Appendix G

Winter Spreading Technical Guidance

Interim Final

Technical Guidance for the Application of CAFO Manure on Land in the Winter

Water Division
Region 5
United States Environmental Protection Agency

Introduction[1]

Many owners or operators of concentrated animal feeding operations (CAFOs) use their manure, litter, and process wastewater (hereinafter *manure*) as a source of nutrients for the growth of crops or forage or to improve the tilth of soil. Others dispose of manure on land. The longer manure remains in the soil before plants take the nutrients up, the more likely those nutrients will be lost through volatilization, denitrification, leaching to subsurface drainage tile lines or ground water, and runoff to surface water. To use the greatest fraction of the nutrients in manure, late spring and early summer are the best times for land application. Some CAFO owners or operators apply manure on land in the late fall or winter because crops are not growing, labor is available, and, when it is frozen, the soil is able to handle the weight of manure hauling equipment without excessive compaction. Application in the late fall or winter also enables the owner or operator to avoid the cost of the structures that would be needed to store manure through the winter months. From the dual perspectives of nutrient utilization and pollution prevention, however, winter is the least desirable time for land application. Appendix G-1 contains an excerpt from the U.S. Environmental Protection Agency (EPA) (2002 p. 177–78) summarizing the literature on the risk that land application in the winter poses to water quality.

Under regulations that EPA promulgated in 2003, agencies that are authorized to issue National Pollutant Discharge Elimination System permits (hereinafter *states*) need to have technical standards for nutrient management that address, among other factors, the times at which CAFOs may apply manure on land (see Title 40 of the *Code of Federal Regulations* [CFR]part 123.36). Technical standards are to achieve realistic crop or forage production goals while minimizing movement of nitrogen and phosphorus to waters of the United States. They will form the basis for the nutrient management plans that CAFO owners and operators will implement under 40 CFR parts 122.42, 412.4.

EPA recognizes certain times during which there could be an increased likelihood that runoff from CAFO land application areas could reach waters of the United States. The times include, among others, when the soil is frozen or covered with ice or snow. Frozen soil will occur in areas where snow or other ground cover is shallow and where prolonged periods of subfreezing air temperatures prevail (U.S. Army Corps of Engineers 1998). The January normal daily minimum air temperature in EPA Region 5 ranges from minus 8 degrees Fahrenheit (°F) in the northwest to 22 °F in the south. Thus, all areas in the region are subject to air temperatures that can cause soil to freeze. For December through March, the mean precipitation in the region ranges from 3 inches of water in the northwest to 14.6 inches of water in the south. The mean snowfall in those months ranges from 13 inches in the south to 108 inches in the coastal north. The above normals notwithstanding, the only reliable way to predict temperature and precipitation before any winter is through statistical analysis of historical data for the location of interest.

To ensure effective implementation of the regulations, EPA (2003) has expressed its strong preference that states prohibit the discharge of manure from land application. That is applicable unless the discharge is an agricultural stormwater discharge (i.e., a precipitation-related discharge from land where manure was applied in accordance with a nutrient management plan). EPA has also expressed its strong preference for the way in which states in their technical standards should address the timing of land application. With regard to the winter months, EPA strongly prefers that technical standards either prohibit surface application on snow, ice, and frozen soil or include specific protocols that CAFO owners or operators, nutrient management planners, and inspectors will use to conclude whether application to a frozen or snow- or ice-covered field, or a portion thereof, poses a reasonable risk of runoff. Where there is a reasonable risk, EPA strongly prefers that technical standards prohibit application on the field or the pertinent portion thereof during times when the risk exists or could arise.

Technical Guidance

This paper presents technical guidance to which EPA Region 5 will refer as we work together with those states that plan to allow CAFO owners or operators to apply manure on land in the winter where a crop will not be grown in that season or nutrients need not be applied in the winter to grow the crop. For that purpose, Region 5 assumes that the risk of runoff will be minimized if a state requires injection or timely incorporation of manure in the winter, provided that the CAFO owner or operator adheres to the setback requirements in 40 CFR part 412.4(c)(5). Further, we assume that the risk of runoff will be minimized if waters of the United States, sinkholes, open tile line intake structures, and other conduits to waters of the United States are upslope from the land on which manure would be surface applied. Thus, the balance of this technical guidance is intended to provide a basis for the region to evaluate the adequacy of preliminary technical standards that would allow surface application without timely incorporation where waters of the United States, sinkholes, open tile line intake structures, or other conduits to waters of the United States are downslope from the land on which the manure would be applied.[2]

