The enclosed issue paper proposes a rationale that can be documented and provides consistency in its determination.

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ISSUE PAPER
STORAGE PERIOD
FOR
AGRICULTURAL WASTE MANAGEMENT SYSTEMS

ISSUE

Waste storage structures, waste storage ponds, and waste treatment lagoons are designed to accommodate a waste and wastewater accumulation for certain length of time. This length of time is most frequently referred to as the storage period.

NRCS Practice Standard 313, Waste Storage Facility, defines the storage period as the length of time between emptying events. Criteria stated in this standard for the storage period is: “The minimum storage period shall be based on the timing required for environmentally safe waste utilization considering the climate, crops, soil, equipment, and local, state, and Federal regulations. "

The NRCS Agricultural Waste Management Field Handbook (pg 10-11) indicates that, the determination of the storage period is crucial to proper management of an agricultural waste management system (SWMS) .If too short a period is selected, the facility may fill before the waste can be used in an environmentally sound manner. Too long a period may result in an unjustified expenditure for the facility. The handbook goes on to elaborate on the factors that are involved in selecting an appropriate storage period for a facility.

Practice standard criteria and handbook guidance for determining the storage period are purposely vague because of the wide variation of conditions and variables involved in the storage period determination across the country. Consequently, the national practice standard criteria without modification by a State Supplement to the standard allows the designer wide latitude in selecting an appropriate storage period in consideration of the many variables involved and their interaction with each other. This vagueness, however, can be troublesome. It can be troublesome to the designer because without specific definition, storage period can become an issue subject to negotiation rather than being based on defensible technology. It is troublesome to reviewers because the selected storage period must either be accepted on the basis that it is the designer's best judgment or the designer's judgment must be questioned. Questioning the designer's judgment is very uncomfortable because it pits the reviewer's judgment against that of the designer.

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Proposed by this paper is a rationale for objectively determining the waste storage period under Oregon conditions that may help minimize the amount of judgment that a designer must use for determining the storage period.

VARIABLES, CONSIDERATIONS, AND ASSUMPTIONS

1. Basic assumptions

Basic to the rationale proposed is the assumption that an adequate nutrient management plan has been incorporated into and is part of the overall agricultural waste management system. An adequate nutrient management plan is meant to imply that the nutrients resulting from the system will not exceed the crop requirement for the operation. The proposal further assumes that in normal years there are periods of time within the basic storage period, as defined below, when temperatures are moderate and free of precipitation.

2. Land application timing considerations.

To minimize losses of nutrients to leaching and runoff, and to maximize crop uptake of nutrients, it is essential that manure be applied before the crop needs the nutrients. The soil moisture and temperature needed for plant growth are approximately those necessary for the nutrients in manure to mineralize. This is a favorable circumstance for early year manure application because nutrients mineralize and become available concurrently with crop needs. However, an overriding consideration in early year application is the necessity of avoiding application of manure when the soil is saturated and runoff will occur causing loss of organics, nutrients, and fecal coliforms. The rationale presented assumes that the earliest date in the year when manure can be applied is when evapotranspiration (ET) is equal to or exceeds precipitation. This would apply to regions of the state where precipitation exceeds evaporation. In arid regions, storage period would usually be based on spanning periods of frozen ground and/or snow, and periods of flooding.

Unfortunately, the coincidence of similar soil conditions required for mineralization of nutrients and plant growth is unfavorable for manure applications in late summer or early fall when soil conditions for plant growth still exist but crop growth has either slowed or stopped. Nutrients mineralized at this time of year and not used by the crop are available for loss in leaching and runoff. For this reason, the rationale establishes that manure should not be applied after 3/4 of the crop's ET has accrued. It is assumed that ET is an indicator of crop growth and nutrient uptake.

Overriding conditions in determining storage period are seasonal flooding, frozen ground and snow. The storage period must begin prior to and end after these conditions are to be anticipated. No adjustments are made to the storage period that would require application when these conditions are anticipated.

