AUSTRALIA'S MOST SUCCESSFUL ALTERNATIVE TO SEWERAGE: SOUTH AUSTRALIA'S SEPTIC TANK EFFLUENT DISPOSAL SCHEMES

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EXECUTIVE SUMMARY

In general, South Australian country towns have not been provided with conventional sewerage schemes. Since 1962, lower capital and operating cost septic tank effluent disposal (STED) schemes have been constructed.

STED schemes were first developed to overcome public health and amenity problems associated with failing or inadequate septic tank soakage trenches. "Temporary" drains were laid to convey septic tank effluent to a central treatment facility (typically an oxidation lagoon), with the expectation that a "permanent" sewerage scheme would replace them. However, as it became evident that these schemes offered an affordable alternative to sewerage, they have been retained and developed for the majority of towns in SA.

In most cases, simple oxidation lagoons provided secondary treatment. More recently, reuse schemes have been developed, often in conjunction with small scale extended aeration plants. There are over 110,000 people in SA now served by STED schemes, with the largest town being Mt Barker with a connected population of 10,000.

This paper describes briefly the development of STED schemes over the last 36 years by the Department of Public Health (now Department of Human Services), the Engineering and Water Supply Department (now SA Water Corporation) and current administration under the Local Government Association. It includes details about financing of schemes, design criteria for drainage and treatment systems, operation, maintenance, desludging of septic tanks and effluent reuse.

A comparison of sewerage and STED capital and operating costs is made indicating significant comparative advantage of STED schemes for wastewater collection from existing townships. Principal construction savings are achieved through the simplification of the collection network including reduced pipe sizes and grades and the use of flushing points instead of manholes. These simplifications have been proved through satisfactory performance in the schemes constructed.

Data obtained in a comparison of construction costs (for networks and treatment) for sewerage schemes in country towns in SA and STED schemes indicate the mean construction cost for EWS country sewerage was $13,800 per connection (updated to 1998 values) compared to $4,300 per connection for STEDS. More recent schemes have risen to over $5,000 per connection due to effluent reuse. Operation and maintenance costs for STED schemes (including the cost of septic tank desludging) were found to be equal to or lower than sewerage schemes serving equivalent communities. Treatment and disposal of septic tank sludges for potential reuse are described.

The paper also discusses design developments which have improved operation, and describes recent development of high rate algal ponds which use a simple paddle wheel mixer and baffles to improve performance and reduce lagoon size.

In summary, the development and use of septic tank effluent disposal schemes in South Australia has resulted in widespread acceptance and use of a practical and affordable alternative to sewerage. The considerable knowledge of design, construction, finance and operation of STED schemes in South Australia would be appropriate for improving public health and amenity in urban residential areas of developing countries which are already served by septic tanks.

KEY WORDS

Sewerage, septic tank, effluent, settled sewage, STEDS, oxidation lagoon, reuse, high rate algal ponds.

HISTORICAL DEVELOPMENT

Administration

In response to the rapidly growing need for STED schemes, the Department of Public Health developed a comprehensive Drainage Section, providing support to Local Government in regulation, design, contract administration and operation. A Drainage Coordination Committee was established with representatives of the Health Department, Engineering and Water Supply Department (EWS - now SA Water Corporation), Local Government and Treasury. All designs were submitted to EWS for approval, Government subsidy was made available and a priority list was established for townships based on an assessment of the seriousness of drainage problems.

Neither SA Water nor the Department of Human Services are now directly involved in administration of subsidies which is carried out by the Local Government Association, with all design, supervision and construction being carried out by private consultants and contractors.

