L_{SR}$

$L_{SR} = L_r + (2 * E_E)$

$W_{SR} = (E_{CC} * (N_r - 1)) + (2 * E_L)$

$S_{SR} = [L_R + (2 * E_E)] * [E_{CC} * (N_r - 1)) + (2 * E_L)]$

Where:

- S_{SR} is the minimum surface/contact area for spacing requirement
- L_{SR} is the length of the minimum surface/contact area for spacing Requirement
- W_{SR} is the width of the minimum surface/contact area for spacing Requirement
- N_r is the number of rows of Enviro-Septic pipe

The ES minimum contact area is the larger of S_E or S_R.

If $S_{SR} > S_E$, $S_{CA} = S_{SR}$

If $S_{SR} < S_E$, $S_{CA} = S_E$

We calculate the minimum surface / base cut area for Enviro-Septic Spacing requirements:

$$\mathbf{S_{SR} = [L_R + (2 \times E_E)] \times [(E_{cc} \times (N_r - 1)) + (2 \times E_L)]}$$

$$\mathbf{S_{SR} = [30.5 + (2 \times 0.3)] \times [(0.45 \times (15 - 1)) + (2 \times 0.45)]}$$

$$\mathbf{S_{SR} = 34.82\ m^2}$$

- **Since $S_{SR} > S_E$, we will use 285 m2 As minimum surface required for infiltration.**

Now, we need to determine the required spacing between the Enviro-Septic rows to spread the pipes over the Contact Area. Using the following formula:

Length of System x Width of System = 285 m2

$$\mathbf{[L_R + (2 \times E_E)] \times [(E_{cc} \times (N_r - 1)) + (2 \times E_L)] = 285\ m2}$$

With these measurements, we can determine the following values:

Enviro-Septic minimum Contact Area = 285 m2

$$\textbf{Length of System} = [L_R + (2 \times E_E)] = [30.5 + (2 \times 0.5)]$$

$$\textbf{Lsystem} = 31.5\ \text{m}$$

$$\textbf{Width of System} = [(E_{cc} \times (N_r - 1)) + (2 \times E_L)] = [(2 \times (15 - 1)) + (2 \times 0.8)]$$

$$\textbf{Wsystem} = 29.6\ \text{m}$$

Tableau 4 The design criteria required for each installation type [1]

Design criteria	Percolation time (T) of native soil		
	T≤6 min/cm	6<T≤50min/cm	T>50 min/cm
Type of installation	In ground, partially raised or fully raised systems		Fully raised system
System sand layer under advanced enviroseptic pipe	300mm		
System sand layer above advanced enviroseptic pipe	100 mm minimum		
Top soil permeable to air on top of the system sand	200 mm minimum		
Minimum vertical separation as measured from the bottom of the enviroseptic system sand to: •High ground water table	600mm	450mm	600mm

•Bedrock •Soil with percolation time (T) greater than 50cm/min			

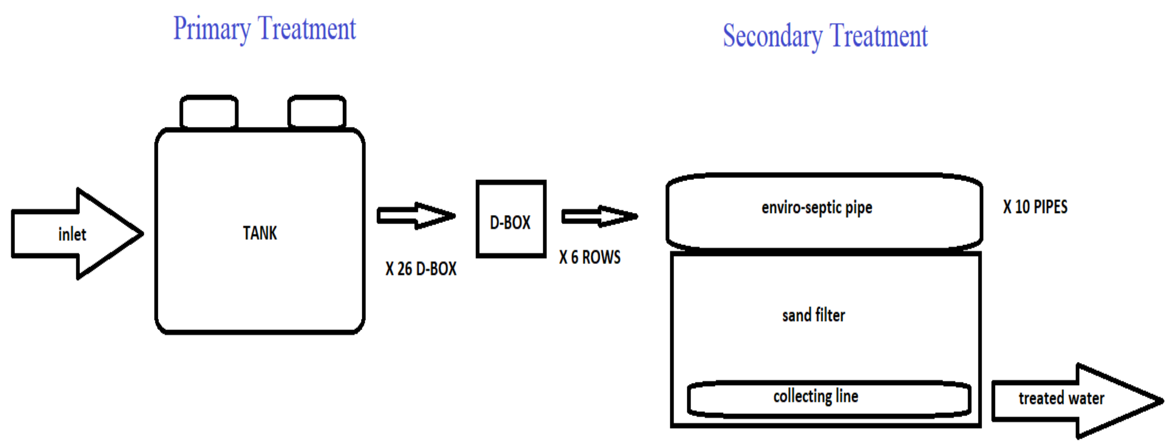

Figure 29 Detailed installation plan

4.10 RESULTS AND DISCUSSION

Based on the TG area, after calculating the septic tank sizing in the Enviro-Septic system, the results indicate that the tank needs to be at least 19000L in size. This calculation of septic tank sizing is based on several factors, including the number of bedrooms in the house, the number of occupants, and the daily water usage. This will help homeowners ensure that their wastewater is naturally treated and that the environment is protected from contamination. If the tank is too small, it can lead to an overload of the system resulting in untreated wastewater leaching into the environment.

