Research Projects

Research Project information from CSIRO Land and Water

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Collection of drainage water samples during pumping from sumps at the bottom of FILTER plots - the oats crop is being cut for fodder

The FILTER System - turning effluent into an asset

The Australian community is increasingly unwilling to accept the dumping of sewage effluent into the sea, rivers, lakes or watercourses.

Land treatment of sewage effluent for irrigated cropping and forestry has been successfully used around the world, where the soil conditions are suitable. However, on soils with impeded drainage where the leaching fraction is inadequate, effluent irrigation can lead to waterlogging and salinisation. This could reduce crop yields and nutrient removal and hence the long-term sustainability of such sites. In woodlots, nutrient removal is low once the forest canopy closes over.

Sewage effluent managers in the larger urban centers have found that effluent treatment by land application for cropping and forestry is often less economical than other treatment techniques. This is mainly due to the cost of effluent storage during wet weather and winter periods, on high-value urban lands.A new technique known as FILTER (Filtration and Irrigated cropping for Land Treatment and Effluent Reuse) was developed by CSIRO Land and Water researchers to overcome these problems.

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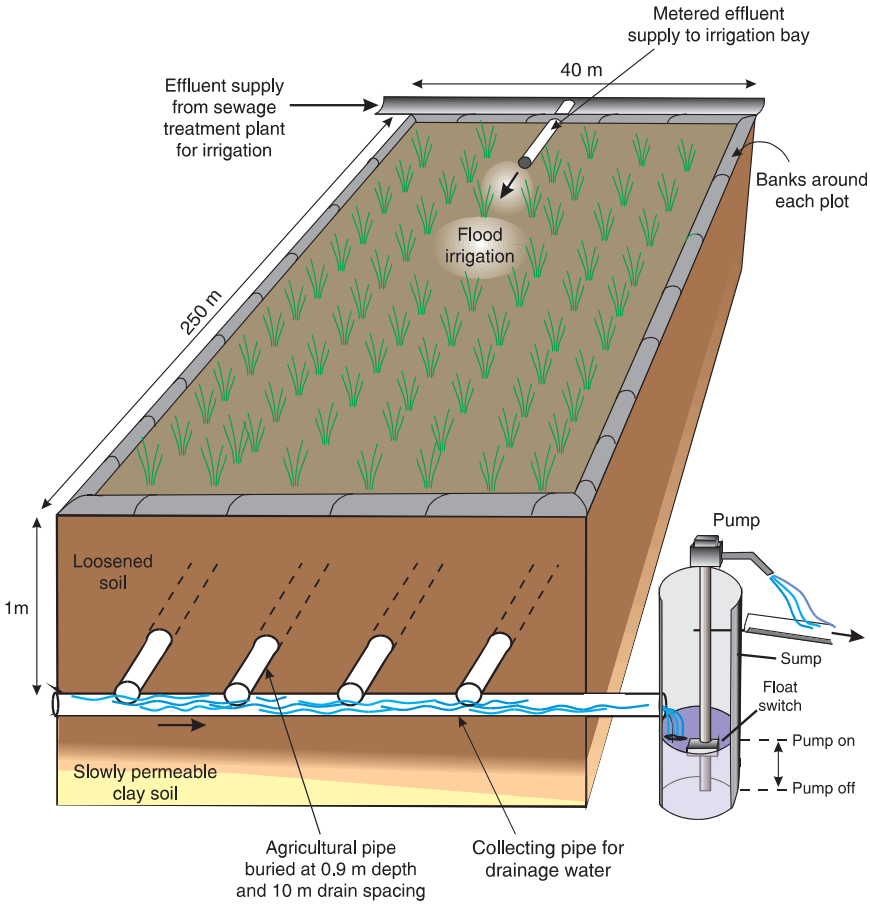
The FILTER system aims to provide a sustainable and economically viable land treatment system, on the limited areas of high-value land around urban centers.

The FILTER technique uses nutrient-rich effluent for intensive cropping, combined with filtration through the soil to an intensive sub-surface drainage system. It could therefore be used to treat effluent through the whole year, removing the need for costly wet weather storage. Effluent application and sub-surface drainage can be regulated to ensure adequate nutrient removal, thereby producing low nutrient drainage waters which meet EPA criteria for discharge to surface water bodies.

Field testing of FILTER system

The FILTER system was initially tested on eight one-hectare experimental plots. It was subsequently trialled in a pilot FILTER trial on four commercial-scale plots (each of these four hectares in area), for treatment of Griffith City Council secondary sewage effluent. FILTER plots were constructed by deep ripping to around 1.0m depth, and installing the sub-surface drainage system at this depth. The sewage effluent was applied as flood irrigation at the top end of the FILTER plots.

