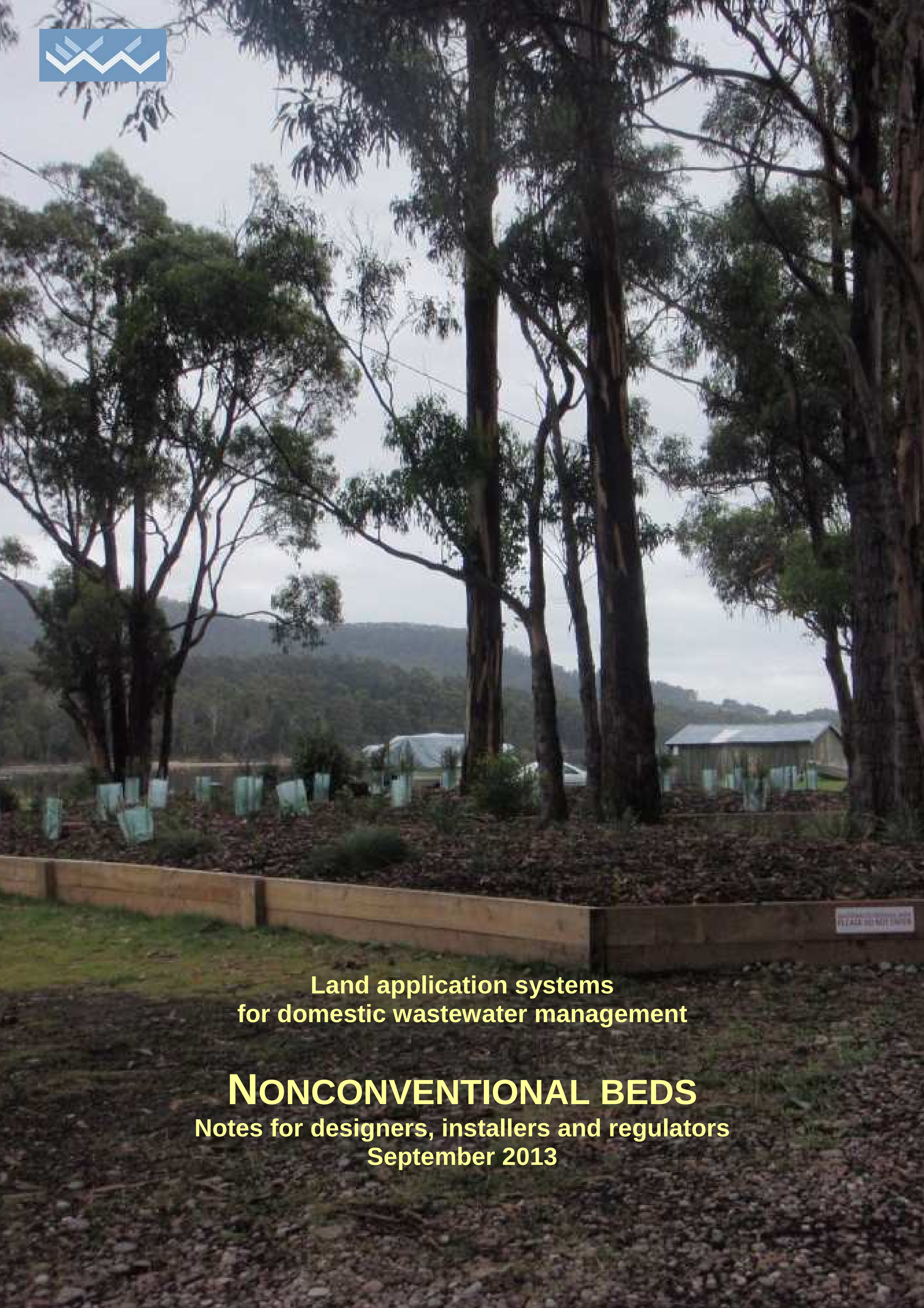


Land application systems
for domestic wastewater management

NONCONVENTIONAL BEDS

Notes for designers, installers and regulators
September 2013

Cover photo

Completed nonconventional bed, southern Tasmania.
Photo: Chris Lewis

Citation

Refer to this document as

> Cromer, W. C. (2013). Nonconventional beds: Notes for designers, installers and regulators, July 2013. Land application systems for domestic wastewater management. Unpublished report by William C Cromer Pty Ltd, 24 September 2013.

It replaces an earlier document of the same name

> Cromer, W. C. (2013). Nonconventional beds: Notes for designers, installers and regulators, July 2013. Land application systems for domestic wastewater management. Unpublished report by William C Cromer Pty Ltd, 7 July 2013.

Notes

This document is one of a series which attempts to disseminate design guidelines for land application systems for domestic wastewater. It was adapted from design specifications in Australian/New Zealand Standard 1547:2000 *On-site domestic-wastewater management*, other sources as cited, and more recently Australian/New Zealand Standard 1547:2012 *On-site domestic wastewater management*. Assessors, designers, regulators and installers in Australia and New Zealand should be familiar with the requirements of the later standard.

Subject to the requirements of local or national jurisdictions, the principles of wastewater management and the generic system designs described here ought to be globally applicable. For considerably more detailed information and guidance, the Excel-based software Trench®3.0, accepted Australia-wide since 1999, remains a valuable tool to help wastewater practitioners and regulators assess and size wastewater management systems. A free preview is available from www.williamccromer.com

This document aims to be a practical installation guide, and a discussion paper. It may be freely copied provided it or information in it is properly cited. Practitioners may have ideas on variations to the designs included here. Constructive comments are welcomed and ought to result in improved design guidelines.

People using this document should check that it has not been superseded by a later version.

> "This Standard does not preclude the use of any material, system, design or method of implementation provided the completed system and installation meet the performance requirements of this Standard…..Systems not covered by this Standard require advice from a suitably qualified and experienced person."
>
> Australian/New Zealand Standard 1547:2012 (Section 1.2.1.1)

Notes for Designers, Installers and Regulators in this series include

Conventional beds (2004)
Nonconventional beds (September 2013)
Bottomless sand filters (October 2013)

1. FUNDAMENTALS OF LAND APPLICATION SYSTEMS FOR WASTEWATER

1.1 Basic module

All land application (except some irrigation) systems for wastewater comprise a basic distribution module surrounded by soil.

The basic module comprises one or more perforated pipes or arches or both in a relatively thin bed of durable screened aggregate, with a filter cloth cover (Figure 1).

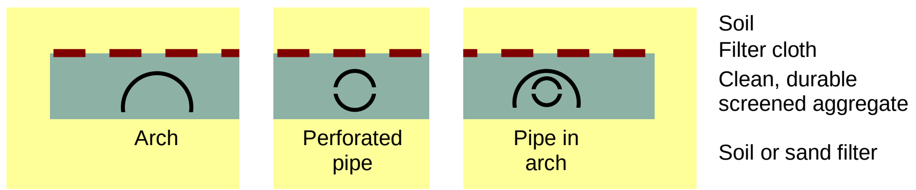
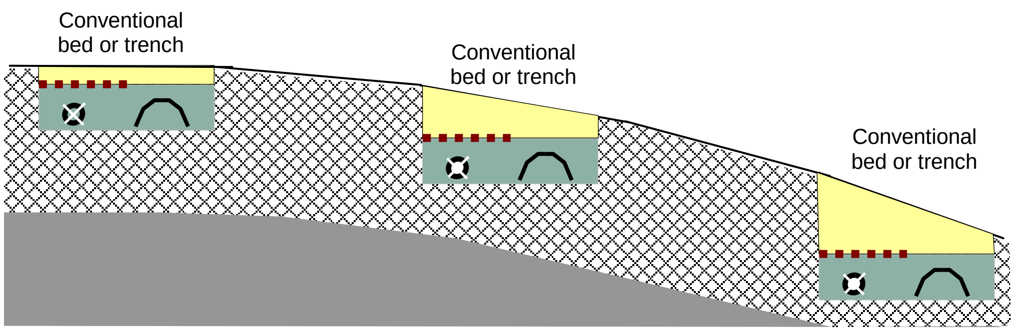


Figure 1 Basic module (section view)

The basic module may be wholly below the natural land surface, partly below natural surface, or fully above it (Figure 2).



Above. If existing soils are sufficiently thick, beds may be acceptable on increasingly steeper slopes by installing the basic module deeper, and backfilling with extra topsoil or imported soil. The basic module remains the same, and the bed remains in-ground, but the thickness of the topsoil or imported soil varies.

Below. If existing soils are relatively thin, beds may be acceptable on increasingly steeper slopes by raising the basic module partly or fully above ground (by definition, a nonconventional bed). The module is surrounded by natural or imported soil, to provide an additional treatment medium and to physically support the system. Wisconsin Mounds and Bottomless Sand Filters are special cases of nonconventional beds.

