

This booklet is prepared by the Minnesota Pollution Control Agency.



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For questions on how to use this booklet please contact your regional Minnesota Pollution Control Agency office.



Minnesota Pollution Control Agency Regional Offices

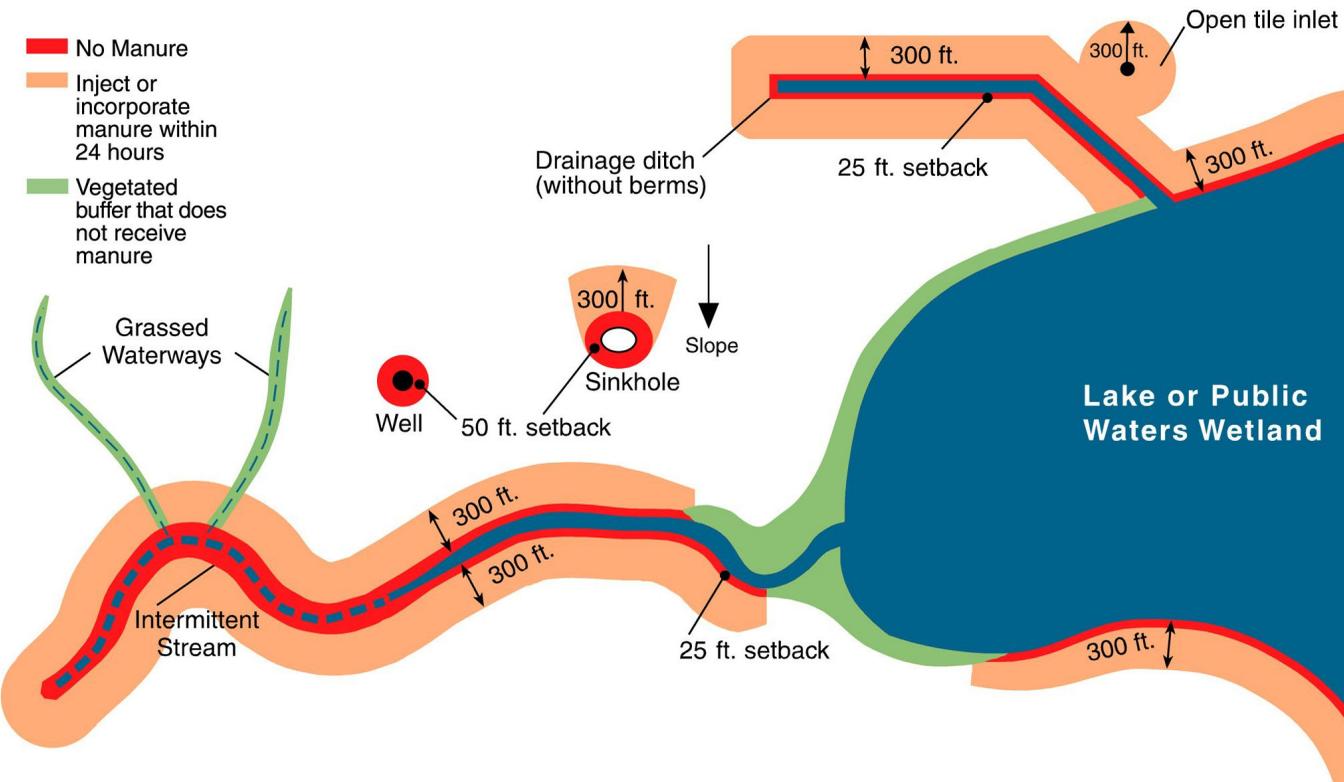
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Manure Application Rate Guide



Land application setbacks from waters



NOTE: This graphic summarizes the State setback requirements (more info on pg 20). County and/or Township requirements may be more restrictive.

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How to use this booklet

This booklet is designed to assist anyone applying manure in determining a rate that meets the crop nitrogen needs.

This booklet should not be used as a substitute for a Manure Management Plan (MMP), but is useful when a MMP is not required.

To determine an appropriate application rate:

1. Locate the correct chart using the animal species, manure type (liquid/solid), and the method of application.
2. In the far left column find the manure nitrogen (N) test value (lbs/1000gal or lbs/ton).
3. In the top row of the chart locate the desired amount of nitrogen you want to be available to the crop grown.
4. Where these two values intersect on the chart is the desired application rate in either 1,000's of gallons or tons per acre.

NOTE: Due to rounding, applied nitrogen rates may be slightly higher or lower than the values shown in the chart.

Example – How to use the application rate charts

Sweep injected liquid swine manure with a nitrogen test value of 52 lbs/1,000 gal.
To obtain 180 lbs of available nitrogen the application rate would be 4,500 gal/acre.

Injected liquid swine manure application rate (1,000 gal/acre)

N Test	Knife Injection					Sweep Injection				
	Desired Available N (lbs/acre)					Desired Available N (lbs/acre)				
	80	120	150	180	195	80	120	150	180	195
24	5.0	7.0	9.0	10.5	11.5	4.0	6.5	8.0	9.5	10.0
28	4.0	6.0	7.5	9.0	10.0	3.5	5.5	6.5	8.0	8.5
32	3.5	5.5	6.5	8.0	8.5	3.0	4.5	6.0	7.0	7.5
36	3.0	5.0	6.0	7.0	7.5	3.0	4.0	5.0	6.5	7.0
40	3.0	4.5	5.5	6.5	7.0	2.5	4.0	4.5	5.5	6.0
44	2.5	4.0	5.0	6.0	6.5	2.5	3.5	4.5	5.0	5.5
48	2.5	3.5	4.5	5.5	6.0	2.0	3.0	4.0	4.5	5.0
52	2.0	3.5	4.0	5.0	5.5	2.0	3.0	3.5	4.5	4.5
56	2.0	3.0	4.0	4.5	5.0	2.0	2.5	3.5	4.0	4.5
60	2.0	3.0	3.5	4.5	4.5	1.5	2.5	3.0	4.0	4.0

N test or desired available N not on the chart? – You can still find the appropriate rate.

If you need to find a rate for 60 lbs of N you can simply take ½ of the rate for 120 lbs of N.

Likewise, to find a rate for an N test of 12 you can simply double the rate for an N test of 24.

How to take a manure sample

Liquid samples can be taken by dipping a plastic cup or small can attached to a pole, and solid samples can be taken with a pitchfork, shovel, or plastic glove. You will need a clean 5 gallon bucket for mixing sub-samples, as well as a sample bottle/container from the lab. After mixing many sub-samples in the bucket, transfer a smaller sample to the lab bottle/container.

