NITROGEN ISSUES

NUTRIENTS

Macro-nutrients	mg/kg*
Nitrogen (N)	15,000
Potassium (K)	10,000
Calcium (Ca)	5,000
Magnesium (Mg)	2,000
Phosphorus (P)	2,000
Sulfur (S)	1,000

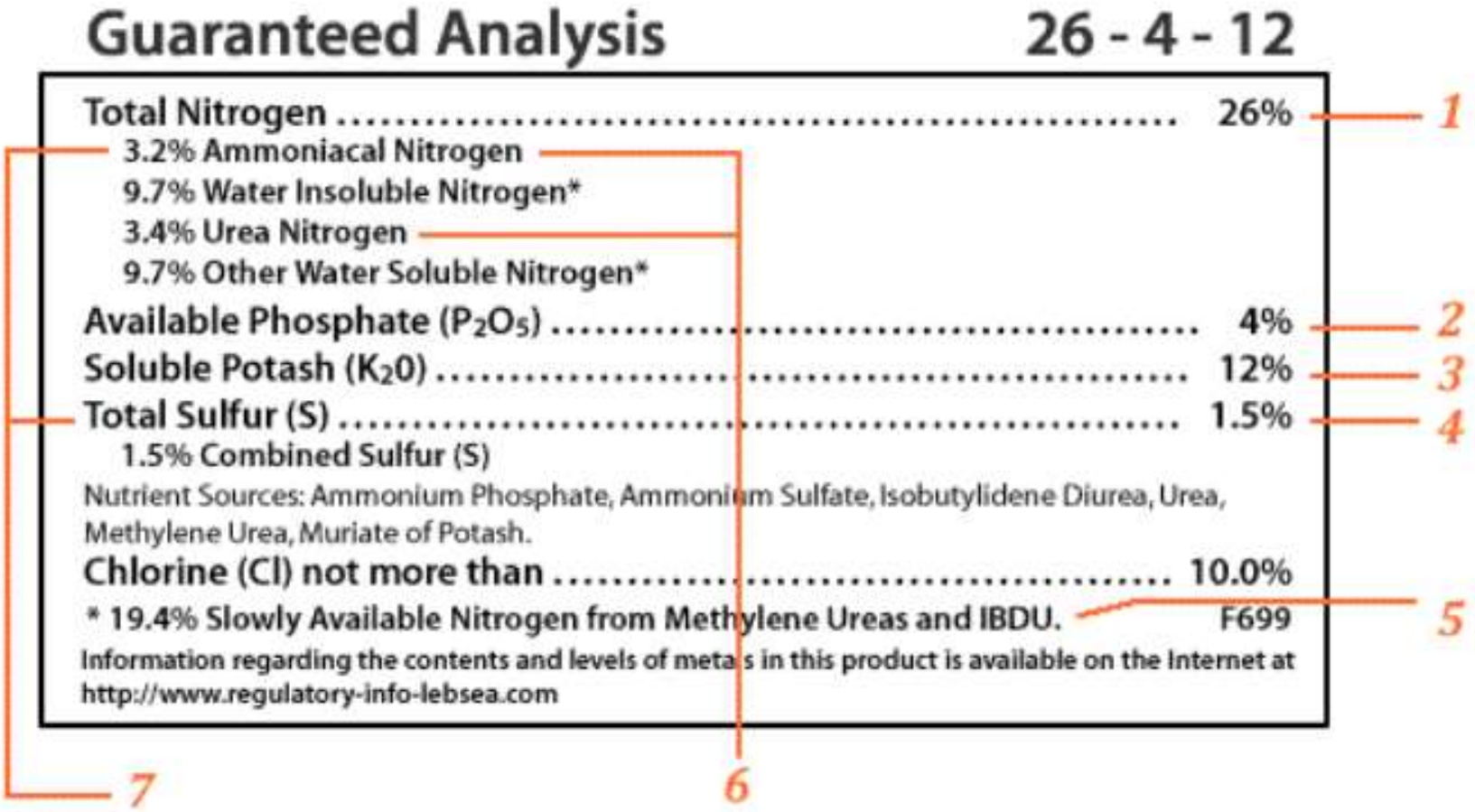
Micro-nutrients	mg/kg*
Chlorine (Cl)	100
Iron (Fe)	100
Boron (B)	20
Manganese (Mn)	50
Zinc (Zn)	20
Copper (Cu)	6
Molybdenum (Mo)	0.1
Nickel (Ni)	0.1

