On-site Wastewater Management Training Course

Evapotranspiration Systems and Sizing by Water Balance

Terminology

Evapotranspiration Systems referred to as:

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

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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- Table L1 gives recommended DLRs of between 12 mm/d (CL) and 5 mm/d (LC/MC) based on soil texture
- 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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- 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

Water Balance Design

- Background outlined in Appendix Q in AS/NZS1547:2012
- 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

Important Components of ET Bed Design

- Crop Factors (Cf), Evaporation (E) and Evapotranspiration (ET) – explained further in water balance example later
- Long term average Eo (reference crop evapotranspiration) values are accurate enough for water balance calculations
- Reference crop Eo values represent evapotranspiration from a well grassed paddock i.e. similar to grass on an evapotranspiration bed
- Average monthly Eo values available for a range of New Zealand Sites (i.e. Eo = ET)

Important Components of ET Bed Design

- 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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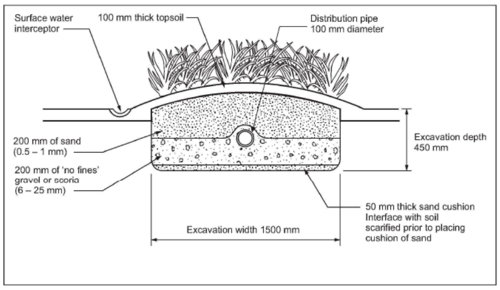
AS/NZS 1547:2012 ETA Bed Design Detail



(Source: Standards Australia 2012)

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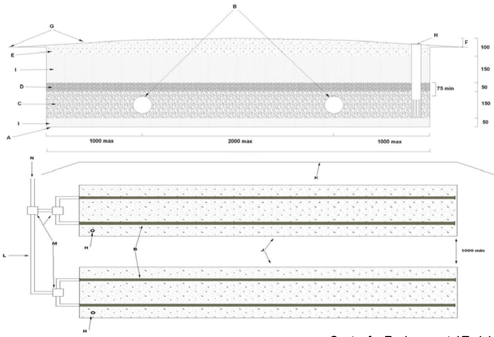
'Typical' ETA Bed Layout



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ETA Bed Installed

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Raised ETA Bed

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Consideration of Climatic Data

- Pan evaporation (E) or Reference crop Eo
  - From nearest climatically similar meteorological station
- Rainfall (R)
  - From nearest climatically similar meteorological station
- Or use Virtual Climate Station data:
- https://niwa.co.nz/climate-and-weather/virtual-climate-station-data-and-products

'Class A' Evaporation Pan

(Source: BoM)

- Alternatively determine evapotranspiration data by use of Class A pan evaporation data and a Crop Factor which varies by crop and season
- Limited class A pan evaporation data available

Monthly Average Reference Crop (Eo) values for NZ Sites

Table 1 – Average monthly FAO-56 evaporation for a range of New Zealand sites. The symbol * indicates solar radiation data were available. Sunshine hour data were used to estimate solar radiation at the other sites. 'A' stands for Airport.

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Kaitaia A *	133	109	97	67	49	36	39	47	63	86	101	125	951
Whenuapai A*	126	105	92	59	40	30	33	41	57	82	100	119	884
Hamilton (Rukuhia) *	127	108	92	61	40	30	32	43	58	81	102	120	893
Tauranga A	141	116	101	69	46	35	40	47	66	92	113	132	999
Rotorua A *	133	109	93	62	41	29	32	41	60	87	107	125	918
Gisborne A *	141	111	93	62	46	36	37	46	66	93	120	136	987
New Plymouth A	121	103	89	64	46	36	38	45	57	78	93	114	884
Napier	142	112	96	63	43	31	32	43	66	97	119	136	978
Masterton (Waingawa)	133	107	86	53	32	24	24	35	55	83	103	123	857
Palmerston North	123	103	86	55	35	24	25	37	53	77	97	116	831
Blenheim	158	130	108	73	47	35	36	48	73	103	125	146	1080
Hokitika A *	101	84	70	45	32	27	28	38	48	67	86	101	727
Lincoln	133	107	85	53	34	25	25	36	57	90	109	128	881
Alexandra *	131	104	81	43	21	11	10	23	50	84	110	129	795
Dunedin A *	117	93	78	53	39	26	27	40	59	85	101	116	832
Invercargill A *	104	85	69	45	33	22	23	35	52	75	90	107	741

