# Dewatering of sludge from a sewage treatment plant with geotextile tubes

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ABSTRACT
It is observed that most, if not all, human activities contemplate the use of water, and for sanitation this statement could not be more correct. However, the reality of the treatment of sanitary effluents is still precarious, where the sewage treatment plants usually discharge their effluents directly into the water bodies, without any previous treatment, disregarding the current regulations. In this context, dewatering solutions for those effluents are interesting, representing the separation of the solid phase from the liquid, providing a more efficient transport and disposition for the solid particulate and, also, the correct treatment for the percolate, either through its return to the water bodies or to the beginning of the treatment process of the plant. Thus, this article addresses the suitability of a sewage treatment drying bed for the reception of geotextile tubes, aiming at the cleaning of silted stabilization ponds, making the dewatering of the dredged effluent faster and allowing the storage of a larger volume of sludge than the previous system. The dewatering process was performed by pumping the effluent from the stabilization ponds, with initial solids contents of approximately 5%, into the geotextile tubes. 14 tubes were used, contemplating the dewatering of more than 12.000m³, estimating the reduction in more than 8,5 times in relation to this initial volume. The dewatering was a success, where the 14 geotextile tubes of 10m perimeter and 15m length were able to receive the desired dredged volume, separating the solid particulate from the water, providing great volume reduction, adequate encapsulation and revitalization of the stabilization ponds.

Keywords: Effluents; Sewage treatment plant; Dewatering; Geotextile tubes; Volume reduction.

## 1. INTRODUCTION

Water is an important resource for people's quality of life, indispensable for several types of use, including desedentation. However, this resource is finite and available in small quantities in the quality of freshwater, at liquid state and on the surface. Therefore, rivers and lakes, providers of surface water resources, must be treated and kept clean, protected from any pollution.

Even with people's knowledge of the importance of water, the scenario is just the opposite, with surface water resources being treated unsustainably, receiving loads of effluents, such as domestic and industrial sewage, being constantly degraded. Due to this scenario, Ghisi (2006) states that several countries, including Brazil, will suffer from problems and insufficiencies in the distribution of potable water to their populations.

Seeking to collaborate with the maintenance of the water resources, regulating agencies, fiscal of the quality of the water and the effluents that it receives, seek to maintain the current state or improve the quality of the water bodies. In Brazil, the regulatory agency is the *Conselho Nacional do Meio Ambiente* (CONAMA) and the supervisory agent, for example in the state of São Paulo, is the *Companhia Ambiental do Estado de São Paulo* (CETESB). But despite a resolution and enforcements, pollution and negligence still occur with rivers and lakes across the country.

The water made available to the population as potable is treated in water treatment plants (WTP) and, after being used, is then classified as sewage and again treated, now in sewage treatment plants (STP). If water is used for industrial purposes, additional treatment steps may be required and in such cases wastewater treatment should be performed at industrial wastewater treatment plants (IWTP) (Di Bernardo and Dantas, 2005). The treatment plants seek to comply with Resolution 430 of CONAMA (2011), and then return the treated effluent to water bodies (Marçal and Silva, 2017).

However, in the cleaning processes of the treatment plants, significant amounts of wet waste (sludge) are generated, which have low solids content. The waste generated then needs a correct transportation and final disposal, but the transporting and disposing of these untreated wastes can be impracticable, resulting in the transport of large wet volumes, being charged (disposal cost) for this volume and also allowing the formation of larger amounts of slurry in the landfill, which represents a risk for the environment in case of leakage. Therefore, techniques and processes that collaborate with the dewatering of these sludges are fundamental, allowing the transport of a smaller volume, with lower tariffs and implying in more safety for disposal in landfills.

In view of the problems caused by the generation of wet waste, this article deals with the use of the dewatering technique in geotextile tubes, providing the elevation of the solids content of the dewatered material, decreasing its volume and facilitating its handling as solid or semi-solid (Müller, 2019; Vertematti, 2015).

The geotextile tube dewatering technique is a mixed dewatering solution, consisting of geosynthetic made tube that receives hydraulically filling cycles with sludge (Castro, 2005; Koerner, 2005; Müller, 2019; Pilarczyk, 2000; Tominaga, 2010; Vertematti, 2015). In the filling step, corresponding to the mechanical dewatering, the hydraulic pressure causes the liquid part to be expelled through the geosynthetic (forced filtration), while the solid part is retained by it. After filling and relieving of pressures, the sludge is naturally dewatered, where the evaporation process becomes increasingly relevant as unsaturated zones begin to form.

For the correct use of this dewatering technique, the geotextile tubes must be positioned over a draining cradle, the cradle is responsible for collecting percolated water from the tubes, allowing their recirculation in the treatment system or their correct return to the relevant water body.

In this article, then, actual dewatering project is presented and discussed. The project consisting of the dewatering of the material contained in three sedimentation lagoons of the Boituva sewage treatment plant in São Paulo. Using the existing drying beds in the STP for the correct positioning of geotextile tubes, seeking lower intervention costs and increased dewatering capacity in relation to existing beds.

