

ANIMAL WASTE MANAGEMENT PLAN

Date: 05/06/11

Farm Name: Lancaster Dairy

Operated by: Ryan & Freyne Lancaster

Facility Address: 1206 Marolf Loop Road
Tillamook, Oregon 97141

As the owner/operator of Lancaster Dairy I agree to manage the CAFO in accordance with this animal waste management plan and maintain those practices described in the plan.

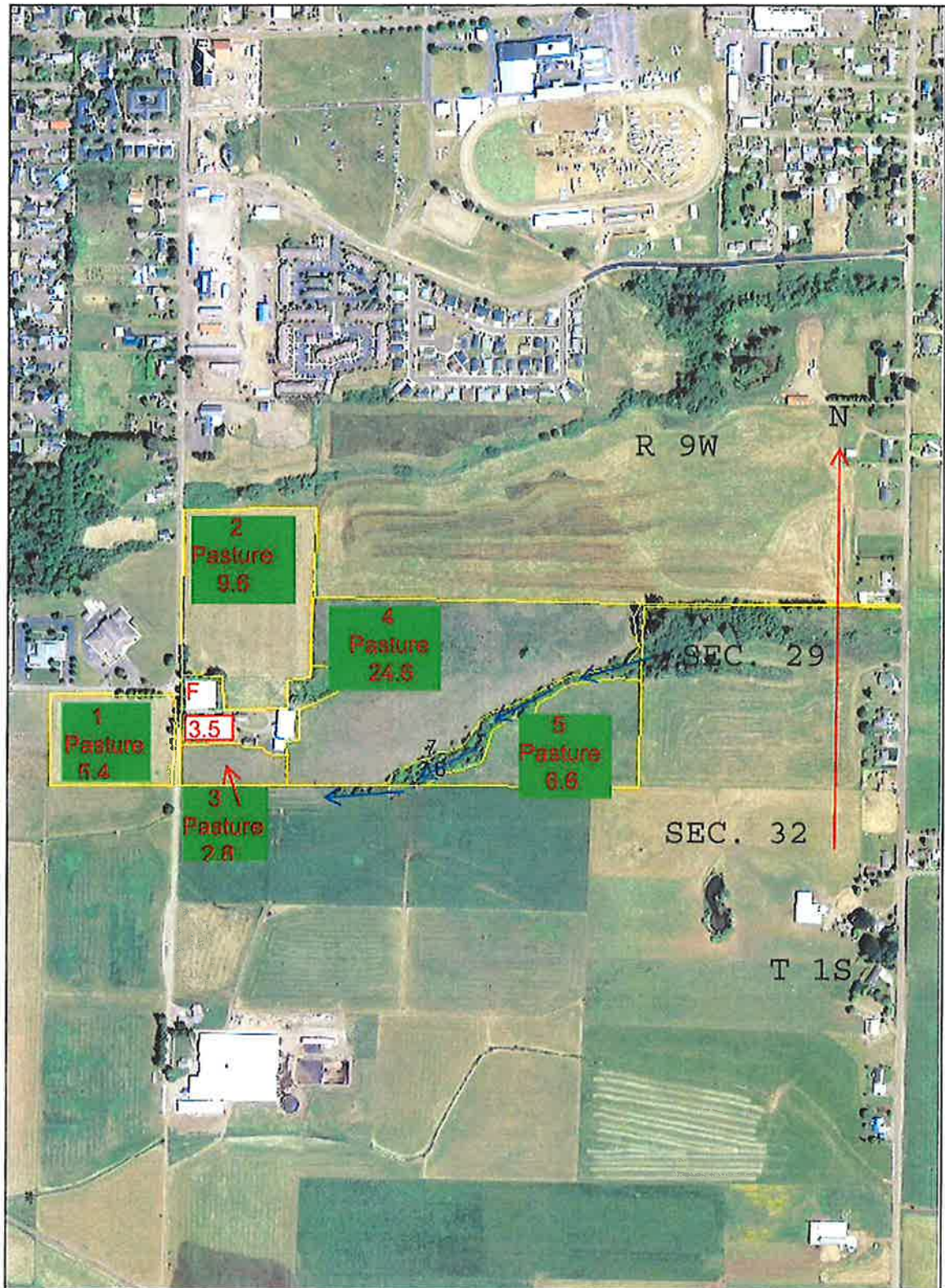
Signature: Freyne Lancaster

Date: 5-6-11

Ryan & Freyne Lancaster Farmstead Layout



CONSERVATION PLAN



WILSON

Slough

Slough

Sêc. 32

Fairview

TRASK

Anderson

Ryan & Freyne Lancaster
04/2011

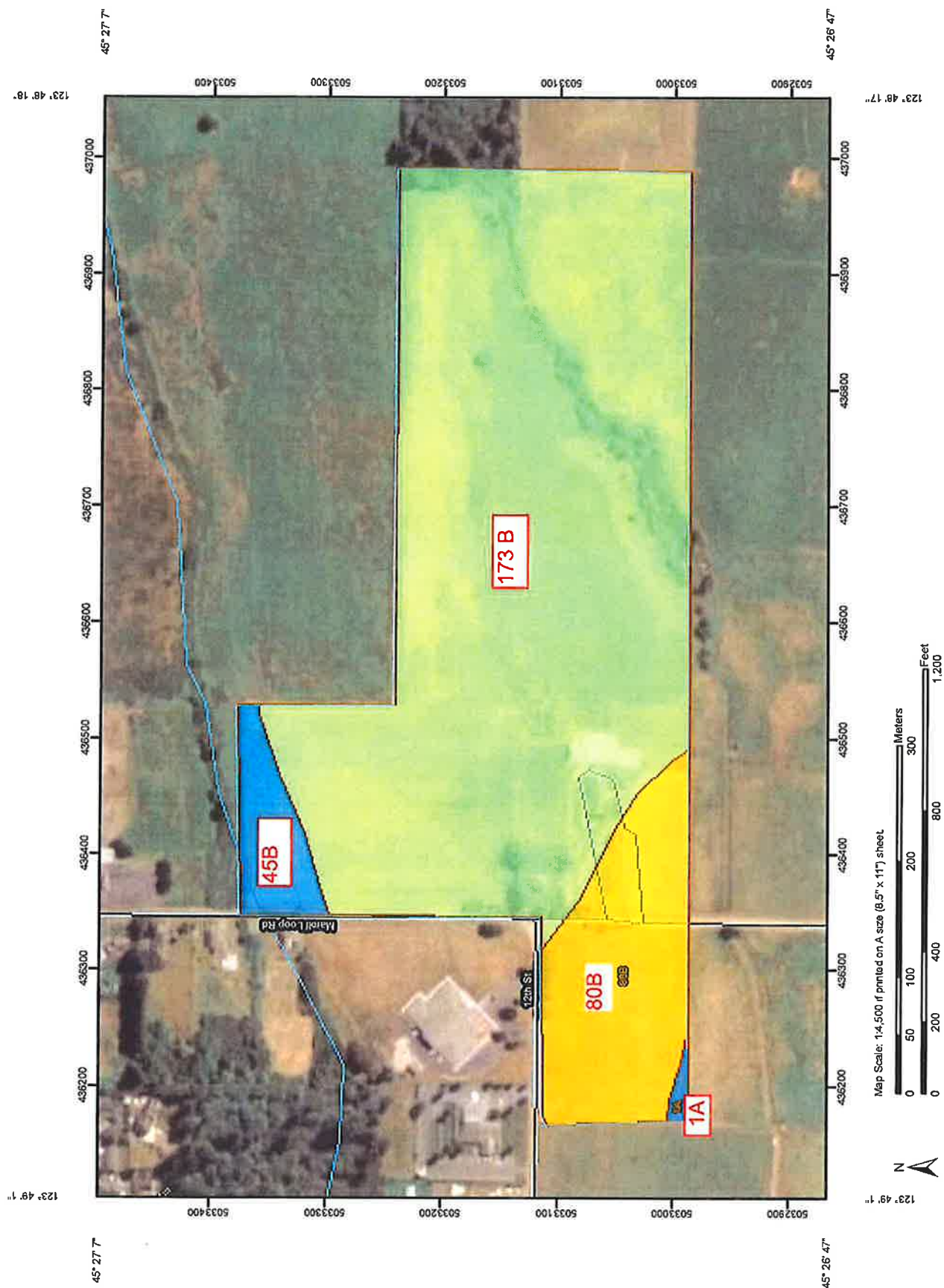
LAND USE SUMMARY

<u>Tract</u>	<u>Field</u>	<u>Land Use</u>	<u>Acres</u>
318	1	Pasture	5.4
	2	Pasture	9.6
	3	Pasture	2.8
	4	Pasture	24.6
	5	Pasture	6.6
	F	Farmstead	3.5
Total			52.5

SUMMARY

Pasture	49.0
Farmstead	3.5
Total	52.5

Soils Map Ryan & Freyne Lancaster



MAP LEGEND

- Area of Interest (AOI)
 - Area of Interest (AOI)
- Soils
 - Soil Map Units
- Soil Ratings
 - Excessively drained
 - Somewhat excessively drained
 - Well drained
 - Moderately well drained
 - Somewhat poorly drained
 - Poorly drained
 - Very poorly drained
 - Not rated or not available
- Political Features
 - Cities
- Water Features
 - Oceans
 - Streams and Canals
- Transportation
 - Rails
 - Interstate Highways
 - US Routes
 - Major Roads
 - Local Roads

MAP INFORMATION

Map Scale: 1:4,500 if printed on A size (8.5" x 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:24,000. Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: <http://websoilsurvey.nrcs.usda.gov>
Coordinate System: UTM Zone 10N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

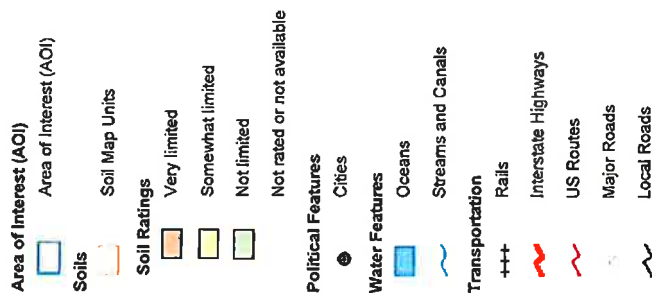
Soil Survey Area: Tillamook County, Oregon
Survey Area Data: Version 3, Feb 8, 2010
Date(s) aerial images were photographed: 7/19/2005

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Manure and Food-Processing Waste—Tillamook County, Oregon
(Ryan & Freyne Lancaster)



MAP LEGEND



MAP INFORMATION

Map Scale: 1:4,500 if printed on A size (8.5" x 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:24,000. Please rely on the bar scale on each map sheet for accurate map measurements.