Mean Monthly Rainfall

Mean monthly rainfall (mm)

Data are mean monthly values for the 1991-2020 period for locations having at least 5 complete years of data

Station details are available in separate table

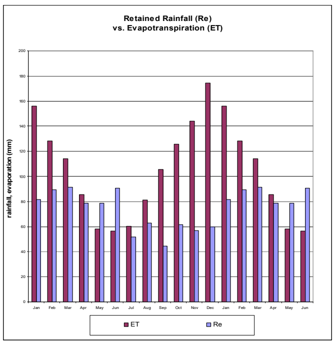
LOCATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
----------------------------	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	------
Kaitaia	75.0	86.0	84.7	98.8	130.5	149.9	168.1	137.0	121.7	90.4	76.3	101.6	1320.0
Whangarei	78.0	83.2	119.2	94.1	112.9	142.2	173.5	130.0	112.3	76.8	75.9	90.9	1289.0
Auckland	58.1	63.1	75.0	87.1	119.8	119.4	136.9	117.2	100.1	91.6	68.9	81.7	1118.9
Tauranga	76.2	83.2	94.9	132.1	116.2	120.6	133.4	111.6	86.5	80.4	63.4	103.0	1201.5
Hamilton	75.4	65.0	75.4	92.3	103.3	117.8	124.2	106.5	100.1	86.0	79.0	99.2	1124.2
Rotorua	93.8	100.4	100.3	133.0	130.2	131.9	137.4	125.2	106.6	92.9	86.8	117.1	1355.6
Gisborne	71.4	65.9	94.0	107.1	84.0	107.4	118.7	78.1	73.1	76.1	65.2	59.9	1000.9
Taupo	73.4	64.8	65.9	77.3	79.4	93.0	99.8	88.6	79.0	74.2	64.7	88.0	948.1
New Plymouth	76.3	89.8	91.1	117.1	149.4	143.6	141.3	128.8	122.9	127.0	103.7	119.3	1410.3
Napier	63.8	54.1	61.8	81.2	62.2	78.5	97.0	57.0	58.1	60.9	57.3	57.8	789.7
Whanganui	58.1	69.6	60.5	84.5	80.8	90.3	87.0	83.5	75.9	89.1	75.3	89.5	944.1
Palmerston North	58.7	68.6	57.4	83.6	87.2	95.5	87.5	83.5	89.0	96.3	86.3	89.9	983.5
Masterton	52.4	48.5	69.9	71.5	72.9	91.0	113.6	81.7	73.2	82.0	71.9	60.6	889.2
Wellington	79.2	55.5	99.6	126.7	144.9	123.8	147.1	139.1	108.0	118.7	85.4	91.1	1319.1
Nelson	73.2	62.8	71.1	84.9	87.7	99.5	78.6	83.8	84.6	89.0	67.9	93.0	976.1
Blenheim	43.0	44.6	39.4	53.8	56.9	68.6	64.2	57.9	54.4	57.2	49.1	49.7	638.8
Westport	163.4	121.4	143.1	163.8	186.5	199.5	170.1	187.0	182.6	202.2	157.3	196.9	2073.8
Kaikoura	47.4	39.3	66.1	66.6	51.0	73.0	86.5	59.1	53.6	64.4	58.8	49.3	715.1
Hokitika	257.4	191.7	213.4	244.9	252.8	261.2	228.0	246.9	244.7	284.8	222.9	272.1	2920.8
Christchurch	42.4	39.8	45.1	57.5	58.1	68.3	64.2	58.1	42.2	49.1	45.1	47.8	617.7