## 2. CASE STUDY

### 2.1 Boituva Sludge treatment Plant

STP Campos de Boituva is located in Boituva, São Paulo. The station is operated by SABESP and serves a great portion of the city.

The treatment plant has for its processes three aeration ponds, three decantation ponds and twenty covered drying beds, each with 75m². Plant layout of the station can be seen in Figure 1 below.

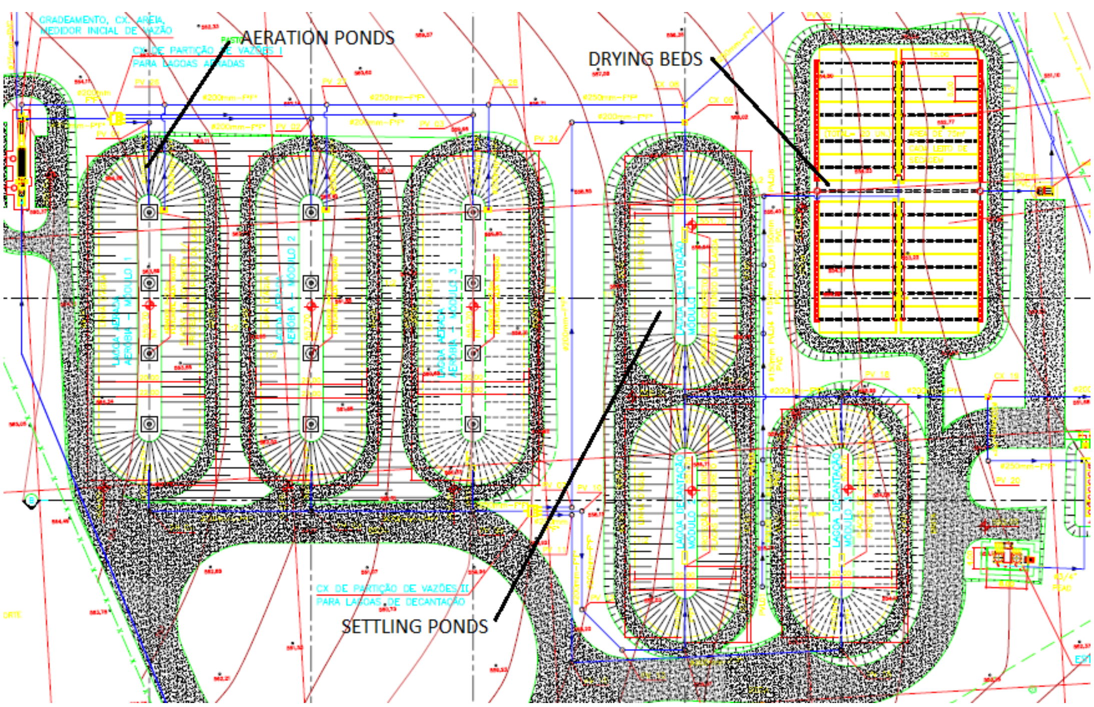


Figure 1. STP Campos de Boituva (Authors, adapted from SABESP, 2019).

### 2.2 Necessity

The three settling ponds of the Campos de Boituva STP were heavily loaded with solid organic material in their interiors, compromising the receipt of more effluent and impairing its operating processes. Thus, cleaning of the three ponds was necessary.

Through tests performed by the treatment plant, it was observed the existence of approximately 12.000m³ of densified material with 5% solids content per mass. This material being predominantly composed of organic matter.

### 2.3 Solution

Given the need to clean the three settling ponds, solutions began to be evaluated. Initially it was considered the pumping of the dense material for hydro vacuum tank trucks, but soon it was realized that the wet volume to be transported was too great, making this option unfeasible. Then, dewatering techniques were considered, aiming to separate the liquid part from the solid part, providing a smaller volume to be treated.

In front of the various dewatering techniques that are available in Brazil, the mechanicals were soon discarded, representing high acquisition and maintenance costs. Therefore, as the existing drying bed dewatering technique was not able to deal with the required volume in pertinent time, the geotextile tube dewatering technique was chosen.

## 3. IMPLEMENTED DEWATERING SOLUTION

The dewatering technique chosen corresponds to the use of containers made of geosynthetics, assuming a linear tubular shape upon filling, designed in a variety of perimeters and lengths, resulting in a geotextile tube (Müller, 2019). Geotextile tubes have then the function of filtering the sludge, retaining the solid particulate in its inside and allowing the water to percolate. (Castro, 2005; Koerner, 2005; Moo-young et al., 2002; Müller, 2019; Pilarczyk, 2000; Tominaga, 2010; Vertematti, 2015).

Through filtration and retention of solid particulate, this dewatering technique provides the raise of solids content of a sludge. Corresponding to an operation where the moisture content is reduced so that the generated waste can be handled as a semi-solid/solid, thus providing much easier and more efficient handling and transportation than would happen to the previous wet material (Castro, 2005; Koerner, 2005; Müller, 2019; Pilarczyk, 2000; Tominaga, 2010; Vertematti, 2015).

