APPENDIX E

SITE-AND-SOIL PROPERTIES

(Normative)

E1 SCOPE

This Appendix describes the assessment inspection and data collection procedures that determine the site-and-soil properties as required by Table B2, Appendix C, and Appendix D. The Appendix covers site exposure, soil colour, soil texture, soil structure, coarse fragments, and soil dispersion.

E2 ASSESSMENT OF SITE EXPOSURE

The existing exposure of the site to sun and wind shall be assessed and noted for future evaluation in the selection process for a land application system.

CE2

Exposure of a site to sun and wind influences evapotranspiration of moisture from the soil and plant cover. A reduction in the amount of sun and wind reduces the effectiveness of land application systems relying on evapotranspiration. The site-and-soil evaluation should mark areas where evapotranspiration is likely to be limited.

It should be noted that meteorological stations from which climate information is derived are always exposed to full sun and wind.

E3 ASSESSMENT OF SOIL COLOUR

The colour of a soil shall be described when the soil is moist using simple terms, such as: black, white, grey, red, brown, orange, yellow, green, or blue. These may be modified as necessary by the words: pale, dark, or mottled. Transitional colours may be described as a combination of these colours (for example, red-brown).

Where a soil-horizon colour consists of a predominant colour with blotches or mottles of another colour, it shall be described in the form: (predominant colour) mottled (secondary colour), for example, grey mottled red-brown.

Where a soil consists of two colours present in roughly equal proportions, the colour description shall be: mottled (first colour) and (second colour), for example, mottled brown and red-brown.

A mixture of distinct colours may be described, such as mottled red/grey.

For consistency of colour identification an appropriate soil colour chart shall be used.

E4 ASSESSMENT OF SOIL TEXTURE

E4.1 Field assessment

The soil texture shall be determined on a sample of soil consisting only of mineral particles finer than 2 mm as follows:

(a) Remove any material larger than 2 mm;

(b) Take a sample of soil sufficient to fit comfortably into the palm of the hand;

(c) Moisten the soil with water, a little at a time, and the resulting ball of soil kneaded until it just fails to stick to the fingers; and

(d) Determine the texture by noting:

  (i) The force required to deform or work the ball of soil

  (ii) The length of flat ribbon, approximately 5 mm thick, that will form when squeezed between thumb and forefinger, and

  (iii) The sandy nature of the ball of soil.

Use Table E1 to help assign the soil category level in Table 5.1.

CE4.1

As a range of factors in the soil affects its elasticity when worked as described in item (d), the ribbon lengths given in Table E1 are a guide only. This determination is often called the 'field texture' and is a somewhat subjective judgement. Training and experience are required to produce consistent results.

E4.2 Laboratory assessment

A detailed laboratory particle-size analysis may be undertaken if considered appropriate. The soil texture is then determined by use of a textural analysis chart or diagram.

CE4.2

Laboratory assessment of field texture is not normally required if experienced personnel have carried out the field assessment.

