

On-site Wastewater Management Training Course

Evapotranspiration Systems and Sizing by Water Balance

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Terminology

Evapotranspiration Systems referred to as:

- Evapotranspiration Absorption Systems ETA – Australia (unlined)
- Evapotranspiration Seepage Systems ETS – New Zealand (unlined)
- Or simply Evapotranspiration Systems ET, if lined

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Purpose

ETA/S Systems designed to:

- Maximise evapotranspiration
- Reduce absorption (drainage) in unlined systems
- Avoid absorption in lined systems
- Provide alternative to conventional trenches/beds in areas of low permeability soils (<0.5-1.5 m/d) e.g. clay loams, light, medium and heavy clays

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AS/NZS 1547:2012

- Table L1 (AS/NZS 1547:2012) gives recommended DLRs of between 12 mm/d (CL) and 5 mm/d (LC/MC) based on soil texture
- Secondary treated effluent is required in Category 6 soils
- Not necessary for annual evaporation to exceed annual precipitation
- Can use plant transpiration and void space storage to manage hydraulic load throughout seasons

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AS/NZS 1547:2012

- DLRs are conservative values
- Any variation to be justified by full water balance for 12-month cycle (Appendix Q)
- No higher DLRs for Secondary treated effluent (may be better to use conventional trench or bed)
- Plant with grasses and shrubs which tolerate wet conditions and have high evapotranspiration capacity
- Construction outlined in Appendix L (AS/NZS 1547:2012) and EDRS Appendix 1 (EPA Vic, 2024)

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Water Balance Design

- Background outlined in Appendix Q in AS/NZS 1547:2012
- Main factors:
 - Effluent largely disposed of through deep infiltration, interflow and evapotranspiration
 - Evapotranspiration is significant, but may not dominate water balance
 - Some deep infiltration is required to prevent salt build up
 - Not suited to shallow water tables unless using a lined system

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Important Components in ET Bed Design

- Crop Factors (Cf), Evaporation (E) and Evapotranspiration (ET) – explained further in water balance example later
- Capillary Water – movement of water laterally and upwards under surface tension
- Field Capacity (FC) – upper limit of available water storage in soil / medium
- Void Ratio (n) – proportion of bed available for water/air storage

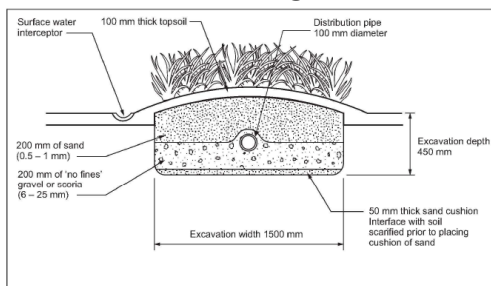
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ETA Bed Design Considerations

- Generally constructed subsurface, with mounded upper surface to reduce rainfall ingress
- Suited to slopes <10%
- Consider Linear Loading Rate
- Prefer good exposure to sun and wind
- Maximum bed length 20m if gravity fed
- Prefer pressure dosing to ensure even distribution
- May require downslope Nutrient Uptake Area. Size with nutrient balance.

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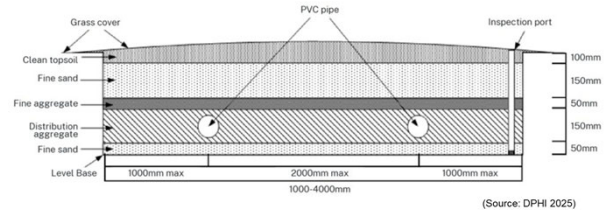
AS/NZS 1547:2012 ETA Bed Design Detail



(Source: Standards Australia 2012)

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'Typical' ETA Bed Arrangement



(Source: DPHI 2025)