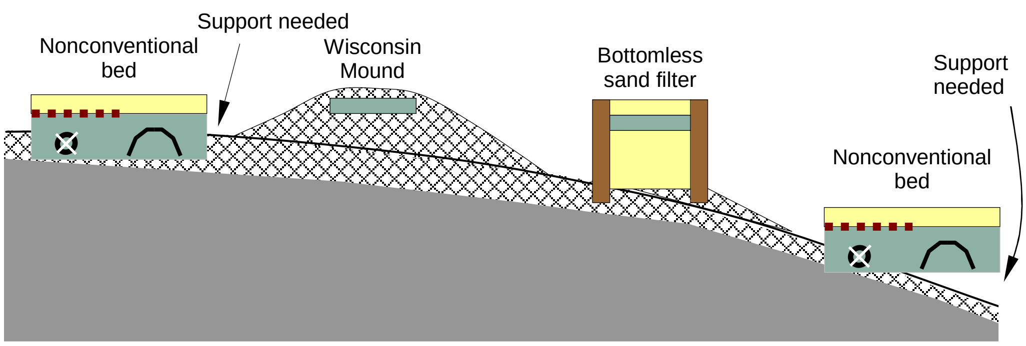


Figure 2. Basic module in relation to the ground surface (section views)

1.2 Wetted area requirements

The purpose of the basic module is to distribute wastewater evenly over a wetted area. The wetted area may be any shape in plan.

For trenches and beds, including nonconventional beds, the wetted area (ie the basic module) must be sized according to the Design Loading Rate (DLR) of the underlying soil profile. From this is derived the concept of a *minimum wetted area requirement*.

1.3 Primary and Secondary Disposal Areas

The Primary Disposal Area (PDA) is the wetted area of the basic module and any protective perimeter strip around it. The Secondary Disposal Area (SDA), if required, is the same size but not necessarily the same shape, as the PDA. The PDA may be divided into a number of subareas of any shape but wastewater must be delivered simultaneously to all of them.

1.4 Available Disposal Area

The Available Disposal Area (ADA) is the land area (eg of a typical residential lot) less all infrastructure, and after setbacks to downgradient, cross gradient and upgradient sensitive features have been applied. The PDA and SDA must both be wholly within the ADA, but may be anywhere within it.

The concepts of ADA, PDA, SDA, wetted area and setbacks are shown in Figure 3.

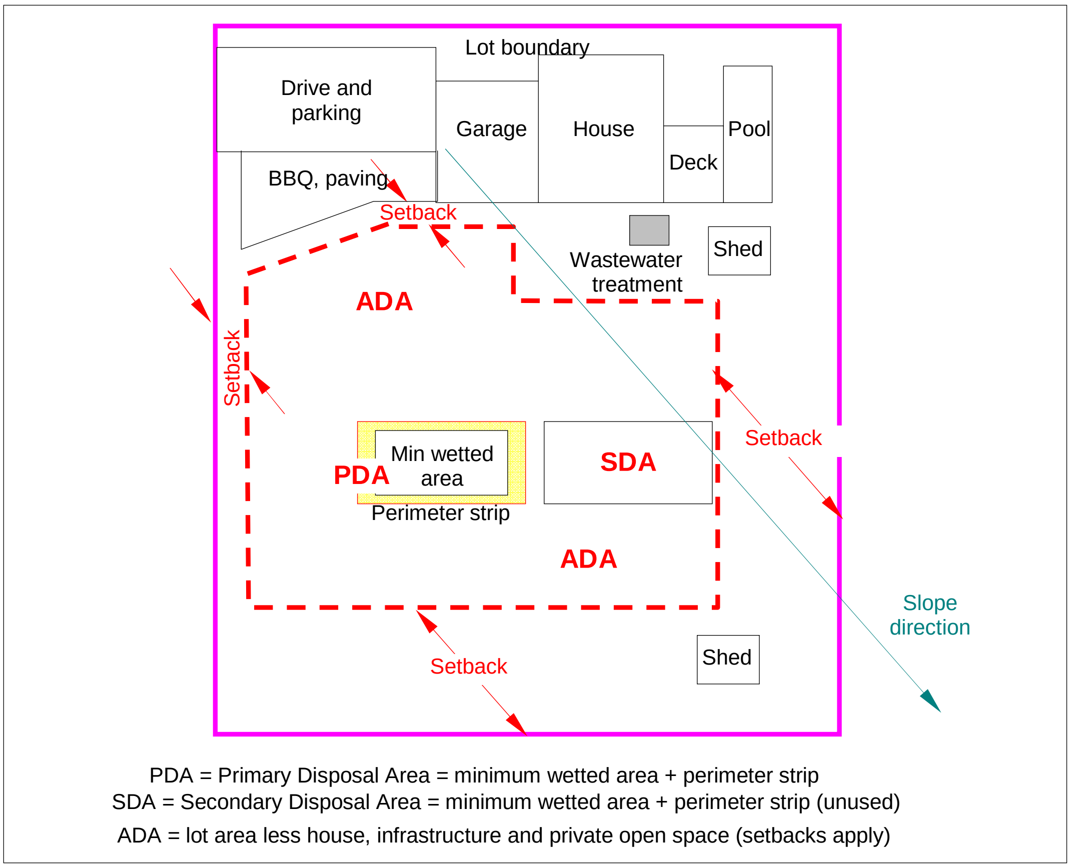
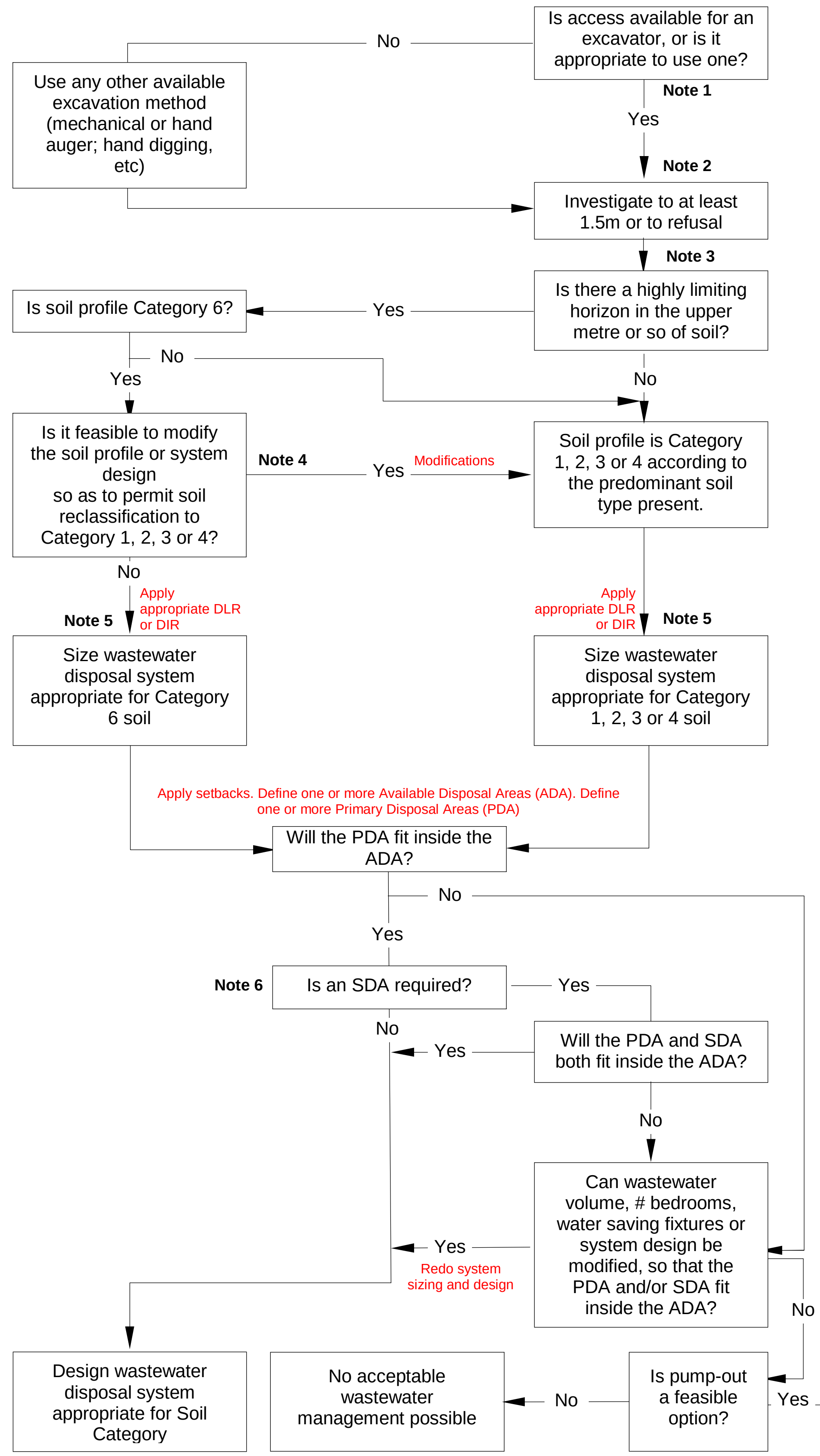


Figure 3 **Schematic diagram showing the relationship between lot size and various areas within the lot related to wastewater management. Setbacks are measured parallel to slope direction.**



Note 1. An excavator test hole provides much more information than a small diameter hole.

Note 2. Log, photograph, sample, test. Use USC system of classification and industry standard log sheets.

Note 3. Examples of highly limiting soil attributes include Category 5 and 6 soils, and any type of soil with permeabilities less than about 0.06m/day, such as many hardpans, dense to very dense clayey sands, sands, gravels, and weathered and/or fractured bedrock of many rock types. Also highly limiting might be shallow groundwater, depending on its quality.

