Site and soil assessment for on-site domestic wastewater management

With reference to AS/NZS 1547:2000
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by

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1. INTRODUCTION

This paper presents information on assessing sites for on-site management and disposal of domestic wastewater. The emphasis is on site and soil conditions. The methods, terminology and philosophy are based on AS/NZS 1547:2000. Special reference is made to South Australian conditions, and the emphasis is on assessment of individual allotments.

The structure of this paper is:

1. **Introduction**
2. **The Problem - and the Solution**
3. **Assessment Methods and Reporting**
4. **A Role for Local Government**
5. **What happened to the "percolation test"?**
6. **Some aspects of SA soils**
7. **Summary**

I have used various conventions in structuring this paper. Generally information is presented in dot-form, and references to clauses or parts of AS/NZS 1547:2000 are given in the form Pt # *indicating part number, or* ♮#.#.# (i) p ## *indicating clause number and page number.*

2. THE PROBLEM - and THE SOLUTION

2.1 THE PROBLEM

Management and disposal on-site of wastewater (effluent) from domestic use

- public health and safety (disease pathogens)
- soil health - long term (salinity - water-logging)
- appropriate system for site and soil conditions (topography - soil characteristic)
- capacity requirements (wastewater inflow)

2.2 THE SOLUTION

Detailed, well structured and executed investigation and assessment => appropriate system selection and sizing

1. Site Assessment - site location, topography, land use
2. Soil Assessment - soil characteristics
3. "Rational" basis for design - based on characteristic of the site

3. ASSESSMENT METHODS

3.1 PHILOSOPHY - AS/NZS 1547:2000

The approach is to complete a detailed investigation to determine site and soil characteristics, which allow estimation of a Long Term Acceptance Rate (LTAR) - which is a measure of the capacity of the soil to accept effluent infiltration.

Assessment methods are described in detail in AS/NZS 1547:2000 ("the Code"). I will highlight key aspects of the assessment, and provide some additional emphasis and information. The Code refers to assessments for sub-divisions and for individual sites. Generally the methods are similar - with important differences. This paper concentrates on assessment for individual allotments.

The methodology of the Code is different to the 1995 SA Health Commission Standards. In particular the old standards had a reliance on permeability (percolation) testing. The Code states:

> *"Permeability test results are not used as the sole determinant of soil category."*
> *§4.1.1 p 54*

Most sites can accommodate some kind of wastewater management and disposal system. A detailed assessment of each site is required to determine the preferred/optimal solution.

It is important that ALL parts of the evaluation and assessment process are completed.

3.2 WHO SHOULD DO THE ASSESSMENT ?

§3.5.4 p 35

Site and Soil assessment should be undertaken only by suitably qualified and experienced personnel, independent of the land owner or developer. This could include:

- soil scientist, geotechnical engineer, civil and environmental engineer, land surveyor
- have attended appropriate accredited training program (? Where are these ?)
- familiar with requirements
- supervise other personnel
- accept professional liability for the assessment
- appropriately certified Reports

3.3 DESK TOP STUDY

♮4.1.3.4(a) p 55

Initial study of documents.

- to establish what to expect, what will be the likely problems, extent and detail required of further investigation
- shall include reference to available soil or geological maps (Note 1)
- information on groundwater (well logs etc). Local knowledge that permanent groundwater is well below the depth of influence of the disposal system may be sufficient
- topographic maps and aerial photographs may be useful
- the experience of the evaluator may be valuable

*NOTE 1: Do **not** accept that 'Bulletin 46' is the only soil information available. There are soil maps covering most of SA, and geological maps covering all SA.*

3.4 SITE INSPECTION

♮4.1.3.4(b) p 56

This is a very important part of the investigation.

- on foot by the assessor
- examine features - topography - buildings - services - land use - vegetation
- define the preferred disposal area(s)
- define unsuitable area(s)

3.5 DETAILED SITE AND SOIL EVALUATION - INDIVIDUAL ALLOTMENTS

♮4.1.3.4(c) p 56; ♮4.1.3.5/6/&7 p 56 - 58; Appx 4.1A p 72

Objective: Determine soil characteristics => Long Term Acceptance Rate (LTAR) *{ability of the soil to accept application of effluent}* => determine a Design Loading Rate (DLR) or Design Irrigation Rate (DIR).

This allows recommendation of suitable system(s) and sizing to suit effluent load.