3. Level of management

The level of management is a variable of paramount importance in its impacts on the storage period needed for an AWMS. A mismanaged " AWMS of the best design possible can result in significant environmental degradation. On the other hand, excellent management can partially compensate for inadequate AWMS facilities. However, it must be recognized that "There is storage period for every AWMS that is too short even for the best manager to operate without environmental degradation."

Unfortunately, the level of management is perhaps the most difficult to assess of all the variables affecting storage period. The proposed rationale assumes that it is appropriate to allow an AWMS that has a high management a shorter storage period than one that has a low level of management. The proposed rationale gives indicators for assessing the level of management.

4. Soils

A variety of soil and site conditions have an effect on the consequences from the land application of wastes. The proposed rationale allows adjustment to the storage period is based on the availability of soils that minimize the risk to environmental consequence based on the hydrologic soil group and consistency of the waste. For a soil to be considered in the adjustment, the following soil and site conditions should exist:

1. An average water holding capacity in the profile greater than 3 inches.
2. A cation exchange capacity greater than 0.05 meq/100 g of soil.
3. Thin layer/cemented pan at a depth greater than 20 inches, if present.
4. A depth to high water table greater than 2 feet. 5. A permeability greater than 0.06 but less than 6 inches/hour.
6. Cobbles less than 35% by weight in the surface layer.
7. Stones and boulders less than 15% by weight in the surface layer.
8. A pH greater than 5.0.
9. Salts less than a SAR 13
10. Land slope less than 15%

5. The location of fields

The location of fields to be used for land application is an important factor in determining storage period. If the fields are subject to flooding from adjacent water bodies, the storage period must extend from a fall date prior to and a spring date past the threat of flooding. If fields are located in close proximity to water bodies or ground water sources for drinking water, and/or have areas of concentrated flow. The amount of application area available is reduced to areas within the field which are buffered from these water bodies, ground water sources, and concentrated flow areas. The rationale allows for an adjustment to the storage period based on the amount of land available that is not subject to

flooding and buffered from water bodies, ground water sources, and areas of concentrated flow.

6. Method of application

.Early year manure that is applied by injection or immediately incorporated minimizes the risk of losses of organics, nutrients, and coliforms loss in runoff as compared to surface application. As such, use of these methods instead of surface application without incorporation for early year application may reduce storage period required. However, since these methods of application minimize nitrogen volatilization losses, their use in late summer and early fall applications may result in greater nitrate leaching losses than by surface application. The proposed rationale makes allowance for reducing the storage period when injection or immediate incorporation are used.

STORAGE PERIOD DETERMINATION PROCEDURE

1. Determine the basic storage period (SP_b)

a. Julian date when 3/4 of annual ET has accrued (L).

b. Earliest Julian date when ET => precipitation by plot of monthly annual averages (E).

SP_b = 365- (L -E)

.2. Determine adjustment factor for level of management (Fm)

Indicators of a high level of management, as appropriate .

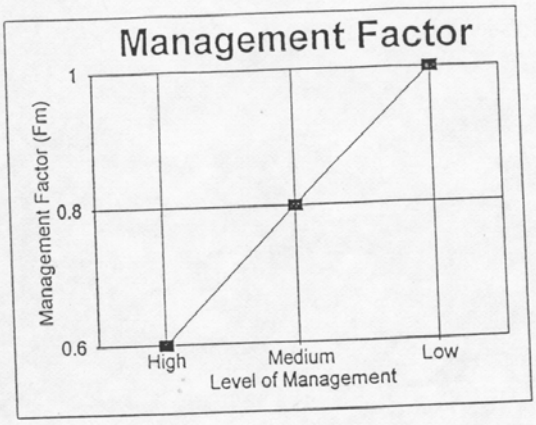
1. Possesses and refers to an up-to-date waste management system plan.
2. Performs soil fertility testing annually 3. Performs manure testing annually
4. Keeps records of manure applications as to time, rate, and location.
5. Calibrates manure application equipment.
6. Practices proper irrigation water management.
7. Maximizes crop nutrient uptake with appropriate agronomic treatments such as residue management, conservation crop rotation, crop variety selection, prescribed grazing, and pest management.
8. Has a demonstrated history of proper operation and maintenance capabilities-

Indicators of a medium level of management

1. Possesses and refers to an up-to-date waste management system plan.
2. Calibrates application equipment.
3. Provides crop with supplemental irrigation.
4. Does not fully use agronomic treatments which would , maximize crop nutrient uptake.
5. Has a demonstrated history of proper operation and maintenance capabilities.