Sample source	Sampling method
Loaded Liquid Tanker or Solids Spreader	Take sub-samples from many loads and mix in bucket to get a representative sample. Avoid large chunks of manure.
Liquid Manure Storage Structures	Take sub-samples from many depths and locations and mix in bucket to get a representative sample. Avoid sampling the bottom foot, edges, scum, and debris.
Stockpile or Manure Pack	Take many sub-samples from different depths and locations and mix together in bucket to get a representative sample. Avoid sampling the outer 1 ½ feet.
Scrape and Haul	Scrape the floor or lot at many locations and mix together in bucket to get a representative sample. Avoid areas very close to waterers, drains, or feedbunks.
Litter	Take many sub-samples to the depth of the floor throughout the house and mix together in bucket to get a representative sample. Avoid areas very close to feeders or waterers.
Overhead Irrigation, Traveling Gun, or Towed Hose	Prior to application place many catch pans or buckets in the field, or take many sub-samples at the pump, and mix in one bucket to get a representative sample.



For more info, refer to the U of MN [Manure sampling and nutrient analysis](#) webpage.

Estimated nutrient content of liquid and solid manure

When possible, actual manure test results should be used in place of these estimates.

Animal type	Liquid manure (lbs/1000 gal)			Solid manure (lbs/ton)		
	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O
Beef						
Feeder cattle/Slaughter steer	29	18	26	11	7	11
Cow	20	16	24	7	4	7
Calf	27	18	24	9	4	8
Dairy						
Mature cow (milked or dry)	31	15	19	10	3	6
Heifer	32	14	28	10	3	7
Calf	27	14	24	10	3	5
Swine						
Nursery	25	19	22	13	8	4
Wean-Finish <small>second number is</small>	42 (57)	34 (46)	24 (34)	14 (14)	6 (6)	4 (4)
Grow-Finish <small>for wet/dry feeders</small>	58 (75)	44 (54)	40 (40)	16 (22)	9 (22)	5 (17)
Farrowing	15	12	11	14	6	4
Gestation	25	25	24	9	7	5
Poultry						
Layers	57	52	33	34	51	26
Broilers	63	40	29	46	53	36
Turkeys	56	39	31	40	50	30

Sources: – Manure Management in Minnesota (WW-03553, U of M Extension 2012)
 Manure Characteristics (MWPS-18 Section 1, Midwest Plan Service 2004)
 Liquid Swine Manure Nutrients (ASL-R 1596, Iowa State University)

Nitrogen rates for corn production



Nitrogen application rates should be consistent with the appropriate University of Minnesota “maximum return to N” (MRTN) value to limit the likelihood of N leaching/loss.

N application rates should not exceed the N needs values for the 0.05 MRTN in the table below.

Nitrogen needs for corn crops (including corn silage)^a

Yield	Crop last year	Crop 2 years ago	0.1 MRTN Max N needs ^b	0.05 MRTN Max N needs ^b
Any	Soybeans	No Alfalfa	130	150
Any	Corn	No Alfalfa	165	195
Any	Corn	Alfalfa (2+ yr old stand)	80	80
Any	Corn	Alfalfa (1 yr old stand)	120	120
Any	Alfalfa	Alfalfa	40	40
Any	Alfalfa	No Alfalfa	80	80
Any	Peas/Edible beans	No Alfalfa	145	175

^a Site specific factors (e.g. alfalfa harvest timing) may influence the values in this chart. To obtain a specific recommendation refer to University of Minnesota and MPCA publication(s).

^b For corn grown on irrigated sandy soils, additional N application may be recommended but available N from manure cannot exceed 180 lbs. Refer to the MPCA publication [*Manure management for corn on irrigated sandy soils*](#) (*wq-f8-52*) for more information.

Nitrogen rates for crops other than corn

Nitrogen application rates should be consistent with the appropriate University of Minnesota recommendations based on realistic yield goals to limit the likelihood of N leaching/loss.

N application rates should not exceed the N needs values in the table below.

Nitrogen needs for various crops

Crop to be grown	Yield	Crop last year	Crop 2 years ago	Max N needs ^a
Wheat	60 – 80 bu	Corn	No Alfalfa	110 - 150
Wheat	60 – 80 bu	Soybeans	No Alfalfa	90 - 130
Oats	81 – 100 bu	Corn	No Alfalfa	70
Oats	81 – 100 bu	Soybeans	No Alfalfa	30
Sweet corn	8 - 9 tons	Corn	Any	120
Sweet corn	8 - 9 tons	Soybeans	Any	90
Edible beans	2400 - 2900 lbs	Corn or Soybeans	No Alfalfa	70 - 90
Alfalfa ^b	5 ton	Any	Any	255
Grass hay/Pasture ^b	2 ton	Any	Any	54

^a The nitrogen needs values in this chart may not be the best nitrogen recommendation for every case. To obtain specific nitrogen recommendations please refer to the applicable University of Minnesota and MPCA publication(s).

^b N is not needed but N from manure will be utilized when applied.

Choosing the appropriate nitrogen recommendation

Some fields can achieve highly productive and profitable yields by applying N at rates below the maximum University of Minnesota recommendations.

- Soils and drainage. Fields with low organic matter (3% or less) or poor drainage have less response to N.
 - For corn grown on non-irrigated loamy fine sands with less than 3% organic matter, the recommended N application is 100 lbs N/acre for corn following corn or 70 lbs N/acre for corn following soybeans.
- Regional differences. Yields in northern Minnesota might be lowered by a shorter growing season, while farms in southeast Minnesota with loess soils may be able to maximize yield with lower rates of N.
- Application timing. The time of year N is applied can influence N utilization. Fall application increases the chance for N losses due to weather effects.
 - The use of cover crops can help limit loss/leaching of fall applied N.

BMPs for nitrogen applications

The University of Minnesota has produced various documents that outline BMPs for improved nitrogen utilization that give you best chance to grow a profitable crop while limiting N loss to the environment.

Links to these BMP documents can be found on the Minnesota Department of Agriculture's [Nitrogen Fertilizer BMPs](#) webpage.



