Reuse of waste water in Aboriginal communities in Western Australia

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Abstract

Western Australia is a very arid area and freshwater is a precious resource. The wise and efficient use of this resource is essential for the establishment of communities in this region. Wastewater reuse in Aboriginal communities is a very recent development. Initially leach drains disposed of wastewater. Due to their failure most of the major communities now have the effluent from the septic tanks collected by a small diameter reticulated sewerage system and directed to oxidation ponds for treatment. The overflow from the oxidation ponds is allowed to flow over land or to a creek without any specific use. This paper discusses available reuse options as well as the options specific to Aboriginal communities in Western Australia. It is intended to demonstrate that in arid regions reuse wastewater can act as a water conservation and pollution control measure.

KEYWORDS

Aboriginal communities; Western Australia; wastewater; reuse

Introduction

Even though wastewater reuse has been practiced in an informal manner throughout history, formal strategic planning of reuse as part of the treatment and disposal of wastewater only emerged as an international trend during the early seventies (Odendaal, 1992). Many of the world's arid and water-short regions have developed specific water reuse policies. From among such countries, Israel might have devoted more effort than any other country (Shelef, 1991).

Western Australia is one of the driest States among the arid areas in the world. Fresh water is Western Australia's precious resource. The wise and efficient use of this resource is essential for the establishment of communities in this region. Wastewater reuse in Aboriginal communities is a very recent development. Initially wastewater from every house or community ablution facility was connected to a septic tank and leach drain system. But in many places, due to the large quantity of inflow, the leach drain failed due to the low infiltration capacity of the soil and created undesirable conditions of surface flooding of wastewater. Now in most of the major communities the wastewater from the houses is directed to a septic tank system and the effluent from the septic tank is collected by a reticulated sewerage system and directed to oxidation ponds for treatment. The overflow from the oxidation pond system is allowed to flow over land or to a creek without any specific designed use. This paper considers available reuse options and discusses specifically reuse options applicable to Aboriginal communities in Western Australia.

Reasons for wastewater reuse

There are many reasons for promoting the implementation of wastewater reuse. But the discussion here will consider only factors valid to an Aboriginal Community in an arid region.

Supplementation of freshwater supplies where shortages are being experienced or expected in the future.

The demand for water in many cases may exceed the existing designed delivery of the water supply.

Wastewater is a perennial supply right at the doorstep as a reliable source both in quality and quantity even during drought.

Reuse in a community situation can make use of nutrients which otherwise would have been wasted, or can polute ground or surface water.

Wastewater from a treatment pond system is currently left to flow onto land or a creek unattended and is therefore a potential health hazard as the wastewater is available for children to play in and animals to drink. Such problems can be avoided by a designed reuse.

If direct reuse can be achieved, it reduces the load on a treatment system. This means cost and maintenance support for the treatment system can be decreased.

If reuse is by recharging a ground water aquifer it will help the water source to be more dependable

General options for wastewater reuse

Not all the available reuse options will be applicable to Aboriginal communities in an arid region. It is technically possible to produce water of any desired quality from domestic wastewater but what is economically feasible is what matters from a practical proposition. So only such options which are now or in the future can be considered as practical are shown below.

Agricultural Irrigation - Agriculture is not generally practiced in Aboriginal communities, but there are communities that show interest in growing vegetables. Twenty Aboriginal settlements in central Australia have individual or community permaculture gardens (Wade, 1991). In the future as a community settles in one place for a longer time, the possibility of agriculture of some form is likely to develop.

Aquaculture - Edwards (1992) reviewed the application of wastewater for fish culture in ponds. Examples of fish ponds with wastewater in China, India, Indonesia, Israel and Europe are described in the review. There have been no attempts for fish aquaculture using wastewater in Australia. Yabbie farming has been tried in an Aboriginal community in South Australia. As evaporation is very high an open pond will not be easy to maintain. So aquaculture may not be suitable for arid region.

Industrial Use - In most Aboriginal communities there is currently no activity other than community maintenance. But in the future activities such as roadworks, dust suppression, mudbrick making, general washing of paved area, composting or similar activities can take place. All of these activities can use reclaimed water.