- Can be raised bed, but beware of potential for seepage of stored effluent

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ETA Bed



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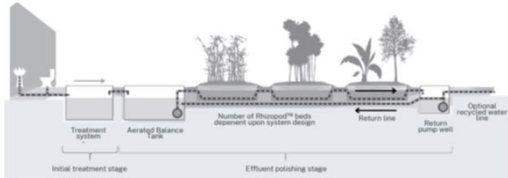
Raised ETA Bed



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Recirculating Evapotranspiration Channel System (Rhizopod®)

- With sufficient pods, can be configured as a no-release system
- Size using a water balance and to determine the number and frequency of pumpouts required



(Source: DPHI 2025)

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Consideration of Climatic Data

- Pan evaporation (E)
 - From nearest climatically similar meteorological station
- Rainfall (R)
 - From nearest climatically similar meteorological station
- www.bom.gov.au
- Or use SILO data:
- <https://www.longpaddock.qld.gov.au/silo/>

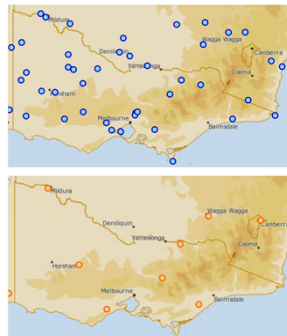
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'Class A' Evaporation Pan



(Source: BoM)



VIC rainfall and evaporation stations
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'Class A' Evaporation Pan

- Diminishing number of evaporation stations
- Move to SILO data (5km x 5km intersections)

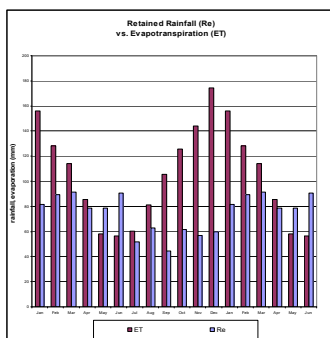


(Source: BoM)

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Inputs (Re) vs. Outputs (ET)



- ET dominates the WB, but not completely
- Excess rainfall can be managed for periods of the year provided that there is storage available in the system

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The Use of Water Balances

- See Section 4.4.2 of EDRS (EPA Vic, 2024)
- Will work through an example of an unlined ETA bed
- Have provided a water balance template for both beds and irrigation areas
- Once you have practiced the skills required in doing water balances longhand they lend themselves to setting up spreadsheets to speed calculation

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Water Balance Exercise

- Calculate the minimum area and depth of an evapotranspiration-absorption/seepage area for a three bedroom / five person dwelling
- BoM rainfall (Mornington) and pan evaporation data (Melbourne Airport)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Monthly rainfall (mm)	44.3	42.6	48.7	62.3	70	71.6	68.5	71.1	71	68.9	60.8	53.5
Mean Daily Evaporation (mm)	8.1	7	5.7	3.8	2.5	1.8	2	2.7	4	5.2	6	7.4

Water Balance Exercise

- Three test pits excavated on the proposed effluent application area indicate that the soils are 475mm weakly structured clay loam, overlying moderately structured light clay to a depth of 2,000mm. Use the recommended design loading rate derived from Table L1 of AS/NZS 1547:2012 (see the Field Workshop and Design Exercise section of these Course Notes)

Water Balance Exercise

- Calculate the required evapotranspiration-absorption basal area using the worksheet provided following the PowerPoint slides
- The evapotranspiration-absorption area is to be constructed of imported aggregate, is to have a maximum depth of 400 mm with a minimum of 50mm freeboard (i.e. maximum depth of stored effluent is 350mm)
- Conventional beds may have between 300mm and 600mm of aggregate, ETA beds have 400mm of aggregate and sand

Calculation of evapotranspiration-absorption area size by water balance method

Size of area for each month								
(1) Month	(2) Pan evaporation E mm	(3) Evapo transpiration ET ET = 0.75E mm	(4) Rainfall R mm	(5) Retained rainfall R _r R _r = 0.75R mm	(6) DLR per month mm	(7) Disposal rate per month (3)-(5)*(6) mm	(8) Effluent applied per month L	(9) Size of area (8)/(7) m ²
Jan								
Feb								
Mar								
Apr								
May								
Jun								
Jul								
Aug								
Sep								
Oct								
Nov								
Dec								
First trial area = average monthly area =								m ²