Note 4. A common example of a modified soil profile is placing enough Category 1, 2, 3 or 4 soil over the Category 6 profile so as to cover the highly limiting horizon by about a metre or more.

Note 5. A DLR may be obtained from a selected Soil Category with reference to AS/NZS1547 (2012). These categories are indicative only and may be modified by experience, limiting soil horizons, soil permeability testing etc.

Note 6. Section 5.5.3.4 of AS/NZX1547 (2012) allows an SDA to be discretionary.

Figure 4 **Suggested flow chart for on-site wastewater assessment.**
Elements of this flow chart have been influenced by Schedule 12 of Sorell Council's Planning Scheme 1993 (amended 10 Aug 2011). Other approaches may be acceptable.

1.5 Soil categories

In Australia and New Zealand, AS/NZS 1547:2012 *On-site domestic wastewater management*, soil categories 1 – 6 are based on texture and structure (Table 1). Hydraulic loadings (Design Loading Rates, DLRs) or Design Irrigation Rates (DIRs) are then allocated. In Australia and New Zealand, DLRs and DIRs are expressed in terms of mm/day (equivalent to L/m^2/day).

Table 1 Soil categories used in Australia and New Zealand for on-site wastewater management

Soil category	Soil texture
1	Gravel and sand
2	Sandy loams
3	Loams
4	Clay loams
5	Light clays
6	Medium to heavy clays

Notes
1. Adapted from Table L1 of AS/NZS1547:2012 *On-site domestic wastewatrer management*
2. Category 2 – 6 soils are further subdivided on the basis of soil structure

The DLRs and DIRs can (and usually should) be amended to account for on-site permeability testing, or for limiting site conditions (see Section 2.1). In Tasmania, at local government level, Sorell Council has adopted a proactive approach[1] which requires that all soils with a limiting horizon in the top metre or so are classed as Category 6. This appears overly conservative but in practice it promotes lateral thinking and creative designs for difficult sites, and is inherently flexible. Aspects of it have been incorporated in a suggested approach to site assessment and wastewater management shown in Figure 4.

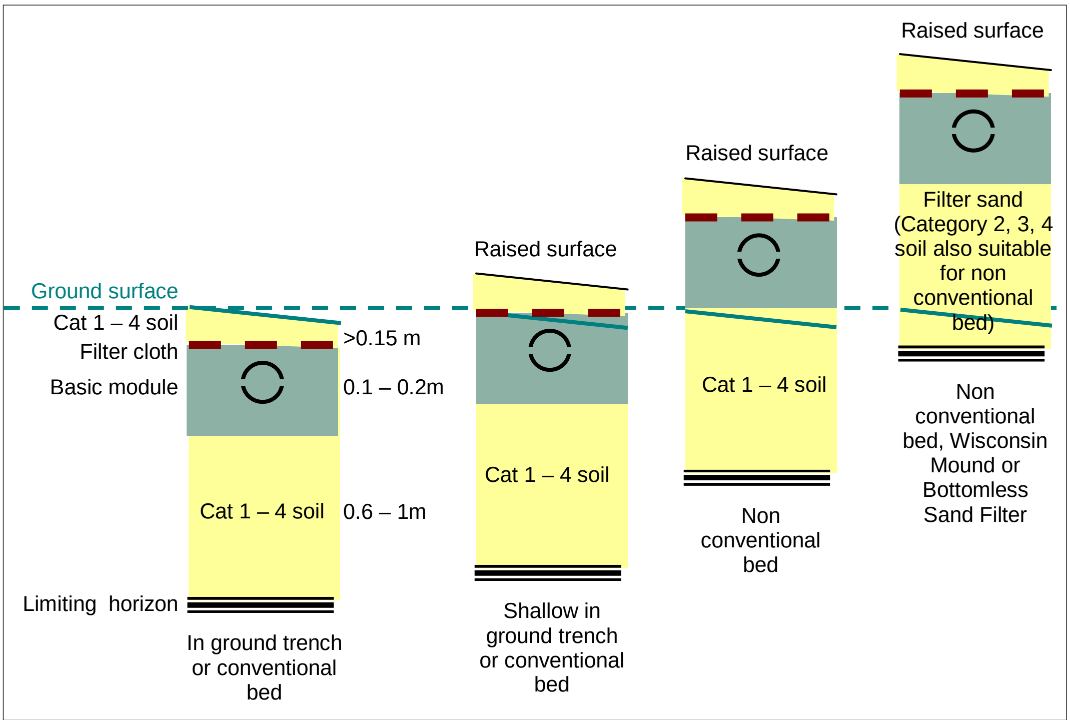


Figure 5. Cross sections of four wastewater disposal systems in relation to ground surface and the depth to a limiting horizon.
Adapted from Converse and Tyler (2000) and Cromer (2004)

[1] See Schedule 12 in http://www.sorell.tas.gov.au/planning-scheme

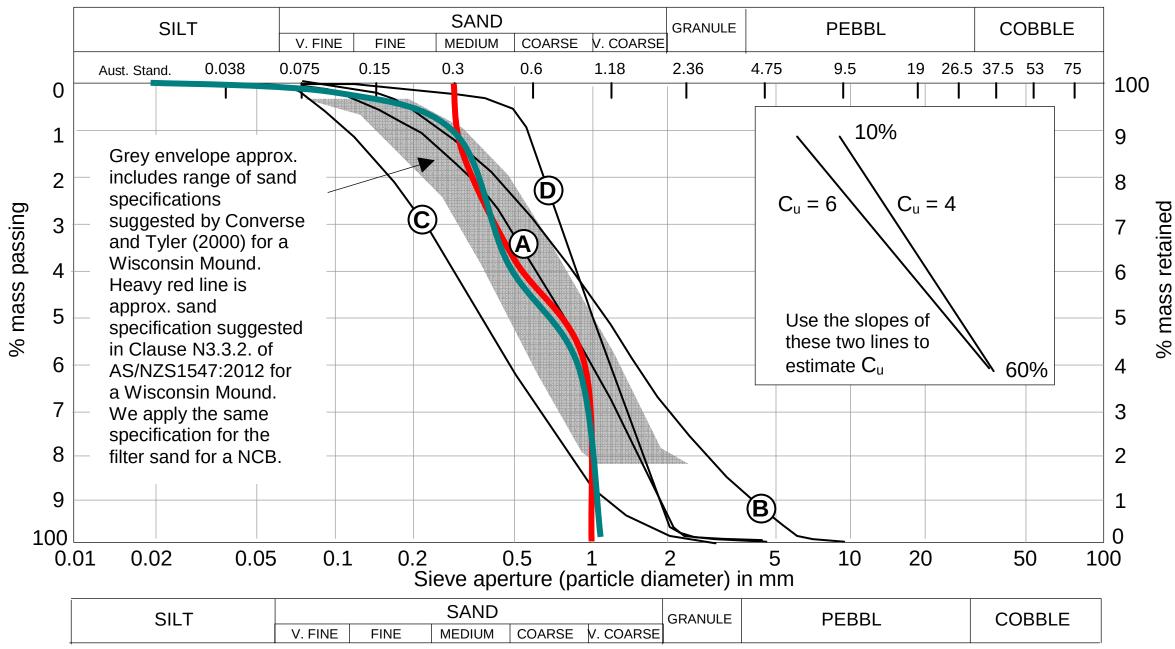
2. NONCONVENTIONAL BEDS (NCBS)

2.1 Sites suitable for NCBs

NCBs can be installed at any site or on any soil, but are best suited (Figure 5) to sloping sites with limiting conditions in the upper metre or so of natural soil. Examples of highly limiting soil attributes include Category 5 and 6 soils, and any type of soil with permeabilities less than about 0.06m/day, such as many hardpans, dense to very dense clayey sands, sands, gravels, and weathered and/or fractured bedrock of many rock types. Also highly limiting might be shallow groundwater, depending on its quality.

NCBs may receive effluent from a range of sources: for example,

- primary-treated effluent via gravity flow from a septic tank equipped with an outlet filter,
- primary-treated effluent from a float-operated pump in a pump pit installed after a septic tank, employing intermittent pressure dosing (preferably on a time rather than demand basis[2]), or
- secondary-treated effluent from an aerated wastewater treatment system.



(A) "Medium washed sand" from *Island Resources* near Scottsdale (Phone 6352 2500). Also stockpiled at Boral Quarries, Brighton. Cu = 5; effective diameter = 0.2mm. Analysis curve reported by T. Rainbow 15 01 03.

(B) "Coarse washed sand" from *Island Resources* near Scottsdale (Phone 6352 2500). Also stockpiled at Boral Quarries, Brighton. Cu = 6.5; effective diameter = 0.25mm. Analysis curve reported by T. Rainbow 15 01 03.

(C) "Normal coarse sand" from *G. L. and D. H. Males* near Scottsdale (Phone 6223 6088). Cu = 4; effective diameter = 0.12mm. Analysis curve reported 15 01 03.

(D) "Propagating sand" from *G. L. and D. H. Males* near Scottsdale (Phone 6223 6088). Cu = 2; effective diameter = 0.6mm. Analysis curve reported 15 01 03.

