AUSTRALIA

Water Studies Centre

Constructed Wetlands for Wastewater Treatment

Thomas H. Davies, Senior Lecturer

Constructed wetlands have been used successfully for many years (since early 70's in Europe) to treat a variety of wastewaters.

Gross solids are usually removed before application to the beds to prevent clogging and odour problems.

The water flows horizontally subsurface in a high hydraulic conductivity medium, usually gravel, and the pollutants are broken down by bacteria in the root and rhizome zone of the aquatic plants (Fig. 1). Subsurface flow eliminates possible odour problems.

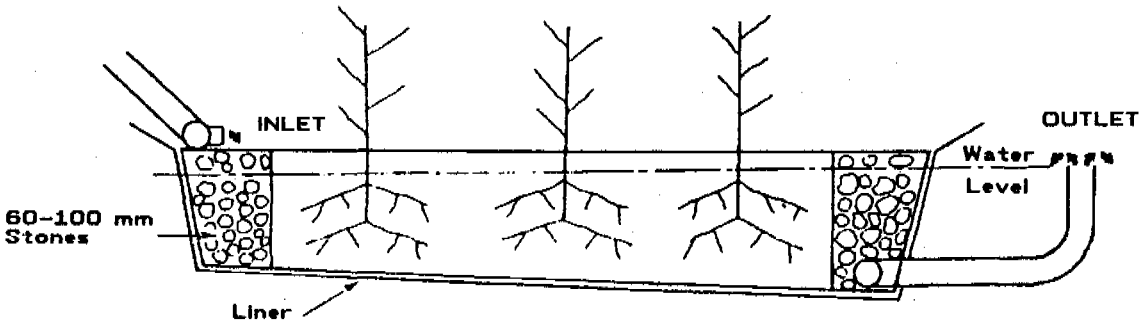

Figure 1

Caulfield and Frankston Campuses
PO BOX 197, CAULFIELD EAST, MELBOURNE, VICTORIA 3145, AUSTRALIA TELEX: AA154087 FAX (61) (3) 572 1298 TELEPHONE: (03) 573 2222 ISD: +61 3 573 2222

GENERAL CRITERIA

(a) Gross Solids Removal

- Primary Settling
- Septic Tank
- Screening
- Primary Lagoon

(b) Aquatic Plants

The main purpose of these is to move oxygen from the atmosphere into the root and rhizome zones for aerobic bacteria to proliferate there, with anaerobic bacteria away from these zones.

Phragmites australis and *Typha latifolia* are the most effective species but any plant which grows in wet conditions could be used.

(c) Retention Time

3-4 days is usually sufficient which relates to a sizing of 2-3 m^2 per person equivalent.

(d) Performance

BOD_5 > 90% removal
Suspended Solids > 90% removal
Nitrogen around 40% removal

The nitrification step (ammonia to nitrate) is rate limiting and controls the final removal by denitrification (nitrate to nitrogen gas).

Where nitrogen removal is critical it can be increased by aeration to speed up the nitrification step or by use of multiple beds with vertical flow on a fill and empty rotational basis.

Phosphorus removal is usually quite small but it can be easily removed by internal chemical dosing and using the bed as a clarifier to remove the insoluble phosphate produced.

APPLICATIONS FOR CONSTRUCTED WETLANDS

Gravel or similar high hydraulic conductivity bed media ensures that all of the wastewater being treated flows underground and so avoids any possible odour problem.

1. Municipal Sewage

Gross solids should be removed by primary settling, a short retention time septic tank or by a primary lagoon, before application to the beds.

Retention time of around 3-4 days in the relatively shallow bed (0.6 m approximately) gives a surface area requirement of 2-3 m^2 per person equivalent.

Excellent BOD_5 and suspended solids removal is obtained, but nutrient (nitrogen and phosphorus species) removal is limited and may need special attention if discharge specifications are tight.

Land availability is usually the limiting factor for size but towns of up to 5,000 persons in USA and Europe commonly use the wetland concept.

Usually the more vigorous growing and effective macrophytes *Phragmites australis* or *Typha latifolia* are used.

