AS/NZS STANDARDS APPROACH TO ON-SITE WASTEWATER DESIGN AND MAINTENANCE

Ian Gunn
Department of Civil and Resource Engineering, The University of Auckland, New Zealand

Abstract

The joint Australia and New Zealand Standard, AS/NZS 1547:2000, presents a new approach to on-site domestic wastewater management. This avoids the prescriptive emphasis of the past, and focuses on performance requirements related to implementation of design and maintenance processes. Designers have a special role in ensuring that these processes result in sound implementation of site investigation, system selection and sizing, installation and commissioning, and ongoing operation and maintenance of on-site systems. The objective of such design and maintenance processes is to achieve sustainable wastewater servicing for unsewered development.

Keywords

Design, management, on-site wastewater, operation and maintenance, septic tank systems

1 Introduction

The publication of the new joint Australia and New Zealand Standard, AS/NZS 1547:2000 "On-site Domestic Wastewater Management" (Standards Australia, Standards New Zealand, 2000) provides the opportunity to move away from the old prescriptive standards and codes of the past, and enter a new era in which a performance approach to unsewered wastewater servicing ensures soundly designed and maintained technical solutions are implemented to the benefit of both the environment and the community. However, successful implementation of such servicing will be less dependant on the available technical solutions, and more dependant on those persons undertaking the design, installation, ongoing maintenance, and long-term management of on-site systems. In this regard, significant responsibility rests with the designer as the key person in ensuring the integrity of this process. The designer's role extends through the initial scoping of the on-site option, ensuring appropriate and adequate site investigation is undertaken, carrying out the design, and ensuring that the resulting system is installed in accordance with the design and then operated and maintained throughout its design life. That design life will essentially be the life of the facility being serviced, which may well be indefinite. In other words, the objective of the installed system is to provide a sustainable wastewater servicing solution. Design is a key element of that sustainability, but ongoing operation and maintenance attention is essential to achieving that objective. Past practices have not delivered such sustainability. The new standard is intended to provide the basis for such an outcome.

2 Evolution of the New Standard

When in 1994 a combined group of Australian and New Zealand specialists were assigned the task of drawing up a replacement for the newly issued AS 1547-1994 "Disposal Systems for Effluent from Domestic Premises" and making the resulting document relevant to both countries, it began by examining the design rules for sizing effluent soakage systems in current practice. Australian, New Zealand and North American practice was assessed, and this turned up very significant differences in design loading rates for equivalent household wastewater flows into equivalent soil types.

It became clear from the wide variation in design loading rates that the agencies responsible for them have probably developed the present numbers through an evolutionary process based on a response to historical field performance problems. This has resulted in a shift from less conservative to more conservative design criteria with the objective of increasing the factor of safety in design so as to allow for:

- poor soil assessment practices
- flawed design loading rate choices
- inadequate supervision of construction
- short cuts in installation practices, and
- negligible operation and maintenance attention.

Taking trench soakage systems as an example, the relationship between selected design loading rate (mm/d) and its application over either trench bottom area alone, trench bottom area plus sidewall area, or trench sidewall area alone, results in wide variations in size of installed system. This is illustrated in Table 1, which draws on a range of loading rates from current practice and applies them to a 3 bedroom dwelling with 5 persons producing 900 litres/day septic tank effluent which is disposed into a 450 mm wide trench system with 225 mm sidewall depth (for design purposes). The soil categories used are not the same as those in the AS/NZS 1547:2000, but relate to NZ designations for soils.

Table 1. Trench Total Length for NZ Category 3 and 5 Soils for Disposal of 900 litres per day (3 bedroom household)

AGENCY AND/OR TECHNICAL GUIDELINE		LENGTH OF 450 BY 450 MM TRENCH	
		Category 3 (NZ) Soil (Medium fine and loamy sand; good drainage)	**Category 5 (NZ) Soil** (Sandy clay-loam, clay-loam and silty clay-loam; moderate to slow drainage)
1.	AS 1547:1994 (bottom plus sidewall)	40 m	67 m
2.	NZS 4610:1982 (bottom plus sidewall)	51 m	77 m
3.	US-EPA:1980 (bottom area)	61 m	111 m
4.	State of Maine:1984 (bottom area)	100 m	167 m
5.	TP 58 (Auckland Regional Council:1994) (bottom area; most conservative value)	100 m	200 m
6.	Metcalf and Eddy:1991 (sidewall area)	125 m	167 m
7.	South Australia:1988 (bottom area)	133 m	133 m
8.	Larimer County, CO:1984 (bottom area)	143 m	285 m