Figure 6. Grain size curves for Tasmanian screened sand materials (slightly modified from Cromer, 2004). The red and green lines are two of a series of curves that comply with Clause N3.3.2 of AS/NZS1547:2012; in both cases, the C_u is about 3.3.

[2] Demand dosing may result in most effluent arriving at the NCB in the mornings and evenings. Time-based dosing permits regular smaller doses throughout the 24 hour period, promoting biological activity and effluent treatment in the NCB.

In all cases, additional treatment at the NCB is achieved via vertical infiltration through a layer of on-site or imported soil, or filter sand[3]. If on-site or imported soil is used, it must be Category 1, 2, 3 or 4 but not Category 5 or 6. If filter sand is used, it is desirable it meets or closely conforms to the requirements of Clause N3.3.2 in AS/NZS1547:2012 ie the sand must be of medium grain size in the range 0.25 – 1.0mm with a uniformity coefficient (C_u)[4] less than 4, with less than 3% of fines passing a 0.074mm sieve, and be free of clay, limestone, and organic matter (Figure 6).

Figure 7 provides general guidance on the effectiveness of sand filters for removing biochemical oxygen demand (BOD), total suspended solids (TSS), total nitrogen (N), Total phosphorus (TP) and faecal coliforms (thermotolerant coliforms).

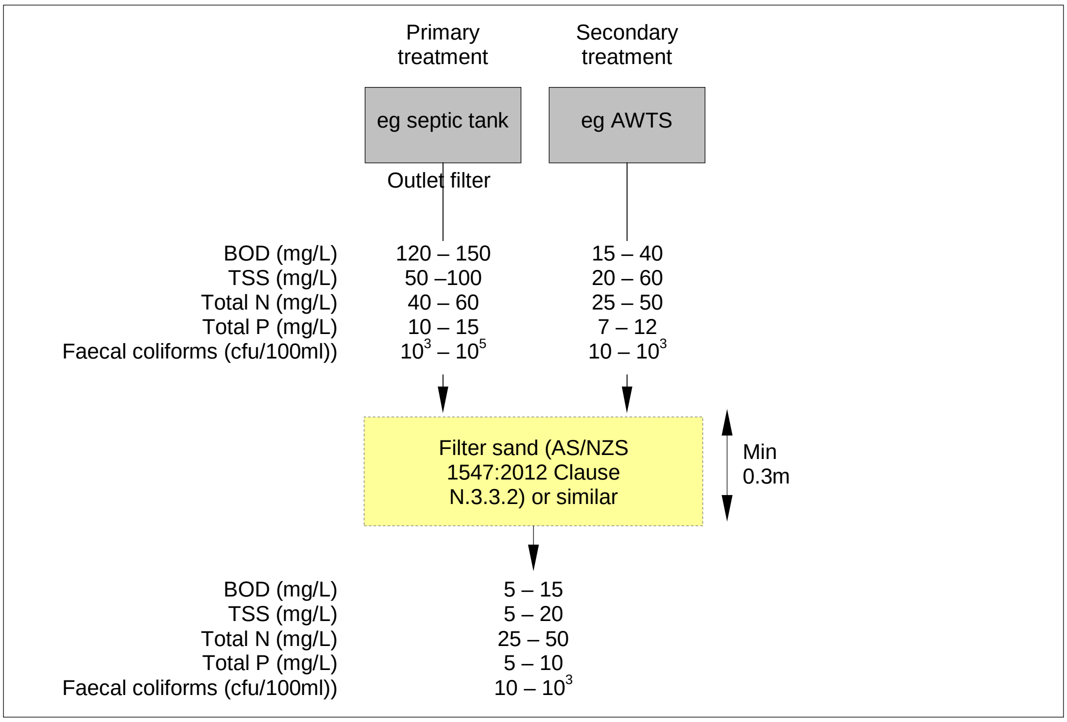


Figure 7. Approximate treatment efficiencies of filter sand

Constituent ranges in Figure 7 have been derived with reference to the following:

Amador, J., Potts, D., Patenaude, E., and Görres, J. (2008). Effects of Sand Depth on Domestic Wastewater Renovation in Intermittently Aerated Leachfield Mesocosms. *J. Hydrol. Eng.* 13, SPECIAL ISSUE: Interactions between Onsite Waste Water Systems and the Environment, 729–734.

Anon (1999). Wastewater Technology Fact Sheet: Intermittent Sand Filters. US EPA 932-F-99-067 September 1999. http://water.epa.gov/aboutow/owm/upload/2005_07_14_isf.pdf

Anon (date?). Sustainable Wastewater Management: A handbook for smaller communities. Part 3: Options for Wastewater Servicing. Minister for the Environment, New Zealand http://www.mfe.govt.nz/publications/waste/wastewater-mgmt-jun03/html/part3-section10.html#table10-2

Information menu in Trench®3.0. See Cromer, W. C. (1999). Trench™3.0: A computer application for site assessment and system sizing, in Patterson, R. A. (Ed.) *On-site '99 – Proceedings of the On-Site '99 Conference: Making on-site wastewater systems work*. University of New England, Armidale, 13-15 July 1999, pp 85-88.

Rodgers, M., Walsh, G., Healy, M.G. (2011). Different depth sand filters for laboratory treatment of synthetic wastewater with concentrations close to measured septic tank effluent. *Journal of Environmental Science and Health*, Part A: Toxic/Hazardous Substances and Environmental Engineering 46(1):80-85. http://aran.library.nuigalway.ie/xmlui/bitstream/handle/10379/2904/Aran_Rodgers_et_al._J.Env.Sci.Health.pdf.pdf?sequence=1

---

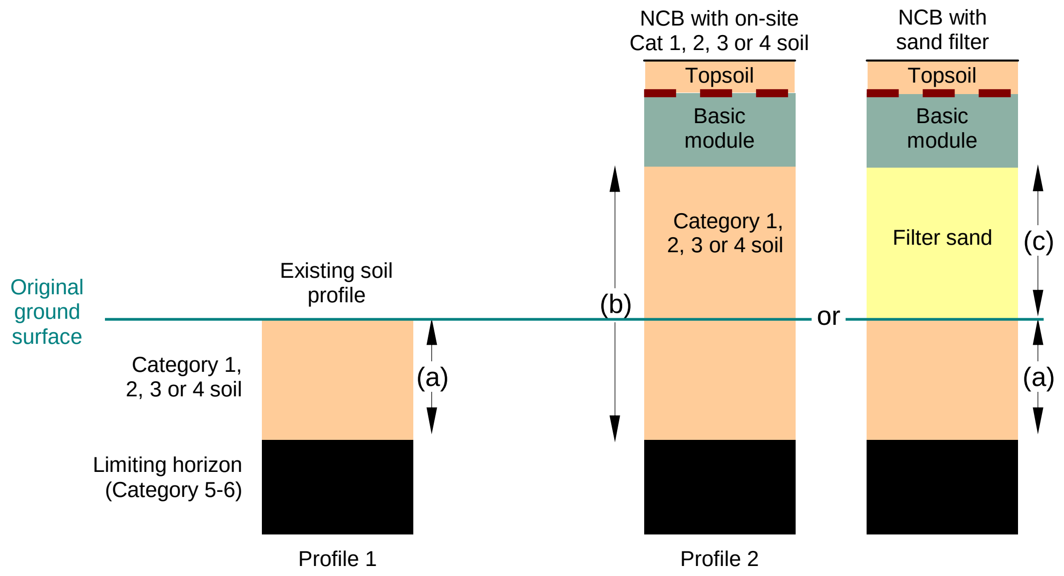
[3] Converse, J. C. (2000). Pressure distribution network design. *Small Scale Waste Management Project, University of Wisconsin-Madison.* www.wisc.edu/sswmp/ and Converse, J. C. and Tyler, E. J. (2000). Wisconsin Mound Soil Absorption System: Siting, Design and Construction Manual. *Small Scale Waste Management Project, University of Wisconsin-Madison.* www.wisc.edu/sswmp/

[4] The uniformity coefficient (C_u) is the ratio of the sieve aperture sizes retaining 40% and 90% of the material. A sieve or grain size analysis is required to calculate C_U. A perfectly uniform sand, with every particle of the same size, would have a C_U of 1. A silty sand with grains ranging from silt to coarse sand would have a C_U of between about 2 and 4. A very poorly sorted material, with (say) equal amounts of silt, sand, granules and pebbles, would have a C_U of about 100.

For on-site or imported Category 1 – 4 soil, or for filter sand, an average minimum thickness of about 0.3 – 0.4m is required, and there is evidence that increasing the thickness beyond this does not significantly increase effluent treatment[5].

2.2 Design loading rates (DLRs) for NCBs

The design loading rate (DLR) for an NCB is less than or equal to the loading rate of the least capable (permeable) soil within the first metre or so beneath the basic module (Figure 8). This in turn implies that wastewater movement in the soil profile will be predominantly vertical, so that the concept of linear loading rates applied to Bottomless Sand Filters (BSFs) and Wisconsin Mounds (WMs) does not apply.



In Profile 1, if (a) is less than about one metre, the profile is Category 6, and a NCB, Bottomless Sand Filter (BSF), Wisconsin Mound (WM) or similar system ought to be considered for wastewater disposal.

