# Biosolids Calculations

Rachel Barnes-McAden

Solids	30.94	309400
Nitrogen (TKN)	4,45	44500
Phosphorus	1.72	17200
Potassium	0.20	2000
Sulfur	0.60	6000
Calcium	9.86	98600
Magnesium	0.29	2900
Sodium	0.10	1000
Iron		49600
Manganese		178
Copper		269
Zinc		421
Ammonia Nitrogen	0.27	2700
NO <sub>3</sub> -NO <sub>2</sub> Nitrogen		21
Cadmium		2.0
Chromium		49
Nickel		19
Lead		40
Arsenic		2.15
Mercury		0.96
Selenium		2.23
pH (Standard Units)	12.10	
Calcium Carbonate Eq	14.63	146300
Volatile Solids	64.88	648800
Organic Nitrogen	4.18	41800
Molybdenum		13

All Values, except for Solids, are on a Dry Weight Basis.

The biosolids analysis reports nutrient levels in terms of the percent by weight.

We're going to figure out how much of each nutrient there is in terms of pounds per dry ton.

For % to decimal: divide by 100

(or use % button on calculator)

#### Calculating Nitrogen

0.045 (TKN) X 2,000 lbs/ T = 89.0 lbs TKN/ DT (4.45%)

 $0.0027 \text{ (NH}_3) \text{ X } 2,000 \text{ lbs./ T} = 5.4 \text{ lbs NH}_3/\text{ DT}$  (0.27%)

 $89.0 \text{ TKN/DT} - 5.4 \text{ lbs NH}_3/\text{DT} = 83.6 \text{ lbs organic N/DT}$ 

## Nitrogen Calculations for Ammonium, Organic and Residual Nitrogen Based on Analysis of Material

#### First Year - Plant Available Nitrogen (PAN)

Unit = Ton or 1,000 Gallons

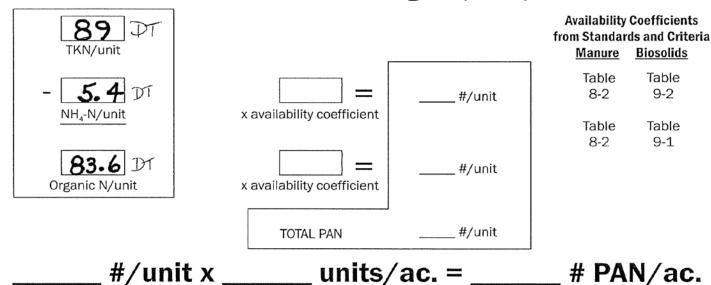


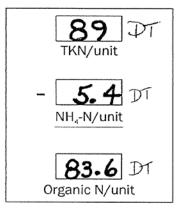
Table 9-1
Estimated Nitrogen Mineralization Rates for Biosolids¹
(S&C pg 117)

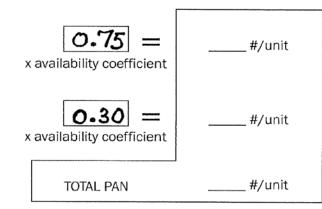
	Application Year								
Biosolids Type	Application Year	1 Year After Application	2 Years After Application	3 Years After Application					
Lime Stabilized	0.30	0.10	0.10	0.05					
Aerobic Digestion	0.30	0.10	0.10	0.05					
Anaerobic Digestion	0.30	0.10	0.10	0.05					
Composted <sup>2</sup>	0.10	0.05	0.03	0.00					

Table 9-2
Biosolids Ammonium Nitrogen Availability Coefficients¹
(S&C pg 117)

Method of Application	Biosolids pH < 10	Biosolids pH > 10
Injection	1.00	1.00
Incorporated within 24 hours	0.85	0.75
Incorporated within 1-7 days	0.70	0.50
Incorporated after 7 days or no incorporation	0.50	0.25

#### First Year - Plant Available Nitrogen (PAN)





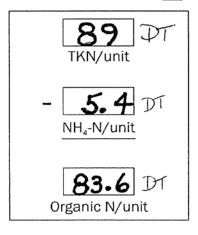
Availability Coefficients from Standards and Criteria Manure Biosolids

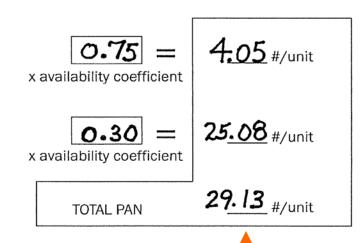
Table	Table
8-2	9-2
Table	Table
8-2	9-1

\_\_\_\_\_ #/unit x \_\_\_\_ units/ac. = \_\_\_\_ # PAN/ac.