The wide variations shown in Table 1 throw into question the whole basis upon which design criteria are selected. The approach to loading rate determination appears to be very much "ad hoc", rather than based upon technical merit or certainty. There is clearly no scientifically or technically based approach that has universal acceptance in achieving a design outcome. This presented a significant challenge to the Committee in developing a joint standard applicable to two separate countries with widely varying regulatory structures and design practices. The Committee decided that there was no universally agreed technical basis for sizing soil soakage systems that it could claim would be superior to all the design codes and rules already in use. A new approach was required. It therefore set about developing a standard based on guiding the process of implementation of on-site systems to achieve sustainable performance.

3 Performance Requirements

3.1 Background

The Committee agreed that the approach to revising AS 1547 had to centre around the "performance" of the implementation processes that achieve on-site wastewater servicing, and the "performance" of those persons who have responsibility for carrying out those implementation processes. The approach needed to be flexible enough to provide for different administrative structures in both countries, and to take into account variations in design, regulatory approval procedures, geographic and topographic characteristics, and land development pressures and methodologies. Given that much of on-site wastewater design practice has been more an "art" than a "science", sufficient factors of safety are required to ensure that performance objectives are met. The standard must thus set up a framework to ensure that:

- a quality implementation process is set in place, and
- levels and lines of responsibility for implementation are clearly defined.

Therefore, the performance context of the standard focuses on the quality of design, installation and operational procedures, and on the exercise of responsibility by the persons involved.

3.2 Performance Requirements for the Management of On-Site Wastewater Systems

The performance objectives in AS/NZS 1547 centre around:

- protection of public health,
- maintenance and enhancement of the quality of the environment, and
- maintaining and enhancing community amenity.

A principal performance requirement is that the site investigation and design procedures should evaluate both public health and environmental effects of a proposed on-site wastewater servicing solution , and compare this with the option of full sewerage servicing so that the best practicable option in achieving public health and environmental quality is adopted. In enhancing community amenity, the focus is on ensuring that on-site systems provide sustainable long-term performance, and that where wastewater products are reclaimed for resource utilisation, public health considerations take priority over resource re-use objectives. The installation is not to "detract from nor lower property and neighbourhood community values", thus requiring ongoing operation and maintenance attention that ensures all public health, environmental quality, and amenity objectives are sustained. Clearly the design process must cement in place this continuum of implementation processes leading to sustainability.

3.3 Performance of Wastewater Systems

The overall performance requirements for wastewater systems including both the pre-treatment units (such as septic tanks or aerated wastewater treatment systems, AWTS) and the associated land application systems (such as soakage trenches, evapo-transpiration absorption/seepage beds, or drip irrigation fields) relate to their ability to handle design loads, retain their construction integrity, and perform adequately under routine ("normal") maintenance procedures for their serviceable life. The matter of "serviceable life" has raised many queries from regulators and designers.

For New Zealand the standard states that serviceable life should be a minimum of 15 years, that is for both the pre-treatment unit and the land application area. However, the design objective of achieving sustainable on-site wastewater servicing means that design coupled with ongoing maintenance should result in a substantial lifespan for any system, and at least for the life of the dwelling.

The standard covers "serviceable life" in the Australian context by stating that "the anticipated life of any elements of a wastewater system that have a serviceable life of less than 15 years, shall be nominated". To some extent this is a more flexible approach than the NZ approach, but none-the-less has still resulted in queries by regulators in Australia as to how they should assess design life. It is the intention of the standard to provide a management system that ensures much longer practical life than 15 years, and designers should be under no illusion that what they are required to set in place is an installed system that can be maintained for an indefinite service life.