Indicators of the low level of management

1. Possesses a waste management plan but does not use it.
2. Has a demonstrated history of inadequate operation and maintenance.

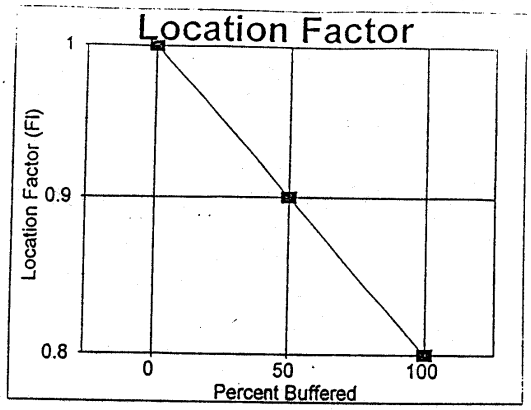


3. Determine adjustment factor for availability soils for land application (F_S).

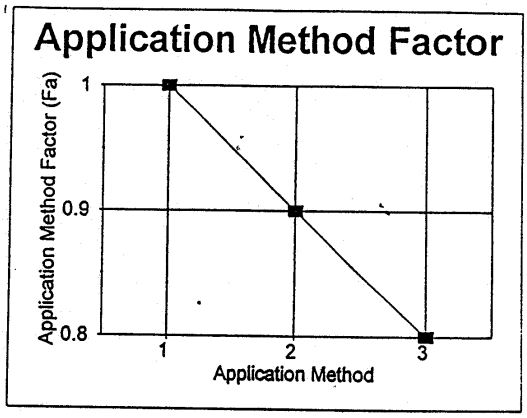
F_S				
	Consistency of Waste			
HSG	Liquid	Slurry	Semi-Solid	Solid
A	1.00	0.95	0.90	0.80
B	0.80	0.75	0.70	0.65
C	0.90	0.85	0.80	0.75
D	1.00	1.00	0.95	0.90

Note: Subtract 0.05 from table value if subsurface drained.

4. Determine location adjustment factor for availability of land application area buffered from water bodies and free of concentrated flow areas (F_1). Buffered application areas are outside the 50 year floodplain and at least 50 feet from water bodies, ground water sources, and areas of concentrated flow.



5. Determine adjustment factor for method of land application (F_a).



Method 1 - Solid manure - Surface applied, no incorporation
Method 2 - Liquid manure - Surface applied, no incorporation
Method 3 - Injection or immediate incorporation

6. Compute storage period (SP).

$SP = SP_b * F_m * F_s * F_l * F_a$

7. Check storage period for spanning periods of frozen ground and/or snow, and periods of seasonal flooding. Adjust storage period if necessary.

Late date = L adjusted earlier to include seasonal flooding or frozen ground.

Early Julian date = SP - (365 - L) adjusted later to include seasonal flooding or frozen ground.

EXAMPLE MINIMUM STORAGE PERIOD DETERMINATIONS

Northern Oregon Coast

Given:

1. Medium level of management
2. Manure is slurry and is surface applied to pasture without incorporation.
3. Utilization area has 75% HSG B soils and 25% HSG C soils and is 50% buffered. The HSG C soil is subsurface drained.
4. No flooding after February or before November 1.

Solution:

1. Determine the basic storage period (SP_b)

a. Julian date when 3/4 of annual ET has accrued (L).