In special situations surface flow wetlands can be used for final polishing to reduce pollutants and nutrients to very low levels.

For example, Orlando, Florida, 500 ha wetland treating 80 ML/d of secondary effluent with a 30 day retention time. Byron Bay, NSW, has a similar application for tertiary effluent.

2. Small Communities

Isolated subdivisions, hotel-motels, holiday resorts, tourist sites, caravan parks, restaurants, schools and single households.

(a) Pretreatment

(i) Single large septic tank treats the total wastewaters before application to the wetland.

Reticulation is more expensive as greater pipe gradients must be used to get the raw sewage flowing to the septic tank.

(ii) Individual septic tanks for each house or section and effluents are collected in common for wetland treatment.

Reticulation is cheaper as transfer pipes for the septic effluent can be smaller and need only small gradients for satisfactory transfer.

(b) Plants.

Because of the partial treatment obtained in the septic tank, plants which are less effective but more decorative may be used instead of phragmites or typha, e.g. Canna or calla lilies, irises, ginger lilies, ferns or other plants which thrive in wet conditions could be very suitable.

(c) Effluent Disposal

(i) Year Round Ground Absorption

If the soil is suitably absorbent and the rainfall not extreme a 2 unit wetland can be used. The first unit is fully lined for treatment and discharges into a second unit which is partly lined, (bottom and first 20% of walls) for final treatment and disposal into the surrounding soil.

(ii) Insufficient Ground Absorption in Winter

Fully lined wetlands will produce an effluent which can be collected in winter in a pond and used for irrigation purposes in summer.

To minimise storage capacity of the pond the summer and autumn effluent could be diverted into a separate partly lined bed for disposal by soil absorption and transpiration when conditions are suitable.

3. Agricultural

Widespread use of constructed wetlands occurs in the USA mainly for pigs and cattle.

The concept is to use a primary lagoon for the raw effluent which will drop the BOD_5 by about 50% and to then run the lagoon effluent either continuously or periodically (when lagoon is becoming full) into constructed wetlands, often two in series.

Surface flow wetlands are used which are inexpensive to construct and if impervious clay is under the topsoil no liner would be necessary.

The final effluent is collected and re-used for irrigation or for washing and cleaning purposes.

Loading rates vary somewhat but the following criteria has been selected for an example using pigs as the species.

Bed size criteria $125m^2/kg$ BOD_5 per day
1000 pigs require 1 ha wetlands ($10m^2$/pig)
Pig excreta production 30 L/d per pig
Lagoon effluent 2700 mg/L BOD_5 (50% reduction in original load)
Surface water depth of 7.5 cm (corresponds to 25 days retention time)

If the daily volume of water is increased by the incorporation of wash waters the wetland surface water depth can be increased to give the same retention time.

4. Industrial Wastewaters

Wetlands have the capacity for bacterial breakdown for a wide range of organic pollutant materials including priority pollutants. Because bacteria are the means of breakdown of individual molecules there may be the necessity for a period of time to pass before optimum removal is obtained because of the need for bacteria to acclimate to the new substrate.

Heavy metals can be absorbed into the bed substrate and taken up by the plants but the use of the wetlands primarily for heavy metals removal purposes is not desirable as eventually the contaminated plant material must be removed and disposal may present serious problems.

Small portable wetlands (2 m x .5 m) can be developed in stainless steel tanks and these can be used to assess the treatability of wastewaters before large scale installation.

Landfill leachate is a problem area and successful applications of wetlands has been achieved at Lysterfield (Shire of Sherbrooke) and in U.S.A., with one outstanding application at Escambia County, Florida.

Fully lined 2 unit wetlands in series are probably the best approach, as a final effluent (rather than soil absorption) is desirable so that its quality can be monitored before disposal.

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For enquiries or information

Mr Tom Davies
Senior Lecturer
Water Studies Centre
Monash University
PO Box 197
Caulfield East, VIC. 3145 Australia
Telephone: 03 573 2168
Fax: 03 571 3646