Nitrogen availability for different application methods

Percent of total nitrogen available per year

Year available	Broadcast			Injection	
	Incorporation after 4 days	Incorporation 12 - 96 hrs	Incorporation within 12 hrs (includes cover disks)	Knife	Sweep
Beef					
Year 1	25	45	60	50	60
Year 2	25	25	25	25	25
Lost	40	20	5	10	5
Dairy					
Year 1	20	40	55	50	55
Year 2	25	25	25	25	25
Lost	40	20	10	10	5
Swine					
Year 1	35	55	75	70	80
Year 2	15	15	15	15	15
Lost	50	30	10	15	5
Poultry					
Year 1	45	55	70	70	70
Year 2	25	25	25	25	25
Lost	30	20	5	5	5

Manure nitrogen calculations

1. How much N do I need from manure application?

$$\frac{\text{Desired amount of N (see pg 4 or 5)}}{\text{Fertilizer N including starter (see pg 8)}} - \frac{\text{N from manure applied last year (see pg 8)}}{\text{N from irrigation water (see pg 8)}} = \text{N to be supplied by manure (lbs/acre)}$$

Find the manure application rate (or use quick reference charts that follow):

$$\frac{\text{N to be supplied by manure}}{\text{Availability factor (\# from pg 7 / 100)}} \div \frac{\text{N Test}}{\text{Liquid only}} \times 1000 = \text{Application rate (tons or gal/acre)}$$

2. How much N do I still need after I have applied manure?

Find N supplied by manure applied this year:

$$\frac{\text{Application rate (tons or gal/acre)}}{\text{Liquid only}} \times 1000 \times \frac{\text{Availability factor (\# from pg 7 / 100)}}{\text{N Test}} = \text{N from manure this year (lbs/acre)}$$

$$\frac{\text{Desired amount of N (see pg 4 or 5)}}{\text{N from manure applied this year (from above)}} - \frac{\text{N from manure applied last year (see pg 8)}}{\text{N from irrigation water (see pg 8)}} = \text{N to be supplied by commercial fertilizer (lbs/acre)}$$

Broadcast liquid swine manure application rate (1,000 gal/acre)

N Test	Incorporation after 4 days					Incorporation 12 - 96 hrs					Incorporation within 12 hrs (includes cover disks)				
	Desired Available N (lbs/acre)					Desired Available N (lbs/acre)					Desired Available N (lbs/acre)				
	40	80	120	150	195	80	120	150	180	195	80	120	150	180	195
20	5.5	11.5	17.0	21.5	28.0	7.5	11.0	13.5	16.5	17.5	5.5	8.0	10.0	12.0	13.0
24	5.0	9.5	14.5	18.0	23.0	6.0	9.0	11.5	13.5	15.0	4.5	6.5	8.5	10.0	11.0
28	4.0	8.0	12.0	15.5	20.0	5.0	8.0	9.5	11.5	12.5	4.0	5.5	7.0	8.5	9.5
32	3.5	7.0	10.5	13.5	17.5	4.5	7.0	8.5	10.0	11.0	3.5	5.0	6.5	7.5	8.0
36	3.0	6.5	9.5	12.0	15.5	4.0	6.0	7.5	9.0	10.0	3.0	4.5	5.5	6.5	7.0
40	3.0	5.5	8.5	10.5	14.0	3.5	5.5	7.0	8.0	9.0	2.5	4.0	5.0	6.0	6.5
44	2.5	5.0	8.0	9.5	12.5	3.5	5.0	6.0	7.5	8.0	2.5	3.5	4.5	5.5	6.0
48	2.5	5.0	7.0	9.0	11.5	3.0	4.5	5.5	7.0	7.5	2.0	3.5	4.0	5.0	5.5
52	2.0	4.5	6.5	8.0	10.5	3.0	4.0	5.0	6.5	7.0	2.0	3.0	4.0	4.5	5.0
56	2.0	4.0	6.0	7.5	10.0	2.5	4.0	5.0	6.0	6.5	2.0	3.0	3.5	4.5	4.5
60	2.0	4.0	5.5	7.0	9.5	2.5	3.5	4.5	5.5	6.0	2.0	2.5	3.5	4.0	4.5
64	2.0	3.5	5.5	6.5	8.5	2.5	3.5	4.5	5.0	5.5	1.5	2.5	3.0	4.0	4.0
68	1.5	3.5	5.0	6.5	8.0	2.0	3.0	4.0	5.0	5.0	1.5	2.5	3.0	3.5	4.0
72	1.5	3.0	5.0	6.0	7.5	2.0	3.0	4.0	4.5	5.0	1.5	2.0	3.0	3.5	3.5
76	1.5	3.0	4.5	5.5	7.5	2.0	3.0	3.5	4.5	4.5	1.5	2.0	2.5	3.0	3.5
80	1.5	3.0	4.5	5.5	7.0	2.0	2.5	3.5	4.0	4.5	1.5	2.0	2.5	3.0	3.5
84	1.5	2.5	4.0	5.0	6.5	1.5	2.5	3.0	4.0	4.0	1.5	2.0	2.5	3.0	3.0

Injected liquid swine manure application rate (1,000 gal/acre)

N Test	Knife Injection					Sweep Injection				
	Desired Available N (lbs/acre)					Desired Available N (lbs/acre)				
	80	120	150	180	195	80	120	150	180	195
20	5.5	8.5	10.5	13.0	14.0	5.0	7.5	9.5	11.5	12.0
24	5.0	7.0	9.0	10.5	11.5	4.0	6.5	8.0	9.5	10.0
28	4.0	6.0	7.5	9.0	10.0	3.5	5.5	6.5	8.0	8.5
32	3.5	5.5	6.5	8.0	8.5	3.0	4.5	6.0	7.0	7.5
36	3.0	5.0	6.0	7.0	7.5	3.0	4.0	5.0	6.5	7.0
40	3.0	4.5	5.5	6.5	7.0	2.5	4.0	4.5	5.5	6.0
44	2.5	4.0	5.0	6.0	6.5	2.5	3.5	4.5	5.0	5.5
48	2.5	3.5	4.5	5.5	6.0	2.0	3.0	4.0	4.5	5.0
52	2.0	3.5	4.0	5.0	5.5	2.0	3.0	3.5	4.5	4.5
56	2.0	3.0	4.0	4.5	5.0	2.0	2.5	3.5	4.0	4.5
60	2.0	3.0	3.5	4.5	4.5	1.5	2.5	3.0	4.0	4.0
64	2.0	2.5	3.5	4.0	4.5	1.5	2.5	3.0	3.5	4.0
68	1.5	2.5	3.0	4.0	4.0	1.5	2.0	3.0	3.5	3.5
72	1.5	2.5	3.0	3.5	4.0	1.5	2.0	2.5	3.0	3.5
76	1.5	2.5	3.0	3.5	3.5	1.5	2.0	2.5	3.0	3.0
80	1.5	2.0	2.5	3.0	3.5	1.5	2.0	2.5	3.0	3.0
84	1.5	2.0	2.5	3.0	3.5	1.0	2.0	2.0	2.5	3.0

Broadcast liquid dairy manure application rate (1,000 gal/acre)

