

TECHNICAL NOTES

NATURAL RESOURCES CONSERVATION SERVICE – WYOMING

AGRONOMY NO. 24

August 28, 2003

SUBJECT: Ag Waste Available Water Holding Capacity Example

Background:

An alternative for AFO/CAFO producers that is increasingly popular is a short-term retention structure. Although we have tools available (Agronomy Tech Note #20) to quantify the area needed to agronomically utilize the nutrients in the run-off water, we also need to assure that we adequately address available soil water holding capacity (AWHC).

The following example explains the calculations needed to determine the adequacy of the AWHC in the area receiving the run-off water.

Scenario:

Iy Lyk Steak runs 2,500 head of feeders in a 17 acre feedlot near Douglas (see Conservation Plan Map). The 25-year, 24-hour storm event is 2.8 inches (see NOAA, WY Engineering Tech. Note 18, or comparable). Iy has contacted NRCS about a short-term retention structure. The feedlot sits on a small ridge where all clean water is easily diverted and immediately above a 21 acre, non-irrigated field of pubescent wheatgrass. The soil on this area is a Clarkelen fine sandy loam, 0-4%. The local District Conservationist has proposed a short-term retention structure to Iy and a preliminary design has been completed by the Team Specialist. The structure would retain the entire 25/24 event, which can then be spread across the pubescent wheatgrass field via a contour ditch system or gated pipe.

From Agronomy Technical Note #20, we calculate that there is adequate area below the spreader dike to agronomically utilize the nutrients from the run-on water. However, we also need to consider the available water-holding capacity of the soil receiving the water. From the soil description for Clarkelen:

Horizon Depth	Texture	AWHC (Inches/Foot)	Total AWHC
0 – 6"	Very fine sandy loam	2.0	1.0
6 – 20"	Fine sandy loam	1.5	1.8
20 – 60"	Loamy sand	1.0	3.3
Total			6.1

If we assume a 60% Maximum Allowable Depletion (we would use 50% for irrigated situations, but on a dryland scenario, 60% is more realistic), the profile could store:

$$6.1 \times 60\% = 3.7 \text{ inches}$$

The 25-year, 24-hour event is 2.8 inches.

From EFM-2 (RCN of 90), that equates to 1.8 inches of runoff (see Table 1 from EFM-2). Based on our 17 acre feedlot area, total runoff will be 111,078 cubic feet (2.55 acre foot, or 30.6 acre inches) of water, all of which will be retained by the planned structure. This water will be stored for a few days, until such time as the pubescent wheatgrass field can infiltrate the applied water.

The wheatgrass field also received the same 2.8 inch rainfall event. Based on a Runoff Curve Number of 65, the runoff from the field is 0.4 inches, or 2.4 inches retained and assumed to have infiltrated into the profile. Since the Available Water Holding Capacity for the Clarkelen soil is 3.7 inches, we have 1.3 inches of remaining Available Water Holding Capacity.

The average ET for grass in Converse County is 0.15 inches per day, so after 3 days, there will be an additional 0.45 inches of available water holding capacity. Therefore, the total AWHC of the pubescent wheatgrass field is

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$1.3 + 0.45 = 1.75$ inches. We could also account for the evaporation from the retention structure for the May through August period. Class A evaporation pan data is shown in Table 2.

Assuming we can uniformly apply the 111,079 cubic feet to the 21 acres, we would be applying 0.12 feet of water, or 1.5 inches per acre, well within the 1.75 inches of available water holding capacity.

If there was inadequate AWHC to store the applied water, additional retention time could be considered. However, it is incumbent upon the planner needs to assess the depth to groundwater, the permeability of the soil beneath the retention structure, and the potential for groundwater contamination.

The same procedure could be used to determine if the retention area would be large enough to utilize the runoff through plant usage, evaporation, and soil water holding capacity without release. In this case the retention area would have to be vegetated, essentially level, and a maximum water depth generally less than 10 inches.