The procedure is set out in detail in *Appendix 4.1A4 p 77*. {The Flow-Chart *Fig 4.1B1 p 82* is for sub-divisions, but much is also applicable for individual allotments.}

3.5.1 Select and define potential disposal area, and test locations within area

3.5.2 Collect soil samples ~ method requires **minimum three** test locations (1 each end + 1 in centre)

- two boreholes + one test pit; or more commonly in SA, three boreholes using typical push-tube method and cores > 50mm diameter
- target depth: min 0.6m below base of trench, or min. 1.2 m below base of trench for sands and gravels with high permeability (Cat 1 by Table 4.1.1)

3.5.3 Assess soil properties - geotechnical logging

3.5.4 Determine Soil Category *Table 4.1.1 p59*

3.5.5 Select appropriate land application (disposal) system(s)

3.6 SOIL PROPERTIES

App 4.1A4.3 p 77; Table 4.1A2

This is the crucial step in the assessment and evaluation procedure. It is also open to the interpretation of the assessor. It is important to remember that a soil borelog is not a factual document, but is the logger's interpretation of the soil properties from the sample available *(Ref: "Guidelines for the Provision of Geotechnical Information in Construction Contracts", IEAust .. 1991)*

Essential information in a soil log: - Ref: AS 1726 'Geotechnical site investigations' *{for some reason this information is restated in slightly different form in AS/NZS 1547:2000}*

- site details (address) and sampling locations
- date of sampling (Note: **not** date of writing the Report)
- excavation/sampling method used *
- depth of horizon
- soil classification (gravel, sand, silt, clay etc) *
- Unified Soil Classification Symbol *
- colour(s), including mottling etc
- presence of minor constituents (clay, sand, gravels, lime) *
- moisture content - texture - structure - plasticity - dilatency
- presence and nature of cracks etc
- ground water
- results of in-situ, field or laboratory tests - dispersion - strength - shrink/swell etc

** NOTE: these characteristics are not shown on the proforma sheet on page 80 of the Code.*

Evaluation of the results from the soil sampling and logging allows categorization of the soil according to *Table 4.1.1 p 59*. The Table assigns a Category based on the soil texture and structure, and an inferred Indicative Permeability.

NOTE: The use of the term "loam" is contrary to AS 1726. "Loam" is an imprecise term, and loams are mixtures of sand, silt and clay.

Some points to be wary of:

- unexpectedly favorable results - eg: "sand" in areas of known deep heavy clays - is this just a sand lens of unknown extent ? Has the log been falsified ?

- unrealistic permeability (or LTAR) assigned to soils. eg: a sandy clay with Ksat = 3.0 m/d
- “collapsing” soils (refer later). Characterized by lime-rich (calcareous) silt/sand/gravels. Common in SA
- reworked/remoulded soils. eg rock “flour” from augering into rock
- focusing on “favorable soil layers and overlooking critical limiting factors. eg: a thin near-surface sand layer over a massive clay. The clay is not suitable for disposal trenches. Check available depth of sand, considering construction and cover requirements
- reliance on unqualified personnel with no evidence of supervision by assessor. eg: using the soil driller to do the site inspection - what training does he have ? What has been missed ?
- inadequate investigation - especially the use of a single “confirmationary” borehole

3.7 REPORTING

♮4.1.5 p 60

Reports need to provide essential information for the design of the on-site management and disposal system. It also needs to be readily interpreted, and able to be verified and checked by the approving Authority. To this end standardized sheets are provided in the Code.

At the very least, a Site and Soil Evaluation Report should contain:

- unambiguous site and location details
- methodology used
- list of references used
- record results - borelogs, dates, test results (including method used)
- soil Category
- recommend appropriate disposal system(s) and applicable LTAR, DLR. DIR
- identify soil layers suitable for disposal
- any limitations/cautions etc

4. A ROLE FOR LOCAL GOVERNMENT

Local Government has vital roles to play in the establishment of effective and efficient domestic wastewater management in SA. Critical roles are:

4.1 EDUCATION

Education of the public, including developers.

Held in Council records is a wealth of data on local conditions, soil types, development, topography. Local Govt Health, Planning and Building Officers have extensive and often detailed knowledge of their Council area.

I believe it is vital that this information is made available to the public. Some strategies:

- provide advice to developers who are considering sub-division or residential development
- advise individual customers of problems at their site (eg: heavy clay, dispersive soil)
- advise customers of systems which have been successful nearby their site

- assist customers to understand the process in assessing their site (is there a role for the LGA here - to develop a handout ?)

4.2 LOCAL AREA STUDIES

To define areas within Council with specific characteristics

In SA this would probably focus on areas which are **not** suitable for conventional soakage systems. The Code provides guidance on methodology for such studies.

An example might be the northern around the towns of Roseworthy, Freeling, Wasleys, Hamley Bridge, Owen. These areas are known to have extremely “reactive” Black Earth soil profiles.

4.3 REGULATORY

A regulatory role in granting approvals.

5. WHAT HAPPENED TO THE PERCOLATION TEST ?

The 1995 SA Health Commission Standard set out methods for determining soil permeability (percolation). One method was the “Direct Method” which involved a percolation test, using either static head or falling head method. The actual test methods are described in earlier publications and standard texts.

