


## On-site Wastewater Management Training Course

### Soil Absorption Systems; Trenches and Beds

Honorary Associate Professor Phillip Geary  
School of Environmental & Life Sciences  
The University of Newcastle NSW

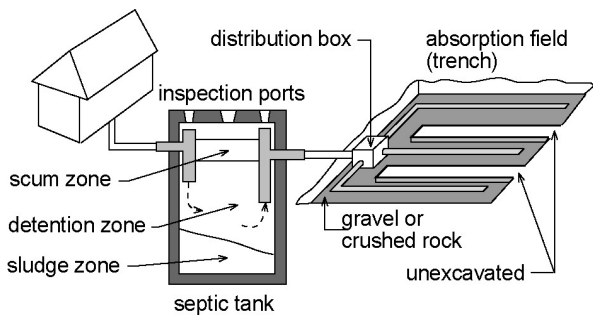
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### Soil Based Systems

- Significant physical, chemical and microbiological treatment of effluent occurs in unsaturated soils
- Rely on infiltration & percolation of effluent through an unsaturated aerobic soil where treatment occurs
- Different systems are suited to different sites based on site & soil limitations
- Poor performance of systems is often related to an inadequate understanding of the hydraulic capacity of the receiving soils resulting in under-design & overloading

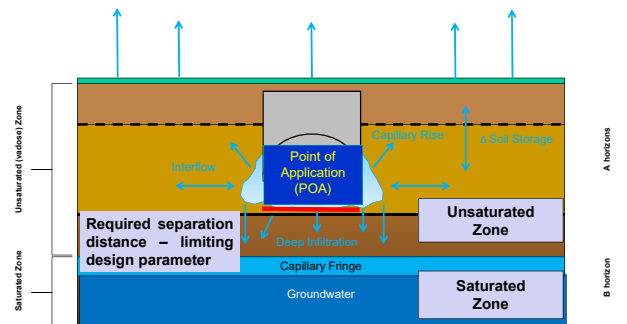
**Design of soil absorption system and calculation of lineal metres of trench needs to be based on hydraulic capacity of most limiting horizon or layer**


### Schematic of On-site System Design Using Soil Absorption



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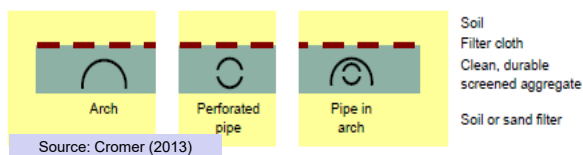
### Subsurface Effluent Disposal



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### Standard or Conventional Trench Designs

- All trenches & bed systems are constructed below ground; can be media filled or consist of a durable self-supporting arch resting on gravel or coarse sand & rely on soil absorption
- Effluent delivered is along a manifold laid along the entire length
- Trenches for effluent dispersal may be piped, boxed or arch trenches; dosed by pressure, low pressure or gravity
- Only base of trench used to calculate application area



### Piped/Boxed Trench

Source for figure: [https://www.lanfaxlabs.com/septic\\_tanks.htm#DOMESTIC%20WASTEWATER](https://www.lanfaxlabs.com/septic_tanks.htm#DOMESTIC%20WASTEWATER)

Drainfield with pipe distribution

Perforated Pipe

Boxed Trench Leach Drains

### Self Supporting Arch Trench

Source for figure: [https://www.lanfaxlabs.com/septic\\_tanks.htm#DOMESTIC%20WASTEWATER](https://www.lanfaxlabs.com/septic_tanks.htm#DOMESTIC%20WASTEWATER)  
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### Low Pressure Effluent Distribution

- Dispersal of wastewater to subsoils using thin gravel trenches
- Pressure dose primary (or secondary) effluent in shallow trenches (0.2 x 0.2 m)
- Perforated pressure line within a distribution pipe
- LPED not suitable for gravity distribution
- Commonly used in NZ
- See AS/NZS 1547:2012 On-site Domestic Wastewater Management (Appendix M) & Section 2.4.3.2 EPA Guideline for onsite wastewater effluent dispersal & recycling systems (2024)

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### Evapotranspiration Trenches or Beds

- Lined or unlined systems use subsurface absorption plus evaporation and transpiration (evt - evapotranspiration)
- Require good sun & wind exposure; vegetation cover must be maintained to optimise evt
- Effluent drawn up from storage into root zone of plants by capillary action
- Water balance required to calculate surface area
- ET or ETA bed recommended for environmentally sensitive sites e.g. where site limitations exist such as heavy clay
- Useful in locations with low permeability soils and in drier climates with high evt