Potential Discharges That Are Not Precipitation Related

When liquid manure is applied on frozen soil in the absence of snow cover, Region 5 has concluded that the manure will run off and potentially discharge if it is applied in excess of the pertinent rate specified in Table G-1a or G-1b.[3] For an example that shows how the region came to this conclusion, see Appendix G-2. In as much as the discharge of manure is not an agricultural stormwater discharge when it is not related to precipitation, technical standards need to prohibit the application of liquid manure on frozen soil, in excess of the rates provided in the following tables, when the soil is not covered with snow.

Liquid Manure Maximum Rates of Application onto Frozen Soil

Table G-1a. Harvested Crops were row crops planted in straight rows with land in good hydrologic condition

Hydrologic Soil Group*	Maximum rate of application (gallons per acre)
A	3,000
B	1,600
C	1,100
D	1,100

Table G-1b. Harvested crops were close-seeded legumes planted in straight rows with land in good hydrologic condition

Hydrologic Soil Group	Maximum rate of application (gallons per acre)
A	4,100
B	2,200
C	1,100
D	1,100

*See Appendix A of U.S. Department of Agriculture, Soil Conservation Service (1986) for information on the Hydrologic Soil Group within which a given soil is classified. The appendix is at *ftp://ftp.wcc.nrcs.usda.gov/wntsc/H&H/other/TR55documentation.pdf*.

Discharges That Are Precipitation Related

When manure is applied on land in the winter, Region 5 assumes that nutrients and manure pollutants will dissolve or become suspended in any precipitation that comes into contact with the manure. That assumption is consistent with the findings reported in Appendix G-1 and Table G-2. The technical guidance that follows is intended to provide a basis for the region to evaluate the adequacy of preliminary technical standards as such standards affect the movement of nutrients and manure pollutants in precipitation runoff during the winter or early spring. Six substantive steps are presented below. The first three involve the formulation of state policy for nutrient management. As contemplated in ***Step 1***, the policy should include a standard for the concentration or mass of biochemical oxygen demand (BOD) in precipitation-related discharges. Nutrients, including ammonia and nitrite, contribute to that demand. The final three involve engineering analysis to determine whether the BOD standard will be met.

Step 1: In collaboration with Region 5, the state establishes a standard for the concentration or mass of BOD that will be permitted in precipitation-related discharges from land on which manure has been surface applied in the winter.

Table G-2. **Assumed initial concentration of bod in runoff from land on which manure or process wastewater has been surface applied**

Type of material	Initial total BOD in runoff (mg/L)
Broiler manure[a]	708
Cattle (other than manure dairy cow) manure	Reserved
Cattle open lot process wastewater	Reserved
Egg wash process wastewater	Reserved
Feed storage process wastewater	Reserved
Layer manure[b]	809
Mature dairy cow manure[c]	924
Swine manure[d]	204
Turkey manure	Reserved

[a] Daniel et al. 1995
[b] Ibid.
[c] Thompson et al. 1979
[d] Daniel et al. 1995

Step 2: ***A.*** The state establishes preliminary technical standards for the setback[4] and the type, form, and maximum quantity of manure that could be surface applied on land in the winter. Standards for the setback should be expressed in terms of distance and slope. The minimum distance is that required under 40 CFR part 412.4(c)(5). As required to use equations 2 or 3, below, standards for the setback should also be expressed in terms of the land cover and treatment practice and the crop residue rate (in the case of equation 2) or the Hydrologic Soil Group (in the case of equation 3). For information on various residue rates and land cover and treatment practices, see Tables G-3 and G-4.

B. If the standard established in ***Step 1*** is expressed as a mass, the state establishes additional preliminary technical standards for the land cover and treatment practice and Hydrologic Soil Group applicable to land that is upslope from the setback.