TABLE E1
ASSESSMENT OF SOIL TEXTURES

Soil category	Classification	Properties	Typical clay content% (see Note)
1	Sand	Very little to no coherence; cannot be moulded; single grains stick to fingers	Less than 5
2	Loamy sand	Slight coherence; forms a fragile cast that just bears handling; gives a very short (5 mm) ribbon that breaks easily: discolours the fingers	5 – 10
	Sandy loam	Forms a cast but will not roll into a coherent ball; individual sand grains can be seen and felt; gives a ribbon 15 – 25 mm long	10 – 20
3	Fine sandy loam	As for sandy loams, except that individual sand grains are not visible, although they can be heard and felt; gives a ribbon 15 – 25 mm long	10 – 20
	Loam	As for sandy loams but cast feels spongy, with no obvious sandiness or silkiness; may feel greasy if much organic matter is present; forms a thick ribbon about 25 mm long	10 – 25
	Silty loam	As for loams but not spongy; very smooth and silky; will form a very thin ribbon 25 mm long and dries out rapidly	10 – 25
4	Sandy clay loam	Can be rolled into a ball in which sand grains can be felt; forms a ribbon 25 – 40 mm long	20 – 30
	Fine sandy clay	As for sandy clay loam, except that individual sand grains loam are not visible although they can be heard and felt; forms a ribbon 40 – 50 mm long	20 – 30
	Clay loam	Can be rolled into a ball with a rather spongy feel; slightly plastic; smooth to manipulate; will form a ribbon 40 – 50 mm long	25 – 35
	Silty clay loam	As for clay loams but not spongy; very smooth and silky; will form a ribbon about 40 – 50 mm long; dries out rapidly	25 – 35
5	Sandy clay	Forms a plastic ball in which sand grains can be seen, felt or heard; forms a ribbon 50 – 75 mm long	35 – 45
	Light clay	Smooth plastic ball that can be rolled into a rod; slight resistance to shearing between thumb and forefinger; forms a ribbon 50 – 75 mm long	35 – 40
	Silty clay	As for light clay but very smooth and silky; will form a ribbon about 50 – 75 mm long but very fragmentary; dries out rapidly	40 – 50
6	Medium clay	Smooth plastic ball, handles like plasticine and can be moulded into rods without fracture; some resistance to ribboning, forms a ribbon 75 mm or more long	40 – 55
	Heavy clay	Smooth plastic ball that handles like stiff plasticine; can be moulded into rods without fracture; firm resistance to ribboning; forms a ribbon 75 mm or more in length	50 or more

NOTE: The typical clay content figures are included for information only.

E5 ASSESSMENT OF COARSE FRAGMENTS

E5.1 General

Coarse fragments include hard rock material and nodules or segregations, which may have developed as the soil formed. The rock may have weathered from the parent material or have been transported from elsewhere.

The abundance, size, and type of rock (see E5.2 and E5.3) making up coarse fragments shall be recorded.

The assessment is usually done in the field using a 2 mm sieve and comparing the relative proportions of fine earth with coarse fragments. This can be difficult in moist heavy soils. In such cases, a field estimate using abundance charts is acceptable.

E5.2 Abundance

Record a visual estimate of abundance in the classes set out in Table E2.

TABLE E2
ABUNDANCE OF COARSE FRAGMENTS

Class	**% of coarse fragments**
Very few	< 2
Few	2 – 10
Common	10 – 20
Many	20 – 50
Abundant	50 – 90
Profuse	> 90

E5.3 Size

Record size range of coarse fragments as set out in Table E3.

TABLE E3
SIZE OF COARSE FRAGMENTS

Type	**Size** (mm)
Fine gravel	2 – 6
Medium gravel	6 – 20
Coarse gravel	20 – 60
Cobbles	60 – 200
Stones	200 – 600
Boulders	> 600

E5.4 Relevance and impact

E5.4.1

When coarse fragments occupy more than 20% of the soil volume, consideration shall be given to whether it is desirable to change the soil category by one class (for example from Category 2 to Category 3).

CE5.4.1

Coarse fragments occupying soil volume may impede or accelerate the flow of water.

E5.4.2

The size and amount of coarse fragments shall be taken into account when selecting the system type.

CE5.4.2

Large coarse fragments, such as cobbles, stones, and boulders can interfere with the design layout of the on-site system.

If there are more than 20% cobbles, stones and boulders, this can interfere with surface preparation and excavation and may pose hazards such as trench collapse.

E6 ASSESSMENT OF SOIL STRUCTURE

The type of soil structure shall be assessed by examining exposed soil surfaces such as in a soil observation pit. Table E4 is a guide to assessing structure.

TABLE E4
STRUCTURE

Degree of structure	Appearance
Massive	Coherent, with any partings both vertically and horizontally spaced at greater than 100 mm. Pieces do not break along planes of weakness but break according to stress loads
Single grained	Loose incohesive, for example, sandy soils
Weak	Peds indistinct and barely observable on pit face. When disturbed approx. 30% consist of peds smaller than 100 mm
Moderate	Peds well formed and evident when disturbed but not distinct in undisturbed soil. When disturbed 30% – 60% consists of peds smaller than 100 mm
Strong	Peds quite distinct in undisturbed soil. When disturbed > 60% consists of peds smaller than 100 mm

E7 ASSESSMENT OF SOIL DISPERSION

This shall be done using a modified version of the Emerson Aggregate Test (refer to AS 1289.3.8.1). It provides a simple field assessment of aggregate stability or dispersibility from similar Emerson Aggregate Classes, which are based on a 24-hour testing period. The test requires minimal equipment and is not intended for the laboratory.