Design Criteria

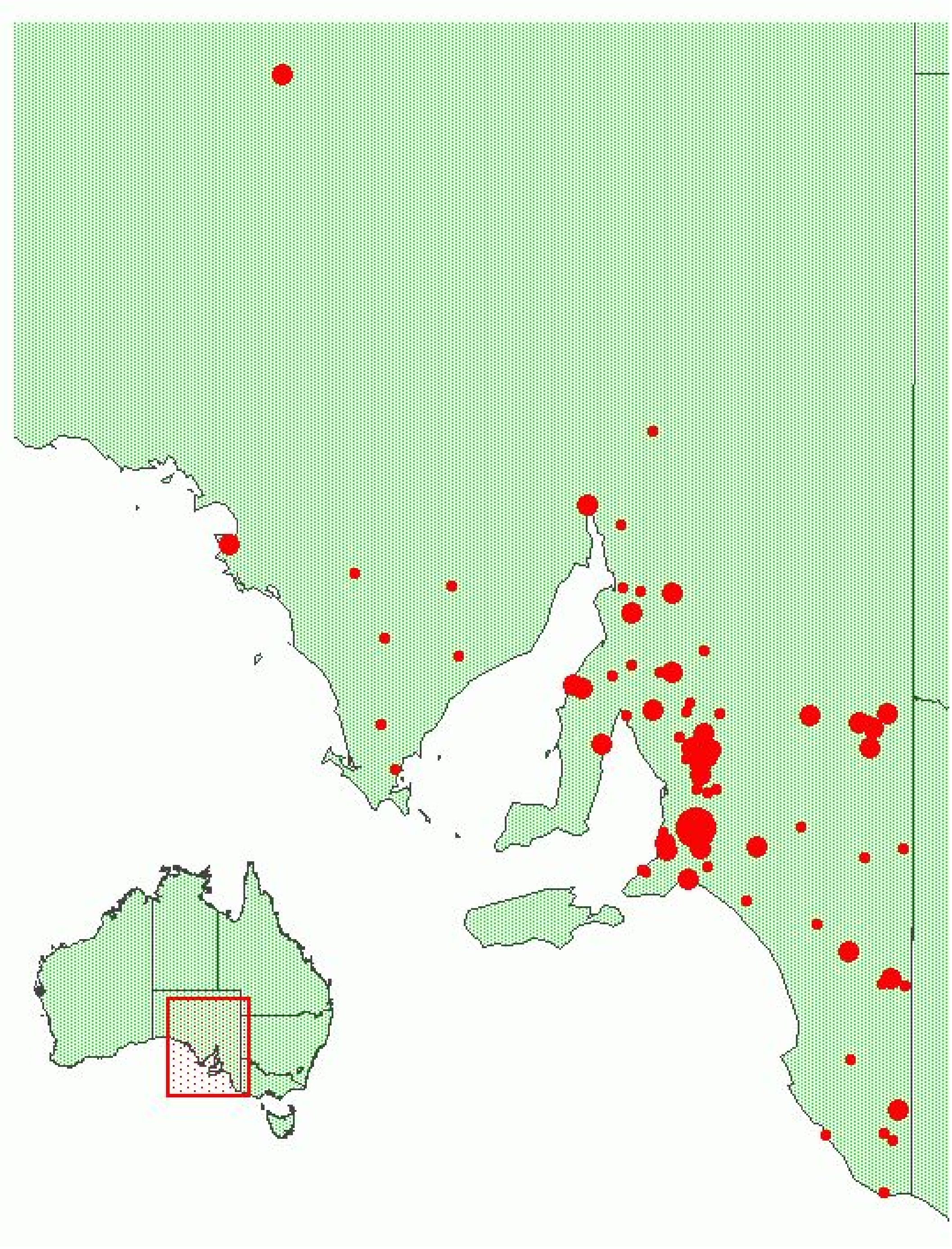
Design criteria were originally developed by EWS with Health Department approval. Dry weather flow was 140 L/c/d. Design criteria for drains included a minimum pipe size of 100 mm and grade 0.4%. For comparison, the minimum for sewerage was 150 mm dia and grade 0.7% (earthenware) and 0.5% (PVC) reflecting the advantage of removing gross solids in the septic tanks. Drainage system development has seen the elimination of manholes with flushing points now provided for network access.

Oxidation lagoons were almost universally adopted for treatment, with design criteria basically consisting of 60 days’ detention in two or three lagoons of water depth 1.2 m. In water catchment areas, 90 days’ detention was required to maximise bacteria reduction. More recent schemes have tended to use intermittently decanted extended aeration plants with sand filtration and disinfection, with effluent used for irrigation of reserves and golf courses. Current oxidation lagoon design criteria provide for a five compartment lagoon with a 30 day detention primary compartment for BOD reduction followed by four 7.5 day compartments in series for pathogen reduction.