Step 3: So that Region 5 can perform the engineering analysis, the state establishes appropriate design conditions for the land use, form of precipitation (rain or ripe snow), depth of precipitation, and the temperature and moisture content of soil. At a minimum, the design condition for the moisture content of soil should be antecedent moisture condition III (i.e., saturated soil) (Wright 2004; Linsley et al. 1982). States should carefully review climate data to determine whether the design temperature of soil should be 0 degrees Celsius (°C) or less. In no case should the design temperature of soil exceed 3 °C.

Table G-3. Recommended Manning's roughness coefficients for overland flow

Cover or treatment	Residue rate (ton/acre)*	Recommended coefficient	Range
Bare clay-loam (eroded)		0.02	0.012 to 0.033
Fallow - no residue		0.05	0.006 to 0.16
Chisel plow	< 0.25	0.07	0.006 to 0.17
	0.25 to 1	0.18	0.07 to 0.34
	1 to 3	0.3	0.19 to 0.47
	> 3	0.4	0.34 to 0.46
Disk/harrow	< 0.25	0.08	0.008 to 0.41
	0.25 to 1	0.16	0.1 to 0.25
	1 to 3	0.25	0.14 to 0.53
	> 3	0.3	--
No till	< 0.25	0.04	0.03 to 0.07
	0.25 to 1	0.07	0.01 to 0.13
	1 to 3	0.3	0.16 to 0.47
Moldboard plow (fall)		0.06	0.02 to 0.1
Coulter		0.1	0.05 to 0.13
Range (natural)		0.13	0.02 to 0.32
Range (clipped)		0.1	0.02 to 0.24
Short grass prairie		0.15	0.1 to 0.2
Dense grass		0.24	0.17 to 0.3

Source: Engman 1986

* See Figure G-2 to convert residue cover from a percent to a mass.

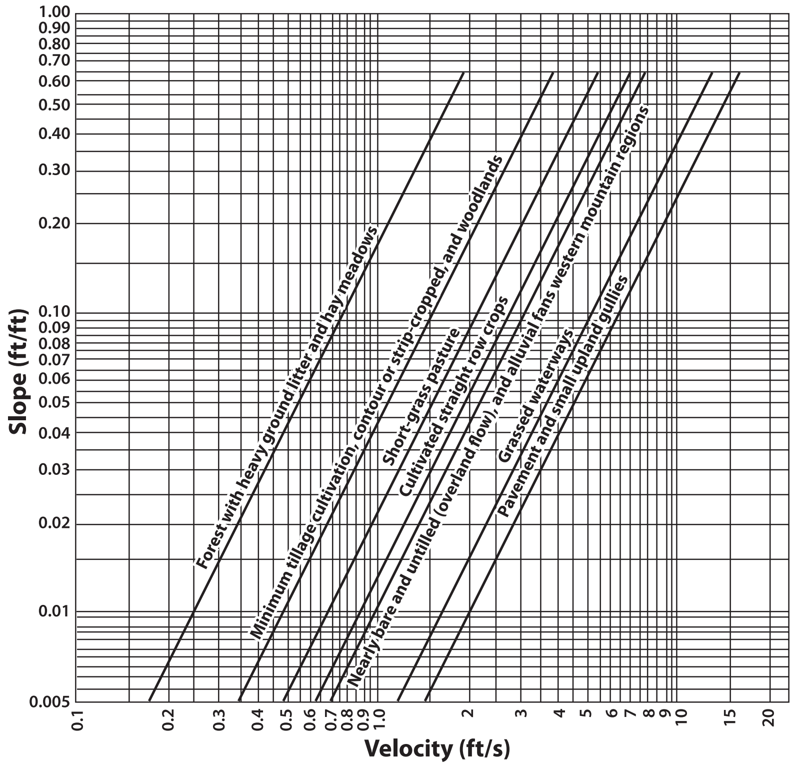

Figure G-1. Average velocity of shallow concentrated flow. (Source: USDA NRCS 1993)