Under this test, three undisturbed soil aggregates, of approximately 5 mm diameter, are carefully immersed in a beaker of distilled water and left free of vibration and undisturbed for 24 hours. Similarly three reworked aggregates (from the texture ball) are also placed in a beaker of distilled water for 24 hours.

The behaviour of the most dispersive aggregates or worked soils is also tested after 24 hours. The behaviour shall be assessed as follows:

Possible results:

(a) No change to aggregate;

(b) Aggregates slake (smaller aggregates/particles fret away from the original aggregate);

(c) Aggregates disperse (clouding the solution);

(d) Worked ball material disperses.

If any replicate for the modified Emerson aggregate test exhibits any dispersion (that is, a positive result) then the soil shall be considered dispersive and the soil shall be categorised as Category 6.

CE7

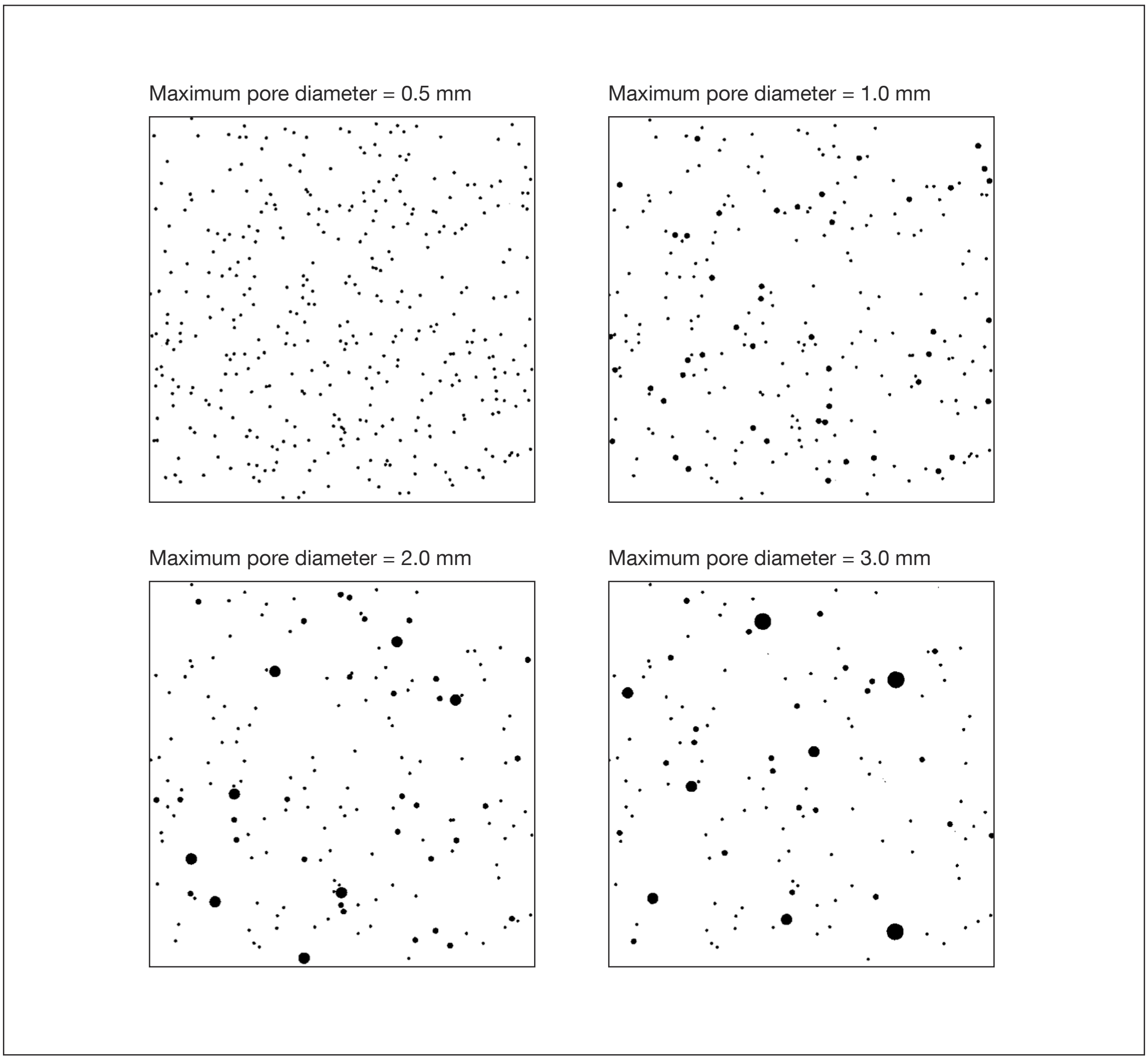
Ideally, soils should not be dispersive. Results (c) and (d) indicate dispersive soil.