In Profile 2, the NCB has been constructed by adding Category 1, 2, 3 or 4 soil to the natural ground surface. If (b) is more than about one metre, a DLR appropriate to Category 1, 2, 3 or 4 soil (as the case may be) should be used to size the NCB. If (b) is less than about one metre, the profile is Category 6 and a DLR appropriate to that Category should be used to size the NCB.

In Profile 3, the NCB has been constructed by adding filter sand to the natural ground surface. If (c) is more than about one metre, a DLR appropriate to a sand filter should be used to size the NCB. If © is less than about a metre, but (c) + (a) is more than about one metre, a DLR appropriate to Category 1, 2, 3 or 4 soil (as the case may be) should be used to size the NCB. If (c) + (a) is less than about one metre, the profile is Category 6 and a DLR appropriate to that Category should be used to size the NCB.

Figure 8. The design loading rate (DLR) of an NCB, and hence the size of its basic module, is less than or equal to the loading rate of the least permeable soil in the first metre or so beneath the basic module.

[5]For example, Amador et al (2008) report ""The depth of soil below the absorption trench of a septic system is considered an important factor in protection of groundwater. We examined the effects of depth on the ability of intermittently aerated sand-filled leachfield mesocosms to renovate domestic wastewater. Mesocosms (*n*=3) consisted of lysimeters with a headspace O_2 concentration maintained at 0.21mol/mol and containing 7.5, 15, or 30cm of sand that were dosed with septic tank effluent every 6h for 328 days (12cm/d) . Sand depth had no effect on pH, dissolved O_2 , PO4 , NH4 , or BOD5 levels in percolate water. Nitrate levels in percolate water were higher for 30cm than for 7.5 and 15cm during the first 70d of the experiment, after which no differences were observed. Time-averaged removal rates of N, P, fecal coliform bacteria, and BOD5 were 22–28, 13–18, 81–92, and 81–99%, respectively, and were unaffected by depth. Wastewater renovation in intermittently aerated leachfield mesocosms appears to take place in a narrow zone (≤7.5cm) below the infiltrative surface, with the medium below contributing little to renovation." (Amador, J., Potts, D., Patenaude, E., and Görres, J. (2008). "Effects of Sand Depth on Domestic Wastewater Renovation in Intermittently Aerated Leachfield Mesocosms." *J. Hydrol. Eng.* 13, SPECIAL ISSUE: Interactions between Onsite Waste Water Systems and the Environment, 729–734.)

DLR ranges for Category 1 – 6 soils in Australian and New Zealand conditions are summarised in Table 2.

Table 2 Design Loading Rates (DLRs) for soil categories used in Australia and New Zealand for on-site wastewater management

		Design loading rates (L/m²/day)	
		Nonconventional beds	
Soil category	Soil texture	Primary treated wastewater	Secondary treated wastewater
1	Gravel and sand	20 – 35	50
2	Sandy loams	15 – 30	50
3	Loams	10 – 25	30 – 50
4	Clay loams	4 – 15	20 – 30
5	Light clays	5 – 10	5 – 10
6	Medium to heavy clays	3 – 5	8

Notes
Based on Table L1 of AS/NZS1547:2012. See Notes attached to Table L1.
Rate of primary treated wastewater for Cat 6 soils is from this report
Rate ranges based on degree of soil structure development
L/m²/day is the same as mm/day.

2.3 Domestic wastewater flow rates

In Australia, AS/NZS1547:2012 (Table H1) allows 120L/day/person (for a house on a roof water tank supply) or 150L/day/person (for a house on a reticulated or bore water supply). Assume about 2 persons per bedroom, or 250L/day/bedroom and 300L/day/bedroom respectively. Rooms or spaces such as studies, offices, etc are regarded as bedrooms to estimate daily wastewater volume.

For Australian conditions, AS/NZS1547:2012 permits no variation to these figures for any water saving fixtures in a dwelling.

2.4 Sizing a NCB

There are two steps involved in sizing a NCB.

2.4.1 Calculate the minimum wetted area of the basic module

To calculate the minimum size of the basic module, (ie the minimum wetted area requirement of the disposal area):

- allocate a daily wastewater volume (V; L/day), and
- divide the daily wastewater volume by a DLR (Table 2) appropriate to the soil profile (Figure 7) and to primary or secondary treated effluent.

A more rigorous water balance approach[6] which accounts for evapotranspiration and rainfall can be used to refine these calculations.

Example 1
A four-bedroom equivalent house with reticulated water has a primary-treated wastewater volume of 1,200L/day. Natural soils are moderately structured Category 3 loams 0.5m thick

[6] For example, see the software application Trench®3.0. Cromer, W. C. (1999). *Trench™3.0: An AIEH computer software application for managing on-site wastewater disposal*. Environmental Health Review, May 1999, pp 23-25, and Cromer, W. C. (1999). Trench™3.0: A computer application for site assessment and system sizing, in Patterson, R. A. (Ed.) *On-site '99 – Proceedings of the On-Site '99 Conference: Making on-site wastewater systems work*. Univ. of New England, Armidale, 13-15 Jul 1999, pp 85-88.

over Category 6 clay. The BSF will use additional on-site soil so the combined thickness (Profile 2 in Figure 8) is about 0.8 – 1m. What is the minimum wetted area required for the basic module?

Answer
From Figure 7, the soil profile is Category 3. From Table 2, Category 3 DLRs for primary treated wastewater range from 10 – 25mm/day. Conservatively, a DLR of 15mm/day is appropriate for moderately structured loams.

Minimum wetted area (A; m^2) of basic module is

$$A = V \div DLR$$

$$A = 1{,}200L/day \div 15L/m^2/day = 80m^2$$

The length (L) and width (W) of the basic module is allocated to suit on-site conditions.

The required minimum wetted area may comprise one, two or more separate sub-areas provided wastewater is supplied to each proportionately and simultaneously.

2.4.2 Apply a perimeter strip to the basic module

A perimeter strip nom. 0.8m wide on al sides should be applied to the basic module so that wastewater discharge is not excessively close to the edge of the system (Figure 9).

Basic module + perimeter strip = Primary Disposal Area (PDA)

The basic module of a NCB may be laterally supported by a retaining wall (of any construction except that it shall have no foundation in the soil), or a toe of soil.

Example 2
The basic module of the house in Example 1 is 16 m long and 5m wide. A perimeter strip 1m wide is allocated to all four sides. What is the minimum area of the PDA?

Answer
Basic module length = 16m
Add 1m to each end
PDA length = 18m

Basic module width = 5m
Add 1m to each end
PDA width = 7m

PDA area = 18m x 7m = 126m2

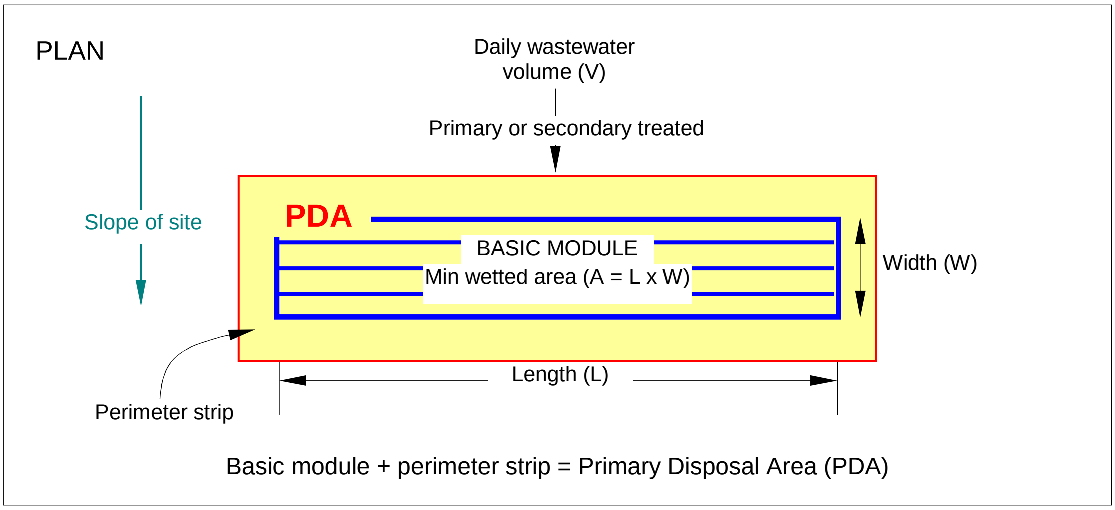


Figure 9. Schematic showing the basic module and perimeter strip of a NCB

2.5 Construction and installation notes for NCBs

2.5.1 General comments

These construction and installation notes are derived from Converse (2000)[7], Converse and Tyler (2000)[8], Cromer (2004)[9], AS/NZS1547:2012 Section L7 and more than ten years' experience installing NCBs in southern Tasmania.

The following notes, specifications, diagrams and photographs are intended as guidance only for NCBs. They may be amended to suit individual sites provided the system performance is not compromised. They may also be copied and used by interested parties.

Attachments 1, 2 and 3 contain photographs of NCBs at various stages of construction.

2.5.2 Suggested construction and installation steps

1. Prior to construction, protect the disposal site from vehicular access to avoid soil compaction. Also prohibit vehicles (eg backhoes, excavators, bobcats, cars) from moving over and damaging, the soils on the downslope side of the system.

