Non-Discharge Lagoon/ET Wetland Technology for Small Wastewater Treatment Facilities

By William Li, P.E.

Non-discharge lagoon/evapotranspiration wetland systems are being used in Colorado state parks with great success.

Small wastewater systems present many unique challenges including significant organic loading and flow variations, limited financial resources, limited operational and maintenance budgets, stringent discharge requirements and operator availability. Therefore, effective low maintenance, simple-to-operate and inexpensive treatment systems must be developed for the small wastewater systems. While quite a few treatment systems have proven to be successful for these systems, almost all of them require surface or subsurface discharges. A discharge system requires extensive regulatory monitoring, compliance and record keeping that can be a big burden for a small wastewater system.

A non-discharge lagoon/evapotranspiration (ET) wetland system is being used in western Colorado for several small wastewater systems including Island Acres State Park, Highline State Park and Ridgway Reservoir State Park with great success.

Process Description

A typical non-discharge lagoon/ET wetland system consists of a septic tank, an aerated lagoon and wetlands as shown in Figure 1. Depending on the site conditions, a lift station may be needed to pump wastewater to the aerated lagoon. Flow from the lagoon to the wetland generally is by gravity. Treated wastewater is disposed of through an evapotranspiration process in the wetland basin without surface or subsurface discharges.

The septic tank of the lagoon/ET wetland system is used to provide sedimentation for solid removal from the wastewater and minimize sludge accumulation in the subsequent processes. Accumulated solids in the septic tank are monitored and removed periodically for optimal performance. This removed sludge from the septic needs to be disposed of at acceptable locations.

The non-discharge lagoon/ET wetland system is a combination of an aerated lagoon and wetland. However, it differs from a conventional lagoon system that typically has three cells, and differs from a conventional wetland system that is used as a primary treatment process or a polishing process following secondary treatment facilities for stringent regulatory requirements in a discharge system. In the lagoon/ET wetland system, the lagoon is a completely mixed aerated cell and is designed as the primary unit for most of the organic loading removal. Another important function of the lagoon is to provide thorough mixing and blend the influent to prevent shock loadings to the wetlands.

Aeration in the lagoon typically is provided by floating aerators for the simplicity of operation and maintenance. The lagoon usually is lined with a UV-resistant synthetic liner.

The ET wetlands of the system are free water surface type marsh ponds that serve three primary functions. The first is to complete biological degradation of organic loadings in addition to many other pollutants including suspended solids, trace metals, nitrogen, phosphorus and pathogens in the wastewater. Wetlands provide a variety of treatment mechanisms for contaminants including biological, physical and chemical processes. The wetlands also provide an area to dispose of treated wastewater by the evapotranspiration process. Finally, the wetlands provide storage during high flows.

As with the lagoon, wetlands also are usually lined with synthetic liners. The liner is completely covered. Typical vegetation used in the wetlands includes cattails, bulrushes and sedges. Vegetation should be transplanted from local regional areas near the project site or a local wetland vegetation nursery. The use of vegetation in the wetland has the benefit of providing stem and roots as the attaching medium for bacteria for BOD removal, transferring of oxygen to the root zone by penetrating the soil, removing contaminants by plant uptake, disposing of treated wastewater by transpiring and offering a habitat for local wildlife and an aesthetic view for the public.

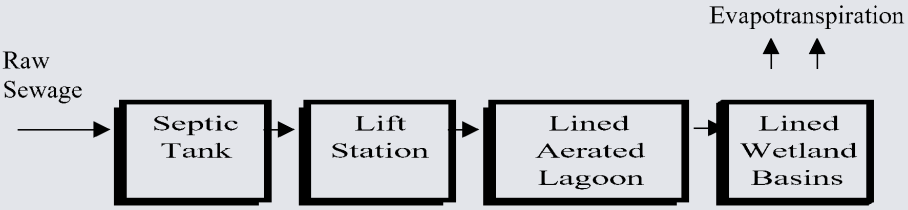
Design Process Considerations

The aerated lagoon is a basin in which wastewater is treated on a flow-through basis. Factors that must be considered in the design of a lagoon are BOD_5 loading, BOD_5 removal efficiency, oxygen requirements,