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The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Tillamook County, Oregon (OR057)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
1A	Brenner silt loam, 0 to 1 percent slopes	0.2	0.4%
45B	Hebo silty clay loam, 0 to 5 percent slopes	2.1	4.1%
80B	Quillamook medial silt loam, 0 to 7 percent slopes	7.5	14.3%
173B	Tillamook-Ginger medial silt loams, 0 to 7 percent slopes	42.3	81.2%
Totals for Area of Interest		52.1	100.0%

Map Unit Description (Brief, Generated)

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions in this report, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

The Map Unit Description (Brief, Generated) report displays a generated description of the major soils that occur in a map unit. Descriptions of non-soil (miscellaneous areas) and minor map unit components are not included. This description is generated from the underlying soil attribute data.

Additional information about the map units described in this report is available in other Soil Data Mart reports, which give properties of the soils and the limitations, capabilities, and potentials for many uses. Also, the narratives that accompany the Soil Data Mart reports define some of the properties included in the map unit descriptions.

Report—Map Unit Description (Brief, Generated)

Tillamook County, Oregon

Map Unit: 1A—Brenner silt loam, 0 to 1 percent slopes

Component: Brenner (85%)

The Brenner component makes up 85 percent of the map unit. Slopes are 0 to 1 percent. This component is on flood plains, river valleys. The parent material consists of alluvium derived from igneous and sedimentary rock. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is poorly drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is high. Shrink-swell potential is moderate. This soil is frequently flooded. It is frequently ponded. A seasonal zone of water saturation is at 0 inches during January, February, March, April, November, December. Organic matter content in the surface horizon is about 8 percent. Nonirrigated land capability classification is 4w. This soil meets hydric criteria.

Map Unit: 45B—Hebo silty clay loam, 0 to 5 percent slopes

Component: Hebo (80%)

The Hebo component makes up 80 percent of the map unit. Slopes are 0 to 5 percent. This component is on depressions on stream terraces, drainageways on fluviomarine terraces, river valleys. The parent material consists of mixed alluvium and/or fluviomarine deposits derived from sedimentary rock. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is poorly drained. Water movement in the most restrictive layer is low. Available water to a depth of 60 inches is high. Shrink-swell potential is moderate. This soil is not flooded. It is frequently ponded. A seasonal zone of water saturation is at 0 inches during January, February, March, April, December. Organic matter content in the surface horizon is about 9 percent. Nonirrigated land capability classification is 4e. This soil meets hydric criteria.

Component: Aquepts (5%)

Generated brief soil descriptions are created for major components. The Aquepts soil is a minor component.

Component: Croquib (5%)

Generated brief soil descriptions are created for major components. The Croquib soil is a minor component.

Map Unit: 80B—Quillamook medial silt loam, 0 to 7 percent slopes

Component: Quillamook (80%)

The Quillamook component makes up 80 percent of the map unit. Slopes are 0 to 7 percent. This component is on stream terraces, river valleys. The parent material consists of silty alluvium. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is very high. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 17 percent. Nonirrigated land capability classification is 2e. Irrigated land capability classification is 3e. This soil does not meet hydric criteria.

Component: Hebo (3%)

Generated brief soil descriptions are created for major components. The Hebo soil is a minor component.

Map Unit: 173B—Tillamook-Ginger medial silt loams, 0 to 7 percent slopes

Component: Tillamook (45%)

The Tillamook component makes up 45 percent of the map unit. Slopes are 0 to 7 percent. This component is on stream terraces, river valleys. The parent material consists of alluvium derived from igneous and sedimentary rock. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is moderately well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is very high. Shrink-swell potential is moderate. This soil is not flooded. It is not ponded. A seasonal zone of water saturation is at 25 inches during January, February, March, December. Organic matter content in the surface horizon is about 17 percent. Nonirrigated land capability classification is 2e. Irrigated land capability classification is 3e. This soil does not meet hydric criteria.

Component: Ginger (40%)

The Ginger component makes up 40 percent of the map unit. Slopes are 0 to 7 percent. This component is on stream terraces, river valleys. The parent material consists of alluvium derived from igneous and sedimentary rock. Depth to a root restrictive layer, strongly contrasting textural stratification, is 40 to 60 inches. The natural drainage class is somewhat poorly drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is very high. Shrink-swell potential is moderate. This soil is not flooded. It is not ponded. A seasonal zone of water saturation is at 17 inches during January, February, December. Organic matter content in the surface horizon is about 15 percent. Nonirrigated land capability classification is 3e. Irrigated land capability classification is 4e. This soil does not meet hydric criteria.

Component: Hebo (5%)

Generated brief soil descriptions are created for major components. The Hebo soil is a minor component.

Data Source Information

Soil Survey Area: Tillamook County, Oregon
Survey Area Data: Version 3, Feb 8, 2010

Nonirrigated Capability Subclass

Nonirrigated Capability Subclass— Summary by Map Unit — Tillamook County, Oregon				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
1A	Brenner silt loam, 0 to 1 percent slopes	w	0.2	0.4%
45B	Hebo silty clay loam, 0 to 5 percent slopes	e	2.1	4.1%
80B	Quillamook medial silt loam, 0 to 7 percent slopes	e	7.5	14.3%
173B	Tillamook-Ginger medial silt loams, 0 to 7 percent slopes	e	42.3	81.2%
Totals for Area of Interest			52.1	100.0%

Description

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations that show suitability and limitations of groups of soils for rangeland, for woodland, or for engineering purposes.

In the capability system, soils are generally grouped at three levels—capability class, subclass, and unit. Only class and subclass are included in this data set.

Capability subclasses are soil groups within one capability class. They are designated by adding a small letter, "e," "w," "s," or "c," to the class numeral, for example, 2e. The letter "e" shows that the main hazard is the risk of erosion unless close-growing plant cover is maintained; "w" shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); "s" shows that the soil is limited mainly because it is shallow, droughty, or stony; and "c," used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class 1 there are no subclasses because the soils of this class have few limitations. Class 5 contains only the subclasses indicated by "w," "s," or "c" because the soils in class 5 are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, forestland, or wildlife habitat.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Lower

Drainage Class

Drainage Class— Summary by Map Unit — Tillamook County, Oregon				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
1A	Brenner silt loam, 0 to 1 percent slopes	Poorly drained	0.2	0.4%
45B	Hebo silty clay loam, 0 to 5 percent slopes	Poorly drained	2.1	4.1%
80B	Quillamook medial silt loam, 0 to 7 percent slopes	Well drained	7.5	14.3%
173B	Tillamook-Ginger medial silt loams, 0 to 7 percent slopes	Moderately well drained	42.3	81.2%
Totals for Area of Interest			52.1	100.0%

Description

"Drainage class (natural)" refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Alterations of the water regime by human activities, either through drainage or irrigation, are not a consideration unless they have significantly changed the morphology of the soil. Seven classes of natural soil drainage are recognized—excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained, and very poorly drained. These classes are defined in the "Soil Survey Manual."

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

BUSINESS NARRATIVE

This confined animal dairy feeding operation plan is for 75-1,000 lb. animal units. There are 50 lactating Jersey's, 10 dry cow Jersey's, 30 heifers, and 30 calves. The number of livestock may be lower, at times, due to culling rates, economic conditions, and/or livestock health. The lactating cows are normally confined for 234 days and on pasture for 131 days. The dry cows are normally confined for 304 days and on pasture for 61 days. The heifers and calves are normally confined for 365 days. Weather conditions, livestock health, and excessive forage production during late fall, winter, and early spring are reason the livestock confinement days may vary from day to day, week to week, month to month, and year to year. Livestock mortality service is provided by the Tillamook County Creamery Association.

The operation consists of one Tract. There are 49 pasture acres that receive manure applications. There is only 0.2 acres that is within the 100-year floodplain. The rest of the acres (48.8) are outside the 100-yr floodplain. The pastures are in fair condition. The target yield is 20 tons at 30% dry matter per acre per year.

The liquid manure is transported to the fields with a tractor and manure tank wagon and applied. The solid manure is transported to the fields with a tractor and manure spreader and applied.

The lactating cow manure will be managed 95% solids and 5 % liquids. The dry cow, heifer, and calf manure will be managed 100% solids. The liquid waste storage facility is a 10' x 45' x 6' covered below ground liquid waste storage tank. The liquid waste storage tank can store the liquid waste produced by the 50-1,000 lb lactating animal for 56 days. The solid manure storage is a covered 41.4' x 27.3' x 6' facility. Solid manure produced by the 75-1,000 lb. animals can be stored for 105 days. The manure storage days is based on the 30-year annual precipitation recorded at the KTIL Radio Station in Tillamook City. If any manure is exported from the operation, records will be kept on the amount and date the manure was exported.

All conservation practices installed will be managed and maintained in accordance with the enclosed "CONSERVATION PRACTICE OPERATION AND MAINTENANCE PLAN".