Evapotranspiration and precipitation

Mo.	ET	Accum ET	Ppt.
Jan	0.21		14.16
Feb	0.87	1.08	11.01
Mar	1.42	2.50	10.25
Apr	2.01	4.51	6.24
May	2.95	7.46	4.04
June	3.62	11.08	3.28
July	4.00	15.08	
Aug	3.76	18.84	
Sept	2.96	21.80	
Oct	2.11		
Nov	1.21		
Dec	0.38		

Total - 25.50

3/4 of ET = 0.75 * 25.5 = 19.13

L = September 10th or Julian date 253

Earliest Julian date when ET => precipitation by plot of monthly annual averages (E) .

E = say May 23rd or Julian date 143

SP_b = 365 -(L -E) = 365- (253- 143) = 255 days

2. Determine adjustment factor for level of management (Fm) . .

Medium- Select 0.8

3. Determine adjustment factor for availability permeable soils for land application (Fs).

HSG	Fs	%	
B	0.75	75	0.56
C	0.85 - 0.05 = 0.80	25	0.20
		Weighted factor	0.76

4. Determine adjustment factor for availability of land application area buffered from water bodies and free of concentrated flow areas (F1) .

50% -Select 0.90

5. Determine adjustment factor for method of land application (Fa).

Surface spread slurry – Select 0.95

6. Compute storage period (SP)

SP = SPb * Fm * Fs * Fl * Fa

= 255 * 0.8 * 0.76 * 0.90 * 0.95 = 133 days

.7. Check storage period for spanning periods of frozen ground
.and/or snow, and periods of seasonal flooding. Adjust storage period if necessary.

Late date (L) adjusted earlier to include seasonal flooding or frozen ground.

Late date = September 10th or Julian date 253. No flooding would be expected before this date. No adjustment of late date needed.

Early Julian date = SP -(365- L) adjusted later to include seasonal flooding or frozen ground.

Early Julian date = SP -(365- L) = 133- (365- 253) = 21 or January 21th

An adjustment is needed because flooding is anticipated through January. The early Julian date is adjusted to 31 (January 31st) .Therefore, the final storage period is:
365- (253- 31) = 143 days or September 10th to January 31st:"

Willamette Valley

Given:

1. Medium level of management
2. Manure is liquid and is surface applied to corn silage followed bya cover crop.
3. Utilization area has 50% HSG B soils and 50% HSG C and is 100% .. buffered from water bod1es and free of concentrated flow.
4. No seasonal flooding.

Solution:

1. Determine the basic storage period (SPb)
    a. Julian date when 3/4 of annual ET has accrued (L).
    b. Evapotranspiration and precipitation

Accum

Mo.	ET	ET	Ppt.
Jan	0.00	0.00	6.90
Feb	0.00	0.00	4.79
Mar	0.89	0.89	4.33
Apr	2.13	3.02	2.29
May	1.77	4.79	2.09
June	3.62	8.41	1.39
July	6.02	14.43	0.35
Aug	5.21	19.64	0.57
Sept	0.50 . ‘		
Oct	1.94		
Nov	0.46		
Dec	0.00		

Total - 22.54

3/4 of ET = 0.75 * 22.54 = 16.91

L = August 15th or Julian date 227

b. Earliest Julian date when ET => precipitation by plot of monthly annual averages (E).

E = say May 4th or Julian date 124

SP_b = 365- (L -E) = 365- (227- 124) = 262 days

2. Determine adjustment factor for level of management (Fm).

Medium -Select 0.8

3. Determine adjustment factor for availability permeable soils for land application (Fs).

HSG	Fs	%	
B	0.80	50	0.40
C	0.90	50	0.45
		Weighted factor	0.85

4. Determine adjustment factor for availability of land application area buffered from water bodies and free of concentrated flow areas (Fl) .

50% -Select 0.90

5. Determine adjustment factor for method of land application (Fa) .

Surface spread liquid - Select 0.90

6. Compute storage period (SP)

$SP = SP_b * Fm * Fs * Fl * Fa$

= 262 * 0.8 * 0.85 * 0.90 * 0.90 = 144 days

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7. Check storage period for spanning periods of frozen ground and/or snow, and periods of seasonal flooding. Adjust storage period if necessary.

Late date (L) adjusted earlier to include seasonal flooding or frozen ground.