* Based on Dry Weight of plant tissue

** Does not mean one nutrient element is more important than another, just that they are required in different quantities & concentrations

Typical concentrations sufficient for plant growth

NUTRIENTS



Source: greenviewfertilizer.com website

N-P-K Labeling

Example:

100 lb bag of fertilizer

N-P-K 30-10-15

Nitrogen: 50 lbs of available nitrogen

Phosphorus: 10 lbs of available nitrogen

Potassium: 15 lbs of available potassium

Remaining 45 lbs = filler/inert materials/other nutrients

Today's Focus: NITROGEN (N)

WASTE TYPES

- SEPTAGE
- BIOSOLIDS (Treated Sewage Sludge)
- INDUSTRIAL WASTES
  - Industrial Sludges
  - Industrial By-Product Solids
  - Industrial Liquid Wastes

NITROGEN TYPES

- INORGANIC
  - Nitrite-Nitrate (NO_2-NO_3)
  - Ammonia (NH_3)
  - Ammonium (NH_4)
- ORGANIC NITROGEN
- TKN (Total Kjeldahl Nitrogen)
  - TKN = N_{org} + NH_4

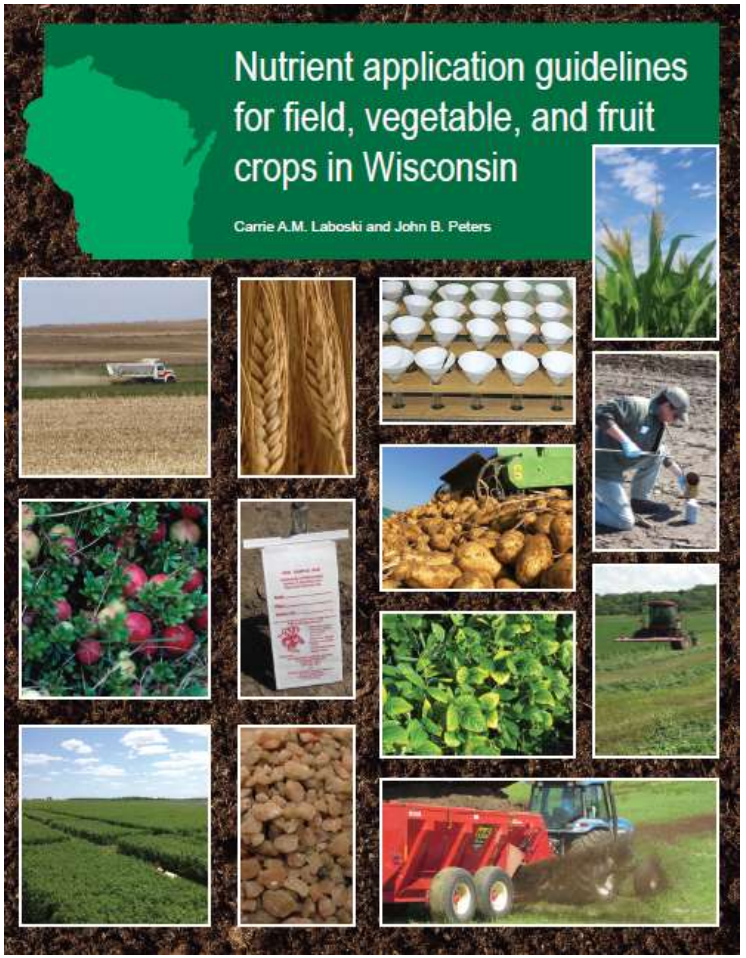
CROP NEEDS

University of Wisconsin, Soils Department.