Soils where manure is applied are: Brenner silt loam, 0-3% slopes, Hebo silty clay loam, 0-5% slopes, Quillamook medial silt loam, 0-7% slopes, and Tillamook-Ginger medial silt loams 0-7 %

slopes. The Quillamook soil is well drained. The Tillamook-Ginger soil is moderately well drained. The Brenner and Hebo soils are poorly drained.

COMPREHENSIVE NUTRIENT MANAGEMENT PLAN

Cooperator: **Ryan & Freyne Lancaster**

Date:

Field No.	Amount	Planned	Applied	LAND USE AND PRACTICE
Farmstead T-318				
F	1	x	x	Waste Storage Facility A 10' x 45' x 5' below ground liquid waste storage tank was installed. The 2,250 cubic foot below ground liquid waste storage tank will store the liquid manure produced by the 75-1,000 lbs. animal units for 56 days;
F	1	x	x	Waste Storage Facility A 41.4' x 27.3' x 6' solid manure storage facility was installed. The 6,781 cubic foot solid manure storage facility will store the solid manure produced by the 75-1,000 lb. animal units for 105 days.
F	1	x	x	Waste Storage Facility A 1,015 square foot roof was installed over the existing below ground liquid waste storage tank to prevent rainwater from entering the liquid waste storage tank.
F	x	x	x	Roof Runoff Management 520 feet of gutters and downspouts was installed on the animal confinement buildings.
F	370 ft	x	x	Underground Outlet A four inch underground PVC nonperforated outlet was installed to outlet the gutters in an area free of manure.
Pasture T-318				
4,5	4.2 ac			Filter Strip A filter strip adjacent to the open watercourse will established and maintained as part of the animal confinement water quality plan to prevent agricultural waste from entering the open watercourse. The filter strip will be established in accordance with the enclosed Filter Strip Specification Sheet Code 393.
1-5	49 ac	x		Prescribed Grazing Pastures will be managed in accordance with the enclosed Prescribed Grazing Specification Sheet Code 528.

COMPREHENSIVE NUTRIENT MANAGEMENT PLAN

Cooperator: **Ryan & Freyne Lancaster**

Date:

Field No.	Amount	Planned	Applied
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LAND USE AND PRACTICE

Pasture T-318

Nutrient Management

Manure will be used for forage production. Soil tests will be used to determine rates of application. nutrient management will be implemented in accordance with the enclosed Nutrient Management Specification Sheet Code 590.

1-5	49 ac	x
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Waste Utilization

Manure will be applied to the forage fields in accordance with in accordance with the enclosed Waste Utilization Conservation Job Sheet Code 633.


CERTIFICATION OF PARTICIPANTS

Franyielamaster

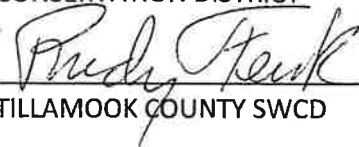
5-5-11
DATE

CERTIFICATION OF:


Robert A. Pedersen
CAFO PLANNER

Date 5/5/11

CONSERVATION DISTRICT


TILLAMOOK COUNTY SWCD 5-5-11
DATE

TILLAMOOK COUNTY SOIL AND WATER CONSERVATION DISTRICT:

Conservation

Development

Self Government

**Tillamook County Soil and Water Conservation District is an Equal Opportunity
Provider and Employer**

TILLAMOOK COUNTY
SOIL AND WATER CONSERVATION DISTRICT

OPERATION AND MAINTENANCE WORKSHEET

**WASTE STORAGE FACILITY
CODE 313**

For: Landowner/Operator Ryan & Freyne Lancaster

Job Location: T1S: R9W Sec. 32

County Tillamook SWCD Tillamook

Farm/Tract No. 318

Prepared By Pedersen Date 04/11

45' x 10' x 5' below ground liquid waste tank

Operation and Maintenance Items

A properly operated and maintained waste storage structure is an asset to your farm. This waste storage structure was designed and installed for temporary storage of animal wastes. The estimated life span of this installation is at least 10 years. If at any time this structure is taken out of service, the Natural Resources Division of the Oregon Department of Agriculture should be contacted for guidance in decommissioning the structure to avoid environmental concerns. The life of this installation can be assured and usually increased by developing and carrying out a good operation and maintenance program.

This practice will require you to perform periodic operation and maintenance to maintain satisfactory performance. A good operation and maintenance plan includes:

- ⇒ Do not allow equipment that exceeds the design loading to operate within 20 feet of the structure.
- ⇒ **WARNING: ENTERING AN UNVENTILATED TANK IS EXTEREMELY "HAZARDOUS" !** Do not allow human entry into the enclosed structure without safety equipment that includes ladders and breathing apparatus.
- ⇒ Continually maintain all pumps, agitators, piping, valves and all other electrical and mechanical equipment in good operating condition by following the manufacturer's recommendations.
- ⇒ Continually maintain grounding rods and wiring for all electrical equipment in good condition.
- ⇒ Facilities will be empty by November 1st to begin winter storage.
- ⇒ A one foot free board will be maintained to prevent spillage.
- ⇒ The waste storage facility will be inspected weekly to ensure structural integrity.
- ⇒ Perform daily inspections of waterlines, including drinking water or cooling water lines. Repair leaking lines immediately to prevent excess water from entering the waste storage system.
- ⇒ The depth of all liquid manure will be recorded during each week's inspection.

- ⇒ Immediately repair any vandalism, vehicular or livestock damage to the structure, earthen areas surrounding the structure, or any appurtenances.
- ⇒ Pump out the facility within the first two years following construction to check for structural damage. If damage is noted, immediately seek a qualified engineer to assess the situation. Thereafter, it should be pumped out at least every four years to check for damages, remove gravel, rocks, sand, wire and other debris to maintain the designed storage capacity.
- ⇒ Immediately remove all foreign debris within the structure that may cause damage to pumps and agitator.
- ⇒ During de-watering of the structure, ensure that waste is spread at minimum rates in areas where crops are grown, spread waste no closer than 45 feet from open watercourses during the winter months and apply no manure within 5 feet of an open watercourse during the summer months. Avoid applying waste during heavy rainfall events.
- ⇒ Dead animals will not be disposed of in the liquid waste storage facility.

TILLAMOOK COUNTY
SOIL AND WATER CONSERVATION DISTRICT

OPERATION AND MAINTENANCE WORKSHEET

**WASTE STORAGE FACILITY (SOLID MANURE STORAGE FACILITY)
CODE 313**

For: Landowner/Operator Ryan & Freyne Lancaster

Job Location T1S; R 9W; Sec 32

County Tillamook SWCD Tillamook Farm/Tract No. 318

Prepared By Pedersen Date 04/11

41.4' 27.3' x 6'

Operation and Maintenance Items

A properly operated and maintained waste storage structure is an asset to your farm. This waste storage structure was designed and installed for temporary storage of animal wastes. The estimated life span of this installation is at least 10 years. If at any time a structure is taken out of service, the Natural Resources Division of the Oregon Department of Agriculture should be contacted for guidance in decommissioning the structure to avoid environmental concerns. The life of this installation can be assured and usually increased by developing and carrying out a good operation and maintenance program.

This practice will require you to perform periodic operation and maintenance to maintain satisfactory performance. A good operation and maintenance plan includes:

- ⇒ Do not allow equipment that exceeds the design loading to operate within 20 feet of the structure
- ⇒ Immediately repair any vandalism, vehicular or livestock damage to the structure, earthen areas surrounding the structure, or any appurtenances.
- ⇒ Storage facility will be empty by November 1st to begin winter storage.
- ⇒ During manure removal from the structure, ensure that waste is spread at minimum rates in areas where crops are grown, spread waste no closer than 45 feet from open watercourses during the winter months and apply no manure within 5 feet of an open watercourse during the summer months. Avoid applying waste during heavy rainfall events.
- ⇒ Roofs of the solid manure storage facilities will be inspected annually.
- ⇒ All roof sections that are rusted and leaking will be repaired and/or replaced.
- ⇒ Loose roof sections on the solid manure storage facilities will be secured.
- ⇒ Broken trusses, beams, poles, gutters and downspouts will be repaired or replaced on the solid waste storage facilities.

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PORT:
ROWER:
DDRESS:
AMPLED:
IELD:
ROP:

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August 17, 2010
S 7657
KRAKE, WAYNE Lancaster, Ryant
1202 MAROLF LP RD; TILLAMOOK, OR 97141

FIELD 3
PASTURE

Agri-Check

A Division of AgSource Cooperative Services
323 Sixth St. • P.O. Box 1350 • Umatilla, OR 97882
Ph: 541-922-4894 • 800-537-1129 • Fax: 541-922-5496

Oil Analysis Report

ab o.	Depth Foot	pH	S.Salt mmhos	O. M. %	P ppm	K ppm	Ca meq	Mg meq	NITROGEN				MOISTURE										TKN %	Cl ppm
									NO3 #/A	NH4 #/A	S ppm	B ppm	Zn ppm	Mn ppm	Cu ppm	Fe ppm	CEC meq	Na meq	Total Bases	Base Sat.%	SMP Buf.pH	Total % Inches		
20	0-6"	5.5			12	294	5.0	1.9		16	49								7.7		5.1			

* * * * *

OTAL BROADCAST FERTILITY NEEDS:

LB PER ACRE N
 LB PER ACRE P205
 LB PER ACRE K20
 LB PER ACRE ACTUAL S
 LB PER ACRE ACTUAL B
 LB PER ACRE ACTUAL Zn
 LB PER ACRE ACTUAL Mg

YIELD GOAL/ACRE:
ACRES:

PREVIOUS CROP:
GYPSUM REQUIREMENT:
LIME REQUIREMENT:
DOLOMITE REQUIREMENT:

PREPLANT:

SIDEDRESS:

SOIL TEXTURE ANALYSIS:

CLASS:
% SAND:
% SILT:
% CLAY:

PLANT TISSUE ANALYSIS REPORT

[illegible]

PHOSPHORUS INDEX WORKSHEET – WESTERN OREGON

Producer: Ryan & Freyne Lancaster	County: Tillamook	Tract No. 318	Field No(s). 3	Date: August 17, 2010
Soil Map Unit(s): 80B Quillamook medial silt loam, 0-7% slopes	Soil Test P: 12 ppm	Lab. Method: Weak Bray	Sample Depth: 0-6"	
Crop Rotation: Permanent Pasture	Nutrient Application Method(s) Manure Tank Wagon & Manure Spreader			

Planner: Federsen:

Notes:

PHOSPHORUS LOSS RATING							Weighted Rating Value	
TRANSPORT FACTORS	Factor Weight	None (0)	Low (1)	Medium (2)	High (4)	Very High (8)	Current	Planned
Soil Erosion – tons/ac/yr (RUSLE)	1.50	< 1 (0)	1 – 3 (1.5)	4 – 6 (3.0)	7 – 15 (6.0)	> 15 (12.0)	0	0
Soil Erosion from Sprinkler Irrigation	0.75	No sprinkler irrigation	Application rate < infiltration rate OR No visible runoff at field borders	Application rate = infiltration rate OR Little to no visible runoff at field borders	Application rate > infiltration rate OR Visible runoff at field borders	Application rate > infiltration rate OR Excessive runoff visible at field borders. Rills and gullies present.	0	0
Runoff Class	1.00	Negligible (0)	Very low or low (1.0)	Medium (2.0)	High (4.0)	Very High (8.0)	1.0	1.0
Flooding Frequency Class	0.75	None or very rare (0)	Rare (0.75)	Occasional (1.5)	Frequent (3.0)	Very Frequent (6.0)	0	0
Distance to Perennial Surface Waters / Buffer Widths	0.75	> 500 feet OR buffer > 30 ft. wide (or meets NRCS standards) next to surface waters (0)	300 – 500 feet OR buffer 20 - 30 ft. wide next to surface waters (0.75)	200 – 299 feet OR buffer 10 -19 ft. wide next to surface waters (1.5)	100 – 199 feet AND buffer < 10 ft. wide next to surface waters (3.0)	< 100 feet AND No buffer next to surface waters (6.0)	0	0
Subsurface Drainage	0.50	No Tile Drains (0)	Tile drains present Soil Test P (Bray P1) < 60 ppm (0.5)	Tile drains present Soil Test P (Bray P1) 61 - 140 ppm (1.0)	Tile drains present Soil Test P (Bray P1) 141- 190 ppm (2.0)	Tile drains present Soil Test P (Bray P1) > 190 ppm (4.0)	0	0
Transport Factors Subtotal (TFS)							1.0	1.0

PHOSPHORUS INDEX WORKSHEET – WESTERN OREGON

Producer: Ryan & Freyne Lancaster	County: Tillamook	Tract No. 318	Field No(s). 4	Date: August 8, 2010
Soil Map Unit(s): 173B Tillamook-Ginger medial silt loam, 0-7% slopes	Soil Test P: 4 ppm	Lab. Method: Weak Bray	Sample Depth: 0-6"	
Crop Rotation: Permanent Pasture	Nutrient Application Method(s) Manure Tank Wagon & Manure Spreader			
Planner: Pedersen	Notes:			

PHOSPHORUS LOSS RATING							Weighted Rating Value	
TRANSPORT FACTORS	Factor Weight	None (0)	Low (1)	Medium (2)	High (4)	Very High (8)	Current	Planned
Soil Erosion – tons/ac/yr (RUSLE)	1.50	< 1 (0)	1 – 3 (1.5)	4 – 6 (3.0)	7 – 15 (6.0)	> 15 (12.0)	0	0
Soil Erosion from Sprinkler Irrigation	0.75	No sprinkler irrigation (0)	Application rate < infiltration rate OR No visible runoff at field borders (0.75)	Application rate = infiltration rate OR Little to no visible runoff at field borders (1.5)	Application rate > infiltration rate OR Visible runoff at field borders (3.0)	Application rate > infiltration rate OR Excessive runoff visible at field borders. Hills and gullies present. (6.0)	0	0
Runoff Class	1.00	Negligible (0)	Very low or low (1.0)	Medium (2.0)	High (4.0)	Very High (8.0)	4.0	4.0
Flooding Frequency Class	0.75	None or very rare (0)	Rare (0.75)	Occasional (1.5)	Frequent (3.0)	Very Frequent (6.0)	0	0
Distance to Perennial Surface Waters / Buffer Widths	0.75	> 500 feet OR buffer > 30 ft. wide (or meets NRCS standards) next to surface waters (0)	300 – 500 feet OR buffer 20 - 30 ft. wide next to surface waters (0.75)	200 – 299 feet OR buffer 10 -19 ft. wide next to surface waters (1.5)	100 – 199 feet AND buffer < 10 ft. wide next to surface waters (3.0)	< 100 feet AND No buffer next to surface waters (6.0)	1.5	1.5
Subsurface Drainage	0.50	No Tile Drains (0)	Tile drains present Soil Test P (Bray P1) < 60 ppm (0.5)	Tile drains present Soil Test P (Bray P1) 61 - 140 ppm (1.0)	Tile drains present Soil Test P (Bray P1) 141 - 190 ppm (2.0)	Tile drains present Soil Test P (Bray P1) > 190 ppm (4.0)	0	0
Transport Factors Subtotal (TFS)							5.5	5.5

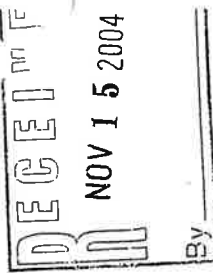
DATE: October 04, 2004
REPORT: S 2481
GROWER: KRAKE, WAYNE Lancaster Ryan + Frey ne
ADDRESS: 1202 MAROLF LOOP RD; TILLAMOOK, OR 97141
SAMPLED: 1
FIELD: 1
PROP: 1

AGRI-CHECK, INC.
Agricultural Testing Laboratory
323 Sixth St. - P.O. Box 1350
Umatilla, OR 97882
800.537.1129 * 541.922.4894



SOIL ANALYSIS REPORT

Lab No.	Depth Foot	pH	S.Salt mmhos %	O.M. %	P ppm	K ppm	Ca meq	Mg meq	NITROGEN		S ppm	B ppm	Zn ppm	Mn ppm	Cu ppm	Fe ppm	CEC meq	Na meq	Total Bases	Base Sat. %	SMP Buf. pH	MOISTURE		TKN %	Cl ppm
									NO3 #/A	NH4 #/A												Total %	Avail. Inches		
1009	0-6"	5.7			3	758	4.4	1.5	39	102															



TOTALS: 39 102

TOTAL INCHES:

TOTAL BROADCAST FERTILITY NEEDS:

YIELD GOAL/ACRE: _____
ACRES: _____
PREVIOUS CROP: _____
GYPSUM REQUIREMENT: _____
LIME REQUIREMENT: _____
DOLOMITE REQUIREMENT: _____
PREPLANT: _____
SIDEDRESS: _____

NITROGEN: _____
PHOSPHORUS: _____
POTASSIUM: _____
SULFUR: _____
BORON: _____
ZINC: _____
MAGNESIUM: _____
OTHERS: _____

LBS PER ACRE N
LBS PER ACRE P2O5
LBS PER ACRE K2O
LBS PER ACRE ACTUAL S
LBS PER ACRE ACTUAL B
LBS PER ACRE ACTUAL Zn
LBS PER ACRE ACTUAL Mg

TONS PER ACRE 6-INCHES
TONS PER ACRE 6-INCHES
TONS PER ACRE 6-INCHES

SOIL TEXTURE ANALYSIS:

CLASS: _____
% SAND: _____
% SILT: _____
% CLAY: _____

COMMENTS:

PLANT TISSUE ANALYSIS REPORT

Lab No.	FIELD: DESCRIPTION:	Total N %		Nitrate N ppm	S %	P %	K %	Ca %	Mg %	B ppm	Zn ppm	Mn ppm	Cu ppm	Fe ppm	Chloride ppm	Na ppm	Moisture %

NOTE: East of Cascades Bicarb P & K extraction/SMP=1/4 SMP Buffer pH; West of Cascades Weak Bray P and Acetate K extractions. Fertility recommendations

PHOSPHORUS INDEX WORKSHEET – WESTERN OREGON

Producer: Ryan & Freyne Lancaster	County: Tillamook	Tract No. 318	Field No(s). 1	Date: 10/04/2004
Soil Map Unit(s): 80B Quillamook medial silt loam, 0-7% slopes	Soil Test P: 3 ppm	Lab. Method: Weak Bray	Sample Depth: 0-6"	
Crop Rotation: Permanent Pasture	Nutrient Application Method(s) Manure Tank Wagon & Manure Spreader			
Planner: Pedersen	Notes:			

PHOSPHORUS LOSS RATING							Weighted Rating Value	
TRANSPORT FACTORS	Factor Weight	None (0)	Low (1)	Medium (2)	High (4)	Very High (8)	Current	Planned
Soil Erosion – tons/ac/yr (RUSLE)	1.50	< 1 (0)	1 – 3 (1.5)	4 – 6 (3.0)	7 – 15 (6.0)	> 15 (12.0)	0	0
Soil Erosion from Sprinkler Irrigation	0.75	No sprinkler irrigation	Application rate < infiltration rate OR No visible runoff at field borders	Application rate = infiltration rate OR Little to no visible runoff at field borders	Application rate > infiltration rate OR Visible runoff at field borders	Application rate > infiltration rate OR Excessive runoff visible at field borders. Rills and gullies present.	0	0
Runoff Class	1.00	Negligible (0)	Very low or low (1.0)	Medium (2.0)	High (4.0)	Very High (8.0)	1.0	1.0
Flooding Frequency Class	0.75	None or very rare (0)	Rare (0.75)	Occasional (1.5)	Frequent (3.0)	Very Frequent (6.0)	0	0
Distance to Perennial Surface Waters / Buffer Widths	0.75	> 500 feet OR buffer > 30 ft. wide (or meets NRCS standards) next to surface waters (0)	300 – 500 feet OR buffer 20 - 30 ft. wide next to surface waters (0.75)	200 – 299 feet OR buffer 10 -19 ft. wide next to surface waters (1.5)	100 – 199 feet AND buffer < 10 ft. wide next to surface waters (3.0)	< 100 feet AND No buffer next to surface waters (6.0)	0	0
Subsurface Drainage	0.50	No Tile Drains (0)	Tile drains present Soil Test P (Bray P1) < 60 ppm (0.5)	Tile drains present Soil Test P (Bray P1) 61 - 140 ppm (1.0)	Tile drains present Soil Test P (Bray P1) 141- 190 ppm (2.0)	Tile drains present Soil Test P (Bray P1) > 190 ppm (4.0)	0	0
Transport Factors Subtotal (TFS)							1.0	1.0

DATE: October 04, 2004

REPORT: S2481

GROWER:

KRAKE, WAYNE L. CARSON, Ryan Frey

ADDRESS:

1202 MAROLF LOOP RD; TILLAMOOK, OR 97141

SAMPLED:

2

FIELD:

CROP:

AGRI-CHECK, INC.