Design Steps

1. Determine soils on utilization area.
2. Determine water holding capacity.
3. Is area dryland or irrigated.
4. Determine CN for area.
 - a. Run EFM2 (or comparable, Wyoming Engineering Technical Note 18) to determine the Runoff Curve Number and how much of the storm we can expect to infiltrate into the soil profile. You will need the acres, slope, and slope length, in addition to soil hydrologic group and vegetation for EFM2.
5. Determine days from event until emptying the retention structure.
 - a. Assume soil at 50% field capacity on irrigated, and 40% on dryland.
 - b. Estimate plant water usage for your specific location. (Reference Wyoming Irrigation Guide, or National Engineering Handbook Part 652 Chapter 4 Wyoming supplements.) Consider average annual precipitation, plant densities and plant evapotranspiration. The daily ET used to determine time to structure evacuation should never be greater than the average ET for the June – August period. The daily ET should be reduced for lower plant densities found on dryland sites in less than 15" precipitation zones.
6. Calculate available water holding capacity and determine the adequacy of the receiving area and if additional retention time is required.
7. Compare the acres required for the agronomic utilization of the nutrients (Agronomy Tech Note 20) to the acres required to store the water. Design the Operation and Maintenance of the retention structure accordingly.

Table 1 – Runoff in Inches for Curve Numbers

Rainfall	40	45	50	55	60	65	70	75	80	85	90	95
1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.3	0.6
1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.3	0.5	0.7
1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.4	0.6	0.9
1.6	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.3	0.5	0.8	1.1
1.8	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.3	0.4	0.7	0.9	1.3
2.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.4	0.6	0.8	1.1	1.5
2.5	0.0	0.0	0.0	0.1	0.2	0.3	0.5	0.7	0.9	1.2	1.5	2.0
3.0	0.0	0.0	0.1	0.2	0.3	0.5	0.7	1.0	1.3	1.6	2.0	2.5
3.5	0.0	0.1	0.2	0.4	0.5	0.8	1.0	1.3	1.6	2.0	2.5	2.9
4.0	0.1	0.2	0.3	0.5	0.8	1.0	1.3	1.7	2.0	2.5	2.9	3.4
4.5	0.1	0.3	0.5	0.7	1.0	1.3	1.7	2.1	2.5	2.9	3.4	3.9
5.0	0.2	0.4	0.7	1.0	1.3	1.7	2.0	2.5	2.9	3.4	3.9	4.4
6.0	0.5	0.8	1.1	1.5	1.9	2.4	2.8	3.3	3.8	4.3	4.9	5.4

Table 2 – Monthly Pan Evaporation (Inches)

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Anchor Dam	0.00	0.00	0.00	0.00	6.46	7.57	9.66	8.31	5.95	5.33	0.00	0.00
Boysen Dam	0.00	0.00	0.00	5.44	6.72	8.24	9.86	9.08	5.92	3.20	0.00	0.00
Gillette 2E	0.00	0.00	0.00	4.52	6.40	7.50	9.88	9.44	6.18	4.36	2.39	0.00
Green River	0.00	0.00	0.00	0.00	8.22	9.71	11.08	9.80	6.82	4.62	0.00	0.00
Heart Mtn.	0.00	0.00	0.00	3.50	5.81	6.38	7.35	6.69	4.38	3.43	0.00	0.00
Laramie 2 NW	0.00	0.00	0.00	0.00	8.21	10.26	10.71	9.58	7.48	4.76	0.00	0.00
Morton 1 NW	0.00	0.00	0.00	3.91	5.59	6.73	8.27	7.31	4.96	3.35	0.00	0.00
Pathfinder	0.00	0.00	3.20	5.07	6.78	8.78	10.53	9.75	7.17	4.95	2.81	0.00
Seminole Dam	0.00	0.00	0.00	0.00	5.24	8.27	8.99	8.12	5.59	0.00	0.00	0.00
Sheridan	0.00	0.00	0.00	3.55	6.19	7.80	10.16	9.65	6.45	0.00	0.00	0.00
Whalen Dam	0.00	0.00	3.32	5.17	7.44	9.00	10.39	9.09	6.24	4.18	0.00	0.00