On-site Wastewater Management Training Course

Soil Assessment for On-site Wastewater Management

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Site and Soil Evaluation

- Soils are examined as part of SSE to determine their capability to assimilate and treat domestic wastewater
- Evaluation also undertaken to determine if wastewater can be managed within property boundaries
- A range of important physical and chemical soil features are investigated on-site and/or samples may be collected for later detailed analysis

Soil Assessment

- Appendix D3 AS/NZS1547:2012
- Min. three observation boreholes investigated
- Excavation of a borehole or soil pit to determine location of best soils undertaken by;
  - backhoe (may not be economic)
  - hand digging or corer or
  - soil auger
- Min. depth should be 600mm below the proposed point of application, or to refusal
  - AS/NZS 1547 and VIC Code require 1.5m below point of application
  - NSW Guideline suggests 1.2m

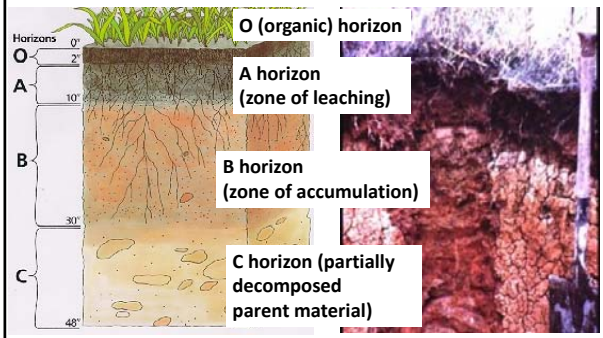
Soil Augering/Excavation

- Layout in order of recovery; do not spread out
- Identify differences by feel when augering
- Decide on horizons or layers and describe including depth
- Number horizons/layers, look at important properties and record

Key Soil Properties

- Assessment of soil colour and mottling if present
- Assessment of coarse fragments (rocks and nodules) and cracks which may affect drainage
- Description of soil texture
- Assessment of soil structure
- Assessment of soil dispersion
- Assessment of porosity
- Recording of depth to water table and bedrock (where encountered)
- Measurement or estimation of soil permeability and determination of design loading rate (DLR) to allow sizing of system

Soil Profile - Horizons



Describe the soil **horizons or layers** which can be distinguished from those above and below and which make up the **profile**

Soil Colour

Reflects the underlying mineralogy of the soil and also its fertility, ability to drain (permeability) and stability. Generally speaking:

- **dull** colours indicate wetness during formation (iron reduced to ferrous form)
- **pale** colours may be from pale rocks (e.g. rhyolite) or leached from darker minerals
- **dark** colours may be from dark rocks such as basalts or contain high levels of organic matter
- bright **red** colours from well aerated soils with high iron and aluminium content
- **bleached** (pale) - minerals removed by water

Soil Mottling

- Is if more than 10% of soil is of a contrasting colour
- Important indicator of soil drainage characteristics
  - colour different from main soil colour, may be spots, blotches or streaks
  - bright colours (orange and yellow) – indicative of oxidising conditions
  - very dull grey colours – strong iron reduction (gleying) – saturated or anoxic conditions
- Mottling indicates periodic waterlogging

Soil Waterlogging

- Important to identify the reason for wetness in SSE
- Could be due to shallow groundwater or seepage from upslope areas and may be permanent or seasonal
- Perched water tables may also occur
- Look for limiting horizons such as shallow hardpan (e.g. coffee rock, iron pan) with waterlogging features such as mottling or gleying

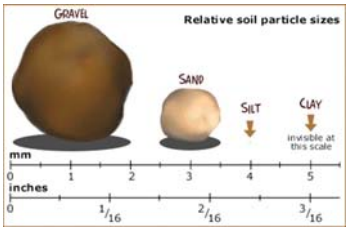
Soil Texture

- Examine soil texture in soil pit or on sample – important for soil drainage
- The relative proportion of sand, silt and clay in a soil sample
  - can be determined by laboratory sieving methods (PSA) and fractionation and/or
  - using a field textural method (ribbon test)

Particle Size

Soil textures are classified according to the relative proportions of:

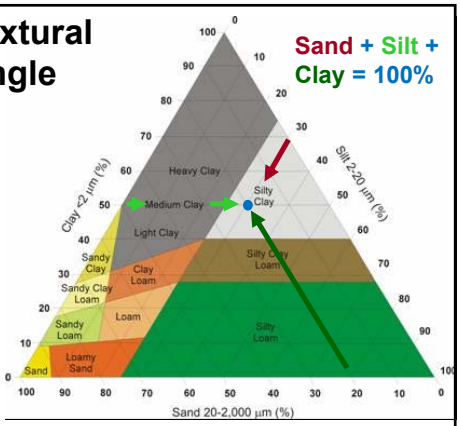
- sand (0.02-2mm)
- silt (0.002-0.02mm)
- clay (<0.002mm)



Soil Textural Triangle

Sand + Silt + Clay = 100%

50% Clay
20% Sand
30% Silt



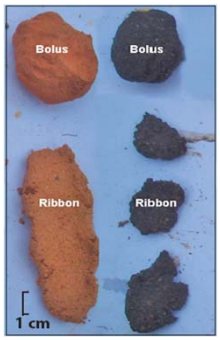
https://soilquality.org.au/
Fact Sheets

Soil Texture Groups

Texture Group	Texture Grades
Sands	sand, loamy sand, clayey sand
Sandy loams	sandy loam, fine sandy loam
Loams	loam, silty loam,
Clay loams	sandy clay loam, clay loam, silty clay loam, fine sandy clay loam, sandy clay
Light clays	silty clay, light clay, light medium clay
Medium-heavy clays	medium clay, heavy clay