After calculating the required number of Enviro-Septic pipes for the installation, the results show that the project requires at least 151 pipes. This calculation was based on the size of the property and estimated water usage. The interpretation of these results is that the installation of 151 Enviro-Septic pipes will effectively manage the wastewater generated without harming the environment. .

Based on the calculation, the recommended total length of pipe for the Enviro-Septic system is 30.5m in each row. The interpretation of these results is that the installation of the calculated length of pipe will provide an effective and efficient way of treating wastewater. This will allow the wastewater to be filtered through the soil, which helps to break down the pollutants and contaminants in the water. The length of the pipes is important because it determines the amount of soil that the wastewater will come into contact with, which affects the efficiency of the system.

Based on our calculation, the recommended number of distribution boxes is 3. The installation of the calculated number of distribution boxes will provide an effective and efficient way of treating wastewater as it works by evenly distributing the wastewater to the enviroseptic pipes which helps to break down the pollutants and contaminants in the wastewater.

After calculating the Enviro-septic contact area sizing in the Enviro-Septic system, the results indicate that the system is able to effectively treat and dispose of wastewater. The sizing calculations take into account the soil type, site conditions, and expected wastewater flow rates. Interpreting the results, it is clear that the Enviro-Septic system is an efficient and reliable method for treating wastewater.

To properly calculate the contact area in an Enviro-Septic system, we first determine the size of the system. This is done by measuring the length, width, and depth of the system. Once the size is determined, the total surface area of the media can be calculated. This surface area is what allows the microorganisms to grow and break down the organic matter in the wastewater. After calculating the Enviro-septic contact area sizing in the Enviro-Septic system, the results indicate that the system is able to effectively treat and dispose of wastewater. The sizing calculations take into account the soil type, site conditions, and expected wastewater flow rates. Interpreting the results, it is clear that the Enviro-Septic system is an efficient and reliable method for treating wastewater.

To determine percolation time in an Enviro-Septic system, you will need to conduct a percolation test. This test involves digging a hole in the soil where the system will be installed and filling it with water. The time it takes for the water to percolate into the soil will determine the percolation time. It is important to note that the percolation time may vary depending on factors such as soil type, depth of the hole, and the amount of water used. Interpreting the percolation time is crucial when calculating the size of the Enviro-Septic system needed. A percolation time that is too short may indicate that the soil is not suitable for the system, while a percolation time that is too long may indicate that the system is too large for the soil.

4.11 Conclusion

Calculating septic tank sizing, number of Enviro-Septic pipes, length of rows and Enviro-Septic system's contact area sizing requires careful consideration of several factors. By taking these factors into account, homeowners can ensure that their septic system is properly sized and installed for optimal performance and efficiency. It also demonstrates its effectiveness in treating wastewater. Its reliable and efficient design makes it a great choice for those looking for a sustainable and environmentally conscious solution for wastewater treatment.

4.12 REFERENCES

[1] Make-Way Environmental, Technologies Inc.

[2] https://www.epa.gov/septic/how-your-septic-system-works

[3 Presby Environmental Inc. Enviro-Septic System Application: A2018-01

[4] Boîte de distribution | Limpido

GENERAL CONCLUSION

The aim of this project was to find an environmentally friendly solution that effectively treats wastewater. After conducting a comprehensive study, we observe that the Enviro-Septic system is an innovative and environmentally-friendly solution that offers a cost-effective and sustainable alternative to other septic systems. By using the natural processes to treat wastewater, it is able to effectively remove pollutants and contaminants, without the need for chemicals, electrical or mechanical components.

The components of the system, including the septic tank, distribution boxes, pipes and system sand work together to effectively treat wastewater while maintaining its longevity.

The methodology for designing an Enviro-Septic system involves careful analysis of the property, including the amount of wastewater generated, soil characteristics, and other factors. By calculating the appropriate dimensions and sizing for the system, we are able to make a detailed installation plan of the Enviro-Septic. In order for it to be an optimized system in his effectiveness and efficiency, while also minimizing the environmental impact.

The interpretation of the results indicates that the system is able to meet the specific needs of the property, while also being sustainable and long-lasting. We also found out that the treated wastewater can be safely used for irrigation purposes, reducing the need for additional water sources.

Overall, the Enviro-Septic system offers a promising solution for managing wastewater in a cost-effective, environmentally-friendly, and sustainable way. By carefully considering the components, methodology, sizing, and results of this system, it is possible to design and install an effective and efficient wastewater treatment solution that meets the needs of the property and protects the environment. As we continue to face growing concerns around water scarcity and pollution, solutions like Enviro-Septic will be crucial in ensuring a sustainable future for our planet.