Source: Water NSW (2023)  
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### Typical Cross-section of Piped ET Bed

R.A.Patterson  
 Cross section of ET bed (lined) or ETA bed (unlined)  
 Source: Patterson (2006)  
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### Effluent Distribution

- Dosing to multiple trenches can be by gravity or pressure
- Passive options (flout, siphon) covered elsewhere in course
- Distribution methods aim to distribute effluent doses evenly rather than trickle loading
- Distribution boxes can use gravity but need to ensure that outlets are level
- Sequencing valves require pressure and automatically switch flow to separate outlet port each time pump activates

<https://reln.com.au/product-range/distribution-pit/>  
<https://wastewaterequipment.com.au/products/K-Rain-Valve-4-Outlet.aspx>  
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### Design of Subsurface Systems ...

Depends on:

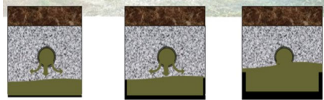
- Hydraulic capacity of soil - limiting design parameter (LDP) for soils of low hydraulic conductivity
- Purification ability of soil - not easily assessed
- Hydraulic load - application rate of wastewater

*A simple set of design criteria which adequately considers all the above factors does not exist*

Source of Figure: [https://www.lanfaxlabs.com/aggregate\\_stability.htm](https://www.lanfaxlabs.com/aggregate_stability.htm)  
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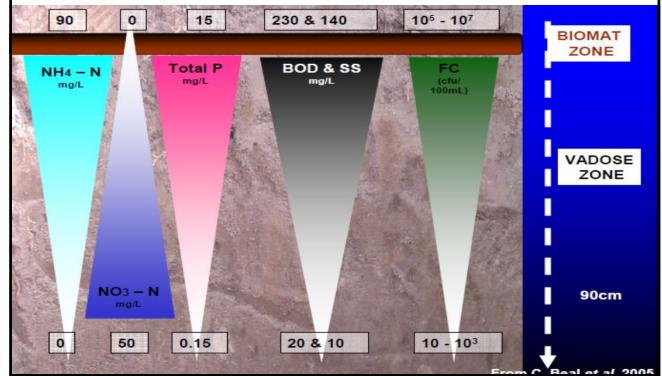
### Design Loading Rate (DLR)

- Infiltration of effluent into soil is limited by clogging layer, but soil texture and structure are important too
- DLR of soil expressed in L/m<sup>2</sup>/d
- DLR is always << clean water permeability



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### ST Effluent Quality Change through Biomat and Unsaturated Soil



### DLR for Trenches and Beds

(Adapted as an example from Table L1 AS/NZS1547:2012)  
(Refer to Tables 4-8 & 4-9 for similar tables used in Victoria (EPA 2024))

Soil Category	Soil Texture	Structure Range of categories not shown	Indicative K (m/d)	Primary Conserv. DLR (mm/d)	Primary Max. DLR (mm/d)
1	Gravels & sands	Massive	> 3.0	See note	See note
2	Sandy loams	Range	1.4 - 3.0	15	25
3	Loams	Range	0.5 - 3.0	10	25
4	Clay loams	Range	0.06 - 1.5	4	15
5	Light clays	Range	0.06 - 0.5	5	8
6	Heavy clays	Range	< 0.06 - 0.5	See note	See note

For primary treated effluent conservative DLRs should be used

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### Soil Absorption - Simple Example

- Assume soil DLR is 15 mm/d\*
- Assume hydraulic load for 1 EP is 150 L/d
- 1 Litre of water or effluent applied to 1 m<sup>2</sup> covers to a depth of 1 mm
- Maximum effluent loading rate should therefore not exceed DLR (15 L/m<sup>2</sup>/d) otherwise failure may occur
- Divide hydraulic load by DLR to calculate required contact area
- Contact area is therefore 10 m<sup>2</sup> for 1 EP (150 L/d divided by 15 L/m<sup>2</sup>/d)

\*Remember – 1 mm/day is equivalent to a loading rate of 1 L/m<sup>2</sup>/day  
For example, 20 mm/day is dimensionally equivalent to 20 L/m<sup>2</sup>/day

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### Design Method - Trenches and Beds

(AS/NZS1547:2012)

- Undertake SSE as part of LCA & determine soil and land capability constraints; identify setbacks or buffers required & location of EDRS
- Assuming site and soil appropriate for soil absorption, select primary DLR taking into account any limiting factors raised in SSE report as part of LCA
- Size disposal areas according to:

$$L = Q / (DLR \times W)^*$$

where L = trench length (m), Q = daily hydraulic load (L/d), DLR = design loading rate (mm/d) and W = width (m) \*only suitable on sites with no climatic constraints. Note that only base of trench used to calculate application area & spacing between trenches is in accordance with soil texture.

