ON-SITE SYSTEMS ACTUAL EXPERIENCE vs GUIDELINES

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Abstract

Anecdotal experience has shown on-site disposal of basic septic systems have been very successful in many locations on small sites where some popular guidelines tend to suggest this is not possible. Conversely, anecdotal experience suggests where compliance with such guidelines has been met failures still occur, particularly in absorption.

This paper examines the earliest history of disposal systems in England and more recently Australia, touching on large systems as well as on-site to help demonstrate the "first principles" involved.

The writer recently visited New Zealand where he observed varying site conditions and their comparison to each other causing problems of logic in standardisation. The same issue is examined for Australia.

A section on the politics and motives addresses some of the emerging regulations. This section explains why on-site disposal systems are becoming increasingly difficult to get approved and suggests new ways of using old knowledge.

There is a view of the legal aspects of performances and likely legal outcomes and how they differ from what one might expect. A short comparison with other standards is used to demonstrate how on-site disposal matters are symptomatic of a "cover your backside" approach now sweeping many consulting fields.

The paper is a general guide to help attendees grasp the essence of what disposal methods should do for us or how to avoid "losing the plot"!

Keywords
actual performance, anomalies, guidelines, Law, politics

1 History of Disposal Systems

History of living organisms began in the earliest Precambrian times of approximately three billion years ago when the first plants began to form on the earth and photosynthesized carbon dioxide and water to make cellulose and other carbohydrates. These compounds were the substance of their very being, as shown by the essential net equation

$$12\ CO_2 + 11\ H_2O \longrightarrow C_{12}\ H_{22}\ O_{11} + 12\ O_2. \qquad \text{Equation 1}$$

A little while later in history, bacteria then animals found it convenient to reverse the process to provide themselves with a chemical energy

$$C_{12}\ H_{22}\ O_{11} + 12\ O_2 \longrightarrow 12\ CO_2 + 11\ H_2O. \qquad \text{Equation 2}$$

Plants and animals continued to evolve happily running in and out of these two equations for billions of years until one of the animals evolved as *Homo sapien*. These *homo sapiens*, whilst in tribal or nomadic form continued without much concern. However, in due course, humans began to develop agriculture and civilization and this tended to cause concentrations of discarded material still consisting typically of the composition of $C_{12}\ H_{22}\ O_{11}$ with modifications containing lesser or trace elements of sulphur, phosphorus, calcium, magnesium and in protein form, substantial quantities of nitrogen. With these concentrations of people came the need for sewage treatment systems.

What we must understand if we are ever going to get it right is *THAT ALL SEWAGE TREATMENT SYSTEMS FROM SQUATTING BEHIND A TREE TO THE MOST ELABORATE AND EXPENSIVE PLANT, ARE STILL BASICALLY MANAGEMENT OF THE TYPICAL DECOMPOSITION PROCESS*

$C_{12}H_{22}O_{11} + 12\,O_2 \longrightarrow 12\,CO_2 + 11\,H_2O.$ Equation 3

In most cases where on-site sewage disposal is required there is a fairly large area of land available and provided sufficient trees are available to squat behind, nature would simply take care of the sewage disposal without human interference.

Humans however, being the interfering animal that they are developed disposal systems commensurate with their circumstances or environment. Up until the last one hundred years or so most sewage disposal systems simply involved emptying the chamber pot out of the window and allowing storm water to take it away. In England and France, where French was largely spoken, the emptying of the chamber pot was accompanied by the cry "*guardez l'eau*" which in English means – watch out for the water. The more astute will notice the resemblance between *l'eau* and the frequently used "loo" word of today!!

Having dutifully emptied the chamber pot out the window, civilised people left its contents to decompose where it fell or was picked up by rainfall and run off to be washed into such water courses as may seem fit.

After a while, a simpler system of dropping directly into rivers and water courses was developed and in these pre-embarrassment days it is believed males and females performed their bodily functions in the same room side by side and thought little of it.

