A Guide to Measuring Sludge in Facultative Lagoons

Introduction

In order for water businesses to account for future expenses and to ensure efficient operation of facultative lagoons it is important to know the quantity of sludge in a lagoon. It is also valuable to know how quickly sludge accumulates to ensure the lagoon is maintained and is performing correctly.

This document has been produced to provide a guide to determining the quantity of sludge in lagoons, the sludge accumulation rate, and how often it is necessary to measure the quantity of sludge in a lagoon.

The rate of sludge accumulation is not uniform and will depend on the design of the lagoon, the strength of the wastewater, the age of the lagoon (annual sludge accumulation rate decreases with the age of the sludge, if a lagoon has never been desludged its sludge accumulation rate will be slow) and the climatic conditions (sludge accumulates more slowly in colder climates).

Figure 1 – Aerial View of Typical Facultative Lagoon

Facultative lagoons generally accumulate solids more quickly than aerobic lagoons as they depend on anaerobic conditions for breakdown of the settled matter, which occurs more slowly than aerobic degradation. Facultative ponds are generally deeper than aerobic ponds and need to be desludged less often.

Generally, desludging of a lagoon is required infrequently; every 5-10 years may be the typical frequency for desludging short detention-time lagoons (90 days), while long detention-time lagoons (6-12 months) may not need to be desludged for even longer periods.

The sludge should be removed when the sludge layer reaches a depth that can be affected by the aerators, or when the net pond volume is substantially reduced (usually when the sludge level reaches 1/3 of the pond depth).

Figure 2 - Diagram of a typical Facultative Lagoon

Method

Lagoon Base Survey

The purpose of the Lagoon Base Survey is to establish the total capacity of the lagoon. The base of the lagoon is surveyed utilizing high accuracy GPS equipment and integrated topographic software. The survey is carried out from a floating platform on the lagoon. The lagoon is surveyed on a grid system with survey points at approximately 15m-25m centers depending on the size and shape of the lagoon. This survey method provides an accurate profile of the base and sides of the lagoon. Once the total capacity of the lagoon is determined, the next step is to establish the volume of the lagoon that is occupied by sludge.

Sludge Water Interface

The level of the sludge/water interface is measured utilizing a suspended solids interface meter; this instrument provides an accurate indication of the level of the top of the sludge. This information is recorded with high accuracy GPS equipment and integrated topographic software, this survey is carried out from a floating platform on the lagoon and provides an accurate profile of the top of the sludge layer.

Sludge Volume

The sludge volume within the lagoon is calculated by comparing the base survey and the survey of the top level of the sludge. This calculation is carried out by the topographic survey software and enables the production of both cross sections through the lagoon and plan profiles of the sludge within the lagoon.

Sludge Density

A purpose built grab sample tube is utilised to recover sludge samples at approximately 25%-50% of the sludge survey locations, these samples are aggregated and used to provide average sludge solids contents for specific areas of the lagoon.

Solids Measurement

A moisture analyser is used to measure the solids content of sewage sludge. The average sludge solids content of the sludge in the lagoon multiplied by the volume of the sludge contained in the lagoon provides the total quantity of dry solids (tDS) contained within the lagoon. The result is an accurate measurement of the quantity of sludge contained within the lagoon and can be used to better estimate the costs associated with the removal and dewatering of the sludge.

Future Monitoring

Ideally, the amount of sludge accumulated in the lagoon should be measured every year or so to determine the volume and accumulation rate, and to plan effectively for desludging operations. However, the method of sludge survey monitoring using high accuracy GPS equipment and topographic software (described above) is a costly process. It is considered uneconomic and unnecessary to have this procedure carried out on a yearly basis.

There are alternative, less expensive methods, such as the ‘white towel technique’ that will give an estimated sludge volume reading.

The white towel technique is where the depth of the lagoon is measured using a lightweight rigid pole (5-7cm in diameter) with white towel pieces tied onto it at regular intervals. The pole is slowly lowered vertically into the lagoon until it hits the bottom. It is then slowly withdrawn. Sludge particles get trapped on the toweling material so the sludge depth is clearly visible, and the full depth of the fluid above the sediment is recorded. Sludge depth should be measured at five or six points in the lagoon. From these measurements the sludge volume can be calculated and then the sludge accumulation value can be calculated.

The sludge accumulation rate (volume/capita/year) is estimated by dividing the total sludge volume by the population served and the number of years the lagoon being tested has been in operation.

Another option to measure sludge accumulation is using a suspended solids meter. Suspended solids meters with a calibrated sensor cable can be used to determine the distance from the top of the sludge to the top of the lagoon. It is helpful to know the total capacity of the lagoon before using this method of measurement to make sure you get an accurate sludge measurement. A suspended solids meter can be quite expensive to purchase, but it is a more durable and accurate method of determining sludge accumulation than the white towel technique.

Depth samplers, a pH electrode fixed on a graduated pole, ultrasonic or optical sludge blanket detectors, or transits, can also be used to determine the amount of sludge accumulated in a lagoon.

Conclusion

The quantity of sludge in lagoons should be measured around every five years using high accuracy GPS equipment and topographic software to get an accurate reading. Sludge levels should be measured every other year using a less expensive option to confirm the annual accumulation rate and ensure efficient operation of the lagoon. This allows the water business to report the sludge accumulated annually and budget for future desludging operation.

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