Agricultural Testing Laboratory

323 Sixth St. - P.O. Box 1350

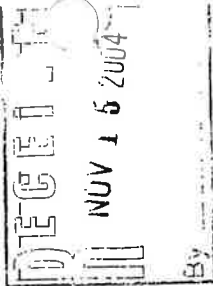
Umatilla, OR 97882

800-537-1128 * 541-922-4894

AGRI-CHECK

SOIL ANALYSIS REPORT

Lab No.	Depth Foot	pH	S.Salt mmhos	O.M. %	P ppm	K ppm	Ca meq	Mg meq	NITROGEN		S ppm	B ppm	Zn ppm	Mn ppm	Cu ppm	Fe ppm	CEC meq	Na meq	Total Bases	Base Sat. %	SMP %	MOISTURE		Cl ppm
									NO3 #/A	NH4 #/A												Total %	Avail. Inches	TKN %
4010	0-6"	5.7			35	761	10.1	4.5	80	130									16.5		5.3			



***** TOTAL INCHES: *****

TOTAL BROADCAST FERTILITY NEEDS:

NITROGEN: LBS PER ACRE N
PHOSPHORUS: LBS PER ACRE P205
POTASSIUM: LBS PER ACRE K2O
SULFUR: LBS PER ACRE ACTUAL S
BORON: LBS PER ACRE ACTUAL B
ZINC: LBS PER ACRE ACTUAL Zn
MAGNESIUM: LBS PER ACRE ACTUAL Mg
OTHERS:

YIELD GOAL/ACRE:

ACRES:

PREVIOUS CROP:

GYPSUM REQUIREMENT:

LIME REQUIREMENT:

DOLOMITE REQUIREMENT:

PREPLANT:

SIDEDRESS:

TONS PER ACRE 6-INCHES
TONS PER ACRE 6-INCHES
TONS PER ACRE 6-INCHES

TOTAL INCHES:

SOIL TEXTURE ANALYSIS:

CLASS:

% SAND:

% SILT:

% CLAY:

PLANT TISSUE ANALYSIS REPORT

Lab No.

FIELD: DESCRIPTION:

Total N %

Nitrate N ppm

S %

P %

K %

Ca %

Mg %

B ppm

Zn ppm

Mn ppm

Cu ppm

Fe ppm

Chloride ppm

Na ppm

Moisture %

NOTE: East of Cascades Bicarb P & K extraction/SMP=1/4 SMP Buffer pH; West of Cascades Weak Bray P and Acetate K extractions. Fertility recommendations may change after application of gypsum or lim

PHOSPHORUS INDEX WORKSHEET – WESTERN OREGON

Producer: Ryan & Freyne Lancaster

County: Tillamook

Tract No. 318

Field No(s). 2

Date: 10/04/2004

Soil Map Unit(s): 45B Hebo silty clay loam, 0-5% slopes

Soil Test P: 35 ppm

Lab. Method: Weak Bray

Sample Depth: 0-6"

Crop Rotation: Permanent Pasture

Nutrient Application Method(s) Manure Tank Wagon & Manure Spreader

Planner: Pedersen

Notes:

		PHOSPHORUS LOSS RATING					Weighted Rating Value	
TRANSPORT FACTORS	Factor Weight	None (0)	Low (1)	Medium (2)	High (4)	Very High (8)	Current	Planned
Soil Erosion – tons/ac/yr (RUSLE)	1.50	< 1 (0)	1 – 3 (1.5)	4 – 6 (3.0)	7 – 15 (6.0)	> 15 (12.0)	0	0
Soil Erosion from Sprinkler Irrigation	0.75	No sprinkler irrigation (0)	Application rate < infiltration rate OR No visible runoff at field borders (0.75)	Application rate = infiltration rate OR Little to no visible runoff at field borders (1.5)	Application rate > infiltration rate OR Visible runoff at field borders (3.0)	Application rate > infiltration rate OR Excessive runoff visible at field borders. Rills and gullies present. (6.0)	0	0
Runoff Class	1.00	Negligible (0)	Very low or low (1.0)	Medium (2.0)	High (4.0)	Very High (8.0)	2.0	2.0
Flooding Frequency Class	0.75	None or very rare (0)	Rare (0.75)	Occasional (1.5)	Frequent (3.0)	Very Frequent (6.0)	0	0
Distance to Perennial Surface Waters / Buffer Widths	0.75	> 500 feet OR buffer > 30 ft. wide (or meets NRCS standards) next to surface waters (0)	300 – 500 feet OR buffer 20 - 30 ft. wide next to surface waters (0.75)	200 – 299 feet OR buffer 10 - 19 ft. wide next to surface waters (1.5)	100 – 199 feet AND buffer < 10 ft. wide next to surface waters (3.0)	< 100 feet AND No buffer next to surface waters (6.0)	1.5	1.5
Subsurface Drainage	0.50	No Tile Drains (0)	Tile drains present Soil Test P (Bray P1) < 60 ppm (0.5)	Tile drains present Soil Test P (Bray P1) 61 - 140 ppm (1.0)	Tile drains present Soil Test P (Bray P1) 141- 190 ppm (2.0)	Tile drains present Soil Test P (Bray P1) > 190 ppm (4.0)	0	0
Transport Factors Subtotal (TFS)							3.5	3.5

PHOSPHORUS INDEX WORKSHEET – WESTERN OREGON

Producer: Ryan & Freyne Lancaster County: Tillamook Tract No. 318 Field No(s). 2 Date: 10/04/2004
 Soil Map Unit(s): 173B Tillamook-Ginger Soil Test P: 35 ppm Lab. Method: Weak Bray Sample Depth: 0-6"
 Crop Rotation: Permanent Pasture Nutrient Application Method(s) Manure Tank Wagon & Manure Spreader
 Planner: Pedersen Notes:

PHOSPHORUS LOSS RATING								Weighted Rating Value	
TRANSPORT FACTORS	Factor Weight	None (0)	Low (1)	Medium (2)	High (4)	Very High (8)	Current	Planned	
Soil Erosion – tons/ac/yr (RUSLE)	1.50	<1 (0)	1 – 3 (1.5)	4 – 6 (3.0)	7 – 15 (6.0)	> 15 (12.0)	0	0	
Soil Erosion from Sprinkler Irrigation	0.75	No sprinkler irrigation (0)	Application rate < infiltration rate OR No visible runoff at field borders (0.75)	Application rate = infiltration rate OR Little to no visible runoff at field borders (1.5)	Application rate > infiltration rate OR Visible runoff at field borders (3.0)	Application rate > infiltration rate OR Excessive runoff visible at field borders. Rills and gullies present. (6.0)	0	0	
Runoff Class	1.00	Negligible (0)	Very low or low (1.0)	Medium (2.0)	High (4.0)	Very High (8.0)	4.0	4.0	
Flooding Frequency Class	0.75	None or very rare (0)	Rare (0.75)	Occasional (1.5)	Frequent (3.0)	Very Frequent (6.0)	0	0	
Distance to Perennial Surface Waters / Buffer Widths	0.75	> 500 feet OR buffer > 30 ft. wide (or meets NRCS standards) next to surface waters (0)	300 – 500 feet OR buffer 20 - 30 ft. wide next to surface waters (0.75)	200 – 299 feet OR buffer 10 -19 ft. wide next to surface waters (1.5)	100 – 199 feet AND buffer < 10 ft. wide next to surface waters (3.0)	< 100 feet AND No buffer next to surface waters (6.0)	0	0	
Subsurface Drainage	0.50	No Tile Drains (0)	Tile drains present Soil Test P (Bray P1) < 60 ppm (0.5)	Tile drains present Soil Test P (Bray P1) 61 - 140 ppm (1.0)	Tile drains present Soil Test P (Bray P1) 141- 190 ppm (2.0)	Tile drains present Soil Test P (Bray P1) > 190 ppm (4.0)	0	0	
Transport Factors Subtotal (TFS)							4.0	4.0	

DATE: October 04, 2004

REPORT: S2481

GROWER:

ADDRESS:

SAMPLED:

FIELD:

CROP:

KRAKE, WAYNE Lancaster, Runt Freyre
1202 MAROLF LOOP RD; TILLAMOOK, OR 97141

3

AGRI-CHECK, INC.