Time went on and sewers were developed using Mr Crapper's flush toilets which are still used today. These sewers mostly ran to water courses where nature initially adequately decomposed the sewage, but as time went on the need for sewerage treatment plants became more obvious.

In the earlier years of this century, the three eastern capitals, Melbourne, Sydney and Brisbane each adopted different approaches. Sydney basically dropped all its sewage raw into the Pacific Ocean and that practice continued until well after World War 2. Melbourne recycled by reusing its effluent at the Werribee farm halfway between Melbourne and Geelong. Brisbane discharged close to raw sewage and gradually worked on improving the quality and extending the reticulation area well into the 1970's. Most of Brisbane was essentially on septic tanks with evapotranspiration through bananas and canna lillies until the late 1960's.

The far Eastern suburbs of Melbourne, developed through the 1950's, were not sewered until the 1970's. Just about every house had a septic tank and the effluent could not soak away due to impervious ground and thus ended up in the Yarra River. Strangely there were little, if any, health problems. Suds used to cause frothing in rapids spots such as Templestowe but fish were still caught in the same water.

In the late 1970's and early 1980's, higher and higher standards of sewage treatment became the norm. Typical sewage plants were asked to provide 20/30 effluents, being 20 parts per million biochemical oxygen demand (BOD) and 30 parts per million suspended solids (TSS). No other performance specifications were considered necessary.

In the second half of the 1960's, Marlin Perkins and various other environmental lobbyists began to emerge. Later they became highly successful protest industries and it is largely due to the activities of such organizations that we have excessively stringent regulations today.

2 Politics and Legals

During the 1990's, each profession such as medicine, law, and engineering developed a system of practicing certificates, which in order to keep intact, one has to maintain the required number of Brownie points through "continuing professional development".

As part of continuing professional development one has to attend a certain number of conferences or seminars, like this one. One gets extra Brownie points for presenting papers and that explains why the writer is here.

In an average year professionals now spend somewhere between 5 and 15 days attending conferences, seminars and conferences including ones like this, as well as foundations, footings & slabs, termite protection and appropriate signing for roadwork construction, both during construction and after the event. One sentence is common to every seminar – "*IF YOU DO THIS YOU SHOULD BE RIGHT WHEN YOU HAVE TO GO TO COURT*".

The prevailing assumption is that for anyone actually doing anything sooner or later, someone, else will claim that it has not been done properly, and as a result that someone else has suffered losses and wishes to be compensated for those losses. There are many bogus claims paid.

The fortunate (or unfortunate) experience of being an expert on many cases lets one see how the legal industry operates. In most cases, the monetary value at official issue is far, far below the costs of all the legal argument, including expert reports. Those who have been involved in courtrooms will have probably also observed barristers argue at length over the admissibility of a single sentence as evidence.

Those professionals who are in local government or in private practice should be aware of a rapidly escalating proportion of total turnover being consumed by insurance costs. The legal industry exists essentially to remove these premiums from the hands of the insurers and distribute it among the law firms, among others. Unfortunately, even our judiciary seem to regard insurance funds as a great source of "money without an owner", existing purely for the raiding thereof.

It is the author's observation that as a direct result of the legal industry indulging itself that most seminars now spend half or more of their discussion time on how the attendees of that seminar can best defend themselves in court. This tendency has resulted in the removal of ingenuity (the very word from which engineering has its origins) from engineering practice and replacing it with a desire to seek a precise prescriptive solution laid down in a set of rules which every practitioner can be seen to have followed in every engineering decision.

Because of the legal system's ability to tap these funds, regardless of the facts, nobody, doing anything whatsoever, following any set of rules whatever, is safe. You may well believe "surely if I follow the rules I will be all right when it comes to court". The simple fact is, that as rules become more and more complicated it becomes easier and easier for one of your contemporaries to criticise your work. Rest assured, if you have enough money or insurance cover someone somewhere will attempt to find something wrong with something you have done and separate you from that money or insurance cover. This is as certain as night follows day, so long as you live and practise long enough.

When this person or persons attempts to take this money from you they will search around for an "expert" who will be prepared to say, in front of the court, that you did something improperly because of X, Y or Z and they will most likely find them. The "hire a liar" syndrome appears to dominate legal expert matters.