Extent of Schemes

The total number of schemes currently in operation in SA is more than 100 with a further 30 on the waiting list. A map showing STED schemes in SA is shown in Figure 1. Figure 2 shows the growth of population connected to STED Schemes since their inception in 1962.

Figure 1. Location of STED Schemes in South Australia

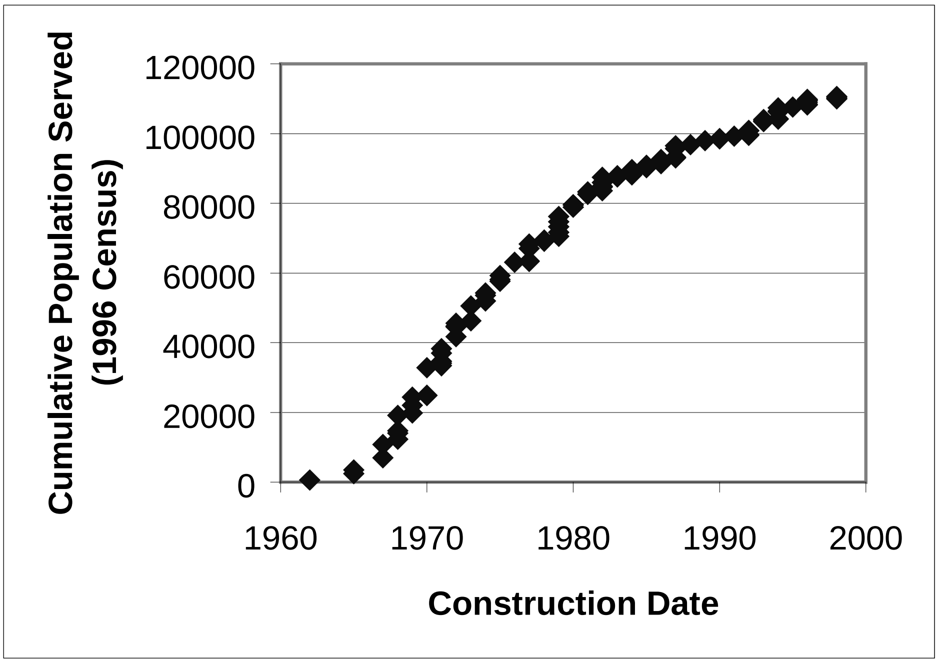


REGULATION AND FINANCE

Regulation

Administration of STED Schemes was transferred from EWS in 1994 to the Local Government Association, operating under amended provisions of the Local Government Act. An allocation of $3 million is now made annually by the SA Government for subsidy. Drainage design criteria form part of the Waste Control Regulations under the Public and Environmental Health Act 1987.

Figure 2 Growth of Population Connected to STED Schemes in South Australia



These regulations also control house drainage, septic tank and effluent soakage installations and on site wastewater treatment systems. Design and construction of all new schemes is carried out by private consulting engineering and construction firms to standard specifications with approval of subsidised schemes by the Local Government Association. Once constructed, schemes are owned and operated by Councils.

Finance

The State Government has provided financial assistance for Councils to construct STED Schemes. Assistance is dependent on the estimated cost of construction and operation and rate revenue from serviced premises and allotments. The principle of the subsidy is to ensure that rates charged are equivalent to SA Water’s sewerage charges, and this determines the size of the capital grant.

Subsidy is only available for initial construction of collection, treatment and re-use systems. Operation and Maintenance, upgrading of the reticulation systems, major asset rehabilitation and upgrading of treatment plants (for effluent reuse) must be financed by Councils.

COMPARISON WITH CONVENTIONAL SEWERAGE

Design Criteria

There are several major differences between the two systems beyond the retention or installation of septic tanks. These indicated in Table 1.

Principal construction savings are achieved through the simplification of the collection network including reduced pipe sizes and grades and the use of flushing points instead of manholes. These simplifications have been proved through satisfactory performance in the schemes constructed. The lower design ADWF has been confirmed through monitoring of existing schemes.