2. Clear the disposal site of trees, shrubs and grass. Remove stumps and backfill stump holes. Scour or rip the existing soil to about 0.2 – 0.3m. Avoid vehicular access over the disposal site while ripping, and rip along, not across, the contours.

3. Mark out the perimeter of the bed with garden stakes or similar. Sizing the system is done in accordance with AS/NZS1547:2012 and/or Trench®3.0.

4. Excavation work (if any) shall not damage the soil. Avoid smearing or compacting the soil, and puddling. Excavate only in fine weather. Avoid excavating clayey soils when their moisture content is above the plastic limit. Rake surfaces which smear. Use teethed buckets if excavating by machine. Where excavation is necessary, excavate the bed parallel to contours on sloping ground, and maintain a level base and vertical sides.

5. In dispersive soils, gypsum may be applied during construction to the base of the bed at a rate of $1kg/m^2$, or as otherwise advised after consultation with a soil specialist. Complete construction as soon as possible.

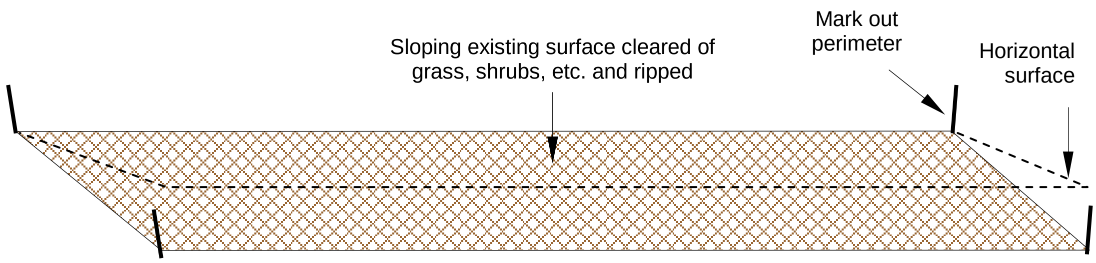


Figure 10. Steps 1 – 5. Protect, clear, mark out, add gypsum if required

6. For the PDA (ie basic module and perimeter strip), create a level surface of the required dimensions (wedge-shaped in cross section) by using on-site or imported Category 1, 2, 3 or 4 soil, or filter sand. IMPORTANT: For sites with Category 1 natural soils (as defined by AS/NZS 1547:2012), use only Category 1 sand (not gravel) or filter sand as fill for the bed. For all other sites (with Category 2 to Category 6 natural soils), use Category 1, 2, 3 or 4 soil

[7] Converse, J. C. (2000). Pressure distribution network design. *Small Scale Waste Management Project, University of Wisconsin-Madison.* www.wisc.edu/sswmp/
[8] Converse, J. C. and Tyler, E. J. (2000). Wisconsin Mound Soil Absorption System: Siting, Design and Construction Manual. *Small Scale Waste Management Project, University of Wisconsin-Madison.* www.wisc.edu/sswmp/
[9] Cromer, W. C. (2004). Land application systems for domestic wastewater management – Notes for Designers, Installers and Regulators (Draft). Nonconventional bed. Unpublished discussion paper by William C Cromer Pty Ltd, May 2004.

(not gravel) or filter sand in accordance with Figure 8. Do not use heavy plant on the filled surface. Foot traffic only.

If the bed is not to be supported by a retaining wall, grade the downslope edge of the fill to nominally 1:3, or as specified. Lightly compact, particularly along thicker, downslope edge. Grade both ends to suit slope. <u>It is important in gravity-flow systems that the surface of the filled area remains level to a tolerance better than 5mm during and after construction.</u> Use a dumpy or laser level to ensure this. System failure is likely if the surface is not sufficiently level. A very slightly raised rim of fill laid outside of and around the distribution grid may be effective in preventing overflow of wastewater.

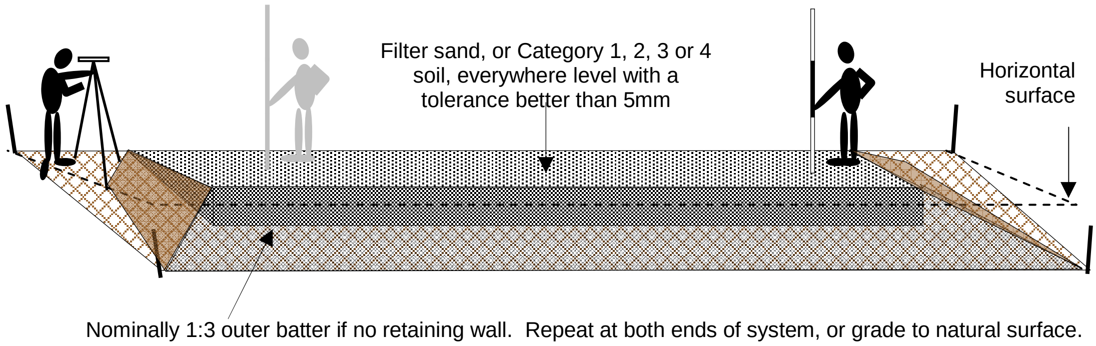


Figure 11. Step 6. Create a level surface of suitable sand-fill; lightly compact; grade edges or retain with wall

7. Next, start constructing the basic module by first carefully placing nominally 50mm of clean, durable 10 – 20mm distribution aggregate evenly over the surface of the fill. Use a dumpy or laser level to ensure the aggregate surface is everywhere level. If required, construct the retaining wall along the downslope side.

8. Lay the distribution pipework on the horizontal distribution aggregate. Keep all pipework at least one metre back from the outer edge or sides of nonconventional beds to minimise leakages. Make all pipework level to a tolerance better than 5mm. Use 90 – 100mm diameter PVC pipework for gravity flow systems, and 25mm and 32mm colour-coded polyethylene pipe if the system is pressurised. Where required, connect up lateral pipework with transverse pipes to form a grid. Make good all pipe joins according to manufacturer's instructions. Install appropriate inspection openings for gravity-flow systems. For pressurised systems, install flush points, or a non-perforated return pipe and valve from the end of the distribution pipework back to the pump chamber, to assist in keeping the system clear of blockages.

9. If not previously done, perforate the distribution pipework.

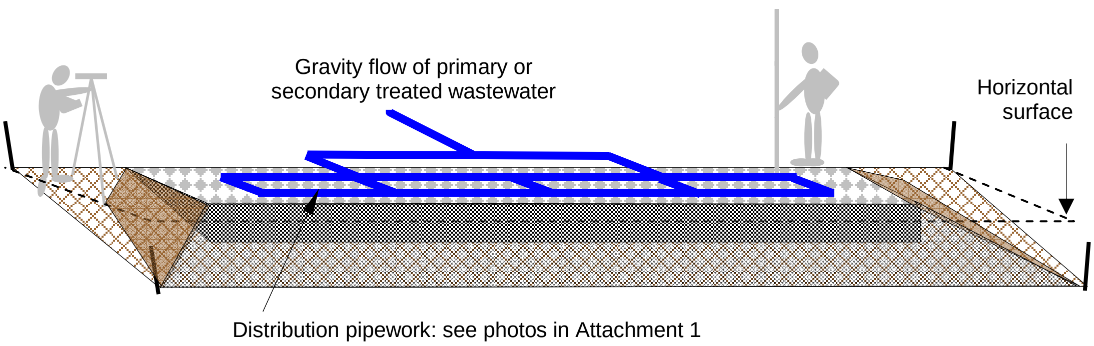


Figure 12. Steps 8 and 9. Lay a distribution grid of pipework over the aggregate surface

10. If required at this stage, install below-ground delivery pipe (90 – 100mm diameter PVC if gravity flow; smaller diameter PVC or polyethylene if system is pressurised), or install later if delivery pipe enters above natural ground level. For pressurised systems, install a return line from the PDA to the pump pit, fitted with a valve at the pump pit, to allow flushing of the system.

11. Mark out the locations of pipes, inspection openings, flush points, etc. in a permanent fashion. So that the householder can locate the system in future, draw a sketch with accurate dimensions and with marked distances from fixed locations.

12. For gravity flow systems. Do a pre-commissioning gravity-flow test after all components are in place, but before the distribution system is covered. Fill the system with water. Check for leaks. Ensure that effluent will flow uniformly from all perforations in the distribution system.

13. For pumped systems. Do a pre-commissioning pump test after all components are in place, but before the distribution system is covered. Follow the pump manufacturer's instructions. Check for leaks. Make sure the pumping system works properly. Ensure that effluent will flow uniformly from all perforations in the distribution system. Check that the visible and audible high-water level alarm for the pump is operating. It is assumed that the pump-out chamber for the pump is of adequate volume.

14. Place caps on all inspection openings. Lay the rest of the distribution aggregate so that the pipework is covered.

15. Place a durable, permeable filter cloth over the distribution aggregate. Ensure inspection openings are clear. Extend inspection openings to final surface level, or finish below grade and later permanently mark their positions so they can be located later.

16. Place 100 – 150mm of topsoil over the filter cloth to the specified thickness. If burrowing animals are likely to be a problem, place a cover of wire mesh either in or at the base of the topsoil over the PDA. Grade topsoil down outer face, or use retaining wall, as specified. Where required, sow grass or plant shallow-rooted shrubs, or otherwise finish off with light-weight structures. Install an upslope cut-off drain if required.