For the correct operation of the technique, the geotextile tubes must be arranged over a draining cradle, ensuring the collection and concentration of the percolate, gauging its quality and then promoting its correct destination (Müller, 2019; Vertematti, 2015). In the application scenario the drying beds were used as drainage cradles for the geotextile tubes, the percolate being redirected to the settling ponds. With this avoiding the need to build a cradle, saving costs and speeding up the begin of the necessary dewatering process.

The geotextile tubes were then designed and quantified, taking into account the length and width constraints of the existing drying beds, representing 5m wide and 15m long. The software GepCoPS 3.0 (Leshchinsky and Leshchinsky, 1996) was used and, by geometric and stress analysis, 14 geotextile tubes were defined for cleaning the lagoons. Figure 2 shows the geometry design performed.

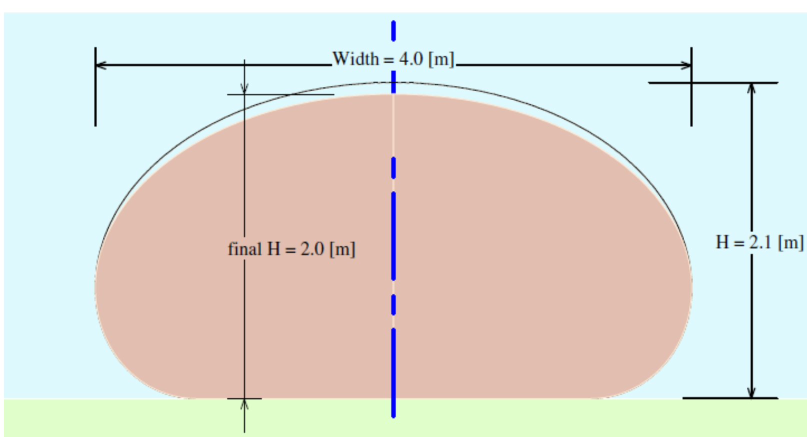

Figure 2. Geometric design (Authors, 2019).

Through cone testing (Vertematti, 2015), high strength polypropylene woven geotextile was then defined as the best option for the sludge filtration. This geotextile was then used to make the geotextile tubes for the pond cleaning service. The geotextile having the following characteristics: Filtration aperture (NBR 12.956, 2013) of 0.2 mm, speed of normal flow through the plane of the geotextile (NBR 11.058, 2013) of $20.10^{-3}$ m/s and resistance to tensile strength (NBR 10.319, 2013), both longitudinal and transversal, of 105 kN/m.

The sludge was then pumped through a dredger, removing the densified material from the ponds and filling the geotextile tubes located in the drying beds, as shown in Figure 3. The geotextile tubes received several filling cycles until their maximum admitted volume was reached. After this process they rested for a period of 3 weeks.


Figure 3. Geotextile tubes located in the drying beds (Authors, 2019).

Through the dewatering process, the sludge increased from 5% solids content by mass to approximately 25% inside geotextile tubes. This representing a reduction from the initial 12.000 m³ to just over 1.400 m³ at the end. Providing 8,5 times less volume than the original, resulting in lower transportation and final disposal costs.

## 4. CONSIDERATIONS ABOUT THE DEWATERING PROCESS

The maximum height that a geotextile dewatering tube can reach must be correctly and clearly indicated by marking, this marking located on the geotextile surface and in an easily viewable location. The indicated height must be strictly respected, representing by means of the tensil forces acting on the tube, the maximum allowable height for safety and correctly usability of the dewatering system.

If the maximum height is not respected and is exceeded for any reason, there is a high risk of the tube breakage. This risk is increased by the gaining of height with its filling, due to increase of internal pressures, and it should be avoided.

It is emphasized that as the geotextile tube is made by a filtering element, over time the water will percolate and the tube will lose height due to the consolidation. In this way, new filling cycles are possible, treating and dewatering larger volumes of sludge. Thus, a geotextile tube can receive a sludge volume many times larger than its nominal volume.

It is observed that the filling of geotextile tube with predominantly organic sludge provides biological clogging of the geotextile pores. This clogging comes from the formation of bacterial and algal colonies that blind the geotextile, preventing water percolation and thus retaining moisture inside the tube. This clogging process is easily avoided, for example, in the case studied, frequent washes of the pipe surface were performed with a pressure hose.

## 5. CONCLUSION

Through the application case presented it is possible to realize that dewatering in drying beds would not provide the effective cleaning and dewatering of the sludge from the consolidation ponds in time. Furthermore, mechanical dewatering techniques, which would be effective for the purpose of cleaning the ponds in time were not viable, representing high investment and maintenance costs for the service.

Thus, it is noticed that the mixed dewatering technique with geotextile tubes is interesting, representing low investment and maintenance costs, combined with the effectiveness in gaining solids contents in time through its dewatering technique.

Therefore, it is observed that the use of geotextile tubes offers advantages over conventional dewatering techniques, such as the need for reduced implementation area, low cost of implementation of the technique, good increase in the sludge solids content, great reduction of volume, ease of transport and disposal of waste generated, rain tolerance, use of existing facilities (sediment pond / drying bed) and recirculation of percolated water at the treatment plant.

## ACKNOWLEDGEMENTS

To HUESKER for the support in the real case analyses.

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