Nominal Monthly Area Requirement

Month	Pan evapo-ration E (mm)	Evapotran-spiration ET ET=0.75E (mm)	Rainfall R (mm)	Retained rainfall R_r R_r=0.75R (mm)	LTAR per month (mm)	Disposal rate per month (mm)	Effluent applied per month (L)	Size of area (m^2)
Jan	207.7	155.8	109	81.75	0	74.01	27900	376.90
Feb	170.8	128.1	119	89.25	0	38.85	25200	648.65
Mar	151.9	113.9	122	91.50	0	22.43	27900	1244.15
Apr	114.0	85.5	105	78.75	0	6.75	27000	4000.00
May	77.5	58.1	105	78.75	0	-20.63	27900	-1352.73
Jun	75.0	56.3	121	90.75	0	-34.50	27000	-782.61
Jul	80.6	60.5	69	51.75	0	8.70	27900	3206.90
Aug	108.5	81.4	84	63.00	0	18.38	27900	1518.37
Sep	141.0	105.8	59	44.25	0	61.50	27000	439.02
Oct	167.4	125.6	82	61.50	0	64.05	27900	435.60
Nov	192.0	144.0	76	57.00	0	87.00	27000	310.34
Dec	232.5	174.4	80	60.00	0	114.38	27900	243.93

Table 3. Calculation of area for each month (disregarding storage of effluent).

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

Depth of Stored Effluent

Month	First trial area m²	Application rate (3) mm	Disposal rate per month (4) mm	(3) - (4) mm	Increase in depth of stored effluent mm	Depth of effluent for month (X - 1) mm	Increase in depth of effluent mm	Computed depth of effluent month (X) mm
Dec	1000							
Jan		27.9	74.01	-46.11	-153.70	0	+ -153.70	= 0
Feb		25.2	38.85	-13.65	-45.50	0	+ -45.50	= 0
Mar		27.9	22.43	5.47	18.23	0	+ 18.23	= 18.23
Apr		27.0	6.75	20.25	67.50	18.23	+ 67.50	= 85.73
May		27.9	-20.63	48.53	161.77	85.73	+ 161.77	= 247.50
Jun		27.0	-34.50	61.50	205.00	247.50	+ 205.00	= 452.50
Jul		27.9	8.70	19.20	64.00	452.50	+ 64.00	= 516.50
Aug		27.9	18.38	9.52	31.73	516.50	+ 31.73	= 548.23
Sep		27.0	61.50	-34.50	-115.00	548.23	+ -115.00	= 433.23
Oct		27.9	64.05	-36.15	-120.50	433.23	+ -120.50	= 312.73
Nov		27.0	87.00	-60.00	-200.00	312.73	+ -200.00	= 112.73
Dec		27.9	114.38	-86.48	-288.27	112.73	+ -288.27	= 0

Table 4. Depth of stored effluent.

The Use of Water Balances

- Will work through two examples of sizing an unlined ETA bed
- Have provided templates for water balances for beds and also irrigation areas
- Once you have practiced the skills required in doing water balances longhand they lend themselves to setting up spreadsheets to speed calculation

Water Balance Exercise

- Calculate the minimum area and depth of an evapotranspiration-absorption/seepage area for a three bedroom / five person dwelling
- Daily hydraulic load is 5 x 150 = 750L/day
- Use rainfall and reference evapotranspiration (Eo) data for Gisborne and Blenheim

Water Balance Exercise

- 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/NZS 1547:2012
- DLR for moderately structured light clay is 5mm/day

Water Balance Exercise

- Calculate the evapotranspiration-absorption/seepage area using the worksheets provided on the following pages
- The evapotranspiration-absorption area is to be constructed of imported aggregate, is to have a maximum depth of 450 mm with a minimum of 50 mm freeboard (i.e. maximum depth of stored effluent is 400 mm)
- Conventional beds may have between 300 mm and 600 mm of aggregate, ETA/ETS beds 400 mm 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) m²
Jan								
Feb								
Mar								
Apr								
May								
Jun								
Jul								
Aug								
Sep								
Oct								
Nov								
Dec								
							First trial area = average monthly area =	m²

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

Conclusions and Discussion

- Loading rate calculation for 750L/day at 5mm/day DIR

  A = Q/DIR

  A = 750/5 = 150m^2
- Water balance indicates that areas required are:

  For Gisborne A = 124m^2

  For Blenheim A = 104m^2
- Hence loading rate method of AS/NZS1547:2012 is conservative

Conclusions and Discussion

- Can use water balances to size/check size of all land application areas
- Previous example of unlined bed
- Slight modification for lined bed or trench (LTAR/DLR = 0)
- Similar water balance used for sizing irrigation areas, but considers soil as an infinitely thin store (i.e. no soil storage) for conservative sizing

References

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

Table 1 – Average monthly FAO-56 evaporation for a range of New Zealand sites. The symbol * indicates solar radiation data were available. Sunshine hour data were used to estimate solar radiation at the other sites. 'A' stands for Airport.

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Napier	142	112	96	63	43	31	32	43	66	97	119	136	978
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Auckland	58.1	63.1	75.0	87.1	119.8	119.4	136.9	117.2	100.1	91.6	68.9	81.7	1118.9
Tauranga	76.2	83.2	94.9	132.1	116.2	120.6	133.4	111.6	86.5	80.4	63.4	103.0	1201.5
Hamilton	75.4	65.0	75.4	92.3	103.3	117.8	124.2	106.5	100.1	86.0	79.0	99.2	1124.2
Rotorua	93.8	100.4	100.3	133.0	130.2	131.9	137.4	125.2	106.6	92.9	86.8	117.1	1355.6
Gisborne	71.4	65.9	94.0	107.1	84.0	107.4	118.7	78.1	73.1	76.1	65.2	59.9	1000.9
Taupo	73.4	64.8	65.9	77.3	79.4	93.0	99.8	88.6	79.0	74.2	64.7	88.0	948.1
New Plymouth	76.3	89.8	91.1	117.1	149.4	143.6	141.3	128.8	122.9	127.0	103.7	119.3	1410.3
Napier	63.8	54.1	61.8	81.2	62.2	78.5	97.0	57.0	58.1	60.9	57.3	57.8	789.7
Whanganui	58.1	69.6	60.5	84.5	80.8	90.3	87.0	83.5	75.9	89.1	75.3	89.5	944.1
Palmerston North	58.7	68.6	57.4	83.6	87.2	95.5	87.5	83.5	89.0	96.3	86.3	89.9	983.5
Masterton	52.4	48.5	69.9	71.5	72.9	91.0	113.6	81.7	73.2	82.0	71.9	60.6	889.2
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Hokitika	257.4	191.7	213.4	244.9	252.8	261.2	228.0	246.9	244.7	284.8	222.9	272.1	2920.8
Christchurch	42.4	39.8	45.1	57.5	58.1	68.3	64.2	58.1	42.2	49.1	45.1	47.8	617.7
Mt Cook	418.7	272.0	315.0	336.5	377.8	291.0	288.6	283.8	361.0	394.4	367.6	425.9	4132.3
Lake Tekapo	38.1	42.2	29.2	51.0	71.6	52.1	50.3	38.2	33.8	44.9	42.3	41.1	534.8
Timaru	50.3	52.3	38.6	49.3	39.7	39.4	42.0	44.6	33.5	47.8	51.5	54.0	543.0
Milford Sound	667.2	466.6	571.3	528.2	645.1	440.4	468.0	457.0	541.3	617.2	557.7	585.1	6545.1
Queenstown	71.6	51.0	49.3	57.5	75.1	62.2	55.8	52.8	62.3	62.4	60.7	60.3	721.0
Alexandra	46.9	41.1	31.2	22.0	34.3	30.9	25.2	15.4	21.3	29.6	32.7	34.5	365.1
Manapouri	88.6	85.3	82.7	85.0	104.4	91.4	94.2	82.0	106.2	113.0	95.7	97.4	1125.9
Dunedin	70.5	69.9	53.9	60.8	63.6	58.5	51.7	54.7	47.1	60.1	62.5	70.8	724.1
Invercargill	88.7	74.2	91.8	89.5	108.4	95.1	88.0	70.4	90.4	106.2	101.7	92.9	1097.3
Chatham Islands	49.2	64.0	75.7	79.0	88.3	93.7	72.3	71.0	71.3	56.2	53.5	62.9	837.1