A2809 Bulletin:

Nutrient application guidelines for field, vegetable, and fruit crops in Wisconsin

- N needs based on soil types, crop, expected harvest
- Search “A2809”



DETERMINING NET N NEEDS

NITROGEN CROP NEEDS

-lbs/acre to achieve expected yield

→*Once determined from Soiltest…now estimated based on expected crop yield and soils*

NET N NEEDS=

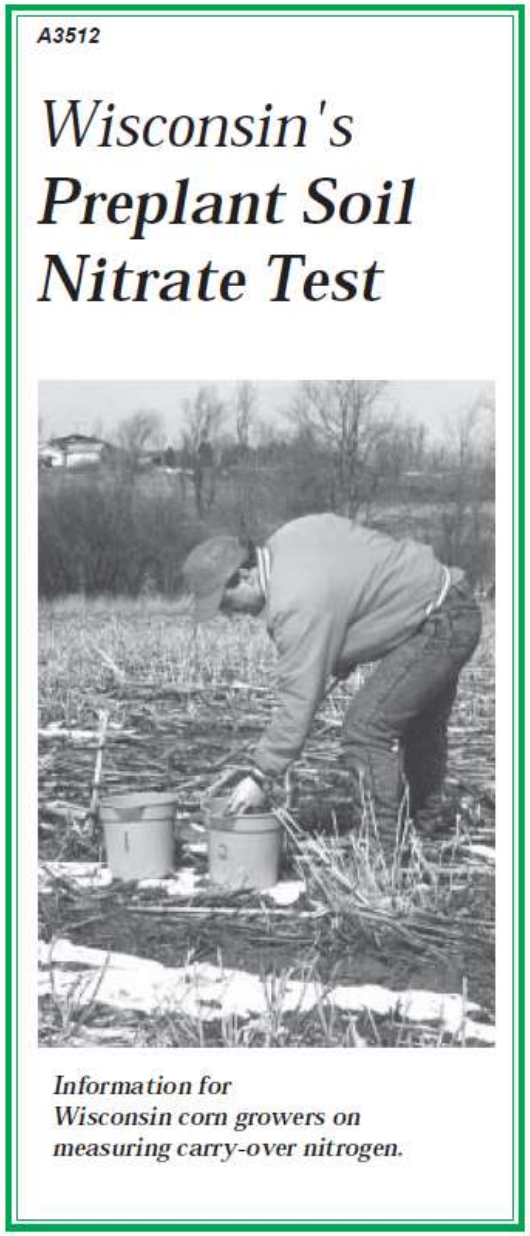
Crop Needs – N Sources

NITROGEN SOURCES:

- Amount of N in soil
  - Nitrate Nitrogen
- Available Residual N
  - Organic Nitrogen applied in previous years
- Other Sources of N
  - Comm Fertilizer, Manure, Industrial Wastes, Septage, Biosolids, Etc.

PREPLANT NITRATE TEST

- Tool to help improve efficiency of N applications
- Significant N can remain in soil after years of below average rainfall
- Helps prevent overapplications of N resulting in GW protections

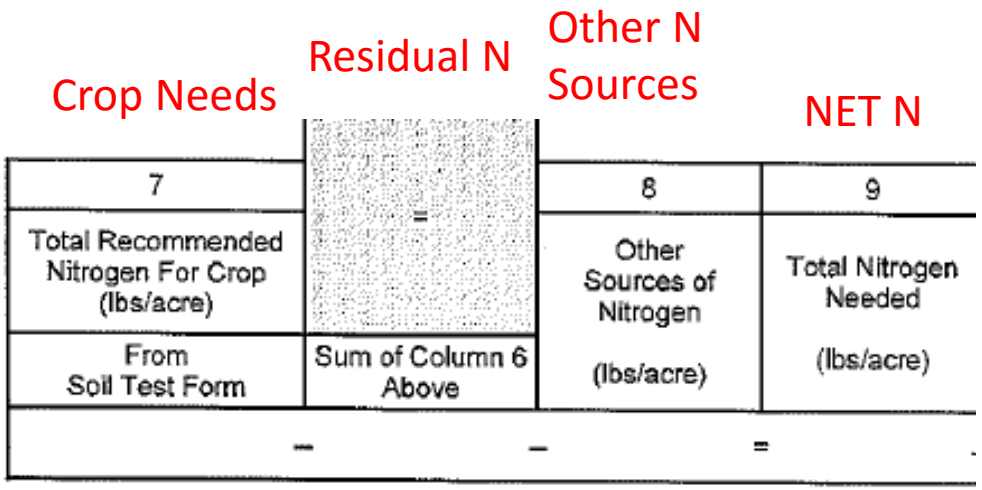


USING THE 3400-054 FORM

- Box 7: Crop Needs for expected yield
- Nitrogen Sources:
  - Residual N:

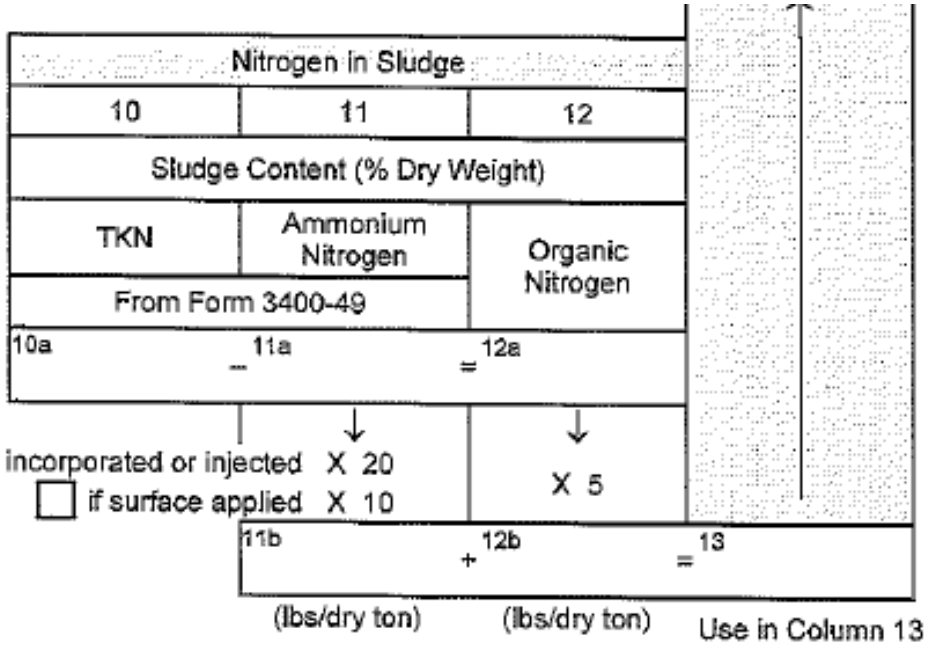
    Sum of Column 6
  - Other Sources of N