Table 1 Comparison of Conventional Sewerage and STEDS Design Criteria

Criteria	**Conventional Sewerage**	**STEDS**
House Connection	Direct	Via Septic Tank
Gross Solids	Enter network	Excluded from network
Average Dry Weather Flow (ADWF)	250 L/c/d	140 L/c/d
Network Access	Manholes	Flushing Points
Minimum Pipe Size	150 mm	100 mm
Minimum Grade	0.5 %	0.4 %
Other	No septic tank maintenance required	Hybrid systems including: • pumped connections • rear of allotment drains • separate sullage and septic systems

Construction Costs

Data obtained in a comparison of construction costs (for networks and treatment) for sewerage schemes in country towns in SA and STED schemes (Norman, 1986) have been updated with recent STEDS construction costs and are represented in Figure 3. The mean construction cost for country sewerage schemes operated by EWS was $13,800 per connection (updated to 1998 values) compared to $4,300 per connection for STEDS. STEDS constructed since 1990 have also included additional treatment to allow irrigation with reclaimed effluent.

Operation and Maintenance Costs

The operation and maintenance costs found in the original study in 1986 indicated that the cost of administration, operation and maintenance of networks and treatment for STEDS schemes was about a third of that for sewerage, due principally to the comparatively low cost of oxidation lagoon treatment. It should be noted that STED costs in this study did not include septic tank desludging.

The operation and maintenance costs for selected conventional sewerage and STEDS (including pumping but excluding treatment) in the Adelaide Hills for 1997/98 are shown in Figure 4. Septic tank desludging costs are separately identified. It can be seen the overall costs for STEDS O&M including desludging are comparable to the conventional sewerage costs. However, sludge treatment and disposal is normally a treatment plant cost rather than a network cost and the overall STED network and lagoon treatment costs (including septic tank desludging) are considered to represent a significant cost advantage over conventional sewerage with secondary treatment.

EFFLUENT REUSE

Effluent reuse has become more widespread with increasing consciousness of the need for water conservation. In 1996, a survey into effluent reuse in Council operated STED schemes carried out by the EPA indicated that over 60% of the total flow of effluent was reused. Recent guidelines have been developed to encourage reuse but at the same time ensure protection of public health and sustainable application to land (EPA, 1998).

Additional treatment specifically for reuse in SA has included the following:

- detention (broad acre irrigation)
- chlorination (recreational and landscape areas)
- filtration and UV disinfection (recreational and landscape areas)

- coagulation, flotation and microfiltration (horticulture)