17. The system may need to be inspected and checked at various stages of construction. Check with the local authority, or designer. Commissioning may also require a separate inspection. A report of the commissioning may also be required by the local authority.

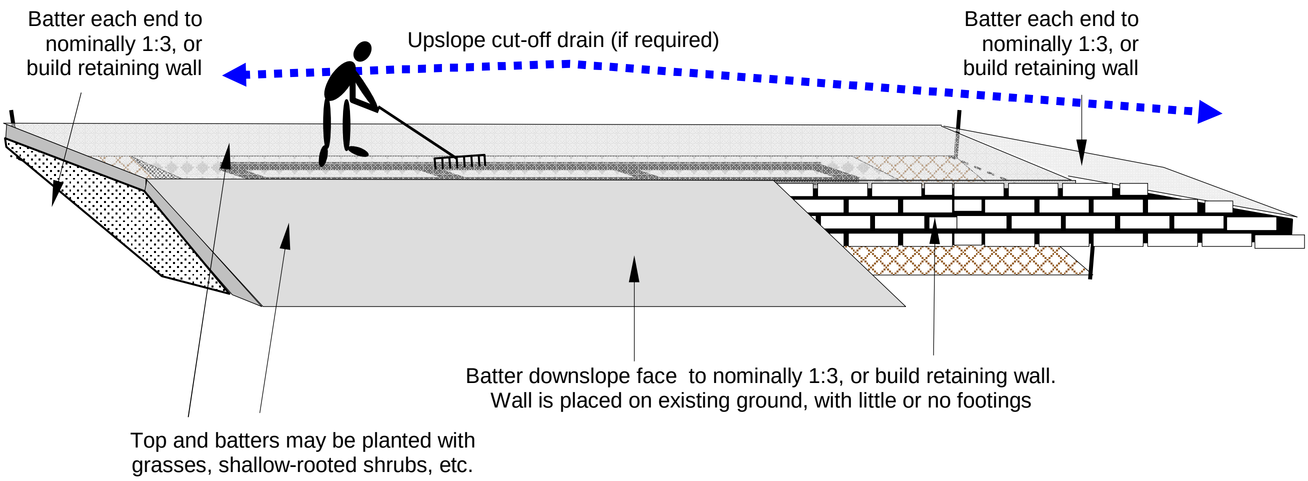


Figure 13. Step 16. Place topsoil over the filter cloth to the specified thickness. Grade topsoil, or build retaining walls

Attachment 1

Constructing a gravity-fed NCB

All photographs courtesy of Chris Lewis Plumbing unless otherwise indicated

Plate 1 (above). This NCB was sized to Category 6 on-site subsoil, but with 0.3 – 0.4m of Category 4 topsoil. Accordingly, it could be constructed as a cut-and-fill operation where the outer edge is built up using soil from the inner edge.

Plate 2 (below). Clean durable 10 – 15mm screened aggregate nominally 50mm thick was placed and levelled over the fill.

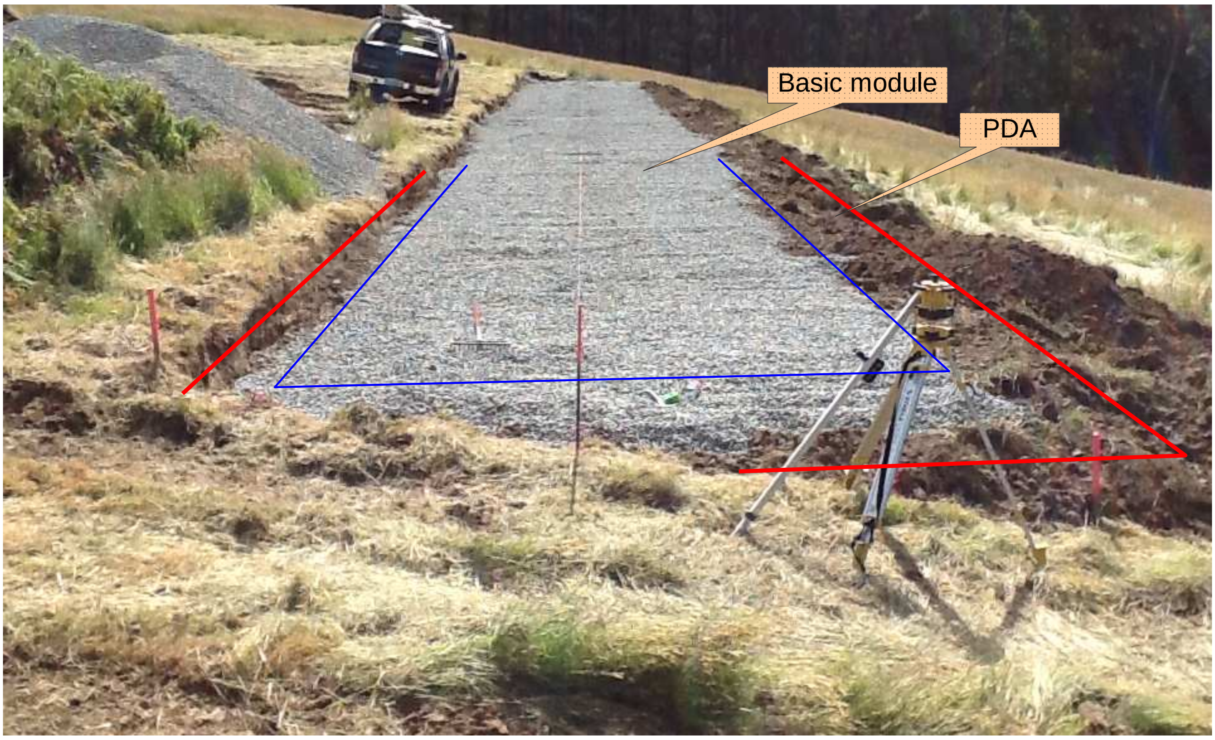


Plate 3 (above). Distribution pipework (100mm PVC, unperforated) laid and levelled (to a tolerance better than 5mm) over aggregate base. Inspection openings are installed at each corner, but could be installed at each end of each length of pipe. Note transverse connecting pipes and battered outer edge of fill. Before covering the pipework with more aggregate, the system is filled with water, circular 3 – 4mm holes are drilled in the pipework, at first several metres apart, but later infilled to about one metre centres, as the outflow from each is checked to ensure even coverage.

Plate 4 (below). It is important that the drill holes (one side only of the pipework) are all the same distance from the pipe invert, otherwise lower holes will preferentially discharge and the full wetted area would not be achieved.
Photo: Bill Cromer

Plate 5 (above). Perforated pipework under test.
Photo: Bill Cromer

Plate 6 (below). Pipework perforated, levelled, tested and being covered with aggregate.

Plate 7 (above). Screened aggregate covering distribution pipework. Inspection openings extended to final surface

Plate 8 (below). Filter cloth cover over aggregate

Plate 9 (above). Final cover of 150mm loam before landscaping.

Plate 10 (below). A two-way distribution box after the septic tank directs wastewater equally to each of two equally-sized PDAs.

Attachment 2

Constructing a pressurised NCB

All photographs courtesy of Chris Lewis Plumbing

Plate 1 (above). Rip beneath basic module; stockpile filter sand. The soil is Category 6 clay to the surface. The PDA is sized to account for this, using a DLR of 3mm/day.

Plate 2 (below). Spread and level filter sand to required thickness; batter the sides.

Plate 3 (above). Place and level nominal thickness of 50mm of durable, clean screened aggregate over the filter sand.

Plate 4 (below). Lay unperforated, colour-coded 25mm polyethylene pipe over the aggregate.

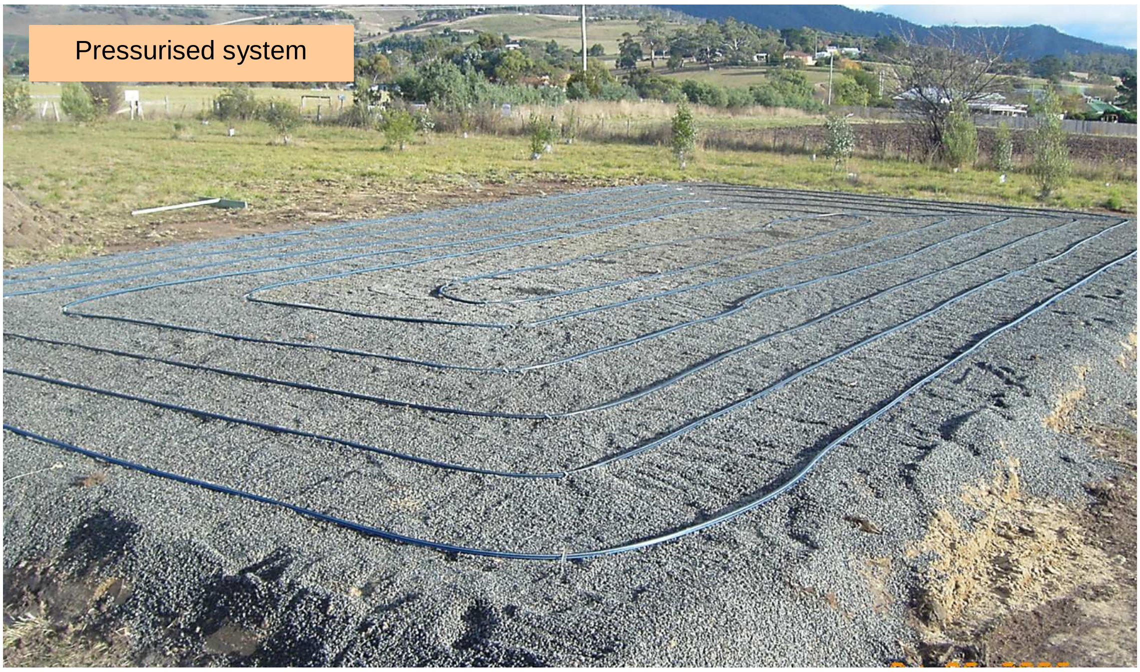
Plate 5 (above). The pump pit is filled with water, a few initial 3 – 4mm diameter holes drilled at random in the pipework, and the pump turned on. Add more drill holes, nominally at about one metre centres, as the outflow from each is checked to ensure even coverage.