    Box 8 -Preplant N, Comm Fert, Etc.
- Net Nitrogen
  - Box 9



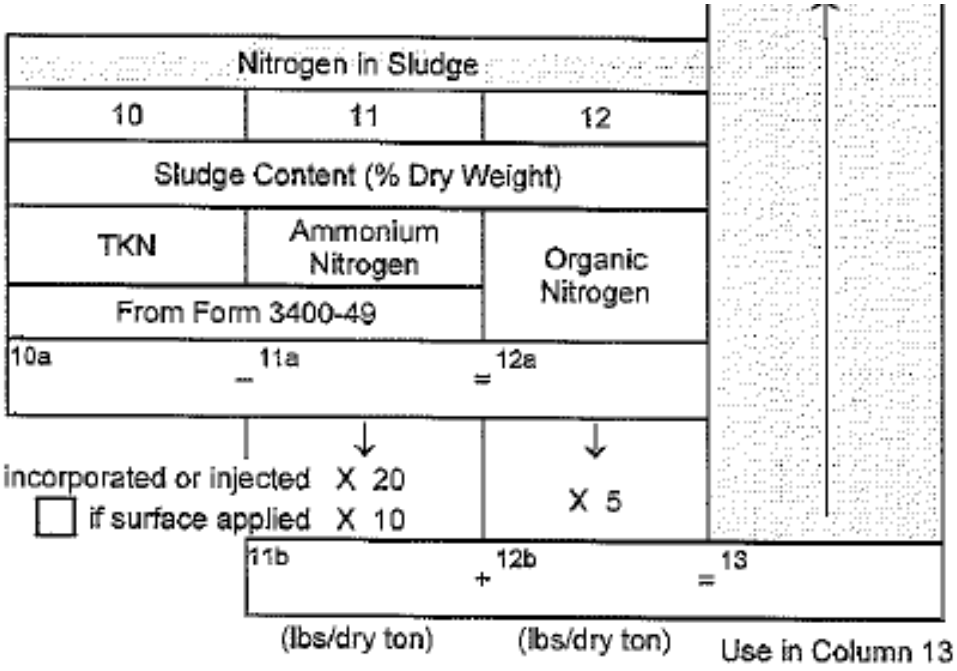
NITROGEN in WASTE

- Total Kjehldahl Nitrogen (TKN) (Box 10a)
  - Ammonia + Organic
- Inorganic Nitrogen
  - Nitrate (NO3)
  - Ammonium (NH4) or Ammonia (NH3) (Box 11a)
- Organic Nitrogen (Box 12a)
- Measured in % Dry Wt



NITROGEN in WASTE

- Ammonium Nitrogen Factor:
  - Incorporation/Injection assumes no volatilization
  - Surface applied assumes half volatilized
- Organic Nitrogen Factor:
  - 25% Mineralization during first year (N_{yr1})



- Available N in 1st year = ammonium + organic N_{yr1}

RESIDUAL NITROGEN

- Residual N is based on:
  - % Organic N in year applied
  - Mineralization Rate
  - Amount of Sludge applied in previous years
- Factors
  - Yr 2: 12% of the 75% remaining
  - Yr 3: 6% of the 63% remaining

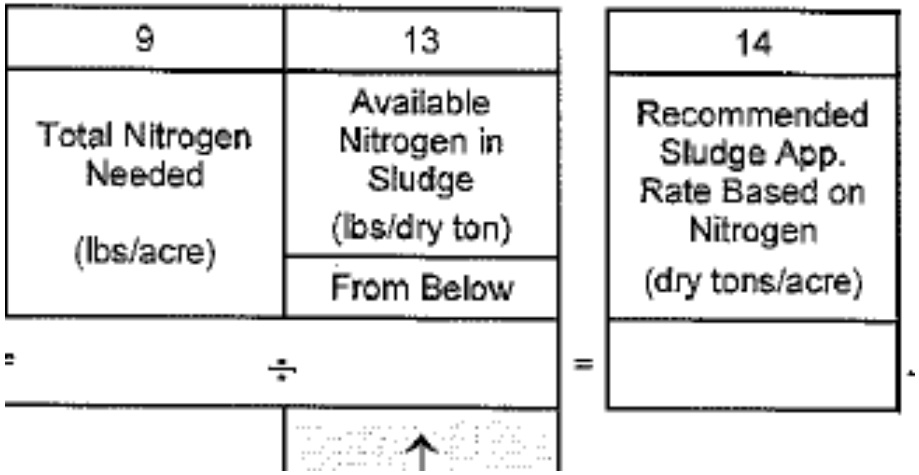
Mineralization Rate based on Decomposition of Organic Source (Box 3)
25% Year 1
12% Year 2
6 % Year 3

Need to refer to 3400-54 Form and 3400-49 Form from previous years

Residual Nitrogen					
1	2	3	4	5	6
Year of Application	% Organic Nitrogen of Sludge	Conversion factors based on mineralization rate	Product of Columns 2 & 3	Total Dry Tons of Sludge Applied Per Acre	Available Residual Nitrogen (lbs/acre)
1 Yr Ago		X 1.8 =		X	=
					+
2 Yrs Ago		X 0.8 =		X	=

RECOMMENDED APPLICATION RATE

- Recommended Sludge Application Rate Based on NITROGEN
- Divide NET N needs in Box 9 by the Available Nitrogen in the sludge from Box 13



2013 YEAR ONE

- Background
  - Site never used for manure
  - Site never used for Biosolids
  - Crop Need 200 lbs/ac
  - 25 lbs/ac Preplant N Test
- Test Results
  - TKN 11%
  - NH4 5.0%
  - % Solids 1.3%

