MO650.1101 General, State Supplement

Table MO-11-1. Surface Area for Various Pool Shapes (Area in acres)

L (ft)	B (ft)							
	150	200	250	300	350	400	450	500
	Parabolic Shape							A = B x L / 65,340
100	0.23	0.31	0.38	0.46	0.54	0.61	0.69	0.77
150	0.34	0.46	0.57	0.69	0.80	0.92	1.03	1.15
200	0.46	0.61	0.77	0.92	1.07	1.22	1.38	1.53
250	0.57	0.77	0.96	1.15	1.34	1.53	1.72	1.91
300	0.69	0.92	1.15	1.38	1.61	1.84	2.07	2.30
350	0.80	1.07	1.34	1.61	1.87	2.14	2.41	2.68
400	0.92	1.22	1.53	1.84	2.14	2.45	2.75	3.06
450	1.03	1.38	1.72	2.07	2.41	2.75	3.10	3.44
500	1.15	1.53	1.91	2.30	2.68	3.06	3.44	3.83
L (ft)	Triangular Shape							A = B x L / 87,120
100	0.17	0.23	0.29	0.34	0.40	0.46	0.52	0.57
150	0.26	0.34	0.43	0.52	0.60	0.69	0.77	0.86
200	0.34	0.46	0.57	0.69	0.80	0.92	1.03	1.15
250	0.43	0.57	0.72	0.86	1.00	1.15	1.29	1.43
300	0.52	0.69	0.86	1.03	1.21	1.38	1.55	1.72
350	0.60	0.80	1.00	1.21	1.41	1.61	1.81	2.01
400	0.69	0.92	1.15	1.38	1.61	1.84	2.07	2.30
450	0.77	1.03	1.29	1.55	1.81	2.07	2.32	2.58
500	0.86	1.15	1.43	1.72	2.01	2.30	2.58	2.87

Semi-Circular Shape			
B (ft)	L (ft)	Area (ac)	$A = B^2 / 110{,}981$
50	79	0.02	
100	157	0.09	
150	236	0.20	
200	314	0.36	
250	393	0.56	
300	471	0.81	
350	550	1.10	
400	628	1.44	

Storage volume (Vs) below permanent pool level may be approximated by 0.4 depth (d) times surface area (A). ($V_s = 0.4 \cdot d \cdot A$). This will give Vs in acre-feet when d is in feet and A is in acres.

