Water for the World

Designing Mechanically Aerated Lagoons
Technical Note No. SAN .2.D.7

A mechanicallly aerated lagoon is similar to a stabilization pond except that it is equipped with one or more electrically powered aerators that treat the effleunt by mixing it with air. Designing a mechanically aerated lagoon requires the services of an engineer experienced with these systems. Designing involves choosing a location; calculating lagoon size; selecting an aerator; and determining labor, materials, and tools needed for construction. The products of the design process are (1) a location map, (2) design drawings of the lagoon, and (3) a detailed materials list.

This technical note describes the elements involved in designing a mechanically aerated lagoon. Read the entire technical note before beginning the design process.

Materials Needed

A master map of the sewer system; see "Designing Sewer Systems," SAN.2.D.4. The technical notes "Designing Stabilization Ponds," SAN.2.D.5, and "Designing a System of Stabilization Ponds," SAN.2.D.6.

General

The prerequisites for a mechanically aerated lagoon are a constant source of electric power and funds to purchase two or more aerators.

There are a number of designs for mechanically aerated lagoons. One design requires a fairly large excavation, 2.0-4.0m deep, that is lined with flat rocks and mortar to prevent erosion caused by the aerators. The aerators float on the surface of the lagoon and treat the effluent by mixing it with oxygen. The treated sewage flows from the lagoon to a maturation pond, and then is discharged to a dry ditch or to an irrigation ditch leading to crop land.

Useful Definitions

BOD - Biochemical oxygen demand; a means of measuring the organic content of effluent.

EFFLUENT - Settled sewage.

HOURSEPOWER - A unit of power used to rate motors.

Selecting a Location

The site requirements for a mechanically aerated lagoon are the same as for a stabilization pond. See "Designing Stabilization Ponds," SAN.2.D.5, and "Designing a System of Stabilization Ponds," SAN.2.D.6. When the site has been determined, draw a location map or draw the site on the master sewer map as shown in Figure 1.

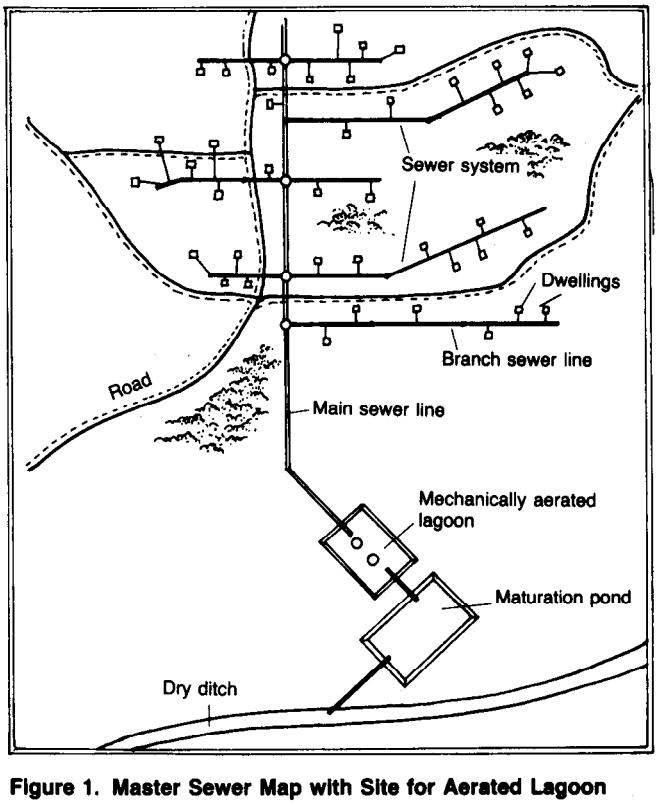

Figure 1. Master Sewer Map with Site for Aerated Lagoon

Calculating Lagoon Size

The size of the lagoon is based on the daily flow of effluent; the BOD of the effluent as determined by laboratory analysis; the desired percentage of BOD removal, usually 80-95 percent; the climate of the area; and the type and size of the aerators. The lagoon size must be determined by an engineer.

In general, the capacity of the lagoon should be at least four times greater than the daily flow of effluent. For example, if the daily flow is 100000 liters, the minimum capacity of the lagoon equals:

100000 liters x 4 = 400000 liters

To calculate the minimum area of the lagoon surface, convert liters to m^3, and divid by the design depth of the lagoon:

1000 liters = m^3

Using the example above,

$$\frac{400000 \text{ liters}}{1000 \text{ liters}/m^3} = 400 m^3$$

Suppose the design depth is 2.5m. Then the area equals:

$$\frac{400 m^3}{2.5 m} = 160 m^2$$

One configuration for this area is 16m long and 10m wide. See Worksheet A, Lines 1 through 6.

To calculate the size of the maturation pond, see "Designing a System of Stabilization Ponds," SAN.2.D.6. When the lagoon and the pond have been designed, prepare a drawing similar to Figure 2 showing their size and configuration.

Selecting an Aerator

There are a number of types of aerators being manufactured. One common design consists of an electric motor mounted on a float, attached to a vertical shaft and propeller, and connected to an electric line. See Figure 3. Mooring lines secured on the lagoon banks hold the aerator in position on the surface of the lagoon. When the power is switched on, the motor spins the shaft and propeller and churns up the effluent, mixing it with oxygen.

Aerator motors vary in size from 1-100 horsepower. The size and number of aerators, generally two or more, must be determined by the engineer using areators manufacturers' specification sheets.