Lawns and Playgrounds - The water requirement for lawns around the house, in public places and playgrounds is very high. Such demands in a community can be even more than all other water demands put together. Even if all the available wastewater is used for these purposes, it is unlikely that the quantity will meet the demand. If a lawn is not supportable by rainfall and needs supplementation by irrigation, it is likely that requirements for irrigation will not be met by the wastewater produced in any of the present communities.

Tree Planting - Revegetation of the communities has become one of the most pressing needs. Reclaimed wastewater can be used for establishing plants in communities. The plants need to be watered for one or two years. So every year a certain number of trees can be planted using the available reclaimed water. Trees have advantages over lawns as they withstand long term variation in the climate better, they can act as windbreaks and can be harvested in a long term sustainable manner for timber, artefact, fruits and other purposes.

Fire Fighting - Fire fighting facility has become an essential infrastructure as the communities have buildings and structures that have to be protected. Treated wastewater can be used as a source of water for this purpose.

Toilet Flushing - Toilet flushing is one of the major uses of water which does not demand high quality water. If reclaimed wastewater is used for toilet flushing it needs a dual supply reticulation. This needs proper community education.

Groundwater Recharge - Generally groundwater recharge is used: (a) to provide barriers for salt water intrusion to a freshwater aquifer especially in coastal areas, (b) to provide further treatment to the wastewater, (c) to

provide storage for wastewater without evaporation loss.

Guidelines for reuse of wastewater

The National Health and Medical Research Council (NH&MRC) and the Australian Water Resources Council (AWRC) developed guidelines for wastewater reuse in 1979 which was updated in 1987. The guidelines have not been developed for regulatory purposes and the values given should not be considered as standards (NHMRC and AWRC 1987).

Generally untreated wastewater should not be used other than for controlled irrigation as part of the treatment process. Primary treated wastewater has limited use such as for irrigation of lots in fenced areas with no public access. Secondary treated wastewater is recommended for wider irrigation use with further purification by ponding and disinfection. The treated reclaimed water should have a faecal coliform count of not exceeding a geometric mean value of 1000 coliforms per 100 ml calculated at each sampling event from five samples collected per month and no more than 20% should exceed 4000 coliforms per 100 ml (ANZECC, 1992). Secondary effluent from domestic wastewater with disinfection can achieve the required standard in all aspects as stipulated in ANZECC (1992) guidelines. The wastewater reuse should have good housekeeping and practices to avoid any associated health problems.

Constraints associated with Reuse Systems

The reuse of wastewater may have to overcome problems depending on the purpose of the reuse. Some of the problems associated with wastewater irrigation are discussed here. It is important to consider the substances in the wastewater which may be harmful. Soap and liquid detergents will not cause any problem for the plants, but most common laundry powders contain sodium salts as bulking agents, which can interfere with soil characteristics. It is advisable to have brands of laundry detergents with potassium rather than sodium salts (EWSD 1987).

A more serious problem comes from boron (borates) in some detergents and powder cleaning materials. Boron toxicity in plants produces stunted growth and scorched leaves but these symptoms would be difficult to distinguish where the climate is harsh enough to cause similar effects. The effect will be serious in soil where significant level of boron already exists. It is important in such situations to select laundry detergents, which do not contain boron.

Dissolved salts in wastewater can accumulate in soil, which causes an increase in soil salinity due to evaporation of wastewater over a long time. Providing sufficient drainage for the salts during rainfall can solve the problems involved with any water soluble salts.

The following are found as main constraints for wastewater irrigation (Azou *et al*., 1992). (1) Health hazards related to pathogens, heavy metals and organic pollutants present in water; (2) Bad odour incidents during effluent storage in open reservoirs; (3)Cross connection with potable water networks; (4) Public acceptance to use of reclaimed wastewater; (5) Agronomic suitability of effluents for different crops; (6) Fluctuation in water quality; (7) Long term effects on crops; (8) Long term effects on soil; (9) Long term effects on groundwater.

This paper takes into consideration all the above factors in suggesting recommendations for reuse of wastewater in Aboriginal Community.

