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IMPROVEMENT IN THE ENVIRONMENTAL QUALITY OF WATER SUPPLY SOURCES AFTER THE IMPLEMENTATION OF SEPTIC TANKS

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ABSTRACT

The population's quality of life depends on its conditions of existence and access to certain goods and socioeconomic services, such as: employment, income, basic education, adequate food, access to good healthcare services, basic sanitation, housing, transportation, among others. The lack of basic sanitation is one of the main causes of environmental degradation, in addition to compromising the quality of life of the population living in both urban and rural areas. This work aims to demonstrate the improvement in the environmental quality of the Suaçuí Pequeno River Basin, a spring that supplies the headquarters of the municipality of Peçanha, Minas Gerais, after the implementation of the septic-tank installation project in rural properties located along the basin. To meet the objective proposed in the project, a model septic tank that was compact, efficient and that could meet the local characteristics of the basin was planned. The Biodigester tank model that was defined, is a domestic sewage treatment system composed of a unified upward flow reactor and anaerobic filter, with satisfactory efficiency and serving up to 5 people in constant use. After defining the model and acquiring the tanks by CENIBRA, mobilization meetings were held with rural landowners, registration of interested landowners, technical visits to each of the properties contemplated to mark the tanks would be installed, preparation of the installation sketch with reference to the manual provided by the manufacturer, delivery and installation of the tanks in the properties. The biodigester tanks were installed in the basin as a way to generate less-aggressive effluent, which is returned to the environment with low contamination potential. The project allowed serving 100 families residing in the Suaçuí River Basin and has been making a significant contribution to improving water quality, the source of which is responsible for supplying a city with a population of over 17,000. With the implementation of the project, 59% of existing residences in the basin now have a sewage treatment system, resulting in a reduction in the launch of approximately 7,300 kg/year of BOD and 8,760 kg/year of TSS in watercourses that makes up the basin.

Keywords: Septic tanks, water quality, sanitation, public supply.

INTRODUCTION

The population's quality of life depends on their conditions of existence and access to certain goods and socioeconomic services, such as: employment, income, basic education, adequate food, access to good healthcare services, basic sanitation, housing, transportation, among others (ADRIANO et al., 2000). The lack of basic sanitation is one of the main causes of environmental degradation, in addition to compromising the quality of life of the population living in both urban and rural areas (ARAÚJO et al., 2015).

The lack of domestic sewage treatment has several negative consequences for society. Literature cites health as the main variable impacted by the sanitary conditions of the population. In this context, the consequence of no sewage treatment, whether rural or urban, causes several diseases, called fecal-oral diseases, which have diarrheal diseases as their main mark. (BALTAZAR *et al*., 1988).

Environmentally correct solutions can be adopted to minimize the environmental impacts arising from the improper disposal of waste in rural areas, such as the use of composting processes, vermicomposting and the use of biodigesters for recycling solid waste of organic origin. These methods are considered of low operational cost, being economically viable in rural properties, besides contributing to the conservation of the environment (PEREIRA NETO, 2007; LOURENÇO, 2014

The quality of life standard of a population is directly related to the availability and quality of its water, which is the most

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critical natural resource for human health and most likely to impose limits on development. (HELLER, 1997)

In several rural communities around the world, especially in developing or underdeveloped countries, the socio-environmental damage caused by untreated domestic sewage is immeasurable. (AL-SHAYAH & MAHMOUD, 2008; MOUSSAVI et al., 2010)

When domestic sewage, mainly characterized by the large amount of organic matter, is released in natura into any river, it tends to be stabilized or assimilated by the liquid medium through self-cleaning processes that involve chemical, physical and biological transformations, through which organic matter is oxidized, turning into compounds of lesser complexity and toxicity. However, when these sewages are released in quantities greater than the assimilation capacity of the receiving water body, the environment is overloaded and its dynamic balance is undone.

According to Brito (2018), water is a natural resource that has given the most signs that it will not subsist human interventions in the environment and climate change for very long. Septic tanks are considered one of the simplest forms of primary treatment, where the separation and transformation of solid matter contained in sewage is carried out (SEABLOOM et al., 1982; USEPA, 2000. The success of the septic tank is mainly due to its simplicity, as septic tanks do not require special construction techniques nor does their operation require the presence of qualified operators (NETO, 1997).