Late date = August 15th or Julian date 227. No adjustment of late date needed because site is not subjected to flooding or frozen ground before this date.

Early Julian date = SP -(365- L) adjusted later to include seasonal flooding or frozen ground.

Early Julian date = SP -(365- L)

= 144- (365- 227) = 6 or January 6th

No adjustment needed because site is not subjected to flooding
or frozen ground after this date.

Final design storage period is from August 3rd to January 6th
(144 days). Initial spreading of manure will begin on January 6th.

Given:

1. Medium level of management
2. Manure is liquid and is surface applied to alfalfa.
3. Utilization area has 100% HSG B soils and is 100% buffered from water bodies and free of-concentrated flow.

Solution:

1. Determine the basic storage period (SP_b)

a. Julian date when 3/4 of annual ET has accrued (L).

Evapotranspiration and precipitation

Mo.	ET	Accum ET	Ppt.
Jan			1.26
Feb			1.04
Mar			0.76
Apr	2.41	2.41	0.75
May	4.99	7.40	1.08
June	6.84	14.24 0.96	
July	8.45	22.69 0.11	
Aug	6.97	29.66 0.37	
Sept	4.23	0.47	
Oct	1.44	0.85	
Nov			1.20
Dec			1.28

Total - 35.33

Procedure does not apply because ET exceeds precipitation for essentially the entire year. Storage period is determined by anticipated frozen ground/or snow conditions. Assume storage is required when monthly median temperature is less than 32 degrees.

Median temperatures

Mo.	Temp
Jan	27.9
Feb	35.8
Mar	43.5
Apr	50.7
May	59.2
June	67.6
July	74.7
Aug	73.2
Sept	62.0
Oct	50.9
Nov	39.8
Dec	30.0

Storage is required from December 1 through February 1.

L is December 1 or Julian date 335 .

E is February 1 or Julian Date 32

$SP_b = 365 - (L - E)$

$= 365 - (335 - 32) = 62$ days

No further adjustment.

Julian calendar for non-leap year. For Leap year, add 1 day after February 28.

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Auq	Sep	Oct	Nov	Dec
1	001	032	060	091	121	152	182	213	244	274	305	335
2	002	033	061	092	122	153	183	214	245	275	306	336
3	003	034	062	093	123	154	184	215	246	276	307	337
4	004	035	063	094	124	155 .	185	216	247	277	308	338
5	005	036	064	095	125	156	186	217	248	278	309	339
6	006	037	065	096	126	157	187	218	249	279	310	340
7	007	038	066	097	127	158	188	219	250	280	311	341
8	008	039	067	098	128	159	189	220	251	281	312	342
9	009	040	068	099	129	160	190	221	252	282	313	343
10	010	041	069	100	130	161	191	222	253	283	314	344
11	011	042	070	101	131	162	192	223	254	284	315	345
12	012	043	071	102	132	163	193	224	255	285	316	346
13	013	044	072	103	133	164	194	225	256	286	317	347
14	014	045	073	104	134	165	195	226	257	287	318	348
15	015	046	074	105	135	166	196	227	258	288	319	349
16	016	047	075	106	136	167	197	228	259	289	320	350
17	017	048	076	107	137	168	198	229	260	290	321	351
18	018	049	077	108	138	169	199	230	261	291	322	352
19	019	050	078	109	139	170	200	2.31	262	292	323	353
20	020	051	079	110	140	171	201	232	263	293	324	354
21	021	052	080	111	141	172	202	233	264	294	325	355
22	022	053	081	112	142	173	203	234	265	295	326	356
23	023	054	082	113	143	174	204	235	266	296	327	357
24	024	055	083	114	144	175	205	236	267	297	328	358
25	025	056	084	115	145	176	206	237	268	298	329	359
26	026	057	085	116	146	177	207	238	269	299	330	360
27	027	058	086	117	147	178	208	239	270	300	331	361
28	028	059	087	118	148	179	209	240	271	301	332	362
29	029	088	119	149	180	210	241	272	302	333	363	
30	030	089	120	150	181	211	242	273	303	334	364	
31	031	090		151		212		243	304		365	