Unit = Ton or 1,000 Gallons

#### First Year - Plant Available Nitrogen (PAN)





#### Availability Coefficients from Standards and Criteria Manure Biosolids

Table	Table
8-2	9-2
Table	Table
8-2	9-1

#### **NUTRIENT MANAGEMENT Balance Sheet**

Name: WilDaLyn Farms Date: February 2010

Tract: T-1989

Field Name	Ac.	Crop Rotation	Expetd Yield (bu or tons)	Nutrient Needs (from soil test & expetd yield) N-P <sub>2</sub> O <sub>5</sub> -K <sub>2</sub> O	Nitrogen Residual (Leg./ Manure)	Days before incorp	Organic Material Applied (1000 gal. or tons/ac)	Org. Nut. Applied N-P₂O₄-K₂O	N-P <sub>2</sub> O <sub>5</sub> -K <sub>2</sub> O Need or (Surplus)	N-P <sub>2</sub> O <sub>5</sub> -K <sub>2</sub> O (commercial)	Notes
HF-1	8	Orchard- grass Pasture	3.6 ac/au	50-40-70	0/14				36-40-70	36-40- 70 br	
HF-2A	16	Corn (grain)	120 bu/ac.	120-80-100	0/14	>7			,	,	
HF-2B	12	Corn (grain)	90 bu/ac	90-0-0	0/0	>2					
HF-2C	9	Orchard- grass Hay (maint.)	3.3 t/ac	140-40-95	0/0	>7					1
HF-3A	11	Corn (grain)	150 bu/ac	150-120-100	0/14	>1					
HF-3B	11.3	Corn (silage)	15. <b>6</b> t/ac	90-100-200	0/7	>2	6 k/ac Dairy	63-69-119	20-31-81	0-0-81 br 20-31-0 ba	

Notes: Application Methods: Ba= Banded, Br = Broadcast, Sd = Sidedress, k = 1000 gal.

1. Nitrogen needs are shown for 2 cuttings of hay.

#### **Biosolids Application Rate**

From case study, Field 3A is a corn (grain) field.

Crop nutrient need is **150-120-100**.

First, credit residual nitrogen carryover to crop nutrient needs:

$$150 \text{ lbs N} - 14 \text{ lbs N} = 136 \text{ lbs N} \text{ need}$$

(dairy manure residual)

Balance of crop nutrient need is 136-120-100

#### How Many Tons of Biosolids to Apply?

Field Name	Acres	Crop Rotation	Expected Yield Bu/ Ton	Nutrient Needs (soil test) N-P <sub>2</sub> O <sub>5</sub> -K <sub>2</sub> O	Nitrogen Residual (Leg./ Manure)	Days before Incorp	Applied (1,000 gal. or Tons/ac)	Org. Nut. Applied N-P <sub>2</sub> O <sub>5</sub> - K <sub>2</sub> O	N N (S
HF-2C	9	Orchard grass Hay	3.3 t/ac	140-40-95	0/0	>7			<u></u>
HF-3A	11	Corn (grain)	150 bu/ac	150-120-100	0/14	>1			T
HF-3B	11.3	Corn (silage)	15.6 t/ac	90-100-200	0/7	>2	6k Dairy	63-69-119	

150 lbs N for corn - 14 lbs N residual = 136 lbs N from Biosolids

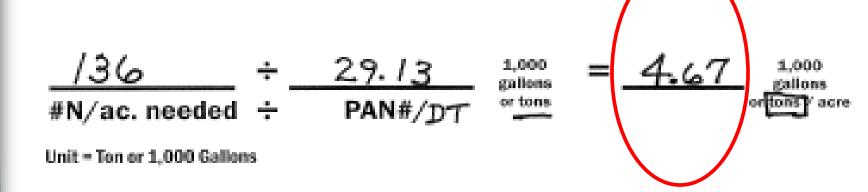
Nitrogen needs are to be met through biosolids application

From worksheet, we get 29.13 lbs PAN/DT

Crop needs, less residual, are 136 lbs N

(14 lbs. dairy manure)