N Test	Incorporation after 4 days					Incorporation 12 - 96 hrs					Incorporation within 12 hrs (includes cover disks)				
	Desired Available N (lbs/acre)					Desired Available N (lbs/acre)					Desired Available N (lbs/acre)				
	40	80	120	150	195	80	120	150	180	195	80	120	150	180	195
12	16.5	33.5	50.0	62.5	81.5	16.5	25.0	31.5	37.5	40.5	12.0	18.0	22.5	27.5	29.5
14	14.5	28.5	43.0	53.5	69.5	14.5	21.5	27.0	32.0	35.0	10.5	15.5	19.5	23.5	25.5
16	12.5	25.0	37.5	47.0	61.0	12.5	19.0	23.5	28.0	30.5	9.0	13.5	17.0	20.5	22.0
18	11.0	22.0	33.5	41.5	54.0	11.0	16.5	21.0	25.0	27.0	8.0	12.0	15.0	18.0	19.5
20	10.0	20.0	30.0	37.5	49.0	10.0	15.0	19.0	22.5	24.5	7.5	11.0	13.5	16.5	17.5
22	9.0	18.0	27.5	34.0	44.5	9.0	13.5	17.0	20.5	22.0	6.5	10.0	12.5	15.0	16.0
24	8.5	16.5	25.0	31.5	40.5	8.5	12.5	15.5	19.0	20.5	6.0	9.0	11.5	13.5	15.0
26	7.5	15.5	23.0	29.0	37.5	7.5	11.5	14.5	17.5	19.0	5.5	8.5	10.5	12.5	13.5
28	7.0	14.5	21.5	27.0	35.0	7.0	10.5	13.5	16.0	17.5	5.0	8.0	9.5	11.5	12.5
30	6.5	13.5	20.0	25.0	32.5	6.5	10.0	12.5	15.0	16.5	5.0	7.5	9.0	11.0	12.0
32	6.5	12.5	19.0	23.5	30.5	6.5	9.5	11.5	14.0	15.0	4.5	7.0	8.5	10.0	11.0
34	6.0	12.0	17.5	22.0	28.5	6.0	9.0	11.0	13.0	14.5	4.5	6.5	8.0	9.5	10.5
36	5.5	11.0	16.5	21.0	27.0	5.5	8.5	10.5	12.5	13.5	4.0	6.0	7.5	9.0	10.0
38	5.5	10.5	16.0	19.5	25.5	5.5	8.0	10.0	12.0	13.0	4.0	5.5	7.0	8.5	9.5
40	5.0	10.0	15.0	19.0	24.5	5.0	7.5	9.5	11.5	12.0	3.5	5.5	7.0	8.0	9.0
42	5.0	9.5	14.5	18.0	23.0	5.0	7.0	9.0	10.5	11.5	3.5	5.0	6.5	8.0	8.5
44	4.5	9.0	13.5	17.0	22.0	4.5	7.0	8.5	10.0	11.0	3.5	5.0	6.0	7.5	8.0

Injected liquid dairy manure application rate (1,000 gal/acre)

N Test	Knife Injection					Sweep Injection				
	Desired Available N (lbs/acre)					Desired Available N (lbs/acre)				
	80	120	150	180	195	80	120	150	180	195
12	13.5	20.0	25.0	30.0	32.5	12.0	18.0	22.5	27.5	29.5
14	11.5	17.0	21.5	25.5	28.0	10.5	15.5	19.5	23.5	25.5
16	10.0	15.0	19.0	22.5	24.5	9.0	13.5	17.0	20.5	22.0
18	9.0	13.5	16.5	20.0	21.5	8.0	12.0	15.0	18.0	19.5
20	8.0	12.0	15.0	18.0	19.5	7.5	11.0	13.5	16.5	17.5
22	7.5	11.0	13.5	16.5	17.5	6.5	10.0	12.5	15.0	16.0
24	6.5	10.0	12.5	15.0	16.5	6.0	9.0	11.5	13.5	15.0
26	6.0	9.0	11.5	14.0	15.0	5.5	8.5	10.5	12.5	13.5
28	5.5	8.5	10.5	13.0	14.0	5.0	8.0	9.5	11.5	12.5
30	5.5	8.0	10.0	12.0	13.0	5.0	7.5	9.0	11.0	12.0
32	5.0	7.5	9.5	11.5	12.0	4.5	7.0	8.5	10.0	11.0
34	4.5	7.0	9.0	10.5	11.5	4.5	6.5	8.0	9.5	10.5
36	4.5	6.5	8.5	10.0	11.0	4.0	6.0	7.5	9.0	10.0
38	4.0	6.5	8.0	9.5	10.5	4.0	5.5	7.0	8.5	9.5
40	4.0	6.0	7.5	9.0	10.0	3.5	5.5	7.0	8.0	9.0
42	4.0	5.5	7.0	8.5	9.5	3.5	5.0	6.5	8.0	8.5
44	3.5	5.5	7.0	8.0	9.0	3.5	5.0	6.0	7.5	8.0

Broadcast liquid beef manure application rate (1,000 gal/acre)

N Test	Incorporation after 4 days					Incorporation 12 - 96 hrs					Incorporation within 12 hrs (includes cover disks)				
	Desired Available N (lbs/acre)					Desired Available N (lbs/acre)					Desired Available N (lbs/acre)				
	40	80	120	150	195	80	120	150	180	195	80	120	150	180	195
10	16.0	32.0	48.0	60.0	78.0	18.0	26.5	33.5	40.0	43.5	13.5	20.0	25.0	30.0	32.5
12	13.5	26.5	40.0	50.0	65.0	15.0	22.0	28.0	33.5	36.0	11.0	16.5	21.0	25.0	27.0
14	11.5	23.0	34.5	43.0	55.5	12.5	19.0	24.0	28.5	31.0	9.5	14.5	18.0	21.5	23.0
16	10.0	20.0	30.0	37.5	49.0	11.0	16.5	21.0	25.0	27.0	8.5	12.5	15.5	19.0	20.5
18	9.0	18.0	26.5	33.5	43.5	10.0	15.0	18.5	22.0	24.0	7.5	11.0	14.0	16.5	18.0
20	8.0	16.0	24.0	30.0	39.0	9.0	13.5	16.5	20.0	21.5	6.5	10.0	12.5	15.0	16.5
22	7.5	14.5	22.0	27.5	35.5	8.0	12.0	15.0	18.0	19.5	6.0	9.0	11.5	13.5	15.0
24	6.5	13.5	20.0	25.0	32.5	7.5	11.0	14.0	16.5	18.0	5.5	8.5	10.5	12.5	13.5
26	6.0	12.5	18.5	23.0	30.0	7.0	10.5	13.0	15.5	16.5	5.0	7.5	9.5	11.5	12.5
28	5.5	11.5	17.0	21.5	28.0	6.5	9.5	12.0	14.5	15.5	5.0	7.0	9.0	10.5	11.5
30	5.5	10.5	16.0	20.0	26.0	6.0	9.0	11.0	13.5	14.5	4.5	6.5	8.5	10.0	11.0
32	5.0	10.0	15.0	19.0	24.5	5.5	8.5	10.5	12.5	13.5	4.0	6.5	8.0	9.5	10.0
34	4.5	9.5	14.0	17.5	23.0	5.0	8.0	10.0	12.0	12.5	4.0	6.0	7.5	9.0	9.5
36	4.5	9.0	13.5	16.5	21.5	5.0	7.5	9.5	11.0	12.0	3.5	5.5	7.0	8.5	9.0
38	4.0	8.5	12.5	16.0	20.5	4.5	7.0	9.0	10.5	11.5	3.5	5.5	6.5	8.0	8.5
40	4.0	8.0	12.0	15.0	19.5	4.5	6.5	8.5	10.0	11.0	3.5	5.0	6.5	7.5	8.0
42	4.0	7.5	11.5	14.5	18.5	4.0	6.5	8.0	9.5	10.5	3.0	5.0	6.0	7.0	7.5