7		8	9
Total Recommended Nitrogen For Crop (lbs/acre)	=	Other Sources of Nitrogen (lbs/acre)	Total Nitrogen Needed (lbs/acre)
From Soil Test Form	Sum of Column 6 Above		
200	- 0	- 25	= 175

NET

Nitrogen in Sludge

10	11	12
Sludge Content (% Dry Weight)		
TKN	Ammonium Nitrogen	Organic Nitrogen
From Form 3400-49		
10a 11.0	- 11a 5.0	= 12a 6.0

if incorporated or injected 20
☐ if surface applied X 10

X 5

11b		12b		13
100	+	30	=	130
(lbs/dry ton)		(lbs/dry ton)		Use in Column 13 above

2013 YEAR ONE

Residual Nitrogen					
1	2	3	4	5	6
Year of Application	% Organic Nitrogen of Sludge	Conversion factors based on mineralization rate	Product of Columns 2 & 3	Total Dry Tons of Sludge Applied Per Acre	Available Residual Nitrogen (lbs/acre)
1 Yr Ago	X 1.8 =		X	=	
					+
2 Yrs Ago	X 0.8 =		X	=	

ZERO

No Residual N in 1st year

13	14	15
Available Nitrogen in Sludge (lbs/dry ton)	Recommended Sludge App. Rate Based on Nitrogen (dry tons/acre)	% Solids
From Below		From Form 3400-49
130	= 1.35	÷ 1.3