E8 ASSESSMENT OF AREAL POROSITY

Porosity may be assessed by visual estimation of the frequency and size of pores compared to standard charts showing black dots on a background of white. Figure E1 provides an example.

These visual estimates shall be done also for soils with known permeability to be able to be used for rough permeability estimates.

A sufficiently large number of actual measurements of permeability may actually require less time and create more confidence.



NOTES:

1 Size is 0.75x actual.

2 From McKenzie and Jacquier, 1997.

FIGURE E1 EXAMPLE OF PORE CHARTS WITH AN AREAL PERCENTAGE OF 1.5%

APPENDIX F

DISPERSIVE SOIL AND SODICITY

(Informative)

F1 SCOPE

This Appendix discusses in greater detail the requirements and concerns outlined in B5.

F2 DISCUSSION

When soil disperses (clay particles separate from the main body of the soil and go into suspension) the clay particles block pores and tend to swell more. This reduces the LTAR and therefore the DLR/DIR.

Sodicity is one way of indicating soils which have a significant percentage of exchangeable sodium (ESP) on their cation exchange complex. Their structure then becomes adversely affected when in contact with water of a certain level of total cation concentration (or salinity). In some soils, the clay can disperse when the ESP is as low as 3%, but in others it may not manifest itself until the ESP is at least 10 – 20%. The mineralogy of the clay fraction also plays a role. Whether adverse effects occur depends also on the pH of the soil and the salinity of the water. Because of salinity levels in effluent and the levels of sodium used in many washing and cleaning products, dispersion has been known to occur at low levels of ESP in otherwise stable soils.

The adverse effect of sodium and salinity on the structure of the clay may result in a reduction of permeability or in a tendency for the clay to become dispersive, causing the water to become turbid. Sodium and salinity can also cause the soil to become strongly swelling and shrinking with changes in water content. Furthermore, sodic and dispersive soils are often highly erodible, and may have low bearing strengths when wet. They often set very hard when dry and can form surface crusts, restricting water entry and hampering seedling emergence. In these situations, care is required when establishing on-site wastewater management systems.

The modified version of the Emerson Aggregate Test (see E7) provides a simple test of whether, and to what degree, a soil is dispersive. If the test indicates a tendency for clay dispersion, adding sodium-rich but low salinity wastewater is likely to increase damage to soil structure. Such soils should be classified as Category 6. If such dispersion-prone soils are known to exist in the land application area, or in the study area, they should be recorded and delineated on plans.

Groundwater with a sodium adsorption ratio (SAR) of 3 or more, indicating a relative dominance of dissolved sodium over dissolved calcium and magnesium, at salinity levels typical of domestic effluent, can cause some soils to disperse. This would reduce the LTAR dramatically and could lead to system failure. Adding gypsum to the soil in the application area increases the salinity of the soil moisture without increasing the sodium level. This lowers its SAR and can help to correct the problem (see L7.2).

The permeability of a soil is often measured as part of the site-and-soil assessment (see Appendix G). The water used in the permeability test, often potable water, has different characteristics to that of wastewater; in particular the sodium content and salinity are much lower. As these components can have a marked impact on the soil structure, permeability estimates based on clean water may be misleading. More accurate estimates of the permeability of soil in relation to wastewater may be obtained by adjusting the composition of the test water to match that of the effluent. Expert advice should be obtained if the site-and-soil assessment indicates that dispersive properties or sodicity are likely to be a significant issue.