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### Design Method - Trenches and Beds

(Refer to Tables 4-3 & 4-8 EPA Guideline 2024)

- Using  $L = Q / (DLR \times W)$  as an example
- Daily design hydraulic load (Q); reticulated supply with water reduction fixtures\* 4 br (5 EP × 150 L/p/d) = 750 L/d
- DLR 15 L/m<sup>2</sup>/d - Soil Category is 3a (texture assessed based on field measurement or field/lab textural method; conservative DLR used for primary effluent)
- Assume a trench 1 m wide then,
- $L = 750 / (15 \times 1) = 50$  lineal metres
- If width is 0.45 m,  $L = 111$  lineal metres\*\*
- Note: only base of trench is used to calculate application area & reserve area needs to be considered
- \*Council needs to be satisfied that fixtures installed & operating
- \*\* Individual trench or bed lengths should not exceed 20 m & should be level (spacing between 1–2 m depending on soil type)

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## Alternative Trench Systems and Non-conventional Beds

- Variety of alternatives to traditional trench and bed designs for effluent dispersal & recycling
- NcBs seek to enhance the performance of more traditional trench and bed designs
- Some NcBs make use of geotextiles, have larger basal area, inter-trench space for evt using various plants and/or provide additional treatment (i.e. filtration) so higher DLRs can be applied
- Amended soil systems take many forms; some use engineered material to enhance the distribution of effluent; others involve importing media or soil such as mounds (considered elsewhere)

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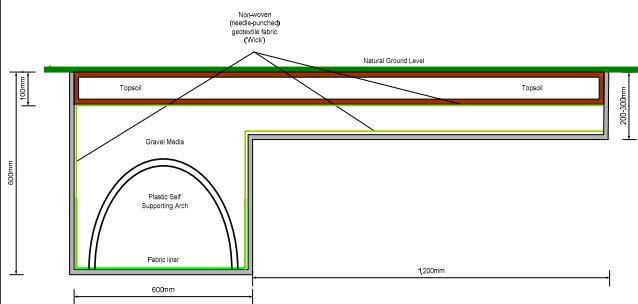
## Wick Trench and Bed

- For use in clay soils but can be used in other soil types too
- Suitable for both Primary and Secondary effluent
- Suited to small blocks
- Assists trench seepage with enhanced evt from adjacent bed through wicking
- Evt bed can be either side of trench
- Trench and bed are linked by a geotextile wrap which lies both under and over the trench and bed
- Geotextile wick draws moisture upwards by capillary action into the root zone of the vegetation above
- Design calculation uses loading factor to reflect improved storage/ET efficiency in the design

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## Cross-section of a Wick Design



Designer: Kerry Flanagan  
Source: WaterNSW (2019)

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Excavated Trench and Bed

Lay Geotextile Over Trench and Bed to Complete Wrap

Place Gravel Over Bed and Over Arch

Lay Geotextile Over Trench and Bed to Complete Wrap and Cover with Topsoil

## Alternative Trench Systems

- Eljen geotextile sand filter (GSF)
- Secondary wastewater treatment system using geotextile modules and filter sand
- Two-stage biomat pre-treatment process, which improves the quality of septic tank effluent before it is released into the soil
- Approvals in South Australia, Tasmania, NSW and Queensland

<https://www.eljenpacific.com/services>



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## Alternative Trench Systems