Over the life of the trials, FILTER has produced these outcomes:



Schematic diagram of FILTER plots

- Total phosphorus concentration was reduced from about 5 mg/L in the effluent applied, to less than the EPA discharge limit of 0.5 mg/L in the sub-surface drainage waters.
- Total phosphorus load was reduced by 96%.
- Total nitrogen concentration was reduced below 5 mg/L after removal of pre-FILTER soil nitrogen accumulations.
- Total nitrogen load was reduced by 55-85%.

Reduction in concentration and loads of pollutants in sewage effluent during flow through the pilot trial FILTER plots, to the subsurface drains

Pollutant	*Concentration (mg/L)*		*Load (kg/ha)*		
	Effluent	*Drainage*	*Effluent*	*Drainage*	*% Reduction*
Total P	6.1	0.4	46.7	1.7	96
Total N	19.2	15.0	131.4	55.8	58
Organic N	6.3	1.2	46.3	4.9	90
NH_4-N	12.5	0.2	82.4	0.7	99
BOD_5	10	0.9	80.1	3.9	95
SS	71	16.9	573.3	88.8	85
Chlorophyll a	0.07	0	0.01	0	100
Oil & Grease	1.8	0	15.9	0	100
E. coli counts*	9	0			

**E.coli* is expressed as colony forming unit (CFU) per 100 mL of effluent

- Due to preferential adsorption of phosphorus, the ratio of nitrogen to phosphorus in the drainage waters was increased, which could help blue-green algal control downstream.
- Marked reductions occurred in concentrations of suspended solids and algae. The drainage water could therefore be more effectively chlorinated for re-use.
- High nutrient removal through intensive cropping and the removal of excess water by sub-surface drainage indicates that a sustainable system is achievable, on relatively smaller land areas.
- The salt load is unchanged after equilibrium is reached. However salt concentration is always higher in the discharge water.
- Pasture and cereal yields obtained indicate that operating costs of commercial systems could be substantially offset.
- Adequate drainage flow rates were maintained throughout the trial period at hydraulic loading rates of 6-12 mm/day, even during periods of heavy rainfall.

Field results indicate that the FILTER technique meets its primary objective of reducing pollutant levels in drainage waters below EPA limits, while maintaining adequate flow rates, crop yields and nutrient removal to provide a potentially sustainable and cost-effective system.

Current CSIRO Land and Water research focuses on optimising the design and management of the FILTER technique to treat sewage effluents and other wastewaters. These studies will assist in maximising the benefits of applying the technique, in combination with existing or planned primary/secondary treatment systems.

Potential use of FILTER system for treating other wastewaters

Farms in irrigation areas face problems in managing their pesticide contaminated farm drainage runoff. FILTER has the potential to clean up pesticide contaminated farm run-off, before discharge to streams. Spiking trials demonstrated FILTER's efficacy in removal of all pesticides commonly used in the Murrumbidgee Irrigation Area, to below EPA discharge limits. The pesticide load reductions exceeding 98% were observed with chlorpyrifos, molinate, malathion, bensulfuron, diuron, bromacil, atrazine, metalochlor and endosulfan.

A modification of the FILTER systems - referred to as Sequential Biological Concentration (SBC) - could be used to manage saline drainage effluent from irrigation areas in a way that could be both economically and environmentally sustainable. This involves the use of a series of FILTER systems to sequentially concentrate the salt waters, combined with the use of progressively more salt-tolerant crops, to reduce the volume of saline water requiring disposal in evaporation ponds.

Modified FILTER systems may be used to treat industrial and commercial effluent containing toxic chemicals and heavy metals, which absorb on soil particles. To accelerate the breakdown of the toxic pollutants retained in the FILTER plots, these plots could be inoculated with genetically engineered or naturally selected microorganisms, which destroy the specific toxic chemicals.

The FILTER system may also be modified for use in feedlots, piggeries and dairies, as well as for treating other agro-industrial waste.

Potential benefits of FILTER to wastewater managers

Cost-effective

- eliminates expensive winter and wet weather effluent storage
- substantially reduces the land area requirements compared to traditional effluent irrigation.
- potential to produce high yielding cash crops
- operating costs are offset by returns to cropping
- low value saline, sodic or other degraded lands may be used and ameliorated
- resultant drainage water is more suitable for re-use.

Simple

- based on existing, low tech agricultural practices
- no harmful chemicals used.

Sustainable

- nutrient and salt balance is achievable under good management.

Manageable

- ability to cope with highly contaminated sewage treatment plant bypass flows
- eliminates runoff from the land application site
- high nutrient-buffer capacity of the soil FILTER system
- FILTER system land area can be progressively expanded to meet gradual increases in annual effluent volumes with urban growth.

CSIRO Land and Water researchers are currently working in close collaboration with the Griffith City Council to develop a commercial FILTER site for year-round treatment of all of the Council's secondary treated sewage discharges.

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Sewage effluent being applied at the top of the FILTER plots during summer cropping

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