Agricultural Testing Laboratory

323 Sixth St. - P.O. Box 1350

Umatilla, OR 97852

800-537-1129 * 541-922-4894

AGRI-CHECK

SOIL ANALYSIS REPORT

Lab No.	Depth Foot	pH	S.Salt mmhos	O.M. %	P ppm	K ppm	Ca meq	Mg meq	NITROGEN				S ppm	B ppm	Zn ppm	Mn ppm	Cu ppm	Fe ppm	CEC meq	Na meq	MOISTURE				TKN %	Cl ppm
									NO3 #/A	NH4 #/A	S ppm	Total Bases									Base Sat. %	SMP Buf.pH	Total %	Avail. Inches		
4011	0-6"	5.3			6	553	5.3	3.1	59	168											9.8		4.9			

RECEIVED
NOV 15 2004

***** TOTAL INCHES: *****

TOTAL BROADCAST FERTILITY NEEDS:

NITROGEN: LBS PER ACRE N
PHOSPHORUS: LBS PER ACRE P2O5
POTASSIUM: LBS PER ACRE K2O
SULFUR: LBS PER ACRE ACTUAL S
BORON: LBS PER ACRE ACTUAL B
ZINC: LBS PER ACRE ACTUAL Zn
MAGNESIUM: LBS PER ACRE ACTUAL Mg
OTHERS:

YIELD GOAL/ACRE:

ACRES:

PREVIOUS CROP:

GYPHOSUM REQUIREMENT:

LIME REQUIREMENT:

DOLOMITE REQUIREMENT:

PREPLANT:

SIDEDRESS:

TONS PER ACRE 6-INCHES

TONS PER ACRE 6-INCHES

TONS PER ACRE 6-INCHES

SOIL TEXTURE ANALYSIS:

CLASS:

% SAND:

% SILT:

% CLAY:

PLANT TISSUE ANALYSIS REPORT

Lab No. FIELD: DESCRIPTION:

Total N % Nitrate N ppm S % P % K % Ca % Mg % B ppm Zn ppm Mn ppm Cu ppm Fe ppm Chloride ppm Na ppm Moisture %

NOTE: East of Cascades Bicarb P & K extraction/SMP=1/4 SMP Buffer pH; West of Cascades Weak Bray P and Acetate K extractions. Fertility recommendations

PHOSPHORUS INDEX WORKSHEET – WESTERN OREGON

Producer: Ryan & Freyne Lancaster
 Soil Map Unit(s): 80B Quillamook medial silt loam, 0-7% slopes
 Crop Rotation: Permanent Pasture
 Planner: Pedersen

County: Tillamook
 Soil Test P: 6 ppm
 Lab. Method: Weak Bray
 Sample Depth: 0-6"

Tract No. 318
 Field No(s). 3
 Date: 10/04/2004

Nutrient Application Method(s) Manure Tank Wagon & Manure Spreader

Notes: _____

		PHOSPHORUS LOSS RATING					Weighted Rating Value	
		Factor Weight	None (0)	Low (1)	Medium (2)	High (4)	Very High (8)	Current Planned
Soil Erosion – tons/ac/yr (RUSLE)	1.50		< 1 (0)	1 – 3 (1.5)	4 – 6 (3.0)	7 – 15 (6.0)	> 15 (12.0)	0 0
Soil Erosion from Sprinkler Irrigation	0.75		No sprinkler irrigation	Application rate < infiltration rate OR No visible runoff at field borders (0.75)	Application rate = infiltration rate OR Little to no visible runoff at field borders (1.5)	Application rate > infiltration rate OR Visible runoff at field borders (3.0)	Application rate > infiltration rate OR Excessive runoff visible at field borders. Rills and gullies present. (6.0)	0 0
Runoff Class	1.00		Negligible (0)	Very low or low (1.0)	Medium (2.0)	High (4.0)	Very High (8.0)	1.0 1.0
Flooding Frequency Class	0.75		None or very rare (0)	Rare (0.75)	Occasional (1.5)	Frequent (3.0)	Very Frequent (6.0)	0 0
Distance to Perennial Surface Waters / Buffer Widths	0.75		> 500 feet OR buffer > 30 ft. wide (or meets NRCS standards) next to surface waters (0)	300 – 500 feet OR buffer 20 - 30 ft. wide next to surface waters (0.75)	200 – 299 feet OR buffer 10 - 19 ft. wide next to surface waters (1.5)	100 – 199 feet AND buffer < 10 ft. wide next to surface waters (3.0)	< 100 feet AND No buffer next to surface waters (6.0)	0 0
Subsurface Drainage	0.50		No Tile Drains (0)	Tile drains present Soil Test P (Bray P1) < 60 ppm (0.5)	Tile drains present Soil Test P (Bray P1) 61 - 140 ppm (1.0)	Tile drains present Soil Test P (Bray P1) 141 - 190 ppm (2.0)	Tile drains present Soil Test P (Bray P1) > 190 ppm (4.0)	0 0
		Transport Factors Subtotal (TFS)					1.0	1.0

NOTE: East of Cascades Bicarb P & K extraction/SMP=1/4 SMP Buffer pH; West of Cascades Weak Bray P and Acetate K extractions. Fertility recommendations may change after application of gypsum or lim.

PHOSPHORUS INDEX WORKSHEET – WESTERN OREGON

Producer: Ryan & Freyne Lancaster	County: Tillamook	Tract No. 318	Field No(s). 4	Date: 10/04/2004
Soil Map Unit(s): 173B Tillamook-Ginger medial silt loam, 0-7% slopes	Soil Test P: 15 ppm	Lab. Method: Weak Bray	Sample Depth: 0-6"	
Crop Rotation: Permanent Pasture	Nutrient Application Method(s) Manure Tank Wagon & Manure Spreader			
Planner: Pedersen	Notes:			

PHOSPHORUS LOSS RATING							Weighted Rating Value	
TRANSPORT FACTORS	Factor Weight	None (0)	Low (1)	Medium (2)	High (4)	Very High (8)	Current	Planned
Soil Erosion – tons/ac/yr (RUSLE)	1.50	<1 (0)	1 – 3 (1.5)	4 – 6 (3.0)	7 – 15 (6.0)	> 15 (12.0)	0	0
Soil Erosion from Sprinkler Irrigation	0.75	No sprinkler irrigation	Application rate < infiltration rate OR No visible runoff at field borders (0.75)	Application rate = infiltration rate OR Little to no visible runoff at field borders (1.5)	Application rate > infiltration rate OR Visible runoff at field borders (3.0)	Application rate > infiltration rate OR Excessive runoff visible at field borders. Rills and gullies present. (6.0)	0	0
Runoff Class	1.00	Negligible (0)	Very low or low (1.0)	Medium (2.0)	High (4.0)	Very High (8.0)	4.0	4.0
Flooding Frequency Class	0.75	None or very rare (0)	Rare (0.75)	Occasional (1.5)	Frequent (3.0)	Very Frequent (6.0)	0	0
Distance to Perennial Surface Waters / Buffer Widths	0.75	> 500 feet OR buffer > 30 ft. wide (or meets NRCS standards) next to surface waters (0)	300 – 500 feet OR buffer 20 - 30 ft. wide next to surface waters (0.75)	200 – 299 feet OR buffer 10 -19 ft. wide next to surface waters (1.5)	100 – 199 feet AND buffer < 10 ft. wide next to surface waters (3.0)	< 100 feet AND No buffer next to surface waters (6.0)	1.5	1.5
Subsurface Drainage	0.50	No Tile Drains (0)	Tile drains present Soil Test P (Bray P1) < 60 ppm (0.5)	Tile drains present Soil Test P (Bray P1) 61 - 140 ppm (1.0)	Tile drains present Soil Test P (Bray P1) 141- 190 ppm (2.0)	Tile drains present Soil Test P (Bray P1) > 190 ppm (4.0)	0	0
Transport Factors Subtotal (TFS)							5.5	5.5

AWMP Minimum Required Elements

Notes

Ryan & Freyne Lancaster

1206 Maroff Lp. Rd

503-812-1362

AWMP Minimum Required Elements		Notes
1. Summary of CAFO Operation		
a)	Contact name, address, phone number	✓
b)	Facility address	✓
c)	Type of operation	✓
(i)	Number and size of animals by species, expansion?	✓
d)	Manure, litter and process waste system – provide a general narrative description of each	
(i)	Collection – How is manure, litter and process waste removed from housing, confinement lots? How is clean water diverted from storage?	✓
(ii)	Storage – Types and size of manure, litter and process waste storage tanks, ponds.	✓
(iii)	Transfer – How is manure, litter and process waste moved to storage, application areas?	✓
(iv)	Use – How is manure, litter and process waste treated (composted, separated, anaerobic digestion or storage, aeration)? How is manure, litter and process waste water used on crops? If export is utilized, describe that process.	✓
2. Specific descriptions and calculations		
a)	A description of production area and land application locations	✓
(i)	Aerial photo or topographical map showing numbered field locations, production area facilities, clean water diversions, and surface water features.	✓
(ii)	Soil maps of all application fields, including those not owned, and map unit descriptions. Indicate areas with application limitations.	✓
b)	Manure, litter and process waste volumes	✓
(i)	Manure (feces and urine), litter and process waste output that is collected and stored in this system.	✓
(ii)	Bedding added and collected.	✓
(iii)	Process and wash water collected, include footbath use when appropriate.	✓
(iv)	Silage and feed processing leachate.	✓
c)	Contaminated storm water	
(i)	Direct rainfall into storage.	✓
(ii)	Slab or lot runoff collected.	✓

AWMP Minimum Required Elements

Notes

(iii) Overflow from gutters or other diversions.	✓	
d) Nutrient content of manure, litter and process waste water		
(i) Content and volume of nutrients in manure, litter and process waste generated – can come from NRCS Animal Waste Field Handbook (chapter 4)), land grant university publications, or analyses of manure, litter and process waste. Actual test values are required of large CAFOs.	✓	
e) Farm nutrient balance		
(i) Show amount of nutrients (N, P, K) generated, lost in storage, lost during application, used by crops, and/or exported off the farm on an annual basis.	✓	
(ii) Nutrient application must balance to most limiting nutrient as determined by NRCS Agronomy Technical Note #26 and the NRCS Phosphorus Index.		
(iii) Include all acres required to balance nutrients owned or leased by the operator.		
f) Application schedule and limitations		
(i) Show scheduled applications of solids and liquids. Include date, amount and method of application to identified fields. Describe calibration of equipment used to apply manure, litter and process waste water.		
(ii) Describe limitations to manure, litter and process waste applications. Indicate buffer areas and management to avoid saturated soils. Justify buffer width and management. If application to frozen soil is planned, include field descriptions, specific management/structural practices, monitoring and record keeping.		
(iii) Using agronomic rates, application limitations, and scheduled applications, calculate the minimum storage required for liquids and solids.		
(iv) How is irrigation water managed relative to manure, litter and process waste water application? Include general timing and application rates of irrigation water. Irrigation water management must not allow leaching of soluble nutrients or runoff.		
g) Animal mortality management		
(i) Describe how the farm handles mortalities.	✓	
h) Operation and maintenance		
(i) Include operation and maintenance narrative for structural and mechanical components included in this plan.	✓	
3. Record keeping and reporting requirements		
a) Testing – Monitoring		
(i) Include the protocol for testing manure, litter and process waste.		