Figure MO-11-1. Temporary Storage Estimate for Ponds

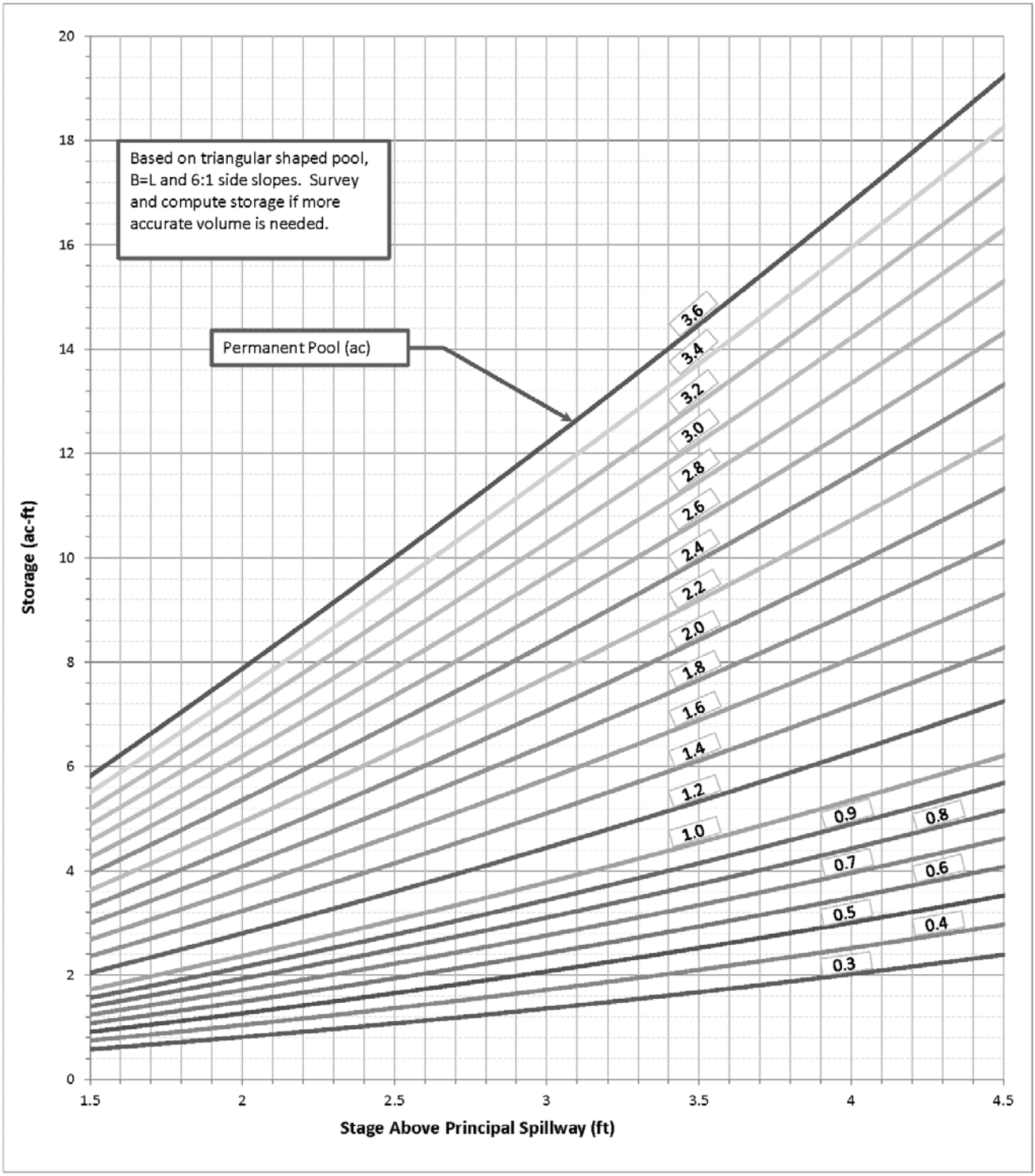
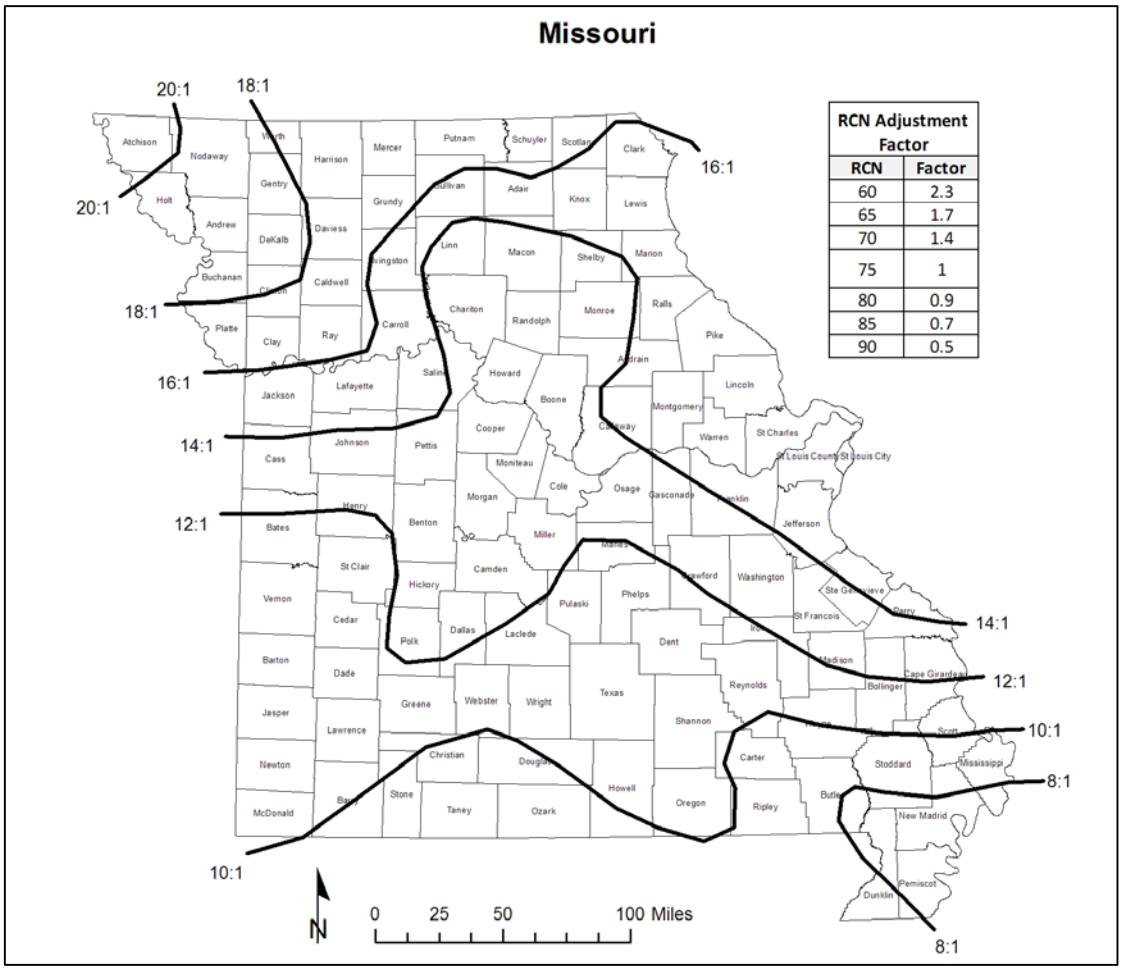