APPENDIX G

SOIL PERMEABILITY MEASUREMENT

– CONSTANT HEAD TEST

(Normative)

G1 SCOPE

This Appendix sets out the Talsma-Hallam method for determining the permeability of soil using a constantly maintained head of water. This method is referenced in B6.

The Talsma-Hallam permeameter described below is suitable for a soil permeability range of 0.009 to 2.9 m/day (8.6 to 2900 mm/d) or $1x10^{-7}$ to $3x10^{-4}$ m/s.

Soil permeability measurement shall only be carried out when the water table is at least 0.5 m below the test hole.

CG1

With certain modifications, the Talsma-Hallam permeameter can also be used for permeabilities less than $1x10^{-7}$ m/s. However this range is not usually required for land application of wastewater.

The Talsma-Hallam permeameter is available commercially or may be handmade. Other constant head permeameters are also available.

G2 PRINCIPLE

In a constant head test, the water that runs out of an unlined test hole in the ground is replenished at the same rate from a reservoir, so that the head of water in the hole remains the same. The loss of water from the reservoir is measured over time and a mathematical model is used to calculate the saturated soil permeability, K_{sat}, from the measurement.

CG2

The constant head test is based on Darcy's Law and is an 'above the water table test', that is, based on the surrounding soil, even to some depth below the base of the test hole, not being saturated and exerting a capillary suction that draws water out of the test hole. The method does not apply to waterlogged conditions when the hydraulic gradient that is the capillary suction is zero. Falling head permeameters are not recommended in this Standard due to the lack of a proper physical model, the lack of a mathematical description of the falling head method in an unlined test hole, and the resultant uncertainty in converting a measured fall rate into a K_{sat} value.

G3 APPARATUS

The apparatus and equipment required shall be as follows:

(a) Permeameter

(i) A permeameter (see Figure G1) is composed of:

(ii) A reservoir made of clear, transparent, rigid tube

(iii) A rubber bung to form an airtight seal

(iv) An air-inlet tube that extends almost to the bottom of the reservoir, sealed airtight into the rubber bung, and

(v) A millimetre graduation scale on the outside of the reservoir along its full length, highest numbers at the top. The 0 cm mark is set at the level of the opening of the air-inlet tube. Identify the net internal volume of the reservoir per unit length to be able to determine the outflow rate Q from the volume loss of water per fixed-time interval (see G6);

(b) Tripod

A tripod or clamping device with adjustable legs that is used to hold the permeameter firmly and upright over the centre of the hole (see Figure G1);

(c) Suction flask

The suction flask is an airtight vessel that is used to remove excess water from an overfilled test hole.

The suction flask is composed of:

(i) A flask, volume at least 1 litre with an air/watertight lid. Two pipes, outside diameter of 12.5 mm, are fitted into the lid of the flask. One pipe is to reach close to the bottom of the flask. The other extends to be just inside the flask below the lid. Both pipes extend to 50 – 100 mm above the lid

(ii) Flexible tubing is fitted to the pipes above the lid of the jar

(iii) The pipe that reaches close to the bottom of the flask is fitted with flexible tubing approximately 0.6 m long, at the end of which is attached another length of rigid, transparent pipe approximately 0.4 m in length, and

(iv) The pipe that reaches to just below the lid is fitted with approximately 0.5 m of flexible tubing.

All connections shall be sealed and airtight;

(d) Anti-scouring device

Water shall be added to a test hole in a manner that minimises turbulence in the water and reduces scouring of the lower part of the test hole.

Equipment to achieve this is illustrated in Figure G2. A wad of filter cloth is used to gently disperse the water. The tube used to introduce water to the hole shall just fit inside the test hole and be long enough to protrude after it has been lowered into the hole;

(e) Augers

Auger minimum diameter of 75 mm;

(f) Stopwatch

Stopwatch or timer to set the selected fixed-time interval.

CG3

Polycarbonate pipe with inside diameter of 30 – 45 mm makes a suitable reservoir.

Polycarbonate pipe with outside diameter of 9.5 mm and inside diameter of 6.0 mm is suitable as the air inlet tube.

Common augers have diameters of 75 mm and 100 mm. A 75 mm auger normally makes a hole of 90 mm diameter; a 100 mm auger normally makes a hole of 120 mm diameter.