Keep New Soil tests.

AWMP Minimum Required Elements

Notes

(ii) Include the protocol for testing and measuring crop nutrient removals.	✓
(iii) Include the protocol for soil testing to evaluate nutrient application and crop uptake.	✓
b) Record keeping. Include the following:	
(i) Date and amount of manure, litter and process waste applied by field. Calculate N and P applied.	✓
(ii) Manure, litter and process waste volume exported.	✓
c) Reporting to Oregon Department of Agriculture	
(i) Any discharge within 24 hours.	✓
(ii) Amount of manure, litter and process waste applied annually.	✓
(iii) Amount of manure, litter and process waste exported annually.	✓
4. Additional requirements for Large CAFOs	
a) Inspections	
(i) Check storm water diversions, runoff diversions, waste transport, storage structures, storage structure volume weekly.	
(ii) Check water lines daily.	
(iii) Check for application equipment leaks periodically.	
b) Record keeping	
(i) Results of daily inspections.	
(ii) Results of weekly inspections.	
(iii) Results of periodic inspections.	
(iv) Corrective actions taken, explain those not corrected.	
(v) Expected crop yields if not in the plan.	

TILLAMOOK COUNTY
SOIL AND WATER CONSERVATION DISTRICT

OPERATION AND MAINTENCE WORKSHEET

UNDERGROUND OUTLETS
Code 620

For: Landowner/Operator Ryan and Freyne Lancaster

Job Location: T1S R9W Sec. 32

County Tillamook SWCD Tillamook

Farm/Tract No. 318

Prepared By Pedersen Date 04/11

Gutter Outlet

Operation and Maintenance Items

Properly operated and maintained under ground outlet for the guttering system is an asset to the farm. This outlet was designed and installed to convey roof runoff in an underground pipeline to where it can be released without causing erosion. The estimated life span of this installation is at least 10 years. The life of the practice can be assured and usually increased by developing and carrying out a good operation and maintenance program.

This practice will require periodic maintenance and may require operational items to maintain satisfactory performance. A good operation and maintenance plan includes:

- ⇒ Check all above ground connections, rodent guards, inlets and outlets to make sure they are functioning properly.
- ⇒ Maintain design depth of cover on all pipelines.
- ⇒ Avoid operation of tillage and sub-soiling equipment that could damage any component of the gutter outlet system.
- ⇒ Remove all foreign debris that hinders the gutter system operation.
- ⇒ Limit traffic over pipeline to designated sections that were designated for traffic loads.
- ⇒ Maintain vigorous growth of vegetative coverings. This includes reseeding, fertilization and application of herbicides when necessary. Periodic mowing may also be needed to control growth.
- ⇒ Eradicate or otherwise remove all rodents or burrowing animals. Immediately repair any damage caused by their activity.
- ⇒ Immediately repair any vandalism, vehicular livestock damage.

TILLAMOOK COUNTY
SOIL AND WATER CONSERVATION DISTRICT

OPERATION AND MAINTENANCE WORKSHEET

**NUTRIENT MANAGEMENT
CODE 590**

For: Landowner/Operator Ryan & Freyne Lancaster

Job Location: T1S: R9W Sec.29.32

County Tillamook SWCD Tillamook Farm/Tract No. 318

Prepared By Pedersen Date 04/11

Operation and Maintenance Items

Waste Utilization can provide economic and resource benefits if applied properly which are assets to the dairy operation. Proper waste utilization requires certain operational procedures to be followed and evaluated on an annual basis.

- ⇒ Manure application equipment is calibrated at least once per year to ensure uniform distribution and accurate application rates.
- ⇒ Records are maintained of manure applications.
- ⇒ Manure application equipment is cleaned up and residual material from the equipment is disposed of properly and in a place where surface runoff does not occur.
- ⇒ Nutrient management plans are reviewed annually and adjustments are made as needed.
- ⇒ Unnecessary exposure to manure is avoided. Protective clothing is worn when necessary.

TILLAMOOK COUNTY
SOIL AND WATER CONSERVATION DISTRICT

OPERATION AND MAINTENANCE WORKSHEET

**WASTE UTILIZATION
CODE 633**

For: Landowner/Operator Ryan & Freyne Lancaster

Job Location: T1S; R9W Sec.29,32

County Tillamook SWCD Tillamook Farm/Tract No. 318

Prepared By Pedersen Date 04/11

Operation and Maintenance Items

Waste Utilization can provide economic and resource benefits if applied properly which are assets to the dairy operation. Proper waste utilization requires certain operational procedures to be followed and evaluated on an annual basis.

- ⇒ Manure application equipment is calibrated at least once per year to ensure uniform distribution and accurate application rates.
- ⇒ Records are maintained of manure applications.
- ⇒ Manure application equipment is cleaned up and residual material from the equipment is disposed of properly and in a place where surface runoff does not occur.
- ⇒ Nutrient management plans are reviewed annually and adjustments are made as needed.
- ⇒ Unnecessary exposure to manure is avoided. Protective clothing is worn when necessary.

TILLAMOOK COUNTY
SOIL AND WATER CONSERVATION DISTRICT

OPERATION AND MAINTENANCE WORKSHEET

**PRESCRIBED GRAZING
CODE 528**

For: Landowner/Operator Ryan & Freyne Lancaster

Job Location: T1S R 9W Sec.29,32

County Tillamook SWCD Tillamook

Farm/Tract No. 318

Prepared By Pedersen Date 04/11

Operation and Maintenance Items

Prescribed Grazing can provide economic and resource benefits if applied properly which are assets to the dairy operation. Proper Prescribed Grazing requires certain operational procedures to be followed and evaluated on an annual basis.

- ⇒ Pastures are reestablished when forage production falls below planned yield threshold.
- ⇒ A rotational grazing system is used to maintain plant vigor.
- ⇒ Pastures are clipped and dragged during the growing season to maintain plant vigor and spread the livestock droppings to prevent grass from becoming rank.
- ⇒ Manure and commercial fertilizer applied in accordance with soil and forage tests.
- ⇒ Pasture weeds are controlled.
- ⇒ Pasture grasses are not grazed below 2 inches during the growing season
- ⇒ Livestock are removed when the soils become wet in the fall.

TILLAMOOK COUNTY
SOIL AND WATER CONSERVATION DISTRICT

OPERATION AND MAINTENANCE WORKSHEET

FILTER STRIP

CODE 393

For: Landowner/Operator Ryan & Freyne Lancaster

Job Location: T1S R 9W Sec. 29, 32

County Tillamook SWCD Tillamook

Farm/Tract No. 318

Prepared By Pedersen Date 04/11

Operation and Maintenance Items

A properly operated and maintained vegetated filter strip is an asset to your farm. This vegetative filter strip was designed and installed to remove sediment and pollutants from runoff. The estimated life span of this practice is at least 10 years. The life of this practice can be assured and usually increased by developing and carrying out a good operation and maintenance program

This practice will require you to perform periodic maintenance and may also require operation items to maintain satisfactory performance. Some recommendations to assist you develop a good operation and maintenance program:

- ⇒ Maintain vigorous growth of vegetative covering. This includes reseeding, commercial fertilization and application of herbicides when necessary. Periodic mowing or grazing may also be needed to control height.
- ⇒ Where the filter strip is used to trap nutrients, periodic grazing or mechanical harvesting and removal of vegetation is needed.
- ⇒ Remove all foreign debris that hinders system operation.
- ⇒ Limit the traffic and do not use as a roadway.
- ⇒ Limit livestock usage to vegetative growth periods when they will not damage vegetative root system or compact the soil.
- ⇒ Immediately repair any vandalism, vehicular, or livestock damage.
- ⇒ Eradicate or remove all rodents or burrowing animals. Immediately repair any damage caused by their activity.