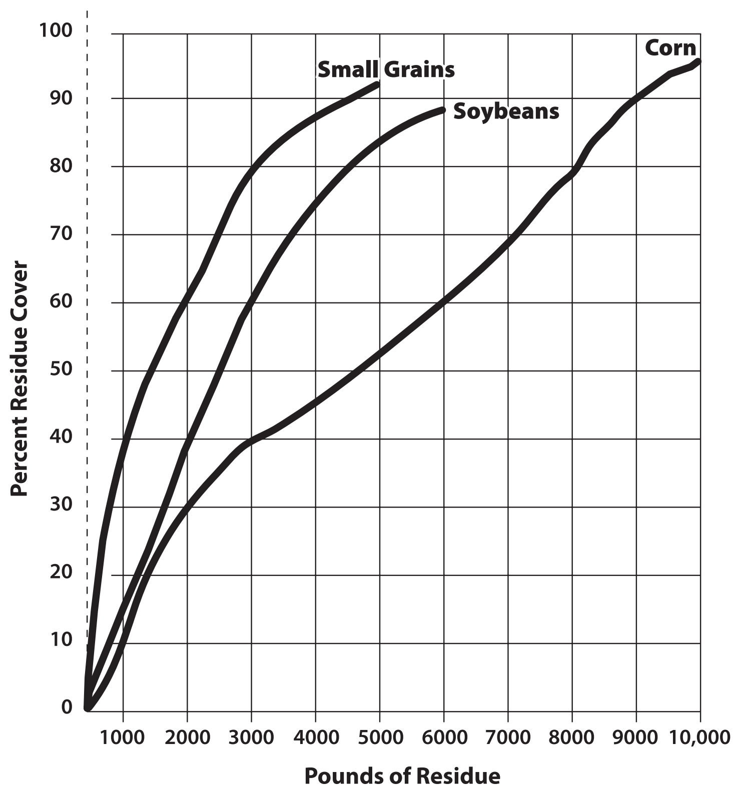

Figure G-2. Pounds of residue vs. percent ground cover. (Source: USDA NRCS 2002b)

Table G-4. Runoff curve numbers for hydrologic soil-cover complexes[a]

Land use	Treatment or practice	Hydrologic condition[b]	Hydrologic soil group			
			A	B	C	D
Fallow	Bare soil		89	94	97	98
	Crop residue cover	Poor	89	94	96	98
	"	Good	88	93	95	96
Row crops	Straight row	Poor	86	92	95	97
	"	Good	83	90	94	96
	Straight row and cop residue cover	Poor	86	91	95	96
	"	Good	81	88	92	94
	Contoured	Poor	85	91	93	95
	"	Good	82	88	92	94
	Contoured and crop residue	Poor	84	90	93	95
	"	Good	81	88	92	94
	Contoured and terraced	Poor	82	88	91	92
	"	Good	79	86	90	92
	Contoured, terraced, and crop residue	Poor	82	87	91	92
	"	Good	78	85	89	91
Small grain	Straight row	Poor	82	89	93	95
	Contoured	Poor	80	88	92	94
	"	Good	78	87	92	93
	Contoured and crop residue	Poor	79	87	92	93
	"	Good	78	86	91	93
	Contoured and terraced	Poor	78	86	91	92
	"	Good	77	85	90	92
	Contoured, terraced, and crop residue	Poor	78	86	90	92
	"	Good	76	84	89	91
Close-seeded legumes[c] or rotation meadow	Straight row	Poor	82	89	94	96
	"	Good	76	86	92	94

Table G-4. Runoff curve numbers for hydrologic soil-cover complexes[a] *(continued)*

Land use	Treatment or practice	Hydrologic condition[b]	Hydrologic soil group			
			A	B	C	D
	Contoured	Poor	81	88	93	94
	"	Good	74	84	90	93
Close-seeded legumes[d] or rotation meadow	Contoured and terraced	Poor	80	87	91	93
	"	Good	70	83	89	91
Pasture or range		Poor	84	91	94	96
		Fair	69	84	91	93
		Good	59	78	88	91
	Contoured	Poor	67	83	92	95
	"	Fair	43	77	88	93
	"	Good	13	55	85	91
Meadow		Good	50	76	86	90

Source: USDA NRCS 1993; USDA SCS 1986

[a] The runoff curve numbers in this table apply to saturated soil conditions (i.e., antecedent moisture condition III). For runoff curve numbers applicable to average soil moisture conditions, see Appendix G-3.

[b] According to USDA SCS (1986), hydrologic condition is based on a combination of factors, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes in rotation, (d) percent of residue cover on the land surface (good ≥ percent), and (e) degree of surface roughness.

[c] Close-drilled or broadcast

[d] Close-drilled or broadcast

Step 4: The region calculates the percent removal of BOD that will occur in the setback, given the design conditions and preliminary technical standards. Calculating the percent removal is a two-step process, as shown in **A** and **B** below.