Depth of stored effluent (first trial)								
(1) Month	(2) First trial area m ²	(3) Application rate (8)/(2) mm	(4) Disposal rate per month (7) mm	(5) (3) - (4) mm	(6) Increase in depth of stored effluent (5)/n mm	(7) Depth of effluent for month (X - 1) mm	(7) Increase in depth of effluent + (6) mm	Computed depth of effluent month (X) mm
Dec						0		
Jan								
Feb								
Mar								
Apr								
May								
Jun								
Jul								
Aug								
Sep								
Oct								
Nov								
Dec								

n = effective void space factor. For imported durable aggregate, n = 0.3

Basal Area vs Storage Depth

- The water balance spreadsheet will calculate the required basal area for zero storage
- If the basal area is reduced, the depth of effluent stored in the bed will increase
- By adjusting the "First trial area", the implications of reducing the basal area can be determined
- The depth of stored effluent must not exceed the bed depth (in this case, 400mm) less any required freeboard (50mm)

References

- Patterson RA, (2006). Evapotranspiration Bed Designs for Inland Areas. Septic Safe Technical Sheet Reference 05/15. NSW Department of Local Government, July 2006

WATER BALANCE ANALYSIS WORKSHOP SESSION

Calculation of evapotranspiration-absorption/seepage area size by the water balance method.

Using the following information using your Course Notes, calculate the minimum area and depth of an evapotranspiration-absorption/seepage area for a three bedroom / five person dwelling.

Bureau of Meteorology rainfall (Morningson) and pan evaporation (Melbourne Airport) data is provided below.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
DAILY PAN EVAPORATION (mm)	8.1	7.0	5.7	3.8	2.5	1.8	2.0	2.7	4.0	5.2	6.0	7.4
MEAN MONTHLY RAINFALL (mm)	44.3	42.6	48.7	62.3	70.0	71.6	68.5	71.1	71.0	68.9	60.8	53.5

Three test pits excavated on the proposed disposal area indicate that the soils are 475 mm weakly structured clay loam overlying moderately structured light clay to a depth of 2,000 mm. Use the recommended design loading rate derived from Table L1 of AS/NZS1547:2012 (see the Field Workshop and Design Exercise section of these Course Notes).

Calculate the evapotranspiration-absorption/seepage area using the worksheets provided on the following two pages.

The evapotranspiration-absorption area is to be constructed of imported aggregate, is to have a maximum depth of 400 mm with a minimum of 50 mm freeboard (i.e. maximum depth of stored effluent is 350 mm).

Calculation of evapotranspiration-absorption area size by water balance method

Size of area for each month

(1) Month	(2) Pan evaporation E mm	(3) Evapo transpiration ET ET = 0.75E mm	(4) Rainfall R mm	(5) Retained rainfall R _r R _r = 0.75R mm	(6) DLR per month mm	(7) Disposal rate per month (3)-(5)+(6) mm	(8) Effluent applied per month L	(9) Size of area (8)/(7) m ²
Jan								
Feb								
Mar								
Apr								
May								
Jun								
Jul								
Aug								
Sep								
Oct								
Nov								
Dec								
First trial area = average monthly area =								m ²

Depth of stored effluent (first trial)

(1) Month	(2) First trial area m ²	(3) Application rate (8)/(2) mm	(4) Disposal rate per month (7) mm	(5) (3) - (4) mm	(6) Increase in depth of stored effluent (5)/n mm	Depth of effluent for month (X - 1) mm	(7) Increase in depth of effluent + (6) mm	Computed depth of effluent month (X) mm
Dec		-	-	-	-	0		
Jan								
Feb								
Mar								
Apr								
May								
Jun								
Jul								
Aug								
Sep								
Oct								
Nov								
Dec								

n = effective void space factor. For imported durable aggregate, n = 0.3