Field Textural Determination

- 'Ribbon Test' developed to provide a fast and repeatable method for field description of in-situ soil texture
  - a subjective test
  - requires practice and skill development
- Determine relative proportions of silt, sand clay fractions based on moistened bolus
- Used to assess soil hydraulic capacity and infer design loading rate (DLR)
- Will be practiced in workshop later



Soil Structure

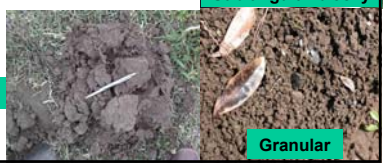
- Arrangement of soil particles into natural aggregates (peds)

- Describes the distinctness, size and shape of peds
- Described in terms of structureless, massive, weak (peds indistinct), moderate or strong structure (peds distinct)

Soil Structure

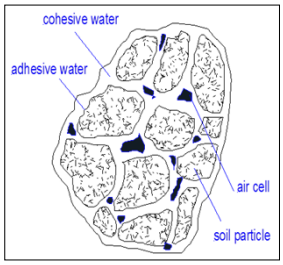
- Should be described from a 'fresh' vertical exposure
- CANNOT be assessed from an augered hole
- Soil structure affects; permeability, aeration, drainage, erosivity, surface condition, stability and general soil productivity

Drop Test Method



Water in Soil – Porosity

- Portion of soil occupied by air and water
- Determined by arrangement of solid particles
- Sands have large pore spaces between the particles, but few compared to silt or clay
- Soil pores may contain part solid matter, water and air



Range of porosities as %

- Sands - 25-50
- Silts - 35-50
- Clays - 40-70

Water in Soil – Suction

- Soil is hydrophilic – attracts water to its surface very strongly
- All soil pores act as capillaries; capillary forces control water movement between voids
- Suctions can be measured
- Sands contain mostly large pores so these can only be full at low suctions; clays with mainly smaller pores, require a wider range of suctions

Soil Water Terms

- Saturation
- Field Capacity
- Wilting Point

Water in Soil - Permeability

- Permeability or hydraulic conductivity is the velocity of movement of a fluid (water) through a porous medium relative to the pressure gradient (hydraulic head) which brings about the movement
- Not possible to precisely correlate percolation (determined by a "perc" test which is a falling head test and should **not** be used) with permeability

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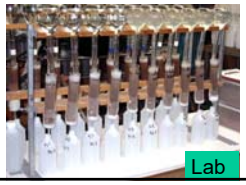
Water in Soil - Permeability

- Can be measured in the field or laboratory under standard conditions involving a constant head……or an assessment made based on soil texture (demonstrated at this course)
- In laboratory using constant head and columns (a soil sample is required plus necessary to know soil bulk density)



Field Permeability

In field permeameters can be used - constant head instruments: Talsma-Hallam (see Appendix G AS/NZS1547:2012), Guelph and Cromer permeameters

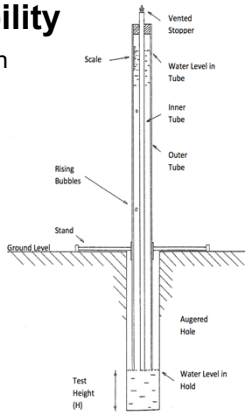


Figure 1: Schematic of a constant head tube permeameter

Water in Soil - Permeability

- Relate soil texture and structure from field and laboratory work to indicative clean water permeability - refer to tables in AS/NZS 1547:2012
- Coarser grained soils typically have higher K_{sat} than fine grained; some fine-grained soils can have higher K_{sat} due to structure such as cracking

Texture Group	Typical Permeability K_{sat} (m/d)
Gravels and sands	> 3.0
Sandy loams	1.4 – 3.0
Loams	0.5 – 1.5
Clay loams	0.06 – 1.5
Light clays	< 0.06 – 0.5
Medium-heavy clays	< 0.06

Other Key Soil Features

- **pH –** acidity/alkalinity
- **Electrical Conductivity -** salinity
- **Emerson Aggregate Class (EAC)** - soil structural stability and susceptibility to erosion
- **Cation Exchange Capacity (CEC)** - capacity of soil to hold and exchange cations (positively charged molecules)
- **Exchangeable Sodium Percentage (ESP)** - indicator of soil sodicity which affects soil structural stability and overall susceptibility to dispersion
- **Phosphorus sorption (P_{sorb})** - direct measure of ability of soil to adsorb (bind) phosphorus

Further Reading

- AS/NZS 1547:2012 On-site Domestic Wastewater Management &
- AS 1726:2017 Geotechnical Site Investigations, Standards Australia, SAI Global, Sydney, NSW.
- Geary, P.M., Whitehead, J. & Patterson, R. (1999) Skills to Assess the Suitability of Sites for On-site Wastewater Disposal, Environmental Health Review - Australia, 28, 2, 42-47.
- https://soilquality.org.au/ Fact Sheets on Soil Texture
- McKenzie N., Coughlan K. and Cresswell H. (2002) Soil Physical Measurement and Interpretation For Land Evaluation, CSIRO Publishing: Collingwood, Victoria.
- van de Graaff, R.H.M. & Alexander, J. (2008) The Percolation Test – A Test with False Pretensions, in Onsite and Decentralised Sewerage and Recycling Conference Proceedings – Coming Clean: Sustainable Backyards and Beyond, Benalla (Victoria) 12-15 October 2008. Australian Water Association, Sydney, NSW.

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