Figure 3. Comparison of Construction Costs for Sewerage and STEDS

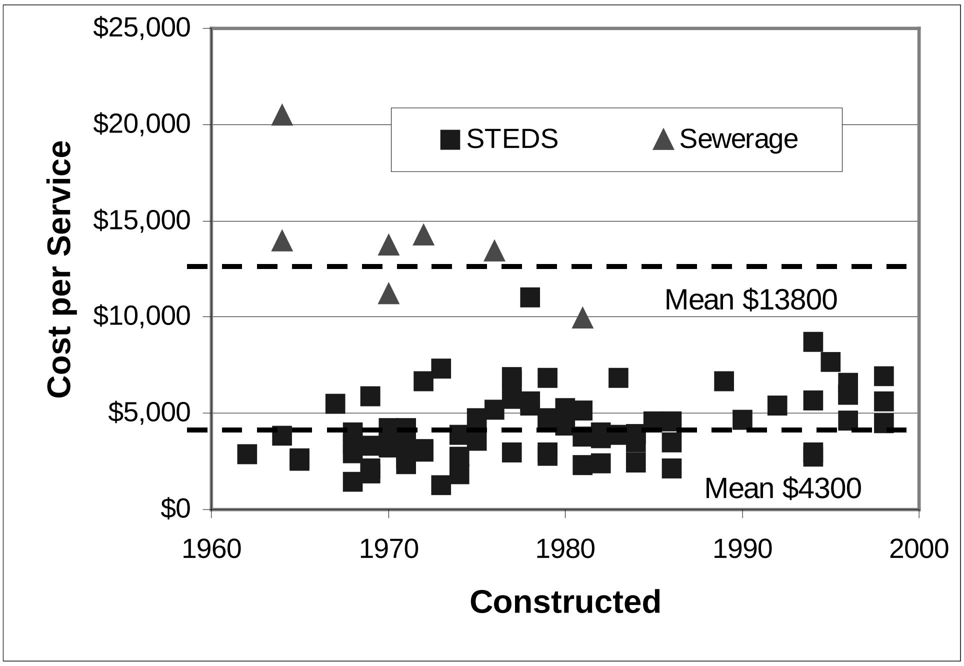
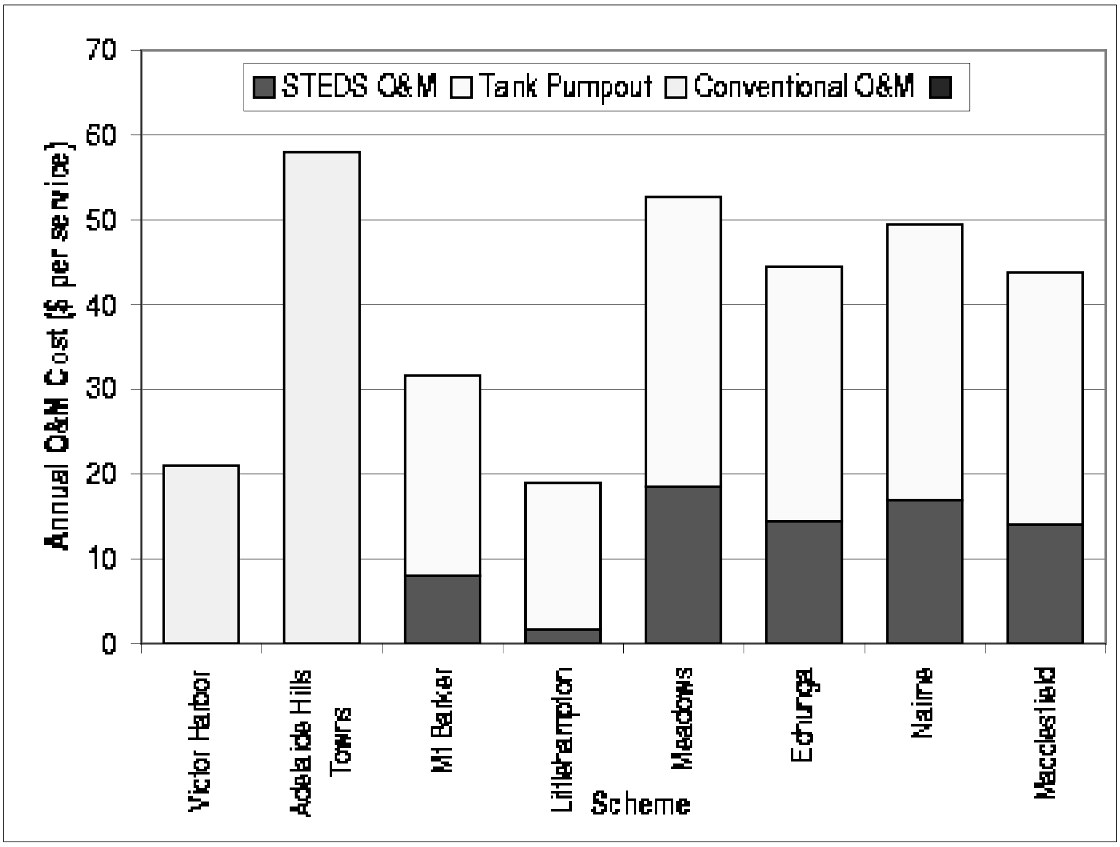


Figure 4 Comparison of Network O&M Costs for Sewerage and STEDS



SLUDGE MANAGEMENT

For many years after the inception of STED schemes, desludging of septic tanks was carried out by householders at their cost. Since 1980 the SA Health Commission has reviewed design and operation of septic tanks, resulting in a four yearly desludging cycle being recommended. This has led many councils to impose compulsory cyclic desludging which has improved performance of householders' internal systems and also the STEDS networks. Desludging is usually carried out by contractors with vacuum tank equipment, with disposal guided by the SA Biosolids Guidelines Part B. Examples of beneficial use include rehabilitation of the Brukunga pyrites mine in the Adelaide Hills and spreading on pasture. The Guidelines permit unrestricted reuse of dried sludge from domestic septic tanks provided it is stockpiled for three years for pathogen reduction.