A. Calculate the amount of time it takes water to travel or *concentrate* (T_c) across the setback distance. Two equations are provided below as options for calculating T_c. In general, use equation 1 (USDA NRCS 2002a) when the design condition consists of rain on frozen soil or rain on ripe snow or when the preliminary technical standards specify a residue rate equal to or greater than 20 percent. Use equation 3 (USDA NRCS 1993) when the design condition consists of ripe snow, the preliminary technical standards do not specify a residue rate, or the rate is less than 20 percent.

Eq. 1 $T_c\,(\text{hr}) = T_{t\,(overland)} + T_{t\,(shallow\ concentrated)}$

where

Eq. 2 $$T_{t\,(overland)} = \frac{0.007 \times (N \times L)^{0.8}}{(P^{0.5}) \times (x^{0.4})}$$

N = Manning's roughness coefficient for overland flow. To select a coefficient that is appropriate in light of the preliminary technical standards, see Table G-3.

L = overland flow portion of the setback distance (maximum of 100 feet) (ft).

P = precipitation design depth (in).

s = preliminary technical standard for the slope over the distance L (ft/ft).

$T_{t\,(shallow\ concentrated)}$ applies to the shallow concentrated flow portion of the setback distance. In other words, it applies to the portion that is between points (a) and (b) as described below.

Point (a): 100 feet downslope from the furthest downslope point at which manure would be applied under the preliminary technical standards.

Point (b): the nearest waters of the United States, sinkhole, open tile line intake structure, or other conduit to waters of the United States. $T_{t\,(shallow\ concentrated)}$ is determined by multiplying the above distance times a velocity of runoff that is appropriate in light of the preliminary technical standards. See Figure G-1.

Eq. 3 $$T_c\,(hr) = \frac{5}{3} \times \frac{(L^{0.8}) \times (S+1)^{0.7}}{1900 \times (s^{0.5})}$$

where

L = preliminary technical standard for the setback distance (ft).

S = potential maximum retention after runoff begins

= (1,000 / CN) – 10

CN= runoff curve number. To select a number that is appropriate in light of the design condition for the land use and the preliminary technical standards, see Table G-3.

s = preliminary technical standard for the slope over the distance L (percent).

B. Calculate the percent removal of BOD in the setback. The equation for percent removal is as follows (modified from Martel et al. 1980):

Eq. 4 $E = (1 - A \times e^{-(k_T) \times t}) \times 100$

where

E = percent removal of BOD

A = nonsettleable fraction of BOD in manure

= 0.5 to 0.6 for animals other than mature dairy cows (Zhu 2003)

= 0.9 for mature dairy cows (Wright 2004)

k_T = first-order reaction rate constant at the design temperature of soil (T) (°C)

= $k \times (\Theta)^{T-20}$

Θ = 1.135 (Schroepfer et al. 1964)

k = 0.03/min[5]

t = detention time

= $T_c \times 60$

Step 5: Region 5 multiplies the percent removal calculated in ***Step 4. B.*** times the initial concentration of BOD in runoff from land where manure has been surface applied (i.e., the concentration before treatment of the runoff by land in the setback). If state-specific data are not available, use the values from Table G-2 as the basis for assumptions about the initial concentration. Subtract from the initial concentration the product of the percent removal times the initial concentration. If the standard established in ***Step 1*** is expressed as a mass, proceed to ***Step 6.*** If it is expressed as a concentration, compare the final concentration to the standard. If the final concentration is less than or equal to the standard, the region will conclude that there is no reasonable risk of runoff. The region will neither object to nor disapprove the state's preliminary technical standards. However, for the analysis to hold, the technical standards need to require the CAFO owner or operator to verify that conditions in the setback at the beginning of any application are consistent with the values assigned to *N* or *S*. In other words, the standards need to prohibit surface application when ice reduces the surface roughness or occupies the surface storage in the setback. If the concentration is greater than the standard established in ***Step 1***, the region will conclude that there is a reasonable risk of runoff. Therefore, the final technical standards need to prohibit surface application of manure in the winter (or on frozen or snow-covered soil) or the state needs to otherwise strengthen the preliminary technical standards so there is no reasonable risk of runoff.