3.4 Effluent Quality Performance Criteria

Many commentators on the development of the new AS/NZS 1457 said that if the standard is to talk about performance requirements, the performance criteria against which these requirements are to be assessed should set out specific effluent quality characteristics to be met by both pre-treatment units and land application systems. There is no problem in setting effluent quality performance criteria for AWTS pre-treatment units, as these can be tested against a set input quality range under controlled conditions in which the inherent buffer capacity of the treatment operation can maintain steady state effluent quality. The testing protocols for AWTS are set out in the new standard for these systems.

There is no way that septic tanks can be subjected to appropriate testing protocols which replicate typical households and be expected to comply with set effluent criteria. The highly variable inputs from the variety of household sizes, water using activities, and waste production and character, when coupled with the rates at which scum and sludge accumulate and interact within the dynamic hydraulic environment within a septic tank, all conspire to make predictable effluent quality unachievable. As the period of use also significantly affects performance (with setting volume decreasing over time), the best the standard has been able to come up with is to set minimum recommended sizes based on settling volume and sludge and scum accumulation volumes matched against pumpout maintenance frequencies.

4 Implementation Roles

The Part 3 management section of the standard sets out the requirements for a range of factors, features and procedures needed, in addition to basic public health and environmental requirements, to achieve appropriate administration and regulation of on-site system implementation. These deal with matters encompassing environmental effects evaluation, information management systems, monitoring of both special designs and operation and maintenance features, certification procedures for construction and installation, reporting and reports, and need for advice and education for all participants in the implementation process.

These participants are listed in the standard, with an explanation of the responsibilities of each participatory group. These groups are regulatory authorities, planners/surveyors/land developers, site evaluators/soil assessors, designers, installers/contractors, equipment manufacturers and suppliers, desludging/pumpout contractors, homeowners, and estate agents and property transfer lawyers.

Operation and maintenance matters are covered by a detailed prescription for procedures, guidelines and monitoring requirements, including the need for regular maintenance inspections certified in an appropriate manner. An associated Appendix 3A outlines items to be included within a set of generic operation and maintenance guidelines. Significantly, the whole Part 3 covering "management of on-site domestic wastewater systems" is labelled "informative" in the standard. An "informative" part of the standard is there for information and guidance only, and for those agencies which adopt the standard in whole or in part, the "informative" parts or appendices place no mandatory requirements on those within the agencies' jurisdiction. The NZ Ministry of Health intends to recommend to local authorities that Part 3 be adopted as "normative".

5 Design Process

5.1 Designer's Role

The designer has the key implementation role within the standard, and thus is the person on whom the highest expectation rests in meeting the performance requirements for achieving sustainable on-site servicing. Essentially "the buck stops here" with the designer, who is made responsible for every aspect of the implementation process, and for ensuring that the framework for on-going operation and maintenance is robust and well established. Key elements of the designer's responsibilities include:

- preparation of the design report (incorporating the site and soil evaluation report);
- provision of installation instructions, and subsequent liaison with the installer;
- ensuring inspection and certification of construction and installation;
- completing a commissioning report;
- preparing final as-built details; and,
- compiling operation and maintenance (O&M) guidelines specific to the design.

One of the problems with the old prescriptive approach was that designers tended to go direct to design sizing tables in a standard to lift out the loading rates applicable to the land application system selected, and ignore the qualifying notes regarding use of the design tables. Hence, systems were implemented to fit the prejudices of the designer, unmodified by the collective wisdom of the group which produced the standard, and as set out in their explanatory text and notes.

Designers should be very cautious about persisting in this approach to design in respect of AS/NZS 1547:2000. They should read and absorb the entire document. Regulators will have done this, and if a design is shown to play only lip service to the new approach set out in the standard, the designers will have their designs rejected at the consent stage. Any attempt to go straight to the design appendices in the Part 4 "means of compliance" will become their undoing under the sharp scrutiny of a regulator familiar with the whole standard.

5.2 Design Sizing of the Land Application Area

Once the designer gets to the design appendices, specifically the land application system selection and sizing in Appendix 4.2A, there will be found tables of recommended design loading rates (DLRs) for the range of land application systems covered in the standard (trenches; evapo-transpiration absorption/seepage beds and trenches; mounds; irrigation systems). Remember, the design appendices have to be used within the context of the overall management requirements set out throughout the document (in other words, READ THE TEXT before using the tables).