TRADE WASTE CONTROLS

Trade Waste Controls are currently being prepared by the Department of Human Services and are focussed on preserving the quality of effluent for reuse. STEDS by definition provides pretreatment at source, allowing easy segregation of industrial sludges from domestic sludges and optimising potential for reuse.

POTENTIAL FOR USE OF STEDS IN DEVELOPING COUNTRIES

One of the authors has served as Engineer in Charge of the sewerage system of a major city in the Pacific. The city was served in its original colonial development by a sewerage scheme to serve the central business district. The city grew with no requirement for sewerage of developing areas until the late 1960s when all new subdivisions were required to be sewered. A backlog of unsewered residential areas therefore surrounds the CBD. The city has a good water supply system and installation of septic tanks was generally undertaken in unsewered areas with the City Council maintaining an effective fleet of vehicles with vacuum desludging equipment. However, septic tanks commonly overflow to open drains. Provision of significant funding to sewer backlog areas has been sought regularly from aid sources without success.

It appeared to the author that STED technology, maximising use of local labour and resources (plastic pipes were made locally) with a long construction period, could have provided an affordable solution to the public health and amenity problems associated with overflow of septic tank effluent to open drains. Such an approach would improve living conditions and public health for a broad range of socio-economic groups which appears to be consistent with recent approaches, for example, to the provision of Australian aid.

In a more general context, the use of smaller catchment based STED schemes to maximise gravity flow of wastewater could lead to significant benefits. Pumping of sewage in developing countries with warm climates is always a problem because energy costs are high, pumps and switchboards are difficult and expensive to maintain, spare parts must be imported and sulphide corrosion is common.

For low cost treatment, high rate algal ponds containing baffles and a paddlewheel mixer have been found to improve hydraulic performance and maximise algal oxygen production (Fallowfield and Garrett, 1996). Equivalent organic and pathogen reduction in conventional oxidation ponds with 25 days detention have been achieved in high rate algal ponds with detention time as low as 4.4 days (Fallowfield et al, 1996). Significant nitrogen and phosphorus reduction has also been observed (Cromar et al, 1996).

The use of STEDS and lagoons represents more affordable public health protection than full sewerage and reclaimed non potable water could be made available during shortages such as those experienced in 1997 in the Philippines from El Nino climatic variations.

A number of courses have been run in South Australia recently with participants from Asian developing nations. Public health issues arising from operation of small scale systems has been high on the agenda of students, confirming the opportunity to propose STEDS for consideration as an appropriate drainage network technology.

CONCLUSION

Almost all towns in South Australia have been provided with STED schemes. They have served the state well and will continue to do so into the next century. Experience in the regulation, design, financing, construction and operation of STED Schemes has enabled most South Australian country towns to be served with a drainage system which would not have been affordable using conventional sewerage. This wealth of experience and knowledge leads to potential for the technology to be applied to urban residential areas in developing countries where septic tanks are already in use. Recent developments in high rate algal ponds suggest the STED technology also could be successfully adapted to improve public health in less densely populated areas.

ACKNOWLEDGEMENTS

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REFERENCES

Cromar, NJ, HJ Fallowfield and NJ Martin (1996): *Influence of Environmental Parameters on Biomass Production and Nutrient Removal in a High Rate Algal Pond Operated by Continuous Culture.* Water Science and Technology 34, 133-140

Environment Protection Agency (SA) (1997): *South Australian Biosolids Guidelines*

Environment Protection Agency (SA) (1998): *Draft South Australian Reclaimed Water Guidelines*

Fallowfield, HJ; NJ Cromar and LM Evison (1996): *Coliform Die-off Rate Constants in a High Rate Algal Pond and the Effect of Operational and Environmental Variables.* Water Science and Technology 34, 133-140

Fallowfield, HJ and MK Garrett (1996): *Treatment of Wastes by Algal Culture* in Microbial Aspects of Water Management (Eds CR White and SM Passmore) Society of Applied Bacteriology, Symposium Series No 14, Journal of Applied Bacteriology, 59, (suppl) 187s-250s

Norman, PA (1986): Appropriate Technology Developments - Wastewater. *Second Interstate Forum on Water and Wastewater in Country Towns,* Perth

Public and Environmental Health Act (1987) (SA) Waste Control Regulations