15		16
% Solids		
From Form 3400-49		
1.3	=	1.04

To convert to Gallons / Acre Multiply by 23981

To convert to Cubic Yards / Acre Multiply by 118.7

Gallons / Acre

25,000

X 23981

X 118.7

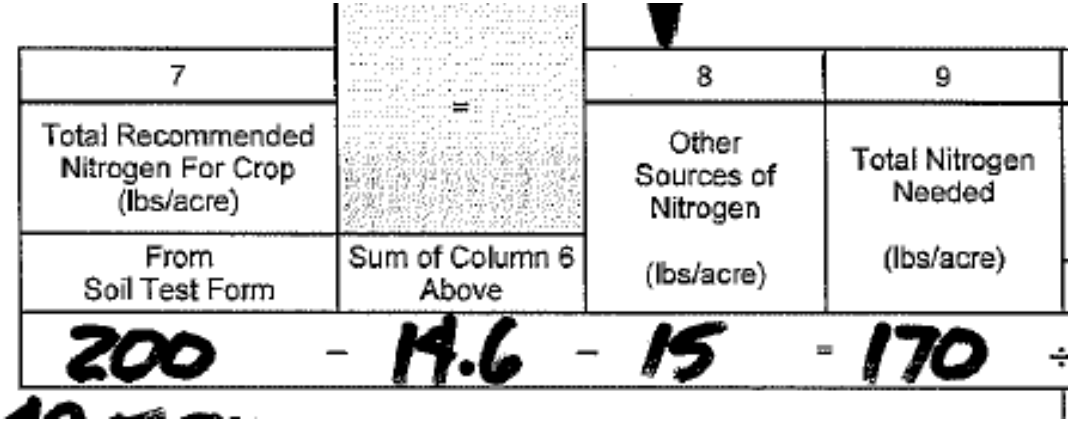
123

Cubic Yards / Acre

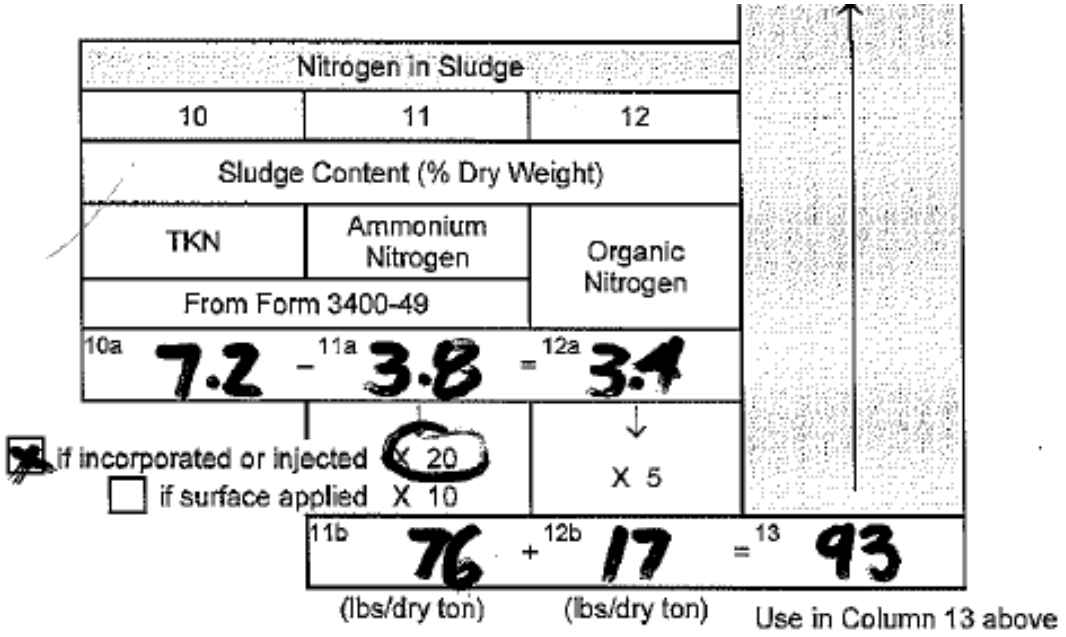
Not Cake Sludge < 6%

2014 YEAR 2

- Crop Need
  - 200 lbs/acre
- Test Results
  - TKN 7.2%
  - NH4 3.8%
  - % solids 2.0 %



7	=	8	9
Total Recommended Nitrogen For Crop (lbs/acre)		Other Sources of Nitrogen (lbs/acre)	Total Nitrogen Needed (lbs/acre)
From Soil Test Form	Sum of Column 6 Above		
200	- 19.6	- 15	= 170 ÷



Nitrogen in Sludge

10	11	12
Sludge Content (% Dry Weight)		
TKN	Ammonium Nitrogen	Organic Nitrogen
From Form 3400-49		
10a 7.2	- 11a 3.8	= 12a 3.4

☒ if incorporated or injected X 20
☐ if surface applied X 10
X 5

11b	+ 12b	= 13
76	17	93
(lbs/dry ton)	(lbs/dry ton)	Use in Column 13 above

2014 YEAR 2

Residual Nitrogen					
1	2	3	4	5	6
Year of Application	% Organic Nitrogen of Sludge	Conversion factors based on mineralization rate	Product of Columns 2 & 3	Total Dry Tons of Sludge Applied Per Acre	Available Residual Nitrogen (lbs/acre)
1 Yr Ago	6.0 X 1.8 =	10.8	X 1.35 =		14.6
					+
2 Yrs Ago	~~X 0.8~~ X			=	ZERO

Residual Nitrogen from year 1 only

9	13	14
Total Nitrogen Needed (lbs/acre)	Available Nitrogen in Sludge (lbs/dry ton) From Below	Recommended Sludge App. Rate Based on Nitrogen (dry tons/acre)
170 ÷	93	= 1.83

Gallons / Acre

21,942

X 23981

↑

To convert to Gallons / Acre Multiply by 23981

15	16
% Solids From Form 3400-49	
÷ 2.0	= 0.915

↓

To convert to Cubic Yards / Acre Multiply by 118.7

↓

X 118.7

~~108.6~~

Cubic Yards / Acre

2015 YEAR 3

- Crop Need
  - 200 lbs/acre N
- Net Crop Need
  - 166 lbs/acre N
- Test Results
  - TKN 7.6%
  - NH4 2.6%
  - % solids 3.0 %

7		8	9
Total Recommended Nitrogen For Crop (lbs/acre)	=	Other Sources of Nitrogen (lbs/acre)	Total Nitrogen Needed (lbs/acre)
From Soil Test Form	Sum of Column 6 Above		
200	- 17.8	- 20	= 166.2