Injected liquid beef manure application rate (1,000 gal/acre)

N Test	Knife Injection					Sweep Injection				
	Desired Available N (lbs/acre)					Desired Available N (lbs/acre)				
	80	120	150	180	195	80	120	150	180	195
10	16.0	24.0	30.0	36.0	39.0	13.5	20.0	25.0	30.0	32.5
12	13.5	20.0	25.0	30.0	32.5	11.0	16.5	21.0	25.0	27.0
14	11.5	17.0	21.5	25.5	28.0	9.5	14.5	18.0	21.5	23.0
16	10.0	15.0	19.0	22.5	24.5	8.5	12.5	15.5	19.0	20.5
18	9.0	13.5	16.5	20.0	21.5	7.5	11.0	14.0	16.5	18.0
20	8.0	12.0	15.0	18.0	19.5	6.5	10.0	12.5	15.0	16.5
22	7.5	11.0	13.5	16.5	17.5	6.0	9.0	11.5	13.5	15.0
24	6.5	10.0	12.5	15.0	16.5	5.5	8.5	10.5	12.5	13.5
26	6.0	9.0	11.5	14.0	15.0	5.0	7.5	9.5	11.5	12.5
28	5.5	8.5	10.5	13.0	14.0	5.0	7.0	9.0	10.5	11.5
30	5.5	8.0	10.0	12.0	13.0	4.5	6.5	8.5	10.0	11.0
32	5.0	7.5	9.5	11.5	12.0	4.0	6.5	8.0	9.5	10.0
34	4.5	7.0	9.0	10.5	11.5	4.0	6.0	7.5	9.0	9.5
36	4.5	6.5	8.5	10.0	11.0	3.5	5.5	7.0	8.5	9.0
38	4.0	6.5	8.0	9.5	10.5	3.5	5.5	6.5	8.0	8.5
40	4.0	6.0	7.5	9.0	10.0	3.5	5.0	6.5	7.5	8.0
42	4.0	5.5	7.0	8.5	9.5	3.0	5.0	6.0	7.0	7.5

Broadcast solid dairy manure application rate (ton/acre)

N Test	Incorporation after 4 days					Incorporation 12 - 96 hrs					Incorporation within 12 hrs (includes cover disks)				
	Desired Available N (lbs/acre)					Desired Available N (lbs/acre)					Desired Available N (lbs/acre)				
	20	40	60	80	100	40	80	100	120	150	40	80	120	150	195
2	50.0	100.0	150.0	200.0	250.0	50.0	100.0	125.0	150.0	187.5	36.5	72.5	109.0	136.5	177.5
4	25.0	50.0	75.0	100.0	125.0	25.0	50.0	62.5	75.0	94.0	18.0	36.5	54.5	68.0	88.5
6	16.5	33.5	50.0	66.5	83.5	16.5	33.5	41.5	50.0	62.5	12.0	24.0	36.5	45.5	59.0
8	12.5	25.0	37.5	50.0	62.5	12.5	25.0	31.5	37.5	47.0	9.0	18.0	27.5	34.0	44.5
10	10.0	20.0	30.0	40.0	50.0	10.0	20.0	25.0	30.0	37.5	7.5	14.5	22.0	27.5	35.5
12	8.5	16.5	25.0	33.5	41.5	8.5	16.5	21.0	25.0	31.5	6.0	12.0	18.0	22.5	29.5
14	7.0	14.5	21.5	28.5	35.5	7.0	14.5	18.0	21.5	27.0	5.0	10.5	15.5	19.5	25.5
16	6.5	12.5	19.0	25.0	31.5	6.5	12.5	15.5	19.0	23.5	4.5	9.0	13.5	17.0	22.0
18	5.5	11.0	16.5	22.0	28.0	5.5	11.0	14.0	16.5	21.0	4.0	8.0	12.0	15.0	19.5
20	5.0	10.0	15.0	20.0	25.0	5.0	10.0	12.5	15.0	19.0	3.5	7.5	11.0	13.5	17.5
22	4.5	9.0	13.5	18.0	22.5	4.5	9.0	11.5	13.5	17.0	3.5	6.5	10.0	12.5	16.0
24	4.0	8.5	12.5	16.5	21.0	4.0	8.5	10.5	12.5	15.5	3.0	6.0	9.0	11.5	15.0
26	4.0	7.5	11.5	15.5	19.0	4.0	7.5	9.5	11.5	14.5	3.0	5.5	8.5	10.5	13.5
28	3.5	7.0	10.5	14.5	18.0	3.5	7.0	9.0	10.5	13.5	2.5	5.0	8.0	9.5	12.5
30	3.5	6.5	10.0	13.5	16.5	3.5	6.5	8.5	10.0	12.5	2.5	5.0	7.5	9.0	12.0
32	3.0	6.5	9.5	12.5	15.5	3.0	6.5	8.0	9.5	11.5	2.5	4.5	7.0	8.5	11.0
34	3.0	6.0	9.0	12.0	14.5	3.0	6.0	7.5	9.0	11.0	2.0	4.5	6.5	8.0	10.5

Broadcast solid beef manure application rate (ton/acre)