At the end of the day it will not matter what the true facts and circumstances of a case are, all that will count is what money can be redistributed.

BEAR IN MIND AT ALL TIMES THE STANDARD OF PROOF IN CIVIL MATTERS IS A BALANCE OF PROBABILITY. THE STANDARD OF PROOF IN CRIMINAL MATTERS IS FAR, FAR HIGHER, BEING "BEYOND REASONABLE DOUBT". BECAUSE OF THE NATURAL CYCLING BETWEEN DECOMPOSITION AND PHOTOSYNTHESIS, TOGETHER WITH RUN OFF SEEPAGE, IT NATURALLY FOLLOWS THAT AT ALL TIMES, SOME WATER CONTAINING SOME ORGANIC MATTER, HOWEVER SMALL, WILL BE REACHING EVERY WATERCOURSE AT ALL TIMES.

THE JUDICIARY WILL FIND AGAINST THE DEFENDANT IN A SEWAGE DISPOSAL CASE, NO MATTER WHAT YOU HAVE DONE.

With regard to politics, those who are familiar with Local Government Planning & Assessment Act and who keep up with the amendments should have observed that in NSW the NSW Environmental Law is amended by an A5 wad approximately a centimetre thick every month, on average, and this is further complicated by a proliferation of case law in environmental matters.

Recently an Australian mining company, interviewed on a popular TV business program, explained that it takes between 5 and 10 years to convert an ore discovery to a mine purely because of environmental legal procedures.

As explained back in the history section, cellulose, proteins and other organics naturally decompose back to carbon dioxide and water plus a few other less relevant compounds and trace elements. It really doesn't matter much how we, with a relatively thinly spread population, treat our sewage. The biggest problem, in fact, is that we must be seen as being regulated so that people in the city can believe that their elected politicians are looking after their environment by making sure we bad people performing our natural bodily functions are seen to be made to pay.

It comes as little surprise that anecdotal observations of performances of successful systems seem to be quite out of step with guidelines being provided.

3 Wallis Lakes – What You May Not Know…

For centuries people have been eating oysters from the tidal part of NSW coastal estuaries. It was considered to be of very low risk, but some risk if oysters were taken straight from the rocks and eaten. However, about 20 years ago a process called depuration was introduced and in this process the oysters are fed by water being recycled through a sterilizing ultra-violet light. Over a few days this sterilized water allegedly purified the oysters and it seems that it did because illness from professionally prepared oysters is very rare. It was however, subsequently discovered that if the turbidity of the water increased slightly, the effectiveness of ultra-violet sterilization in the water was greatly diminished.

Following Wallis Lakes, oyster farmers have had to modify their depuration plants to provide for settling out of solids that might obstruct ultra-violet sterilisation. It follows that there is a universal recognition that all estuarine waters carry contamination.

4 Roofing of Reservoirs

Water engineers discovered, some years ago, that water purified to potable standards for human consumption often became contaminated later before reaching the tap. The main source of this contamination was bird life, although in one case the overseer at Maclean caught some small boys swimming in the reservoir. The method of dealing with this problem has been to roof and bird-proof the reservoirs. That is, keep the contamination out by keeping the wildlife out.

By now it should be obvious that no matter what you do, the environmentalists, politicians and the judiciary will still insist you accept the blame for what their friends the wild animals do!

5 Anomalies in Treatment Experiences

Engineers and plumbers have, for many years, managed with a great deal of success sewage treatment, including on-site sewage treatment. In former times, the politicians were of assistance in obtaining funds for the engineers and plumbers to construct appropriate plants. In more recent times, unfortunately, the soil scientists, green extremists and lawyers have bought into the matter and in on-site sewage treatment the practical people are losing out to these other groups.

It has been well known for many years that whilst engineers are "applied" scientists, in their task of applying physics, chemistry, biology, etc. they have many disagreements with other scientists. Engineers tend to see other scientists in the traditional view of the "absent minded professor" who is so pre-occupied with his science that he forgets to put his pants on, whilst the scientists tend to view the engineer as being obstructive by insisting that what is done must actually work.