According to Chiavenato (1999, p. 121), Social Responsibility is the degree of obligations that an organization assumes through actions that protect and improve the well-being of society as it seeks to achieve its own interests. It should be noted that, in addition to being concerned about its profits, the organization feels the right to reimburse society in some way, so it starts to adopt actions that benefit society, and when this is achieved, it reaches its degree of efficiency and effectiveness.

In view of the above, this work aims to demonstrate the improvement in the environmental quality of the Suaçuí Pequeno River basin, a spring that supplies the headquarters of the municipality of Peçanha, Minas Gerais, after the implementation of the septic tank installation project in the rural properties located along said basin.

METHODS

Study area

The project was developed in the Suaçuí Pequeno river basin, which supplies the headquarters of the municipality of Peçanha located in the eastern region of the state of Minas Gerais. The Suaçuí Pequeno River is part of the Suaçuí River Basin, called UPGRH DO4, a tributary of the Doce River, a basin made up of the Suaçuí Grande River, which occupies an area of 12,413 km², the Suaçuí Pequeno River Basin, with an area of 1,720 km², and the Corrente Grande River basin, with an area of 2,478 km². UPGRH is located in the Vale do Rio Doce mesoregion and in the micro-regions of Guanhães, Governador Valadares and Peçanha, according to IBGE's division.

The Suaçuí Pequeno River has its sources in the municipality of Peçanha. In its total trajectory of about 150 km, it crosses the municipalities of Coroaci and Governador Valadares, until it flows into the Doce River, in this municipality.

In the upper parts of the Suaçuí Grande rivers sub-basins, as well as its main tributaries and also in the upper parts of the Suaçuí Pequeno and Corrente Grande rivers sub-basins, the middle class of susceptibility to erosion prevails. In the other portions of the basin, there is a strong class of susceptibility to erosion, mainly next to the main channel of the Doce River.

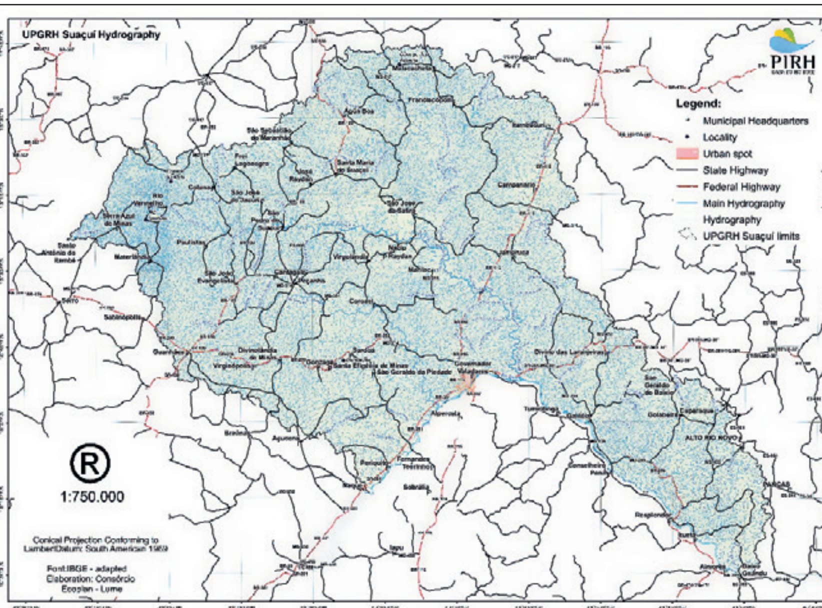

Figure 1: Hydrography of the Suaçuí River basin.