N Test	Incorporation after 4 days					Incorporation 12 - 96 hrs					Incorporation within 12 hrs (includes cover disks)				
	Desired Available N (lbs/acre)					Desired Available N (lbs/acre)					Desired Available N (lbs/acre)				
	20	40	60	80	100	40	80	100	120	150	40	80	120	150	195
2	40.0	80.0	120.0	160.0	200.0	44.5	89.0	111.0	133.5	166.5	33.5	66.5	100.0	125.0	162.5
4	20.0	40.0	60.0	80.0	100.0	22.0	44.5	55.5	66.5	83.5	16.5	33.5	50.0	62.5	81.5
6	13.5	26.5	40.0	53.5	66.5	15.0	29.5	37.0	44.5	55.5	11.0	22.0	33.5	41.5	54.0
8	10.0	20.0	30.0	40.0	50.0	11.0	22.0	28.0	33.5	41.5	8.5	16.5	25.0	31.5	40.5
10	8.0	16.0	24.0	32.0	40.0	9.0	18.0	22.0	26.5	33.5	6.5	13.5	20.0	25.0	32.5
12	6.5	13.5	20.0	26.5	33.5	7.5	15.0	18.5	22.0	28.0	5.5	11.0	16.5	21.0	27.0
14	5.5	11.5	17.0	23.0	28.5	6.5	12.5	16.0	19.0	24.0	5.0	9.5	14.5	18.0	23.0
16	5.0	10.0	15.0	20.0	25.0	5.5	11.0	14.0	16.5	21.0	4.0	8.5	12.5	15.5	20.5
18	4.5	9.0	13.5	18.0	22.0	5.0	10.0	12.5	15.0	18.5	3.5	7.5	11.0	14.0	18.0
20	4.0	8.0	12.0	16.0	20.0	4.5	9.0	11.0	13.5	16.5	3.5	6.5	10.0	12.5	16.5
22	3.5	7.5	11.0	14.5	18.0	4.0	8.0	10.0	12.0	15.0	3.0	6.0	9.0	11.5	15.0
24	3.5	6.5	10.0	13.5	16.5	3.5	7.5	9.5	11.0	14.0	3.0	5.5	8.5	10.5	13.5
26	3.0	6.0	9.0	12.5	15.5	3.5	7.0	8.5	10.5	13.0	2.5	5.0	7.5	9.5	12.5
28	3.0	5.5	8.5	11.5	14.5	3.0	6.5	8.0	9.5	12.0	2.5	5.0	7.0	9.0	11.5
30	2.5	5.5	8.0	10.5	13.5	3.0	6.0	7.5	9.0	11.0	2.0	4.5	6.5	8.5	11.0
32	2.5	5.0	7.5	10.0	12.5	3.0	5.5	7.0	8.5	10.5	2.0	4.0	6.5	8.0	10.0
34	2.5	4.5	7.0	9.5	12.0	2.5	5.0	6.5	8.0	10.0	2.0	4.0	6.0	7.5	9.5

Broadcast solid poultry litter application rate (ton/acre)

N Test	Incorporation after 4 days					Incorporation 12 - 96 hrs					Incorporation within 12 hrs (includes cover disks)				
	Desired Available N (lbs/acre)					Desired Available N (lbs/acre)					Desired Available N (lbs/acre)				
	40	80	120	150	195	80	120	150	180	195	80	120	150	180	195
16	5.5	11.0	16.5	21.0	27.0	9.0	13.5	17.0	20.5	22.0	7.0	10.5	13.5	16.0	17.5
20	4.5	9.0	13.5	16.5	21.5	7.5	11.0	13.5	16.5	17.5	5.5	8.5	10.5	13.0	14.0
24	3.5	7.5	11.0	14.0	18.0	6.0	9.0	11.5	13.5	15.0	5.0	7.0	9.0	10.5	11.5
28	3.0	6.5	9.5	12.0	15.5	5.0	8.0	9.5	11.5	12.5	4.0	6.0	7.5	9.0	10.0
32	3.0	5.5	8.5	10.5	13.5	4.5	7.0	8.5	10.0	11.0	3.5	5.5	6.5	8.0	8.5
36	2.5	5.0	7.5	9.5	12.0	4.0	6.0	7.5	9.0	10.0	3.0	5.0	6.0	7.0	7.5
40	2.0	4.5	6.5	8.5	11.0	3.5	5.5	7.0	8.0	9.0	3.0	4.5	5.5	6.5	7.0
44	2.0	4.0	6.0	7.5	10.0	3.5	5.0	6.0	7.5	8.0	2.5	4.0	5.0	6.0	6.5
48	2.0	3.5	5.5	7.0	9.0	3.0	4.5	5.5	7.0	7.5	2.5	3.5	4.5	5.5	6.0
52	1.5	3.5	5.0	6.5	8.5	3.0	4.0	5.0	6.5	7.0	2.0	3.5	4.0	5.0	5.5
56	1.5	3.0	5.0	6.0	7.5	2.5	4.0	5.0	6.0	6.5	2.0	3.0	4.0	4.5	5.0
60	1.5	3.0	4.5	5.5	7.0	2.5	3.5	4.5	5.5	6.0	2.0	3.0	3.5	4.5	4.5
64	1.5	3.0	4.0	5.0	7.0	2.5	3.5	4.5	5.0	5.5	2.0	2.5	3.5	4.0	4.5
68	1.5	2.5	4.0	5.0	6.5	2.0	3.0	4.0	5.0	5.0	1.5	2.5	3.0	4.0	4.0
72	1.0	2.5	3.5	4.5	6.0	2.0	3.0	4.0	4.5	5.0	1.5	2.5	3.0	3.5	4.0
76	1.0	2.5	3.5	4.5	5.5	2.0	3.0	3.5	4.5	4.5	1.5	2.5	3.0	3.5	3.5
80	1.0	2.0	3.5	4.0	5.5	2.0	2.5	3.5	4.0	4.5	1.5	2.0	2.5	3.0	3.5

Broadcast solid swine manure application rate (ton/acre)