#### Fill in Worksheet



Remember that the biosolids will arrive as wet tons, but we just calculated dry tons. So- we'll need to convert:

$$\underline{DT} = WT$$
% solids

$$\frac{4.67 \text{ DT/ A}}{0.3094}$$
 = 15.09 WT/ A to achieve N = 136 lbs/ A (30.94% solids)

#### **NUTRIENT MANAGEMENT Balance Sheet**

WilDaLyn Farms ne: ct:

Date: February 2010

T-1989

es:

ield ame	Ac.	Crop Rotation	Expctd Yield (bu or tons)	Nutrient Needs (from soil test & expctd yield) N-P <sub>2</sub> O <sub>5</sub> -K <sub>2</sub> O	Nitrogen Residual (Leg./ Manure)	Days befor e Incor p	Organic Material Applied (1000 gal. or tons/ac)	Org. Nut. Applied N-P₂O₅-K₂O	N-P₂O₅-K₂O Need or (Surplus)	N-P <sub>2</sub> O <sub>5</sub> -K <sub>2</sub> O (commercial)	Notes
-1	8	Orchard-	3.6	50-40-70	0/14				36-40-70	36-40- 70 br	
		grass Pasture	ac/au								
-2A	16	Corn (grain)	120 bu/ac.	120-80-100	0/14	>7	•		•		
-2B	12	Corn (grain)	90 bu/ac	90-0-0	0/0	>2	•		•	•	
-2C	9	Orchard- grass Hay (maint.)	3.3 t/ac	140-40-95	0/0	>7	•				1 1
-3A	11	Corn (grain)	150 bu/ac	150-120-100	0/14	>1	4.67 DT 15.09 WT/ac	136-?-?		•	
-3B	1 <b>1</b> .3	Corn (silage)	15.6 t/ac	90-100-200	0/7	>2	6 k/ac Dairy	63-69-119	20-31-81	0-0-81 br 20-31-0 ba	

Application Methods: Ba= Banded, Br = Broadcast, Sd = Sidedress, k = 1000 gal.

1. Nitrogen needs are shown for 2 cuttings of hay.

#### **Calculating Phosphorus**

1.72 % elemental P

$$0.0172 \text{ P } \text{ X } 2,000 \text{ lbs/ T} = 34.4 \text{ lbs P/ DT}$$

For field nutrients, P is dealt with as  $P_2O_5$  (phosphate)

$$P \quad X \quad 2.29 \quad = \quad P_2O_5$$

(conversion factor)

34.4 lbs P/DT X 
$$2.29 = 78.8$$
 lbs  $P_2O_5/DT$ 

#### **Calculating Potassium**

0.20 % elemental K

$$0.0020 \text{ K} \text{ X} \text{ 2,000 lbs/T} = 4.0 \text{ lbs K/DT}$$

For field nutrients, K is dealt with as K<sub>2</sub>O (Potash)

$$K \quad X \quad 1.2 = K_2O$$

4.0 lbs K/DT X 1.2 = 
$$4.8 lbs K_2O/DT$$

We'll need to know how much

**Phosphate** and **Potash** will be applied when biosolids are used to meet the **Nitrogen** needs of the corn.

$$78.8 \text{ lbs } P_2O_5/DT X 4.67 DT/A = 368 \text{ lbs } P_2O_5/A$$

4.8 lbs 
$$K_2O/DT X 4.67 DT/A = 22 lbs  $K_2O/A$$$

Original Crop Needs: 150-120-100

Nutrient		Amount/ Source	Net
Nitrogen	: 150	14 lbs/ A from Residual	136
		136 lbs/ A from Biosolids	0
Phosphat	te: 120	368 lbs/A from Biosolids	+248*
Potash:	100	22 lbs/ A from Biosolids	- 78
		78 lbs/ A from fertilizer	0

<sup>\*</sup> Can be "banked" for crops in remainder of rotation (3 yrs X 120  $\#P_2O_5/yr$ )

#### **NUTRIENT MANAGEMENT Balance Sheet**

me: WilDaLyn Farms

es:

Date: February 2010

T-1989

ield ame	Ac.	Crop Rotation	Expetd Yield (bu or tons)	Nutrient Needs (from soil test & expctd yield) N-P <sub>2</sub> O <sub>5</sub> -K <sub>2</sub> O	Nitrogen Residual (Leg./ Manure)	Days befor e Incor p	Organic Material Applied (1000 gal. or tons/ac)	Org. Nut. Applied N-P₂O₅-K₂O	N-P <sub>2</sub> O <sub>5</sub> -K <sub>2</sub> O Need or (Surplus)	N-P₂O₅-K₂O (commercial)	Notes
-1	8	Orchard- grass Pasture	3.6 ac/au	50-40-70	0/14				36-40-70	36-40- 70 br	
-2A	16	Corn (grain)	120 bu/ac.	120-80-100	0/14	>7					
-2B	12	Corn (grain)	90 bu/ac	90-0-0	0/0	>2	•	•			
-2C	Ø	Orchard- grass Hay (maint.)	3.3 t/ac	140-40-95	0/0	>7	•	•			1 1
-3A	11	Corn (grain)	150 bu/ac	150-120-100	0/14	>1	4.67 DT 15.09 WT/ac	136-368-22	0-(248*)-78	0-0-78	· *P
-3B	11.3	Corn (silage)	15.6 t/ac	90-100-200	0/7	>2	6 k/ac Dairy	63-69-119	20-31-81	0-0-81 br 20-31-0 ba	

Application Methods: Ba= Banded, Br = Broadcast, Sd = Sidedress, k = 1000 gal.

1. Nitrogen needs are shown for 2 cuttings of hay.

'P-Ensure this amount can be used during this this crop rotation.

### Lime Applied

Calculating Lime Application

14.63 % Calcium Carbonate Equiv.

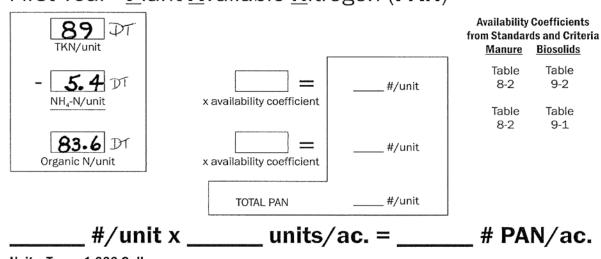
(from biosolids analysis)

 $4.67 \, DT/A \, X \, .1463 = .68 \, T/A \, of Lime$ 

#### **Biosolids Residual**

Nitrogen Calculations for Ammonium, Organic and Residual Nitrogen Based on Analysis of Material

#### First Year - Plant Available Nitrogen (PAN)



Unit = Ton or 1,000 Gallons

#### Use Table 9.1

Ammonium = 5.4 lbs.N/ Dry Ton TKN = 89 lbs. N/ DT

Organic N = 83.6 lbs. N/DT

Section IX. Biosolids Management

Table 9-1 Estimated Nitrogen Mineralization Rates for Biosolids<sup>1</sup>

IS TOO IN THE SECOND SHOULD BE	Application Year								
Biosolids Type	Application Year	1 Year After Application	2 Years After Application	3 Years After Application					
Lime Stabilized	0.30	0.10	0.10	0.05					
Aerobic Digestion	0.30	0.10	0.10	0.05					
Anaerobic Digestion	0.30	0.10	0.10	0.05					
Composted <sup>2</sup>	0.10	0.05	0.03	0.00					

- To determine nitrogen available from previous Biosolids applications, multiply the percent organic nitrogen by the appropriate mineralization factor.
- 2. Total organic nitrogen content of 2% or less and no significant ammonia nitrogen.

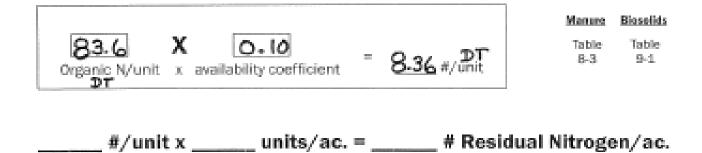
Table 9-2 Biosolids Ammonium Nitrogen Availability Coefficients<sup>1</sup>

Method of Application	Biosolids pH < 10	Biosolids pH >
Injection	1.00	1.00
Incorporated within 24 hours	0.85	0.75
Incorporated within 1-7 days	0.70	0.50
Incorporated after 7 days or no incorporation	0.50	0.25

To determine the plant-available Biosolids ammonium nitrogen in the soil, multiply the Biosolids ammonium nitrogen concentration or total weight applied by the appropriate availability coefficient.

# To Calculate Biosolids Residual One Year after Application

Residual - Plant Available Nitrogen (for following year)



#### Completed Worksheet

Residual - Plant Available Nitrogen (for following year)

8.36 #/unit x 4.67 units/ac. = 39.03# Residual Nitrogen/ac.

# Ouestions P