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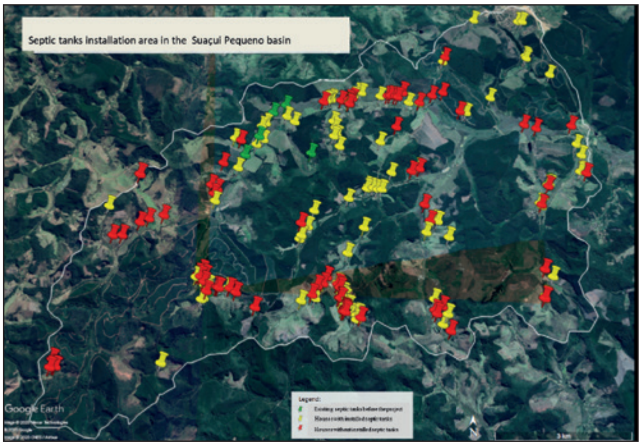

Figure 2. Suaçuí Pequeno Basin upstream from the Peçanha catchment

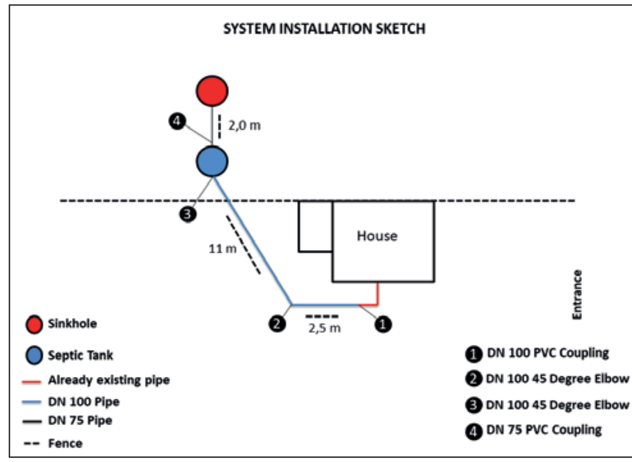

Figure 4. System installation sketch

The soils of the basin have relations between erosion processes and the quality and quantity of surface water. In this basin, Red-Yellow Ferralsols and Red Acrisols predominate. There is also the occurrence of Yellow Ferralsols and Leptsols to a lesser extent. Of these classes, Acrisols are the most erodible and Ferralsols are the least.

In relation to land use and occupation, the basin has 69% of areas earmarked for agriculture, 26% of forests and other natural formations, 3% of planted forests and 2% of other uses.

The priority area of the Suaçuí Pequeno basin, located upstream from the catchment of the city of Peçanha, has an area of 90 km^2 and has 181 houses with an estimated population of 724 people (Figure 2).

To satisfy the project, a tank model that was compact, efficient and that could meet the local characteristics of the basin was designed. For this, we opted to use the compact biodigester tank.

The biodigester is a compact sewage-treatment system

Figure 3: Biodigester tank adopted.

with satisfactory efficiency and serves up to 5 people. Easy to install and maintain, the application can also be done in commercial facilities, farms, granges or any other place in need of home sewage treatment, treating up to 500 liters of domestic sewage per day.

The system is waterproof, the sewage treated has no contact with the ground, requires little space for installation and, according to the manufacturer, guarantees to remove up to 80% of pollutants.

To develop the project, it was necessary to prepare sketches to define the installation location of the treatment unit on the rural property. In this stage, which was carried out by a qualified professional, characteristics were identified of the land, topographies, permeability, height of water table, distance from groundwater capture, distance from the bathroom and quotas to define the best installation location, and quantities of material necessary to execute the work. When installing the equipment, a professional demarcated spots where to drill holes.

With the sketches prepared, it was possible to calculate the material to be purchased by Cenibra to install the tanks, thereby a purchase requisition (PR) was opened for the acquisition of the tank and couplings for installation: DN 100 Pipe, DN 75 Pipe, ¾ Water Pipe, DN 60 Pipe, DN 100 PVC Coupling, DN 100 45 Degree Elbow, DN 75 PVC Coupling, 90 3/4 Degree Elbow Water Pipe, Sealing ring DN 100, DN 75 O-Ring and lubricating paste.

A hardware store in the municipality was selected for purchasing construction material due to logistics and to generate income for the municipality. The delivery of materials to the houses was negotiated, a very complex operation, due to the reduced volume of material in each property. The materials delivered were: cement, sand, gravel, concrete blocks, iron bars, annealed wire, pipes and other materials needed for the activities.