Plate 6 (below). Cover pipework with aggregate, filter cloth and nominally 150mm of loam before landscaping.

Attachment 3

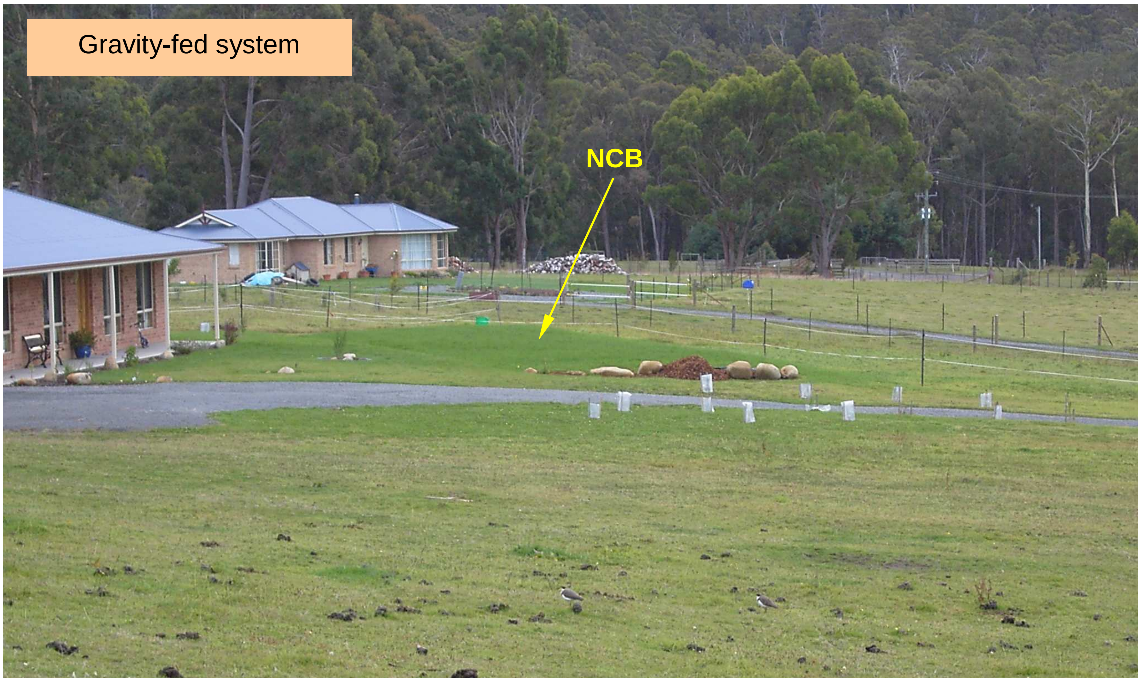
Examples of gravity-fed and pressurised NCBs

All photographs : Bill Cromer



Above. NCBs that receive wastewater under pressure (eg from a pump, or a sufficient gravity head) need not be levelled to the same high tolerance (5mm) as gravity flow systems. They can also be constructed of polyethylene pipe laid in any fashion which uniformly covers the basic module. Perforations are drill holes about 3-4mm in diameter at nominally 0.8m intervals, but it is best to lay the pipework unperforated, and add holes by trial and error during water testing. Excess holes can be plugged, or others added. The conventional (in-ground) bed below is in the process of testing. Use short lengths of pipe to join different parts of the system, to help equalise pressure. A return line to the pump pit, with a control valve attached, should be installed to permit flushing of the pipework from time to time.

Below. Completed and grassed NCB.



Above. This nonconventional bed received gravity flow wastewater from a septic tank up the slope at right.

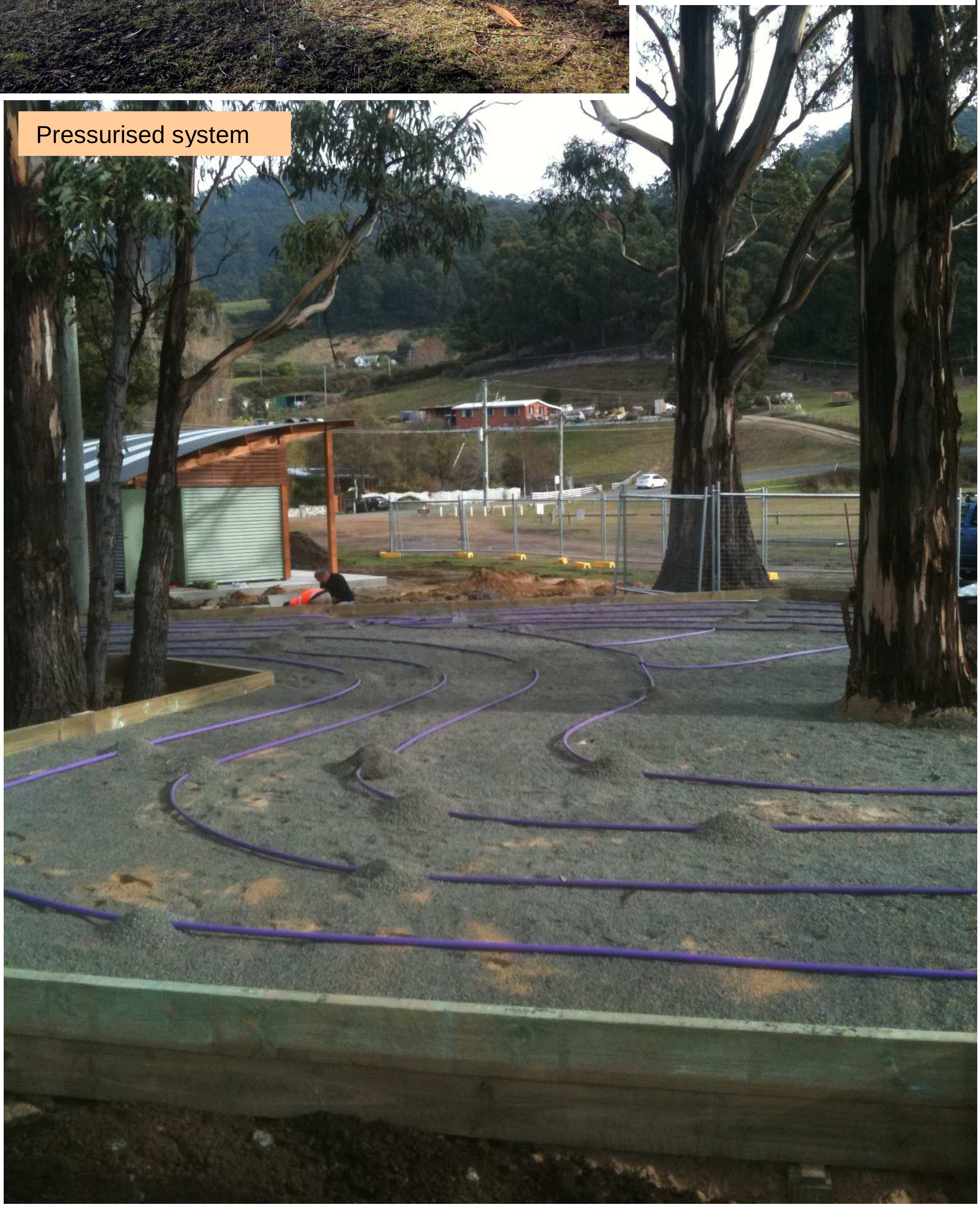
Below. NCBs as terraces with timber retaining walls and surface covers of mulch. An appropriate distance (about 1m suggested) must be maintained between each retaining wall and the distribution pipework behind it.

Above and **right**. An NCB with final soil cover (above), and soon after (right) with a grass cover becoming established.

This bed receives primary treated wastewater from a single purpose septic tank, which discharges into a pump pit (green cover at right). A return line with gate valve from the bed to the pump pit ensures the buried pipework is able to be flushed if needed.

Left. Site selected for an NCB receiving septic tank effluent from a new public toilet block in southern Tasmania.

Below. The NCB during installation. Colour-coded 25mm poly pipe is laid on nominally 50mm of screened durable gravel, itself laid on 0.3m of Category 1 sand soil. The pipe is then to be perforated (3-4mm diam drill holes; one each metre), covered with gravel and geofabric, then 0.15m of loam and finally pine bark.



Pressurised system