Step 6: If the standard is expressed as a mass, Region 5 calculates the mass of BOD that will run off the land given the design conditions for the land use, depth of precipitation, soil temperature, and soil moisture content and the preliminary technical standards for the Hydrologic Soil Group, land cover and treatment practice, and the type and maximum quantity of liquid manure. Calculating the mass is a three-step process as shown below.

A. Use the following equation (USDA NRCS 1993) to calculate the inches of runoff.

Eq. 5 $$Q = \frac{(P - 0.2 \times S)^2}{(P + 0.8 \times S)}$$

where

Q = runoff (in)

P = precipitation design depth plus the depth of water that could be applied in the winter as liquid manure given the preliminary technical standards (in).

S = the same as defined for equation 3 except that, if the design temperature of soil is 0 °C or less, substitute S_f for S where $S_f = (0.1 \times S)$ (Mitchell et al. 1997).

B. Use the following equation to convert the runoff from inches to a volume per acre.

Eq. 6 $$Q\ (gal/ac) = Q\ (in) \times ft/12\ in \times 43{,}560\ ft^2/ac \times 7.48\ gal/ft^3$$

C. Calculate the mass of BOD in runoff by multiplying the volume of runoff times the final concentration of BOD calculated in ***Step 5.*** The equation is as follows:

Eq. 7 $$BOD\ (lb/ac) = BOD\ (mg/l) \times Q\ (gal/ac) \times 3.7854\ L/gal \times g/1000\ mg \times 0.0022\ lb/g$$

Compare the mass with the standard established in ***Step 1***. If the mass is less than or equal to the standard, Region 5 will conclude that there is no reasonable risk of runoff. The region will neither object to nor disapprove the preliminary technical standards. However, for the analysis to hold, the technical standards need to require the CAFO owner or operator to verify that conditions in the setback at the beginning of any application are consistent with the values assigned to *N* or *S*. In other words, the standards need to prohibit surface application when ice reduces the surface roughness or occupies the surface storage in the setback. If the mass is greater than the standard established in ***Step 1***, Region 5 will conclude that there is a reasonable risk of runoff. Therefore, the final technical standards need to prohibit surface application of manure in the winter (or on frozen or snow-covered soil) or the state needs to otherwise strengthen the preliminary technical standards so there is no reasonable risk of runoff.

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Endnotes

1 In accordance with the U.S. Environmental Protection Agency (2000), Region 5 asked three professional engineers to review a February 2004 draft of this document. The peer review record includes responses to the comments that those individuals provided pursuant to the request.

2 For the purpose of this technical guidance, "other conduits to waters of the United States" means any area wherein water is or could be conveyed to waters of the United States via channelized flow.

3 Region 5 developed the tables for the corn and soybean crops commonly grown in the region. On request, the region can supply tables for other land uses and land cover and treatment practices.

4 The term *setback* is defined in 40 CFR part 412.4 to mean a specified distance from surface waters (i.e., waters of the United States) or potential conduits to surface waters where manure may not be land applied.

5 The k value of 0.03 per minute is as reported by Martel et al. (1980) for treatment of municipal wastewater by the overland flow process. The region assumes that Martel et al., reported the constant at 20 °C consistent with standard engineering practice.

Appendix G-1

The following is an excerpt from EPA (2002 p. 177–78):