In order to generate a feeling of belonging to the project, we negotiated with the rural owners the drilling of holes


Figure 5. Drying bed

to install the equipment. And the City took over some actions to carry out the project. Representatives of the Agriculture Department accompanied the field team from the first contact with the rural-area residents where the basin was located and in all subsequent stages. City Hall was responsible for delivering all drains and pipes in the contemplated properties, bearing all transport logistics, loading and unloading.

For the installation of tanks, a service company in the construction industry was contracted. The first action to settle the tanks is building the base for the biodigester. Following the manufacturer's recommendation, a concrete base is made with steel mesh 0.10m thick and 1.40m in diameter. The digging depth of the 500L / day biodigester should be 1.54m. This depth takes into account the height of the settlement base, 0.10m, and the height of the biodigester, 1.44m.

A drying bed was built next to the biodigester, with the sludge outlet pipe. It was built with 0.10m concrete blocks, with uncoated walls and with a soil bottom for the absorption of the liquid part of the sludge. The sludge outlet pipe was connected from the biodigester to the drying bed and the PVC ball valve of this pipe was installed inside the drying bed as recommended by the manufacturer. In the process of installing the tanks, it was necessary to build 2 concrete lids, one for the drying bed and the other for the sinkhole.

Brazilian law offers seven possibilities for the disposal of final effluent: infiltration ditch, infiltration / evapotranspiration site, rainwater gallery, water bodies, sinkhole, reuse or connecting to the sewage capture network. Of the aforementioned options, it was decided to build sinkholes according to technical standard *ABNT NBR 13969 / 97 – Septic tank - Units for treatment and disposal of liquid effluents - Project, construction and operation*. The sinkhole is a unit for purification and final disposal of the septic tank effluent. The system, which was implemented vertically and provided a minimum distance of its bottom from the water table of at least 1.5 meters.

The sewage generated in the residence or in other applications, coming from bathrooms is sent through the sanitary sewer system to the biodigester inlet pipe. Upon reaching the biodigester, the sewage is directed to the bottom of the product, where treatment will take place in an upward flow (from bottom to top). The bacteria from the anaerobic process adhere to the filter medium and digest the organic matter present in the sewage. The filter medium is formed by pieces of conduits. To start the sewage treatment in the biodigester, only sewage is necessary. The treated sewage reaches the surface and is collected by the spillway chute and conducted to the outlet pipe. During the biodigestion process of the organic matter from the sewage, two treatment byproducts are released: Sludge and Biogas. The sludge will be deposited in the bottom of the Biodigester and must be discarded every 6 months through a hydrostatic device and deposited in a drying bed. The biogas must be continuously released by installing a pipe at the gas collecting outlet. This pipeline must conduct the biogas to an upper point on the roof or in an area away from the flow of people.

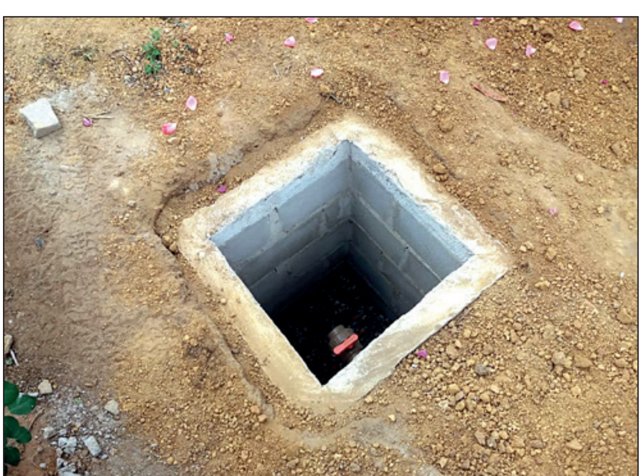
Figure 6. Sinkhole


Figure 7. Septic tank installation set (tank, drying bed and sinkhole)

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RESULTS AND DISCUSSION

The treatment of sanitary sewage is one of the sanitation services that most need analysis and proposals for the forwarding of solutions, especially when thinking about water quality. The sewage collection and treatment deficit in Brazil has resulted in a significant portion of the polluting load reaching bodies of water, causing negative implications for the multiple uses of water resources.