Nitrogen in Sludge

10	11	12
Sludge Content (% Dry Weight)		
TKN	Ammonium Nitrogen	Organic Nitrogen
From Form 3400-49		
10a 7.6	- 11a 2.6	= 12a 5.0
	X 20	X 5
	11b 52	+ 12b 25 = 13 77
	(lbs/dry ton)	(lbs/dry ton)

if incorporated or injected
if surface applied

2015 YEAR 3

Residual Nitrogen					
1	2	3	4	5	6
Year of Application	% Organic Nitrogen of Sludge	Conversion factors based on mineralization rate	Product of Columns 2 & 3	Total Dry Tons of Sludge Applied Per Acre	Available Residual Nitrogen (lbs/acre)
1 Yr Ago	3.4 X 1.8 =	6.12 X	1.83 =		11.2
					+
2 Yrs Ago	6.0 X 0.8 =	4.8 X	1.35 =		6.48

Residual N = 17.8 lbs/ac for two years

9	13	14
Total Nitrogen Needed (lbs/acre)	Available Nitrogen in Sludge (lbs/dry ton) From Below	Recommended Sludge App. Rate Based on Nitrogen (dry tons/acre)
= 166.2 ÷	77 =	2.16

3.0% solids = liquid sludge

14	15	16
Recommended Sludge App. Rate Based on Nitrogen (dry tons/acre)	% Solids From Form 3400-49	
2.16 ÷	3.0 =	0.72

To convert to Gallons / Acre Multiply by 23981

Gallons / Acre

17,300

X 23981

To convert to Cubic Yards / Acre Multiply by 118.7

X 118.7

85.5

Cubic Yards / Acre

SEWAGE SLUDGE

- Sewage Sludge mineralization rates based on many, many studies.
- These mineralization rates are **NOT** for industrial wastes or septage.

SEPTAGE

Nitrogen Formula: s. NR 113.09, Wis. Adm. Code

$$\text{Annual Agronomic Rate (Gallons per acre per year)} = \frac{\text{Pounds of Nitrogen Required For the Expected Crop Yield per Acre}}{0.0026}$$

Assume 100 lbs/N

=100/0.0026

= 38,461 gallons

100 lbs N ~ 39,000 gallons/acre

EASY: No residual calculations, No testing of TKN, Ammonium, etc

INDUSTRIAL WASTES

- All TKN is assumed to be available in 1st year
  - Ammonium available
  - Organic decomposition allows all N availability in first year
  - Industrial wastes not:
    - Necessarily stabilized,
    - Not tested
- Dept. allows mineralization studies of industrial wastes.
  - Quite common with paper mill sludge

COMMENTS

- Ammonia vs. Ammonium
  - No Wastewater Study for Ammonium
  - Similar results if pH and temperature remain constant
  - N moves around fairly quickly when added to soil
  - While conversions exist, not overly accurate at extremes

Volatilization Factor		
Ammonia Coefficient (K_v)		
	Inj/Inc	Surface Applied
kg/mt	1.0	0.5
lbs/dry ton	20	10

CONVERSIONS

Mineralization Rates											Factor
3.02	percent	2000	lbs	25	percent	100	remaining %	=	15.1	lbs N	5
100	percent	1	dry to	100	percent	100	percent			dry ton	
3.02	percent	2000	lbs	12	percent	75	remaining %	=	5.44	lbs N	1.8
100	percent	1	dry to	100	percent	100	percent			dry ton	
3.02	percent	2000	lbs	6	percent	63	remaining %	=	2.28	lbs N	0.8
100	percent	1	dry to	100	percent	100	percent			dry ton	

Calculate the Volume of Solids Applied:											
272	~~Cu Yds~~	27	~~cu ft~~	62.4	~~lbs~~	43.4	% solids	1	dry ton	=	99.44 dry tons
	Acre	1	~~cu yd~~	1	~~cu ft~~	100	% mixture	2000	~~lbs~~		acre
Conversion Multiplier:		27*62.4/100/2000 = 0.008425									
Reciprocal:		1/0.008425 =		118.7							