The most significant qualification related to use of the DLR values is that they apply, in the case of trenches and beds, to the sizing of the horizontal bottom surface of the trench or bed. Bottom versus sidewall effluent application in design has evoked much discussion. Quite simply, the design loading rates (DLR) in AS/NZS 1547 at Table 4.2A1 should be viewed as design sizing requirements (DSR) not design loading rates (DLR). They take into account the sidewall effect (as explained in the text following the table), and enable sidewall infiltration to be automatically coupled into the functioning of the system. One very good argument for dose loading trench systems is to maximise opportunity for sidewall functioning by partly flooding each trench in sequence throughout a day, and thus utilising to good effect the treatment capacity of both sidewall and bottom areas.

Applying the DSR/DLR rates in Table 4.2A1 of AS/NZS 1547 to the trench length design scenarios for Table 1 above illustrates where the new Standard fits within the range of currently used design rules in Australia and New Zealand. This is shown below in Table 2.

Table 2. Trench Total Length as per AS/NZS 1547:2000 for NZ Category 3 and 5 soils for disposal of 900 litres per day (3 bedroom household)

AGENCY AND/OR TECHNICAL GUIDELINE		LENGTH OF 450 BY 450 MM TRENCH	
		Category 3 (NZ) Soil (Medium fine and loamy sand; good drainage)	**Category 5 (NZ) Soil** (Sandy clay-loam, clay-loam and silty clay-loam; moderate to slow drainage)
1.	AS 1547:1994 (bottom plus sidewall)	40 m	67 m
2.	NZS 4610:1982 (bottom plus sidewall)	51 m	77 m
3.	AS/NZS 1547:2000 (bottom area; maximum loading rate)	80 m	200 m
4.	TP 58 (Auckland Regional Council:1994) (bottom area; most conservative value)	100 m	200 m

Table 2 illustrates that the design implications for trench systems in Australia will result in all future trench systems being at least twice the size as would have been installed under the old AS 1457:1994. The reason for this is to do with the shift in design sizing away from applying the loading rates to both sidewall and bottom area, and using them only to size the bottom area of the trench.

5.3 Reserve Areas in Design Practice

The design process is by no means an exact one, and there are a whole host of uncertainties which have to be anticipated in respect of matching soil evaluation results with design loading rate based on the soil's capacity to treat the waste material in the effluent. Furthermore, any oversight or deficiency in operation and maintenance could compromise the performance of the system, and result in premature "failure". Hence, the setting aside of a "reserve area" is recommended in the standard as a means of providing a remedial measure in restoring on-site effectiveness to the property by being able to extend the land application system. Guidelines for sizing the "reserve area" component of design are not provided in the standard. However, given that it is the basic septic tank and soakage trench system that is likely to be the most vulnerable to unforeseen performance fluctuations, then 100% reserve area is desirable. The reserve area could be reduced when higher pre-treatment levels or alternative land application system design approaches are adopted. For example, drip irrigation systems for land application of secondary treated effluent probably require no reserve area.

6 Maintenance Processes

6.1 General

Past operation and maintenance approaches to on-site wastewater management have left matters entirely to the homeowner, with usually little or no support to the owner or occupier of the dwelling as to the best method of looking after and protecting their investment in what is an essential service right in their back yard. The importance of the facility in maintaining the occupants' health and protecting the environment is never explained to the owner. When properties change hands, the new owner may have no inkling that they have an on-site system on the property, or if they do know, they have no idea of its condition or likely future performance. This all has to change, and the new standard makes recommendations to facilitate such a change.

6.2 Pumpout Frequencies

The generally accepted septic tank pumpout interval for removing sludge and scum along with tank contents (septage) is around three years, and many community wide and council organised schemes operate on this basis. However, it is likely that only a small proportion (maybe less than 10%) of all tanks in a locality actually require that frequency of pumpout in order to prevent solids carry-over. Five, or seven, or ten years pumpout intervals could be appropriate for many tanks, particularly when effluent outlet filters are used. The cost of monitoring tanks by lifting lids and checking scum and sludge levels on a regular basis is resource intensive in itself, and many authorities would rather use a blanket pumpout approach to cover this aspect of maintenance.