The lack of sewage systems is considered one of the main environmental problems in our society, the guarantee of this service is of great importance for the health and well-being of the population. According to Instituto Trata Brasil (2016), more than 100 million Brazilians do not have access to sewage collection. In rural areas, the situation is even more critical, as a significant portion of the population has facilities considered unsuitable for disposal of excrements.

In the Suaçuí Pequeno basin in Peçanha, only 3% of households had adequate treatment for domestic sewage. Table 1 presents a diagnosis of the basin in the downstream portion of the catchment of the municipality's headquarters after installation of septic tanks by Cenibra. Of the total 181 houses in the area, 106 houses today have a treatment system that is equivalent to 58.6% of the basin. This data improves the basin's condition to levels higher than that practiced in Brazil, which according to PNAD (2014), only 5.1% of rural households have sewage collection connected to the general network and 26.2% have a septic tank (connected or not to the collection network). Another fact that draws attention is that 49.9% of households use a rudimentary cesspit and 11.4% have no solution, an index that draws attention because it refers to half of all rural households that have an incorrect destination for waste.

Basin Diagnosis	
Houses with tanks installed by Cenibra	100
Houses with suitable tanks installed by another alternative	6
Houses without septic tank systems	75
Total households in the basin	181

Table 1. Basin sanitation diagnosis

The release of untreated sewage into water bodies has resulted in compromised water quality, especially close to urban areas, which may impact the population's health and even make it impossible to meet downstream uses, especially human supply. In the case of the city of Peçanha located at the riverhead where the receiving body at certain times does not have a dilution capacity due to the low relationship between water availability and organic load launched, the project contributes to improving the quality of water supply.

According to the basic sanitation municipal plan in the city of Peçanha, a goal to be achieved for the rural area will also be the universalization of treatment services, by the end of the year 2024, through the implementation of individual isolated septic-tank systems in communities, where households are sparse, with the capacity to serve the entire planning period. Thereby, this project has contributed to achieving the goal in a portion of the municipality.

Another premise that is being met with the project in relation to the plan is the contribution to the framing of the city's water bodies, in addition to the eradication of rudimentary cesspools that throw sewage into the soil without any treatment. With the project, it was possible to carry out a cadastral survey of isolated rural properties regarding the existence of bathrooms and toilets, a type of solution for the disposal of sanitary effluents.

In two residences, a strong odor was reported in the unit after installation. The customer service area of the company that supplied the tanks was called on and, upon visiting the units, the technician found that everything was in accordance with the manufacturer's technical guidance and that the problem would be solved with the maturation of the system.

According to (Sperling, 2014) Limiting Population Equivalent - EPL: demonstrates the equivalence between a polluting source and a certain number of people. The typical per capita contribution of BOD to sanitary sewage is 50 g/inhab/day. In one year, this contribution would be 18.25 kg/inhab/year. For the TSS parameter, the contribution would be 60 g/inhab/day, making a total of 21.9 kg/inhab/year. With the implementation of septic tanks, around 400 people stopped releasing their in-natura waste into the environment. With this, the city's water supply stops receiving around 7,300 kg of BOD and 8,760 kg of TSS per year. In addition, there will be a considerable reduction in the emission of nutrients that cause water eutrophication.

CONCLUSIONS

The project's execution was very well accepted by society and the community's adherence was demonstrated with the rural producers' contribution to the project, through manpower for the execution of the holes necessary to install the tanks.

City Hall's participation was vital for the success of the project, through mobilization, logistics support and incentives to the community participating in the project.

During the installation works, there were some challenges due to climate conditions, access and logistics. In two residences, a strong odor was reported in the unit after installation. The customer service area of the equipment supplier was called on. When visiting the units, the company's technician found that everything was in accordance with the manufacturer's technical guidance and that the problem would be solved with the maturation of the system.

With the completion of the tank installations, 58.6% of the portion of the basin upstream of the catchment began to have sewage treatment, generating direct benefits for 100 families. In addition, a universe of more than 17,000 people were benefited due to the reduction in contamination of the watercourse that supplies the municipality's headquarters.

With the installation of septic tanks, around 400 people stopped releasing their in-natura waste into the environment, thereby the city's water supply stopped receiving roughly 7,300 kg of BOD and 8,760 kg of TSS per year. ■

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