N Test	Incorporation after 4 days					Incorporation 12 - 96 hrs					Incorporation within 12 hrs (includes cover disks)				
	Desired Available N (lbs/acre)					Desired Available N (lbs/acre)					Desired Available N (lbs/acre)				
	20	40	60	80	100	40	80	100	120	150	40	80	120	150	195
2	28.5	57.0	85.5	114.5	143.0	36.5	72.5	91.0	109.0	136.5	26.5	53.5	80.0	100.0	130.0
4	14.5	28.5	43.0	57.0	71.5	18.0	36.5	45.5	54.5	68.0	13.5	26.5	40.0	50.0	65.0
6	9.5	19.0	28.5	38.0	47.5	12.0	24.0	30.5	36.5	45.5	9.0	18.0	26.5	33.5	43.5
8	7.0	14.5	21.5	28.5	35.5	9.0	18.0	22.5	27.5	34.0	6.5	13.5	20.0	25.0	32.5
10	5.5	11.5	17.0	23.0	28.5	7.5	14.5	18.0	22.0	27.5	5.5	10.5	16.0	20.0	26.0
12	5.0	9.5	14.5	19.0	24.0	6.0	12.0	15.0	18.0	22.5	4.5	9.0	13.5	16.5	21.5
14	4.0	8.0	12.0	16.5	20.5	5.0	10.5	13.0	15.5	19.5	4.0	7.5	11.5	14.5	18.5
16	3.5	7.0	10.5	14.5	18.0	4.5	9.0	11.5	13.5	17.0	3.5	6.5	10.0	12.5	16.5
18	3.0	6.5	9.5	12.5	16.0	4.0	8.0	10.0	12.0	15.0	3.0	6.0	9.0	11.0	14.5
20	3.0	5.5	8.5	11.5	14.5	3.5	7.5	9.0	11.0	13.5	2.5	5.5	8.0	10.0	13.0
22	2.5	5.0	8.0	10.5	13.0	3.5	6.5	8.5	10.0	12.5	2.5	5.0	7.5	9.0	12.0
24	2.5	5.0	7.0	9.5	12.0	3.0	6.0	7.5	9.0	11.5	2.0	4.5	6.5	8.5	11.0
26	2.0	4.5	6.5	9.0	11.0	3.0	5.5	7.0	8.5	10.5	2.0	4.0	6.0	7.5	10.0
28	2.0	4.0	6.0	8.0	10.0	2.5	5.0	6.5	8.0	9.5	2.0	4.0	5.5	7.0	9.5
30	2.0	4.0	5.5	7.5	9.5	2.5	5.0	6.0	7.5	9.0	2.0	3.5	5.5	6.5	8.5
32	2.0	3.5	5.5	7.0	9.0	2.5	4.5	5.5	7.0	8.5	1.5	3.5	5.0	6.5	8.0
34	1.5	3.5	5.0	6.5	8.5	2.0	4.5	5.5	6.5	8.0	1.5	3.0	4.5	6.0	7.5

Minimum setback requirements ^a



Sensitive area	No incorporation or incorporation after 24 hrs	Injection or incorporation within 24 hrs
Lake	300 ft ^b	25 ft ^d
Perennial stream	300 ft ^b	25 ft ^d
Intermittent stream	300 ft ^c	25 ft ^d
Protected wetlands (10+ acres)	300 ft ^c	25 ft ^d
Drainage ditches (no berms)	300 ft ^c	25 ft ^d
Sinkhole (no berms/diversions)	300 ft up / 50 ft down	50 ft
Well, mine, quarry, or gravel pit	50 ft	50 ft
Open tile intakes (including rock/blind inlets)	300 ft	0 ft
Road ditches	No application directly into the road ditch	
DWSMA/Wellhead protection	Permit may be needed	
Steeply sloping land	Permit may be needed	
Non-Protected wetlands	Develop a management strategy	
Flooded or high water table soils	Develop a management strategy	
Coarse-Textured soils	Develop a management strategy	
Shallow soils over bedrock	Develop a management strategy	

^a County and/or NPDES permit requirements may be more restrictive

^b 100 ft non-manured vegetated buffer can be used instead of the 300 ft setback (non-winter)

^c 50 ft non-manured vegetated buffer can be used instead of the 300 ft setback (non-winter)

^d Where soil phosphorus exceeds 21 ppm Bray or 16 ppm Olsen, phosphorus must be managed to prevent buildup over a 6 year period. (see pg 23)

Short-Term manure stockpile requirements

Location Restrictions

Waters of the State, tile intakes, road ditches, sinkholes, non-farmed wetlands, and rock outcrops	Setback of 300 ft of flow distance and at least 50 ft horizontal distance
Private well	Setback of 100 ft ^a
Public water supply well	Setback of 1,000 ft
Shoreland or floodplain	Stockpiling is prohibited
Land with greater than a 6% slope	Stockpiling is prohibited
Land with greater than 2 % slope and no clean water diversions and erosion control measures	Stockpiling is prohibited
Land where soil texture to a depth of five feet, except the plow layer, is entirely coarser than a sandy-loam	Stockpiling is prohibited
Sand/Gravel pits, quarries, on bedrock	Stockpiling is prohibited
Drain tile with less than 3 ft of soil cover	Setback of 100 ft

^a Setback increases to 200 ft for vulnerable wells (lack of casing and/or confining layer)

Other Restrictions

- Each stockpile must not exceed agronomic needs of the crops on 320 acres
- Maintain 2 ft separation from the base of the stockpile to the seasonal high water table
- Stockpile must be removed within one year (otherwise considered a permanent stockpile)
- Must have vegetated cover or cropping history for at least one full growing season prior to re-use of the stockpiling site
 - Exemption: If stockpiled for less than 10 consecutive days and no more than 6 times per year, or within open lots with less than 100 animal units.

Minimum state soil phosphorus requirements ^e

Bray P1 (ppm) ^d	< 22	22-75	76-150	> 150
Olsen (ppm) ^d	< 17	17-60	61-120	> 120
<u>More</u> than 300 ft from waters ^a	No Phosphorus management requirements	No Phosphorus management requirements	No Phosphorus management requirements	Permit required if over 300 AU ^c
<u>Less</u> than 300 ft from waters ^a	No Phosphorus management requirements	Prevent long-term build-up of Soil P ^b	Prevent long-term build-up of Soil P ^b Permit required if over 300 AU ^c	Prevent long-term build-up of Soil P ^b Permit required if over 300 AU ^c

^a Lakes, rivers, streams, intermittent streams, protected wetlands, or unbermed drainage ditches. Also includes tile intakes when soil P levels are above 75 Bray (60 Olsen) or at a CAFO or NPDES permitted site above 21 Bray (16 Olsen)

^b The rate and frequency of manure applications must not allow soil phosphorus build-up over a six year period. Single year applications can be based on crop nitrogen needs if remaining phosphorus is removed by subsequent crops. (see next page for more information).

^c Only if over 300 AU. MMP must describe how phosphorus will be managed to prevent phosphorus transport (diet manipulation, soil conservation, fewer applications, etc.).

^d If soil test are in lbs/acre divide by 2 for approximate levels in ppm. If the Mehlich III test is used, the values in the table columns are approximately <30, 31-90, 91-180, >180.

^e Restrictions do not apply if a 100 ft non-manured vegetative buffer along lakes and streams, or a 50 ft non-manured vegetative buffer along intermittent streams, protected wetlands, and unbermed drainage ditches is maintained.