Month	Pan evapo-ration E (mm)	Evapotran-spiration ET, ET=0.75E (mm)	Rainfall R (mm)	Retained rainfall R_r, $R_r=0.75R$ (mm)	LTAR per month (mm)	Disposal rate per month (mm)	Effluent applied per month (L)	Size of area (m^2)
Jan	207.7	155.8	109	81.75	0	74.01	27900	376.90
Feb	170.8	128.1	119	89.25	0	38.85	25200	648.65
Mar	151.9	113.9	122	91.50	0	22.43	27900	1244.15
Apr	114.0	85.5	105	78.75	0	6.75	27000	4000.00
May	77.5	58.1	105	78.75	0	-20.63	27900	-1352.73
Jun	75.0	56.3	121	90.75	0	-34.50	27000	-782.61
Jul	80.6	60.5	69	51.75	0	8.70	27900	3206.90
Aug	108.5	81.4	84	63.00	0	18.38	27900	1518.37
Sep	141.0	105.8	59	44.25	0	61.50	27000	439.02
Oct	167.4	125.6	82	61.50	0	64.05	27900	435.60
Nov	192.0	144.0	76	57.00	0	87.00	27000	310.34
Dec	232.5	174.4	80	60.00	0	114.38	27900	243.93

Table 3. Calculation of area for each month (disregarding storage of effluent).

Month	First trial area m^2	Application rate (3) mm	Disposal rate per month (4) mm	(3) - (4) mm	Increase in depth of stored effluent mm	Depth of effluent for month (X - 1) mm	Increase in depth of effluent mm	Computed depth of effluent month (X) mm
Dec	1000							
Jan		27.9	74.01	-46.11	-153.70	0	+ -153.70	= 0
Feb		25.2	38.85	-13.65	-45.50	0	+ -45.50	= 0
Mar		27.9	22.43	5.47	18.23	0	+ 18.23	= 18.23
Apr		27.0	6.75	20.25	67.50	18.23	+ 67.50	= 85.73
May		27.9	-20.63	48.53	161.77	85.73	+ 161.77	= 247.50
Jun		27.0	-34.50	61.50	205.00	247.50	+ 205.00	= 452.50
Jul		27.9	8.70	19.20	64.00	452.50	+ 64.00	= 516.50
Aug		27.9	18.38	9.52	31.73	516.50	+ 31.73	= 548.23
Sep		27.0	61.50	-34.50	-115.00	548.23	+ -115.00	= 433.23
Oct		27.9	64.05	-36.15	-120.50	433.23	+ -120.50	= 312.73
Nov		27.0	87.00	-60.00	-200.00	312.73	+ -200.00	= 112.73
Dec		27.9	114.38	-86.48	-288.27	112.73	+ -288.27	= 0

Table 4. Depth of stored effluent.

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.

Use rainfall and Reference Crop evaporation (Eo) data from the previous two pages for both Gisborne and Blenheim.

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 2000 mm. Use the recommended design loading rate derived from Table L1 of AS/NZS 1547:2012 (see following page).

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 450 mm with a minimum of 50 mm freeboard (i.e. maximum depth of stored effluent is 400 mm).

TABLE L1
RECOMMENDED DESIGN LOADING RATES FOR TRENCHES AND BEDS

Soil category	Soil texture	Structure	Indicative permeability (K_{sat})(m/d)	Design loading rate (DLR) (mm/d) — Trenches and beds — Primary treated effluent — Conservative rate	Primary treated effluent — Maximum rate	Secondary treated effluent	ETA/ETS beds and trenches
1	Gravels and sands	Structureless (massive)	> 3.0	20 (see Note 1)	35 (see Note 1)	50 (see Note 1)	(see Note 4)
2	Sandy loams	Weakly structured	> 3.0	20 (see Note 1)	30 (see Note 1)	50 (see Note 1)	
		Massive	1.4 – 3.0	15	25	50	
3	Loams	High/ moderate structured	1.5 – 3.0	15	25	50	
		Weakly structured or massive	0.5 – 1.5	10	15	30	
4	Clay loams	High/ moderate structured	0.5 – 1.5	10	15	30	12
		Weakly structured	0.12 – 0.5	6	10	20	8
		Massive	0.06 – 0.12	4	5	10	5
5	Light clays	Strongly structured	0.12 – 0.5	5	8	12	8
		Moderately structured	0.06 – 0.12		5	10	5 (see Notes 2, 3, & 5)
		Weakly structured or massive	< 0.06			8	
6	Medium to heavy clays	Strongly structured	0.06 – 0.5	(see Notes 2 & 3)			
		Moderately structured	< 0.06				
		Weakly structured or massive	< 0.06				