> [C]onsiderable research has demonstrated that runoff from manure application on frozen or snow-covered ground has a high risk of water quality impact. Extremely high concentrations of nitrogen and phosphorus in runoff have been reported from plot studies of winter-applied manure: 23.5 to 1,086 milligrams (mg) of total Kjeldahl nitrogen (TKN) per liter (L) and 1.6 to 15.4 mg/L of phosphorus (P) (Thompson, et al. 1979; Melvin and Lorimor 1996). In two Vermont field studies, Clausen (1990, 1991) reported 165 to 224 percent increases in total P concentrations, 246 to 1,480 percent increases in soluble P concentrations, 114 percent increases in TKN concentrations, and up to 576 percent increases in ammonia-nitrogen (NH_3-N) following winter application of dairy manure. Mass losses of up to 22 percent of applied nitrogen and up to 27 percent of applied P from winter-applied manure have been reported (Midgeley and Dunklee 1945; Hensler et al. 1970; Phillips et al. 1975; Converse et al. 1976; Klausner et al. 1976; Young and Mutchler 1976; Clausen 1990, 1991; Melvin and Lorimor 1996). Much of this loss can occur in a single storm event (Klausner et al. 1976). Such losses could represent a significant portion of annual crop needs.
>
> On a watershed basis, runoff from winter-applied manure can be an important source of annual nutrient loadings to waterbodies. In a Wisconsin lake, 25 percent of annual P load from animal waste sources was estimated to arise from winter spreading (Moore and Madison 1985). In New York, snowmelt runoff from winter-manured cropland contributed more P to Cannonsville Reservoir than did runoff from poorly managed barnyards (Brown et al. 1989). Clausen and Meals (1989) estimated that 40 percent of Vermont streams and lakes would experience significant water quality impairments from the addition of just two winter-spread fields in their watersheds.
>
> Winter application of manure can increase microorganism losses in runoff from agricultural land compared to applications in other seasons (Reddy et al. 1981). Cool temperatures enhance survival of fecal bacteria (Reddy et al., 1981; Kibby et al. 1978). Although some researchers have reported that freezing conditions are lethal to fecal bacteria (Kibby et al. 1978; Stoddard et al. 1998), research results are conflicting. Kudva et al. (1998) found that Escherichia coli can survive more than 100 days in manure frozen at minus 20 degrees Celsius. Vansteelant (2000) observed that freeze/thaw of soil/slurry mix only reduced E. coli levels by about 90 percent. Studies have found that winter spreading of manure does not guarantee die-off of Cryptosporidium oocysts (Carrington and Ransome 1994; Fayer and Nerad 1996). Although several studies have reported little water quality impact from winter-spread manure (Klausner 1976; Young and Mutchler 1976; Young and Holt 1977), such findings typically result from fortuitous circumstances of weather, soil properties, and timing/position of manure in the snowpack. The spatial and temporal variability and unpredictability of such factors makes the possibility of ideal conditions both unlikely and impossible to predict.

Appendix G-2. Example Derivation of the Maximum Rates for Liquid Manure Application on Frozen Soil

Givens

According to USDA NRCS (1993), the following are givens:

Potential maximum retention after runoff begins (S) $= \frac{1{,}000}{CN} - 10$

Runoff curve number (CN) $= \frac{1{,}000}{S + 10}$

According to Mitchell et al. (1997), the following is a given for frozen soil:

$$S_f = 0.1 \times S$$

For *CN* in the range from zero to 100, Table 10.1 in USDA NRCS (1993), identifies the minimum depth of precipitation (*P*) at which the runoff curve begins under dry, average, and saturated antecedent soil moisture conditions. For example, for a *CN* of 91 and average antecedent soil moisture, the runoff curve begins when *P* equals 0.2 inch.

Example

Hydrologic Soil Group A.

Harvested crop was corn planted in straight rows.

The land is in good hydrologic condition.

The antecedent soil moisture is average.

$$S_f = (1{,}000 / 64 - 10) \times 0.1 = 0.56$$

$$CN_f = (1{,}000 / (0.56 + 10) = 94.7 \cong 95$$

According to Table 10.1 in USDA NRCS (1993), for a CN of 95, 0.11 inch is the minimum depth of precipitation (or other liquid) at which the runoff curve begins. Converting that depth to a volume per acre,

$$Q\ (\text{gal/ac}) = 0.11\ \text{in} \times \text{ft}/12\ \text{in} \times 43{,}560\ \text{ft}^2/\text{ac} \times 7.48\ \text{gal/ft}^3$$

results in 2,987 gallons per acre as the maximum quantity of liquid that can be applied on frozen soils in Hydrologic Soil Group A while precluding runoff.

Appendix G-3. Runoff Curve Numbers for Antecedent Moisture Condition II

If the curve number for AMC III is …	then the curve number for AMC II is …
100	99
99	96
98	93
97	91
96	89
95	87
94	85
93	83
92	81
91	79
90	78
89	76
88	74
87	73
86	71
85	70
84	68
83	67
82	65
81	64
80	63
79	62
78	60
77	59
76	58
75	57
74	55
73	54
72	53
71	52
70	50
69	49
68	48
67	47
66	46
65	45
64	44
63	43
62	42
61	41