temperature effects and energy requirements for mixing. The treatment efficiency of the aerated lagoon varies with organic loading and flow variations, and water temperature changes. The design goal for the lagoon is to provide an average of at least 75 percent BOD_5 removal at the design flow and 50 percent minimum BOD_5 removal for the peak flow loading. The dissolved oxygen level in the lagoon should be designed to maintain a minimum 2.0 mg/L for optimal BOD_5 removal performance. Due to varying climatic conditions throughout the year, the effect of temperature change in the wastewater in the lagoon must be considered in the design. In addition to providing adequate oxygen to the lagoon, aerators also should be sized to be powerful enough for complete mixing for the wastewater in the lagoon and maintain the contents of the lagoon in suspension. The lagoon design should provide adequate volume for potential sludge accumulation in the lagoon.

The ET wetlands are designed primarily for the final disposal of wastewater through evaporation and transpiration. Its treatment and storage functions are secondary. In order to size the wetlands properly for the successful disposal of the wastewater, local climatic data such as annual and monthly precipitation and evapotranspiration rates are needed to determine the net evapotranspiration loss for water balance analysis. Since both precipitation and evapotranspiration can vary significantly from month to month, water balance analysis should be performed for each month of the year to ensure the wetlands will not be over-flooded or dry-up in any month. The wetland should be designed to maintain water levels to allow viable and healthy vegetation. The design water depth range depends on the optimum water depth requirements for the selected vegetation. To have a successful wetland, BOD_5 loading rates must be checked to ensure oxygen demand of the applied wastewater will not exceed the oxygen-transfer capacity of the wetland vegetation. Heavy organic loading, especially if not evenly distributed, can cause vegetation to die off or cause an odor problem.

Figure 1: Typical Non-Discharge Lagoon/ET Wetland System



There are no limitations on the geometry of the basins since they are a non-discharge system. The basins can be curved to provide a natural look depending on the site conditions. Wetlands generally are designed with shallow level basins.

Advantages

The non-discharge lagoon/ET wetland system is reliable, simple to operate and maintain and delivers a superior performance. The system's major components such as a septic tank, aerated lagoon and/or lift station are simple elements that require limited skill to operate and maintain. Properly designed wetlands require little maintenance and are self-sustaining. Therefore, operators with even the lowest license certification will be able to operate the system. The maintenance necessary simply consists of periodic sludge removal from the septic tank, pump station and aerators maintenance and vegetation harvesting and disposal. It is not necessary to annually harvest the vegetation based on the experiences at those systems in use in western Colorado. The system generally does not require a full-time operator, which can be a big saving for the operating budget of a small wastewater system.

For environmental protection, the discharge requirements for both large and small wastewater systems are the same. As a consequence, a small wastewater system must provide the same level of treatment that is provided by large systems with sophisticated treatment processes and equipment. For most small wastewater systems, this is difficult to achieve due to limited financial resources. Since the lagoon/wetland system is a non-discharge system and all ponds are lined, there are few regulatory compliance requirements.

This system also has low energy requirements. Aerators in the lagoon and lift station (if required) are the major energy consumption components in the system. Consequently, these systems are less expensive to operate.

The system also has the capability to accommodate significant organic and flow loading variations. Small wastewater systems such as those for campground, park and highway rest areas typically have dramatic organic and flow variations from season to season due to the nature of usage at those facilities. Generally speaking, these facilities have a low usage in the winter and high usage in the summer mostly due to the climatic conditions. Consequently, the wastewater flow from these facilities mimics this usage. The flow variation for these facilities generally parallels the biological and evapotranspiration processes of the

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lagoon and wetland system since evapotranspiration rate and biological degradation rate are lower in the winter and higher in the summer. In addition, the lagoon/wetland system can easily accommodate organic and flow variations by mixing influent in the lagoon and providing significant storage in the wetland basins. Wetlands with cattails and rushes are able to tolerate water level and pollutant concentration fluctuations.

The lagoon/ET wetland system not only provides wastewater treatment but also offers environmental benefits such as providing a habitat for local wildlife and an aesthetic view for the public. The creation of a habitat where none existed is especially attractive for recreational-oriented facilities.

Applicability

The non-discharge lagoon/ET wetland system has the simplicity of operation and maintenance and requires little regulatory compliance work. The system is especially applicable for small wastewater systems in isolated remote locations in arid or semi-arid regions. It has been demonstrated to be very successful in several applications in western Colorado.

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