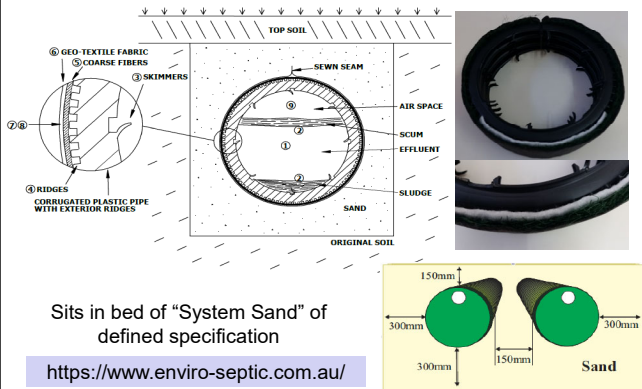
- Advanced Enviro Septic - combined treatment and disposal pipe system using proprietary geotextile
- Pipes wrapped in non-woven geo-textile fabric & installed in land application area as either absorption trenches or evt beds and surrounded by a layer of coarse washed sand
- Sand material promotes aerobic activity as primary effluent percolates through sand which allows air transfer to biomat surface and further filtration before effluent enters underlying soil
- Pipes are corrugated, perforated, high-density plastic with a series of ridges and "skimmers" extending into its interior; skimmers capture grease and expose to aerobic degradation

<https://www.enviro-septic.com.au/>

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## Alternative Trench Systems



## Advanced Enviro Septic

- Recommended maximum hydraulic load of 114 L per pipe length (3 metre) – loading rates approx. 38 L/m<sup>2</sup> for secondary or 30 L/m<sup>2</sup> for advanced secondary
- Trench or bed basal area sized on Secondary treated effluent loading rates of AS/NZS 1547:2012 (Table L1)
- In QLD considered a Secondary treatment system; in NSW not considered a sewage management facility but a land application system and requires approved system for Primary treatment (septic tank)

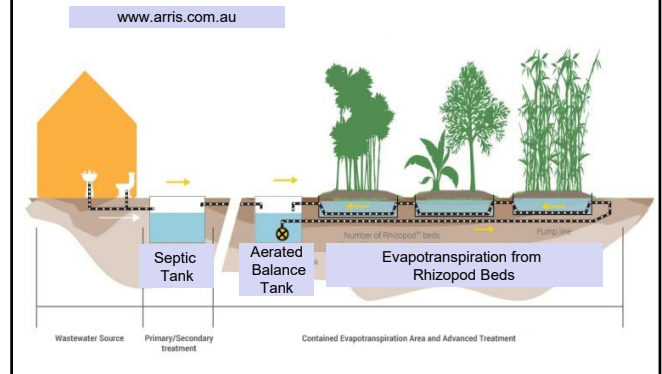


## Vegetated Recirculating Evt Trenches/Beds

- Recirculating evapotranspiration channel system
- Use balance tank after ST and consists of separate linked concrete pods
- Small footprint raised garden beds filled with imported suitable soil
- Suitable for poor soils and difficult sites
- Effluent remains subsurface and is recirculated (no release)
- Requires water balance for sizing



## Rhizopod Beds



## Summary

- Effluent dispersal options for Primary & Secondary treatment include trenches and beds which utilise soil absorption & evt
- Systems which incorporate evt require water balance sizing
- While soil can achieve excellent renovation, systems need to be loaded at appropriate DLRs
- As different systems are suited to different sites based on site & soil limitations, important that design be undertaken by trained persons
- Trenches & beds utilizing soil continue to provide an effective means of land application and treatment of effluent

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## Further Reading

- AS/NZS 1547:2012 On-site Domestic Wastewater Management Table L1
- Cromer, WC (2013) Nonconventional Beds: Notes for Designers, Installers and Regulators, Unpublished Report - <https://www.williamccromer.com/content/uploads/2012/11/Nonconventional-bed-design-notes-24-September-2013.pdf>
- EPA Victoria Guideline for onsite wastewater management (2024) & Guideline for onsite wastewater effluent dispersal & recycling systems (2024) <https://www.epa.vic.gov.au/about-epa/publications/onsite-wastewater-management-guidance>
- Patterson, RA (2006) Evapotranspiration Bed Designs for Inland Areas - <http://lanfaxlabs.com.au/papers/P51-Technical%20Sheet%20%20Evapotranspiration-aug06.pdf>
- WaterNSW (2023) Designing and Installing On-Site Wastewater Systems A WaterNSW Current Recommended Practice [https://www.watnsw.com.au/\\_data/assets/pdf\\_file/0013/113431/Designing-and-Installing-On-Site-Wastewater-Systems-complete-document.pdf](https://www.watnsw.com.au/_data/assets/pdf_file/0013/113431/Designing-and-Installing-On-Site-Wastewater-Systems-complete-document.pdf)

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