Worksheet A. Calculating Minimum Size of Aerated Lagoon

1. Daily flow of effluent = 100,000 liters
2. Minimum capacity of lagoon = Line 1 x 4 = 100,000 liters x 4 = 400,000 liters
3. Minimum capacity expressed in cubic meters = $\frac{\text{Line 2}}{1000 \text{ liters}/m^3}$ = $\frac{(400{,}000 \text{ liters})}{1000 \text{ liters}/m^3}$ = 400 m^3
4. Minimum surface area of lagoon = $\frac{\text{Line 2}}{\text{design depth}}$ = $\frac{(400 \ m^3)}{(2.5 \ m)}$ = 160 m^2
5. Proposed width = 10 m
6. Length = $\frac{\text{Line 4}}{\text{Line 5}}$ = $\frac{(160 \ m^2)}{(10 \ m)}$ = 16 m

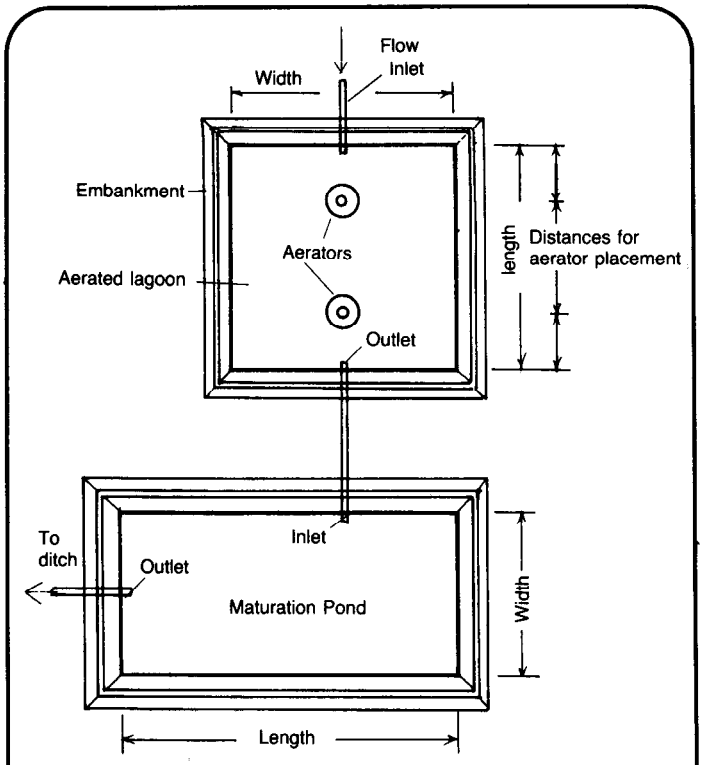

Figure 2. Design of Aerated Lagoon System

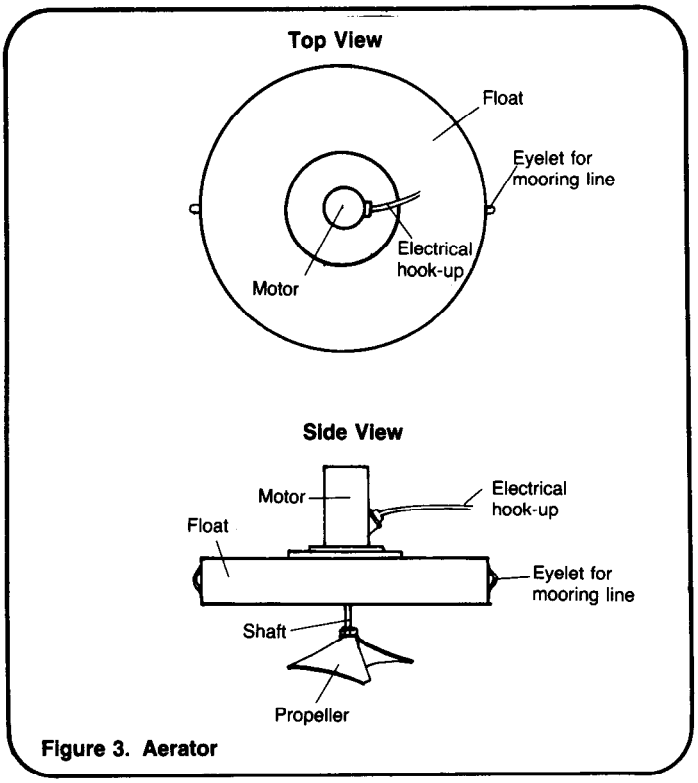

Figure 3. Aerator

Determining Labor, Materials, and Tools

The primary labor requirement is an engineer experienced with mechanically aerated lagoons. A fairly large and reliable work force of 5-20 people is needed. At least one worker must be a skilled electrician. One or more workers should have some experience with concrete mortar. Because of the size of the excavation, motorized excavating equipment, such as a backhoe, may be needed.

Materials needed include the aerators and all necessary wiring and spare parts; flat stones an mortar for lining the lagoons; sewer pipe and valves for inlet and outlet pipes and interpond piping; grass seed or sod for the top and outside of embankments. Tools needed include those used for assembling and installing electrically powered aerators, spreading mortar, laying pipe, and laying sod.

When all decisions on labor, supplies and tools have been made, prepare a materials list similar to Table 1 and give it to the construction foreman.

Table 1. Sample Materials List for Aerated Lagoon

Item	Description	Quantity	Estimated Cost
Labor	Engineer experienced with aerated lagoons	1	____
	Electrician	1	____
	Worker skilled with concrete mortar	1	____
	Unskilled workers	6	____
	Backhoe operator	1	____
Supplies	Aerators, including spare parts, electric cables, and mooring lines	____	____
	Sewer pipe, 100mm diameter	____	____
	Valves, 100mm diameter	____	____
	Flat stones	____	____
	Mortar mix	____	____
	Grass seed	____	____
Tools	Backhoe	____	____
	Shovels	____	____
	Electrician's tools	____	____
	Mixing containers	____	____
	Trowels	____	____

Total Estimated Cost = ____