Thirty-four years ago, the writer had to deal with Federal Government animal health virology scientists and a few problems came up –

a. The virologists insisted that the viruses were so dangerous that they had to be destroyed by boiling every part of the animal at super-heated temperatures in an auto-clav at each dissection unit.

b. They then insisted that all the animal parts had such great nutrient value that they could not be wasted.

c. They further insisted that the animal parts had to be then stored in a giant festering septic tank from which solids, liquids and all dissolved substances would be sprayed over the hillside where they could be recycled as fertiliser for other animals to graze on the thus fertilized paddocks, all within the boundaries of the suburbs of greater Melbourne.

During the process the scientists gave eight different arrangements for the dissection theatres ranging in formation from a circle to ducks flying in a "V" to a league scrum to a union scrum or whatever, every one of which proceeded to final tender plans before being altered. Just before the writer left the job he was reprimanded for failing to notice and incorporate arrangement No. 9. He is now very glad that he did leave the job before the neighbours' complaints came in. From a practical engineer's position, pungent organic acid odours and hydrogen sulphide odours were inevitable, "but he who will not listen cannot be told".

For many, many years there were no real rules for on-site disposal of sewage. Local authorities merely dealt with the matter as they saw fit. It is considered opinion that that was a far better arrangement than we have now. In one shire conditions vary widely and the Council's treatment methods vary widely. In the coastal towns where there are deep Aeolian sands septic tanks with relatively short runs of absorption trenches have been very successful.

In the town of Iluka, on the north coast of NSW, there are very deep Aeolian sands. While the normal tank and trenches system works very well, there does remain concerns for groundwater contamination. It seems, however, that contamination in groundwater varies widely from practically no contamination at all to the lower end of serious. Iluka is dunal in nature and where absorption trenches are on a higher part of the dune effluents can run through an effectively aerated medium of Aeolian sand whereas trenches in the hollows between dunes can be at a level so close to the water table that no aeration can take place. It logically follows that variations in ground water quality will occur due simply to the relative levels (heights) of the nearest absorption trenches and the immediately preceding precipitation history.

Australian Standard AS1547 and the NSW Guidelines (DLG 1998) make attempts to address such matters, but the author's view is that their efforts to too prescriptive and as a result they lose the plot.

Brooms Head is similar to Iluka on paper but an impervious lower layer totally alters performance.

In yet another part of the same shire there is very clayey ground at the surface. For many, many years a system of pumping out of soil water and storage and garden sprinkling of the greywater had been long implemented with a great deal of success.

In a fourth area, percolation testing has been found to give reasonable results, even with testing over a week and in the same area some time later, following recent heavy rains no percolation test result could be obtained. A switch to textural classifications, whilst supposed to help, did very little. The

simple practicality is that surface run off needs to be directed away from the disposal field in such areas.

At an earlier "on-site disposal workshop" several allegedly typical soils were presented for teaching textural classification. The Tertiary Volcanic Krasnozems were represented by a single sample.

Krasnozems, whilst making reasonable disposal fields, vary between five minutes and two hours for falling head method percolation tests. Some Councils know what is what, others simply follow the NSW Guidelines. It is the author's experience that the textural classification for all Krasnozems would be similar.

The opinion salt in effluent caused disastrous results has been expressed. Around saltwater pools, splashes have wide ranging effects on different plants. Salt is not bad for all plants and bananas are known to do well on effluent.

The writer notes with some interest and excitement the comments of Beavers, Tully & Woolley (On-Site 99 Abstracts) "that inadequate or proper maintenance is identified as the main contributor to poor performance".

Poor performance includes–

1. *Illness ensuing from the plant not working correctly*. This particular aspect of poor performance seems to be all but non-existent. Furthermore, it seemed non-existent in the 1950's where overflowing absorption trenches were the norm in Eastern Melbourne.