Figure MO-11-2. Minimum Drainage Area for Ponds (Ratio of Drainage Area: Pool Area, DA:PA) for 50% Chance of Pond Filling in 1 Year 1/

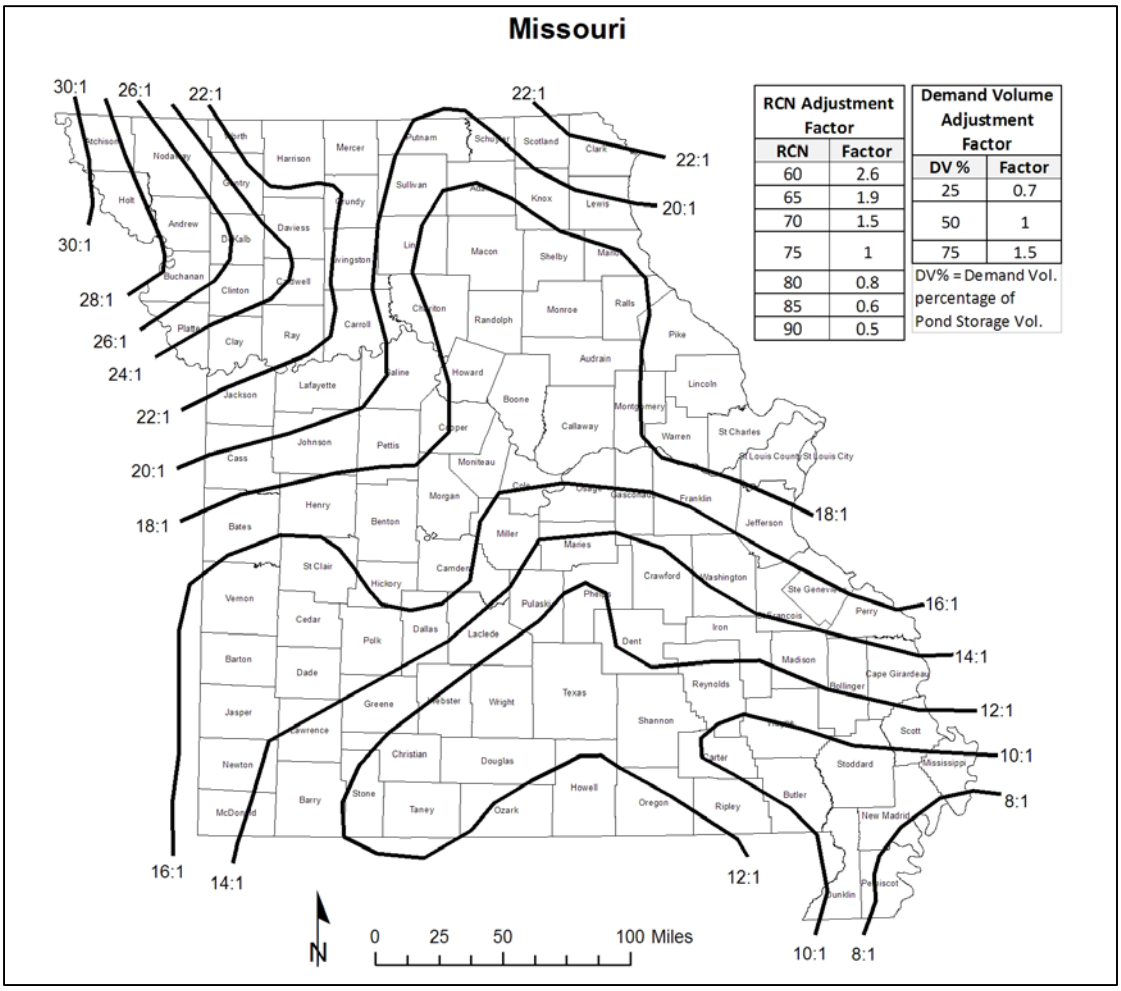


1/ Based upon a yearly water budget computed for a theoretical pond having the following physical characteristics using climate data for the period of 1960-2006:

Pond Surface Area (PA) = 1 acre; Pond Water Depth = 12 feet
Storage Volume (SV) = Surface Area x Max. Depth x 0.4
Storage Volume is assumed to be empty on January 1
Annual Demand Volume (DV) is assumed to be zero (0) during initial filling
Pond Bottom Infiltration (I) = 5 $x10^{-7}$ cm/sec = 6.2 in/year
Runoff Curve Number (RCN) = 75 for the Watershed Drainage Area (DA)
Annual Average (2 yr) Precipitation Amount [P_{avg}] (in)
Annual Average (2 yr) Runoff for RCN 75 [RO_{avg}] (in)
Annual Average Lake Evaporation Amount [LE] (in)
No spillway discharge is assumed to occur during first fill period

Water Budget: $DA = (SV + ((LE + I - P_{avg}) \times PA)) / RO_{avg}$

Figure MO-11-3. Minimum Drainage Area for Ponds (Ratio of Drainage Area: Pool Area, DA:PA) for 90% Chance to Maintain Yearly Demand Volume 1/



1/ Based upon a yearly water budget computed for a theoretical pond having the following physical characteristics using climate data for the period of 1960-2006:

Pond Surface Area (PA) = 1 acre; Pond Water Depth = 12 feet
Storage Volume (SV) = Surface Area x Max. Depth x 0.4
Storage Volume is assumed to be full on January 1
Annual Pond Bottom Infiltration (I) = 1 $x10^{-7}$ cm/sec = 1.25 in/year
Runoff Curve Number (RCN) = 75 for the Watershed Drainage Area (DA)
Annual 10 yr Drought Precipitation Amount [P_{dry}] (in)
Annual 10 yr Drought Runoff for RCN 75 [RO_{dry}] (in)
Annual Average Lake Evaporation Amount [LE] (in)
Annual Demand Volume [DV] (ac-in) = 50% of the Storage Volume
No spillway discharge is assumed to occur during the 10 yr Drought Year

Water Budget: $DA = (DV + ((LE + I - P_{dry}) \times PA)) / RO_{dry}$

Figure MO-11-2 and Figure MO-11-3 are to be used to determine the minimum watershed drainage area of a 378 Pond or embankment type 410 Grade Stabilization Structure.

Example 1: 410 Grade Stabilization Structure for grade control only with no demand.

Given an embankment type Grade Stabilization Structure located in Howard County, Missouri, with a pool surface area at the principal spillway crest elevation of 0.5 acres determine the minimum drainage area required. The structure is for grade control only with no demand volume for usable water. The watershed RCN is 80.

From Figure MO-11-2 read the minimum DA:PA ratio required to fill the pool. For the Howard County location the ratio is 13:1. Next multiply the ratio by the RCN Adjustment Factor for RCN 80, which is 0.9: 13 x 0.9 = **11.7:1**

Since there is no demand water volume, there is no need to use Figure MO-11-3. Therefore, the required minimum drainage area for the 0.5 acre pool is equal to 11.7 x 0.5 acres = 5.8, **use 6 acres**.

Example 2: 378 Pond with livestock water demand.

Given an embankment type Pond located in Howard County, Missouri, with a pool surface area at the principal spillway crest elevation of 1.5 acres determine the minimum drainage area required. The structure has a demand volume for livestock water that is equal to 25% of the total pond storage volume. The watershed RCN is 70.

From Figure MO-11-2 read the minimum DA:PA ratio required to fill the pool. For the Howard County location the ratio is 13:1. Next multiply the ratio by the RCN Adjustment Factor for RCN 70, which is 1.4. 13 x 1.4 = **18.2:1**

From Figure MO-11-3 read the minimum DA:PA ratio required to maintain the yearly demand volume. For the Howard County location the ratio is 18:1. Next multiply the ratio by the RCN Adjustment Factor for RCN 70, 1.5 and the Demand Volume Adjustment Factor for the 25% demand volume percentage, which is 0.7. 18 x 1.5 x 0.7 = **18.9:1**

The minimum required drainage area ratio is the larger of the two ratios from Figures MO-11-2 and MO-11-3, which is 18.9:1. Therefore, the required minimum drainage area for the 1.5 acre pool is equal to 18.9 x 1.5 acres = 28.35, **use 29 acres**.

References:

- WinPond
- SPAW
- Slope Protection
- Livestock Watering Handbook