Problems with the percolation test:

- Falling Head test always used, because it is easier and cheaper - but is less reliable
- The Falling Head test lacks a reliable mathematical model
- an initial investigation is required to identify suitable soil horizon for testing. This is rarely done !
- percolation testing is normally done in soils with low to marginal permeability (why do it in a sand?) Soils in the range of permeability typically tested give results which are difficult to interpret and require considerable experience to conduct the test correctly (Ref: Day).
- conditioning the soil (by pre-soaking) is critical in expansive soils. These soils crack, and percolation through the cracks can be rapid and may transport the test water considerable distances. It may take excessive time (days or weeks ?) To fully close the cracks in the test hole. Pre-soaking is seldom done adequately (or in accordance with the test method).
- multiple test holes are required to provide a statistically meaningful result.
- Soils are variable, and this variability may not be adequately represented by the test holes.
- in reality, they are not useful in the range of (low) permeability soils typically tested.
- who is performing these tests ? What qualifications do they have ? Who is supervising them ?

AN EXAMPLE

Consider the indicative permeabilities given in Table 4.1.1 of the Code.

A “sandy loam” (say a silty clayey sand) Ksat = 3.0 m/d.

Compare this to a typical heavy SA clay with Ksat < 0.06 m/d

3.0/0.06 = 50. Hence we would expect a soakage contact area for the clay **50** times the area for the "loam"

6. SA SOILS

A glance at the soil map from Bulletin 46 confirms that SA is blessed with a wide variety of soils. Many of these soils require special consideration when deciding on a suitable long-term on-site waste-water management system. I will examine some of the problems associated with soil types found in SA.

6.1 THE HEAVY CLAYS

Heavy "reactive" clays cause problems with construction across SA. Buildings crack, roads become rough, underground services fail. We are all familiar with these problems. These clays are also NOT suitable for long-term disposal of effluent by soakage.

Permeability of heavy clays is so low that uneconomically large contact area would be required. Such large beds would also require large land area, and would be difficult to construct. Ground would become water-logged.

Such soils include, the Red-Brown Earths, Black Earths, (Brown) Solonized, and others. These soils typically are tertiary soils of alluvial origin, hence they tend to occur in valleys. The Adelaide Plains, Barossa Valley, Clare Valley are locations we expect to see these soils.

Because these soils also vary over quite short distances, we need to have sufficient investigation to be confident that our results are applicable to the whole of the soakage area.

If it is proposed to use heavy clays for a soakage system, a full water balance should be completed to calculate the size of trench/bed required. *Table 4.2A1 Note 11 p117*

6.2 GILGAIS

A gilgai strictly is a surface feature, but is usually associated with a sub-surface (1-3m depth) soil feature. Gilgais are usually associated with highly reactive soils, and result in the development of a localised volume of limey soil surrounded by clay. Our typical investigation will not reveal the extent of the gilgai, and so the apparently permeable soil within the gilgai should not be relied on to provide suitable soakage.

An indication of the presence of a gilgai is when one or two test locations intersect a layer of calcareous sand or silt over a heavy clay. The calcareous layer may be absent at other test locations on the site or nearby. Black Earth and Brown Solonised soil profiles are well known to contain gilgais.

6.3 THE COLLAPSING SOILS

"Collapsing" soils are characterized by the presence of significant lime (calcareous material). Many of these soils are of aeolian (wind-blown) origin, and/or have deposited on the floor of ancient seas. These deposition mechanisms result in particles which are loosely packed. The lime weakly cements the particles. However the lime is readily dissolved by water, which can result in loss of the cementing, and spontaneous "collapse" of the soil into a more compact structure.

Special care is needed on these soils to avoid effluent soakage (and the risk of soil collapse in and around the soakage) posing a risk to nearby structures.

Collapsing calcareous soils occur across large areas of SA - east of Mt Lofty Ranges, South East. Soils with a limestone "caprock" or calcrete often contain potentially collops

6.4 DISPERSIVE and SALT-SENSITIVE SOILS

Appx 4.1E p101

Some soils have dispersive clays, where fine particles of clay go into suspension. The clay particles tend to block pores and reduce permeability. The modified Emerson Test provides a simple means of testing for this property.

Salt also effects soils. As domestic effluent is typically saline, care must be taken in salt-sensitive soils. The sensitivity of soils to salt is highly variable. Many of our SA soils already contain significant levels of salt.

Effective testing of soils for salt-sensitivity is a specialist area. Local knowledge will be a useful guide on the necessity for testing.

7. SUMMARY

Recommending a suitable domestic waste-water management system is an important task. AS/NZS 1547 provides detailed procedures for undertaking site and soil assessments.

- most owner/occupiers give little or no consideration to this important matter, either at the planning stage or during the life of the system
- recommendations can be made on an individual site basis, at sub-division level, or on a wider area basis
- assessment should be carried out by suitably qualified and experienced people
- site conditions need to be assessed so that the likely preferred system can be determine
- desk study is a vital step
- soil conditions must be assessed
- a soil Category and LTAR are determined
- SA has many "problem" soils which need to be identified, and system design needs to take into account
- system design optimized to suit site and soil conditions

RESULT - happy customers !