Wastewater reuse in Western Australia

Reuse of wastewater has been attempted in many locations in Western Australia. In Perth a pilot-plant study was conducted for recharge of groundwater using treated wastewater (Mathew *et al*., 1982). In Perth about 25% of private houses dispose off their wastewater through septic tank soil absorption systems. This is a source of artificial recharge to shallow aquifers. The remaining 75% of houses dispose of the wastewater through treatment plants and most of the treated wastewater is presently discharged into the sea by ocean outfalls.

In many country towns treated wastewater is used to irrigate sports fields, public parks and open spaces (Chapman 1993). In all cases regular testing of the wastewater is conducted and reported to the Health

Department. The quality of water should satisfy the NH & MRC guidelines for irrigation with wastewater.

Existing Wastewater system

Typically an existing community has a very dependable water supply system. The water consumption by a community can vary quite considerably (Nelson, 1993). The reasons for such variations have not been fully studied. Construction of houses, the movement of population, variation of hot days in a year, community meetings and losses by leaks are all possible reasons. For the purpose of calculation it is assumed the water consumption is 0.5 m^3/day/person. This is on the high end of the range. New houses have toilets inside the house and the wastewater is directed to a septic tank. Overflow from septic tanks is pumped into a series of oxidation ponds.

From the water supplied to the community 40% is assumed to be used for cooking, drinking and other uses and losses which will not end up in the sewer system. There is generally no lawn or irrigation in communities. From the average consumption of 0.5 m^3/day/person, 0.3 m^3 may find its way to the pond system.

Factors to be considered for wastewater reuse system

Wastewater reuse is a new concept for Aboriginal communities. Considering the present system, available quantity of wastewater, climatic condition and soil characteristics it is important to consider the factors which may influence the reuse of wastewater. The following factors are suggested for consideration.

(1) Community Approval: The community has to identify, evaluate and approve projects suitable for the community.

(2) Guidelines for wastewater reuse: The guidelines for wastewater reuse specify that the type of reuse allowed depends on the quality of wastewater. So treatment procedures may need to be improved to satisfy the quality of water required.

(3) Meteriological conditions of the locality: Meteriological conditions influence the reuse practice. The rainfall pattern and evaporation rate are important factors for design of an irrigation system of a sports oval, for example.

(4) Soil characteristics and vegetation of the locality: The drainage characteristics, salinity of soil and presence of chemicals such as boron are important in the design of irrigation systems. The existing vegetation and the vegetation the locality can support also influence the quantity of water required for irrigation.

(5) Available establishments which require use of water: The reuse options are dependent on establishments either existing or planned for the near future. This includes revegetation program, groundwater recharge and other activities such as brick making.

(6) Economic and financial aspects should also be considered as determinant factors for wastewater reuse.

Waste water reuse options

Not all the options cited earlier in the paper are suitable or acceptable in Aboriginal communities. After considering the guidelines for wastewater reuse, constraints associated with reuse and factors to be considered for selection of systems, the options are shown below.

Football oval irrigation - Facilities for sports can help the community in its total developments and can promote a socially healthy environment. The factors which need to be considered when using wastewater from oxidation pond for the spray irrigation are (1) The algae in the water can clog the nozzles and the irrigation system needs regular maintenance; (2) The reclaimed water has to be chlorinated to be used for spray irrigation; (3) The boron in wastewater if accumulates can cause boron toxicity to the lawn so there should be facilities for drainage to allow leaching of boron at least on the occasions of heavy rains.

Revegetation of the community - The requirement of water depends on the species and the method of irrigation.

If irrigated to the root zone by drip irrigation, there will be minimum loss. No further treatment of the wastewater is necessary for irrigation when the water does not come in contact with people The planting area can be decided by the community consultation and taking into account the desire for wind breaks.

Fruit and Nut Trees - A fenced area can be provided for growing fruit and nut trees irrigated by reclaimed water. If spray irrigation is not adopted, fruits and nuts which are peeled for eating, can be grown without further treatment of the water. Drip irrigation will be an acceptable method for fruit and nut trees. This system will need more maintenance and special care, and once started irrigation should be available on a long term basis.