2. *Unpleasant odours coming from areas of disposal*. This particular failure does occur, but mainly with absorption trenches that are subjected to excessive precipitation and run off and/or lack of appropriate vegetation or permeable soil to enable effluents to continue their necessary journey away from the site.

3. The third item of poor performance is an *excess of water*, i.e. hydraulic loading, to the extent that it becomes a nuisance by creating boggy ground or other inconvenience.

4. *Indicators of poor performance* becoming more popularly relevant are phosphorus content, nitrogen content, our old favourites BOD and solids and more recently coliforms and bacterial counts.

It is the author's considered opinion that, except where on-site systems are close together, only excessive odour or hydraulic loading are relevant. With respect to phosphorus and nitrogen in particular our fellow living beings, the plants, are so skilled at dealing with these two matters that we really should just leave it up to them.

Research into the different performances of plants is surprisingly primitive for the late twentieth century. Plants listed in the NSW Guidelines and other publications as suitable, are not performing very well at all. The most classic example of inappropriateness is a recommendation for use of *Melaleuca quinquenervia*. The *Melaleuca quinquenervia* is a paper bark that, whilst being an Australian native, grows in plague proportions in Australia and overseas on wet ground without removing much of the moisture on which it grows. It seems that the plants recommended for disposal fields should be the ones that remove the water. The plants most successful for this – bananas, large exotic pines like Radiata, cypresses, grevilleas, eucalypts, kikiyu grass, seteria grass and a few others.

The plant selectors have "lost the plot", obviously focussing on what plants grow in boggy areas, rather than focusing on the real issue of what plants actually evapotranspire the most water. Crop factors that were clearly 2 and above occur in areas that were not planted specifically to achieve evapotranspiration. The NSW Guidelines seem to have missed the point and recommend crop factors well below 1.

In trying to obtain crop factors more in keeping with experience, there are major anomalies. The CSIRO experimental results are largely based on young trees and mono-culture, and do not appear to relate to mature trees with an unclosed canopy that still allows grass beneath. The next anomaly is the application of the crop factor itself. The crop factor is based on an assumption that evaporation from plants is directly proportional to pan evaporation from a standard pan in a standard set of circumstances. Fortunately for those who live in the real world, but unfortunately for those who want to rely on crop factors, the creator and the plants did not read any such rule.

Observations have shown that plants will defend themselves against excessive evaporation. Similarly, some plants, particularly bananas, will transpire more moisture if it is around their roots in quantities greater than they may need for normal growth. So much for crop factor theory for now!

With water balance calculations, the ratio of run off to infiltration is important. The same ratio comes up in storm water drainage calculations. The assumption that there is such a ratio is actually more for convenience than technical accuracy. When ground is fully saturated, effectively 100% runs off, but this only occurs on clayey type material when humidity is very high.

A Council is quoting 80% run off for drainage calculations and 70% infiltration for effluent disposal. This mutual contradiction escapes them.

The greatest recent error by the soil scientists in the NSW Guidelines is tables showing minor, moderate and major limitations for various factors. Most of these factors, like pH are simply adjusted by adding lime to soils. It has also been the practice, although somewhat infrequently, to add lime to systems as part of normal running.

In New Zealand, the writer recently observed the maximum of extremes. Impervious clays derived from the thermal areas on one hand and the deep stony glacial deposits on the other. The New Zealanders sensibly advocate large primary digesters, but the rest of the NSW Guidelines will have little relevance to most of their situations.

Twenty years ago, the Maclean Shire Engineer and the writer designed the Townsend Village treatment plant which is simply a large lagoon. This plant cost very little to construct and works very well. Now under new management, more money than was spent building the treatment plant has been spent on consultants to report on it.

6 Summary

There is no precise method of deciding the best sewage disposal by off site theory. It is the author's opinion that it will be far better, if and when responsibility is returned to local government and Standards Australia and the NSW Guidelines (DLG, 1998), are shredded.

The Author

The writer is a Fellow of the Institution of Engineers Australia with 40 years experience of living with on-site disposal systems as well as 35 years in design and visual or practical evaluation of systems and consequences.

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