Phosphorus removal by various crops

Crop	P ₂ O ₅ Removal	
Alfalfa	10.8	lbs/ton
Barley (grain)	0.41	lbs/bu
Barley (grain & straw)	0.55	lbs/bu
Corn (grain)	0.34	lbs/bu
Corn silage	3.8	lbs/ton
Grass hay or pasture	8.9	lbs/ton
Grass/legume	11.2	lbs/ton
Oats (grain)	0.25	lbs/bu
Oats (grain & straw)	0.32	lbs/bu

Crop	P ₂ O ₅ Removal	
Peas or Edible beans	0.01	lbs/lb
Potatoes	0.14	lbs/cwt
Rye (grain)	0.44	lbs/bu
Rye (grain & straw)	0.59	lbs/bu
Soybeans	0.82	lbs/bu
Sugar beets	0.73	lbs/ton
Sweet corn	11	lbs/ton
Wheat (grain)	0.53	lbs/bu
Wheat (grain & straw)	0.64	lbs/bu

How to calculate crop P₂O₅ removal over a six year period

Step 1 - Determine average P uptake during the crop rotation (multiply yields by values above)

Ex: 170 bu Corn - [170 * 0.34] = 58 lbs P₂O₅ removed per year

45 bu Soybeans - [45 * 0.82] = 37 lbs P₂O₅ removed per year

Average = 48 lbs P₂O₅ removed per year

Step 2 - Determine the amount of P₂O₅ that is typically applied in manure applications

Ex: 4000 gals/acre * 35 lbs P₂O₅ /1000 gals * 0.8 (availability factor) = 112 lbs P₂O₅ applied

Step 3 - Divide step 2 by the average in step 1;

Ex: 112/48 = 2.3

Step 4 - Take 6 years divided by the step 3 result and round down to the nearest whole number

Ex: 6 yrs/2.3 = 2.6, then round down =

Manure application records



When manure is applied to cropland owned, leased, rented, or otherwise controlled by the feedlot owner, the feedlot owner must keep records of manure application activities.

Feedlot capacity of 100 – 299 animal units ^a

Manure test dates and results	Carry-over N from previous manure applications
Field ID & acreage	Manure N available
Date and rate of manure application	Fertilizer N applied
Method of application and incorporation timing	Total lbs N available/acre (all sources)

Feedlot capacity of 300 or more animal units ^a

Manure test dates and results	Manure N available
Field ID & acreage	Fertilizer N applied
Soil P test dates and results	N from irrigation water
Crop grown and yield goal	Carry-over N from previous manure applications
Previous crop grown	Total lbs N available/acre (all sources)
N recommendation for the crop grown	Manure P ₂ O ₅ available
Date and rate of manure application	Fertilizer P ₂ O ₅ applied
Method of application and incorporation timing	Total lbs P ₂ O ₅ available/acre (all sources)
Commercial applicator name (if used)	Soil nitrate testing results (if recommended)

^a Sites with NPDES or SDS permit coverage may have additional record keeping requirements.

Record retention: When manure is applied in special protection areas or the site has a NPDES or SDS permit, records must be kept for 6 years; all other situations require retention for 3 years.

Manure application records for transferred ownership

When manure is sold or given away from a feedlot with at least 300 AU, the feedlot owner and the manure recipient must keep records of manure application activities.



Feedlot owner record keeping requirements

Info generated at the feedlot	Info generated at the land application site
Manure transfer date and amounts	Stockpiling practices (obtain from recipient)
Manure test results (provide to recipient)	Field locations (obtain from applicator)
Who manure was transferred to	Application rates per acre (obtain from applicator)

Manure recipient record keeping requirements ^a

Info to provide back to feedlot owner	Other required info
Stockpiling practices and locations	Manure test results (from feedlot)
Field locations	Date, acreage, and method used for application
Application rate	N & P ₂ O ₅ applied (account for all sources)
	Soil P test dates and results

^a The manure recipient must keep records equivalent to those highlighted on pg 24.

Commercial applicator record keeping requirements (if used)

Nutrient content of manure	Application rate
Location of application	Volume/tonnage of manure applied

Record retention: When manure is applied in special protection areas or the site has a NPDES or SDS permit, records must be kept for 6 years; all other situations require retention for 3 years.

Manure spreader calibration

Step 1

Solid manure

- Weigh the spreader both empty and full
 - Subtract the empty weight from the full weight to determine the tons of manure per load

Liquid manure

- Determine 1000's of gallons per load (multiply tank volume by 90%)

Step 2

- Calculate how many acres are covered by one load - multiply the distance traveled by the width of the spread.

Example: 800 ft traveled x 20 ft spread = 16,000 sq ft = 0.37 acres per load

Solid: 6 tons per load / 0.37 acres covered per load = 16 tons/acre

Liquid: 4,000 gal per load / 0.37 acres covered per load = 10,800 gal/acre

Alternative step 2

- Calculate how many loads it takes to cover a field when going at a known tractor speed.

Example: Solid: 30 loads x 6 tons per load = 180 tons applied

180 tons applied / 11 acres covered = 16 tons/acre

Liquid: 25 loads x 4,000 gal per load = 100,000 gal applied

100,000 gal applied / 11 acres covered = 9,000 gal/acre

Useful Resources

- MPCA feedlot program homepage
<https://www.pca.state.mn.us/feedlots> 
- U of MN crop nutrient recommendations
<https://extension.umn.edu/nutrient-management/crop-specific-needs> 
- MDA nitrogen fertilizer BMPs
<https://www.mda.state.mn.us/pesticide-fertilizer/nitrogen-fertilizer-best-management-practices-agricultural-lands> 
- MDA runoff risk advisory forecast
<https://www.mda.state.mn.us/protecting/cleanwaterfund/toolstechnology/runoffrisk> 
- U of MN land application of manure homepage
<https://extension.umn.edu/manure-management/manure-land-application> 
- MDA commercial animal waste technician program
<https://www.mda.state.mn.us/pesticide-fertilizer/commercial-animal-waste-technician-licensing> 
- U of MN manure management safety
<https://extension.umn.edu/manure-management/manure-safety> 

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Public Information

Spill response

What to do if you have a spill

- Tend to all injuries
- Plug culverts and tile inlets that manure could enter
- Contain the spill by creating berms to stop the manure flow
- Contact the Minnesota Duty Officer (**1-800-422-0798**) with:
 - the location, date, and time of spill
 - what was spilled and the approximate amount spilled
 - which local officials have been notified (sheriff, fire dept., etc.)
 - the responsible party
 - any surface water(s) impacted
 - what has happened or is happening now
 - a call back number
- Contact the County Feedlot Officer or MPCA
- Recover pooled manure and solids; get a pump truck if necessary
- Scrape large accumulations; leave vegetation if possible
- If spilled on the road, recover what is possible and scrape/sweep the remainder off of the road
- Work areas of bare soils and re-seed