Community uses - If the reclaimed water is available in a storage tank or in a recharged aquifer it can be used for community gardens, aquaculture, flushing toilets, fire fighting, dust suppression and similar uses. It is possible to establish a permaculture garden, mudbrick making facility or composting operation. Many of these at present either do not happen or use the drinking water supply.

New houses - New houses have the option to be connected to the reticulated wastewater disposal collection system or to an on-site system. On-site systems permit the complete use of water avoiding infiltration and evaporation at the oxidation ponds. But the use will be limited to the household such as lawn, vegetable garden, and irrigation for trees and bushes.

Proposed facilities for reuse

At present the final effluent is designed to be disposed on the land and hence for collection, storage and treatment some facilities are needed. This also depends on the type of reuse approved and promoted by the community. The following proposal is presented for consideration.

(1) The final effluent will have coliform organisms in excess of the guideline for reuse (1000 organism/ 100ml). So there should be facilities to chlorinate the water if the reuse involves any spray irrigation or the use involves any human contact with the water. Sub-surface irrigation is therefore preferred.

(2) The effluent will have algae as it comes from the oxidation pond. Chlorination will kill most of the algae, but the water has to be stored in a closed container, which does not allow sunlight promoting any algal growth. According to guidelines there should not be any visible algae in the water. Moreover algae will clog the reticulation, spray, drip or other irrigation system.

(3) The storage tank should be preferably at an elevation and convenient location depending on the type of use. So a pumping facility will also be necessary.

(4) As the oxidation pond system loses water by infiltration and evaporation, on-site reuse systems (e.g. Biocycle) may be advantageous to make water available for lawn and garden.

(5) For transport of water from the storage tank to the place of use either connection by pipe or truck with water tank may have to be provided.

(6) Final effluent can also be stored underground by recharging the groundwater aquifer. There will not be any evaporation loss or algae problem and the effluent gets purified by infiltration through the soil, although contamination of the aquifer should be monitored.

(7) An enclosed area for growing vegetables will be of great value to the community. This needs fencing of the area and preparing the soil.

CONCLUSIONS AND RECOMMENDATIONS

Wastewater in the community after passing through septic tanks is collected by a reticulated system, treated by oxidation ponds and disposed of on the land without planned reuse. Only less than a fourth of the drinking water supply is estimated to reach the final discharge point after most of it has been subjected to infiltration and evaporation. The available effluent water is a valuable resource to be used after chlorination and storage or ground water recharge.

Planting native trees for revegetation and other plants for different uses are considered best option for the reuse

of water. For future houses on-site treatment systems can assure complete reuse of wastewater. A water truck will be useful for transporting water for a variety of uses including dust suppression, industrial use and irrigation.

After considering the special situations such as low rainfall, high evaporation, considerably low portion of water supplied reaching the final effluent discharge point, quality of the effluent and community aspirations, the following recommendations are put forward for consideration.

(a) The quantity of water available for reuse is too small for the complete watering of a football oval and spray irrigation is subject to health regulations as indicated in guidelines for water reuse.

(b) Spray irrigation involves very high evaporation loss (20% in normal situation and can be higher in the climatic conditions in Warralong) other forms of irrigation are preferred.

(c) Revegetation of community by planting native trees which need water only for a few initial years is one of the preferred options for wastewater reuse. About 1000 trees can be planted every year in a community of 200 people.

(d) Planting of fruit and nut trees or community vegetable garden are good options but such attempt should only be proceeded with proper community initiative and support.

(e) New houses to be constructed in future can be connected to the present system, but if the reuse is to be on the backyard of the house for growing trees either fruit trees or native trees it is possible to use an evapotranspiration system. This avoids the need for any pumping and allows all the water available for the plants and trees.

(f) If vegetable garden, permaculture garden or lawn around the house is of interest to people, onsite treatment system such as Biocycle can be adopted. Biocycle is an on-site treatment plant which produces chlorinated wastewater for the above purposes.

(h) A water truck to use reclaimed water for dust-suppression, watering plants and lawns and any other industrial use such as construction of house, roads etc could also be considered.

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