6.3 Council Managed Operation and Maintenance Schemes

The monitoring provisions of the new standard recommend that all on-site wastewater systems should be monitored to ensure they are operating properly and being maintained regularly. This can be accomplished by community wide operation and maintenance schemes, such as a council managed septic tank pumpout scheme. The pumpout scheme is more suited to permanently occupied areas than holiday or recreational areas. In these latter locations, a community-wide inspection programme to a regular schedule is more likely to be cost effective. This would identify solids buildup rates within tanks relative to occupancy frequency. Body corporate management of such an approach would leave councils right out of the management process, and devolve cost charges back onto individual property owners on a user pays basis as distinct from rates levies. Any monitoring programme should, in addition to treatment tank inspections, also incorporate on-property inspections of land application area performance.

6.4 Maintenance Certification

The standard also recommends that in the absence of council managed schemes, individual property monitoring and maintenance programmes be implemented. Maintenance inspections would be commissioned by the owner, undertaken by a private inspection agency under contract to the owner, and result in a maintenance certificate being produced for lodgment with the regulatory agency as well as the owner. The maintenance certification approach has been referred to in NZ as a "WOF" (warrant –of –fitness) scheme similar to the motor vehicle checking programme required by law. Such schemes can be implemented under the environmental monitoring provisions of the Resource Management Act, 1991. The record keeping aspects of managing such a maintenance approach would be best handled by the local council, which would send out reminders as the next check became due. Monitoring checking frequencies would vary according to the operational and environmental significance of the type of facility being served by the on-site wastewater system.

7 Integrating Design and Maintenance

7.1 Case Study in Design and Maintenance Failure

The breakdown in the linkage between design, installation and maintenance is perhaps best illustrated by the shift from septic tank and soakage trench systems to AWTS and spray irrigation systems in Australia during the late 1980s and early 1990s. Manufacturers of AWTS units readily moved in to install their units along with a standard length of distribution line and spray irrigation heads, with the home owner left to lay the irrigation line and place the spray heads at the most convenient location within the lot. Naturally homeowners, given the apparent security of having a "high quality" effluent which they were assured could be utilised for on-lot lawn and garden watering, became less than prudent in placing such systems and allowing family members to interact with the resulting surface spread effluent.

Anecdotal commentary suggests that some manufacturers' inspection processes related to their maintenance contracts were less than desirable, involving in some cases the inspection personnel filling out maintenance sheets in their service vehicle while parked on the street outside the property, and then dropping the sheets in the mailbox before heading onto the next property.

7.2 Designer's Final Responsibility for Maintenance

Although the new standard sets out in Appendix 3A information that may be included in the content of a set of operation and maintenance guidelines, it is up to the designer to prepare specific guidance on operation and maintenance matters pertinent to each individual design. These will detail the design parameters used in selecting and sizing the installed system, and outline the consequences of deviating from design loading criteria (such as increasing the household size, adding extra water using fixtures, removing or replacing water conserving fixtures, extending the dwelling capacity by adding new bedrooms). The as-built details of the installed system should include information outlining the importance of leaving the land application area solely for effluent management, and not occupying or using that area for other purposes. The content of detailed monitoring and inspection procedures, and the owner's responsibility to commission maintenance certification on a regular basis should be emphasised, and an explanation of the consequences (public health, environmental and financial) of neglecting such regular attention should be clearly outlined by the designer.

8 Conclusion

Sustainable on-site wastewater management servicing will not be achieved unless design and maintenance procedures work effectively in an integrated manner. The new joint Australia and New Zealand Standard AS/NZS 1547:2000 provides a prescription for that to happen. Ample design tools and operation and maintenance guidance is set out in this document. The success of design and maintenance in delivering sustainable servicing solutions will, however, depend upon the human factor, that is how well all those persons involved in and responsible for the implementation of on-site servicing undertake their responsibilities. The designer is a key person in achieving this success.

Reference

Standards Australia, Standards New Zealand. (2000). *On-site domestic wastewater management.* Australia/New Zealand Standard™ AS/NZS 1547:2000, Strathfield NSW and Wellington NZ, 24 July 2000.