NOTES:

1 The treatment capacity of the soil and not the hydraulic capacity of the soil or the growth of the clogging layer govern the effluent loading rate in Category 1 and weakly structured Category 2 soils. Land application systems in these soils require design by a suitably qualified and experienced person, and distribution techniques to help achieve even distribution of effluent over the full design surface (see L6.2 and Figure L4 for recommended discharge method by discharge control trench). These soils have low nutrient retention capacities, often allowing accession of nutrients to groundwater.

2 To enable use of such soils for on-site wastewater land application systems, special design requirements and distribution techniques or soil modification procedures will be necessary. For any system designed for these soils, the effluent absorption rate shall be based upon soil permeability testing. Specialist soils advice and special design techniques will be required for clay dominated soils having dispersive (sodic) or shrink/swell behaviour. Such soils shall be treated as Category 6 soils. In most situations, the design will need to rely on more processes than just absorption by the soil.

3 If K_{sat} < 0.06 m/d, a full water balance for the land application can be used to calculate trench/bed size (see Appendix Q).

4 ETA/ETS systems are not normally used on soil Categories 1 to 3.

5 For Category 6 soils ETA/ETS systems are suitable only for use with secondary treated effluent.

(Standards Australia/Standards New Zealand 2012)

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

Minimum Area Method Water Balance and Wet Weather Storage Calculations

Design Wastewater Flow	(Q)	L/day														
Design Percolation Rate	(R)	mm/wk														
Parameter	**Symbol**	**Formula**	**Units**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**Total**
Days in month	(D)	-	days													
Precipitation	(P)	-	mm/month													
Evaporation	(E)	-	mm/month													
Crop factor	(C)	-	-													
Outputs																
Evapotranspiration	(ET)	E x C	mm/month													
Percolation	(B)	(R/7) x D	mm/month													
Outputs		(ET+B)	mm/month													
Inputs																
Precipitation	(P)	-	mm/month													
Possible Effluent Irrigation	(W)	(ET + B) -P	mm/month													
Actual Effluent Production	(I)	H/12	mm/month													
Inputs		(P + I)	mm/month													
Storage	(S)	(P+I) - (ET+B)	mm/month													
Cumulative storage	(M)	-	mm													
Irrigation Area	**(L)**	**365 x Q/H**	**m^2**													
Storage	**(V)**	**largest M**	**mm**													
		(V x L)/1000	**m^3**													

Monthly Water Balance used to Determine Wet Weather Storage for a Medium Rainfall Region with a Nominated Irrigation Area

Design Wastewater Flow	(Q)	L/day														
Design Percolation Rate	(R)	mm/wk														
Land Area	(L)	m^2														
Parameter	**Symbol**	**Formula**	**Units**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**Total**
Days in month	(D)	-	days													
Precipitation	(P)	-	mm/month													
Evaporation	(E)	-	mm/month													
Crop factor	(C)	-	-													
Inputs																
Precipitation	(P)	-	mm/month													
Effluent Irrigation	(W)	(Q x D)/L	mm/month													
Inputs		(P+W)	mm/month													
Outputs																
Evapotranspiration	(ET)	E x C	mm/month													
Percolation	(B)	(R/7) x D	mm/month													
Outputs		(ET+B)	mm/month													
Storage	(S)	(P+W) - (ET+B)	mm/month													
Cumulative storage	(M)	-	mm													
Storage	**(V)**	**largest M**	**mm**													
		(V x L)/1000	**m^3**													