CLIENT: **Ryan & Freyne Lancaster**

ASSISTED BY: **Pedersen**

ANIMAL WASTE MANAGEMENT SYSTEM INVENTORY

ANIMAL INVENTORY

Type of Animal	Number of Animals	Average Weight (lbs.)	Animal Units (1,000 lb.)	Milk Production in Pounds/Cow/Day=										Manure CF/D/AU	Annual			
				Nutrient Production						50					Days Confined	Days Grazed		
				(lbs./day/1000 lb. Animal Unit)			(lbs./day)			K	P	N	K				P	N
				N	P	K	N	P	K									
MILKER (Jersey)	▼	50	1,000	50.0	0.75	0.12	0.43	37.25	6.17	21.68	1.69	234	131					
MILKER (DRY)	▼	10	1,000	10.0	0.30	0.04	0.10	3.00	0.42	1.00	0.92	304	61					
HEIFERS (12-24 Months)	▼	30	400	12.0	0.27	0.05	0.12	3.19	0.55	1.44	0.90	365	0					
CALVES (1-12 Months)	▼	30	100	3.0	0.42	0.05	0.11	1.26	0.16	0.33	1.34	365	0					
	▼																	
	▼																	
	▼																	
	▼																	
	▼																	
	▼																	
	▼																	
Totals/Averages-		120	625	75.0	0.60	0.10	0.33	44.7	7.3	24.4	1.4							

GRAZING PERIOD

Type of Animal	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AU-YR.
MILKER (Jersey)	33%	0%	0%	0%	0%	33%	33%	66%	66%	66%	66%	66%	66%
	50	50	50	50	50	50	50	50	50	50	50	50	50
MILKER (DRY)	33%	0%	0%	0%	0%	0%	0%	33%	33%	33%	33%	33%	33%
	10	10	10	10	10	10	10	10	10	10	10	10	10
HEIFERS (12-24 Months)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	30	30	30	30	30	30	30	30	30	30	30	30	30
CALVES (1-12 Months)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	30	30	30	30	30	30	30	30	30	30	30	30	30
Total AUM's Available>	0	0	0	0	0	0	0	0	0	0	0	0	0
Total AUM's Needed>>>	20	0	0	0	0	17	17	36	36	36	36	36	234
Total AUM's>>>>>>>>>>>>	-20	0	0	0	0	-17	-17	-36	-36	-36	-36	-36	-234

CLIENT: Ryan & Freyne Lancaster

ASSISTED BY: Pedersen

ANIMAL WASTE MANAGEMENT SYSTEM INVENTORY

WEATHER STATION		TILLAMOOK 1 W		▼
Month	25Yr-24Hr	6.00	Lot Runoff Factors as a Percent of Monthly Precipitation	
	Monthly Average in Inches		Paved	Unpaved
	Precipitation	Evaporation		
October	7.16	1.42	50%	20%
November	13.71	0.75	60%	25%
December	13.94	0.60	60%	25%
January	13.09	0.48	60%	25%
February	10.79	0.78	50%	25%
March	9.90	1.26	45%	15%
April	6.81	1.90	40%	15%
May	4.84	3.22	40%	10%
June	3.41	3.40	35%	10%
July	1.64	3.91	30%	0%
August	1.42	3.52	40%	10%
September	3.68	2.54	45%	15%
Annual	90.39	23.78		

AREAS CONTRIBUTING RUNOFF TO LIQUID STORAGE FACILITY

[illegible]

WATER USE THAT ENTERS LIQUID STORAGE FACILITY

		Number of Animals	Number of Washes per Day	Gallons of Water Used per Wash- Day	Total Water Use per Day, Gallons	Total Water Use per Day, Cubic Feet
Type of Water Use		50.0	2	0.00	0	0.0
Animal Washwater			2	88.00	176	23.5
Equipment Wash			0	0.00	0	0.0
Flushwater						
Miscellaneous			2	25.00	50	6.7
Total					226	30.2

CROP DATA

CROP DATA									
Field Number	Acres	Crop	Percent Dry Matter (DM)	Yield Units	Target Yield	Nutrients Removed in Pounds per Acre			
						Nitrogen N	Phosphorous P2O5	Potassium K2O	
T318 1	5.4	Perennial Hay/Pasture(Med-High Intensity)	▼	Ton	20.00	348	110	289	
2	9.6	Perennial Hay/Pasture(Med-High Intensity)	▼	Ton	20.00	348	110	289	
3	2.8	Perennial Hay/Pasture(Med-High Intensity)	▼	Ton	20.00	348	110	289	
4	24.6	Perennial Hay/Pasture(Med-High Intensity)	▼	Ton	20.00	348	110	289	
5	6.6	Perennial Hay/Pasture(Med-High Intensity)	▼	Ton	20.00	348	110	289	
			▼						
			▼						
			▼						
			▼						
Off Farm			▼						

CLIENT: **Ryan & Freyne Lancaster**

ASSISTED BY: **Pedersen**

ANIMAL WASTE MANAGEMENT SYSTEM INVENTORY

BEDDING VOLUME

[illegible]

SOLIDS SEPARATION FACTOR

Type of Animal	Type of Separator	Separation Factor %	Volume of Solids Separated CF/Day	Volume of Solids in Liquids CF/Day	Volume of Manure in Liquids CF/Day	Volume of Manure in Solids CF/Day	Accumulated Sludge in Storage CF/Day	Density of Separated Solids Lbs/CF	Weight of Separated Solids Lbs/Day
MIL KER (Jersey)	Dry Scrape System	95%	92	5	4	80	3	36	3,326
MIL KER (DRY)	Dry Scrape System	100%	10	0	0	9	0	36	367
HEIFERS (12-24 Months)	Dry Scrape System	100%	14	0	0	11	0	36	500
CALVES (1-12 Months)	Dry Scrape System	100%	5	0	0	4	0	36	173
Total Solids			121	5	4	104	3		4,366

CLIENT: Ryan & Freyne Lancaster
ASSISTED BY: Pedersen

Version 3.6

ANIMAL WASTE MANAGEMENT SYSTEM PRODUCTION

MONTHLY VOLUMES

Month	Runoff in Cubic Feet				Facility		Manure		Bedding		Solids Separated		Solids in Liquids		Total	
	Roof Area Square Feet 0	Paved Slab Area Square Feet 0	Unpaved Lot Area Square Feet 0	Silage Pit Surface Area, SF 0	Water Use Cubic Feet	Solids Cubic Feet	Liquids Cubic Feet	Cubic Feet	Pounds	Cubic Feet	Pounds	Cubic Feet	Pounds	Cubic Feet	Solids Cubic Feet	Total Liquids Cubic Feet
October	0	0	0	0	937	872	1,530	409	5,305	2,710	97,572	101	3,636	2,710	2,710	1,125
November	0	0	0	0	906	1,041	2,210	534	6,975	3,639	130,987	146	5,252	3,639	3,639	1,183
December	0	0	0	0	937	1,076	2,283	552	7,208	3,760	135,353	151	5,427	3,760	3,760	1,218
January	0	0	0	0	937	1,076	2,283	552	7,208	3,760	135,353	151	5,427	3,760	3,760	1,218
February	0	0	0	0	846	972	2,062	498	6,510	3,396	122,254	136	4,901	3,396	3,396	1,11
March	0	0	0	0	937	966	1,530	419	5,622	2,815	101,328	101	3,636	2,815	2,815	1,125
April	0	0	0	0	906	935	1,480	406	5,441	2,724	98,059	98	3,519	2,724	2,724	1,092
May	0	0	0	0	937	763	776	277	3,719	1,765	63,546	51	1,845	1,765	1,765	1,032
June	0	0	0	0	906	738	751	268	3,599	1,708	61,497	50	1,786	1,708	1,708	1,000
July	0	0	0	0	937	763	776	277	3,719	1,765	63,546	51	1,845	1,765	1,765	1,032
August	0	0	0	0	937	763	776	277	3,719	1,765	63,546	51	1,845	1,765	1,765	1,032
September	0	0	0	0	906	738	751	268	3,599	1,708	61,497	50	1,786	1,708	1,708	1,000
Annual	0	0	0	0	11,028	10,704	17,211	4,737	62,622	31,515	1,134,539	1,136	40,903	31,515	31,515	13,172

DAILY NUTRIENT PRODUCTION

Type of Animal	Pounds/Day of Nutrients from				Pounds/Day of Nutrients from				Pounds/Day of Nutrients from			
	LIQUIDS		SOLIDS		GRAZING		GRAZING		GRAZING		GRAZING	
	N	P2O5	K2O		N	P2O5	K2O		N	P2O5	K2O	
MILKER (Jersey)	1.86	0.71	1.31		35.39	13.42	24.81		37.25	14.12	26.12	
MILKER (DRY)	0.00	0.00	0.00		3.00	0.96	1.21		3.00	0.96	1.21	
HEIFERS (12-24 Months)	0.00	0.00	0.00		3.19	1.25	1.74		0.00	0.00	0.00	
CALVES (1-12 Months)	0.00	0.00	0.00		1.26	0.37	0.40		0.00	0.00	0.00	
	0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	
	0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	
	0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	
	0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	
	0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	
	0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	
	0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	

OREGON ANIMAL WASTE MANAGEMENT DESIGN AID (ORAWM)

Version 3.6

CLIENT: Ryan & Freyne Lancaster
 ASSISTED BY: Pedersen

ANIMAL WASTE MANAGEMENT SYSTEM PRODUCTION

MONTHLY NUTRIENT PRODUCTION

Month	Pounds of Nutrients from LIQUIDS				Pounds of Nutrients from SOLIDS				Pounds of Nutrients from GRAZING				Pounds of Nutrients going OFF-FARM				Total Pounds of Nutrients from ALL SOURCES			
	N	P2O5	K2O		N	P2O5	K2O		N	P2O5	K2O		N	P2O5	K2O		N	P2O5	K2O	
October	39	15	27		935	349	607		412	154	280		0	0	0		1,386	518	913	
November	56	21	39		1,285	480	845		0	0	0		0	0	0		1,341	501	884	
December	58	22	40		1,328	496	873		0	0	0		0	0	0		1,386	518	913	
January	58	22	40		1,328	496	873		0	0	0		0	0	0		1,386	518	913	
February	52	20	37		1,200	448	788		0	0	0		0	0	0		1,252	468	825	
March	39	15	27		966	359	619		381	144	267		0	0	0		1,386	518	913	
April	37	14	26		935	347	599		369	140	259		0	0	0		1,341	501	884	
May	20	7	14		573	212	353		793	299	547		0	0	0		1,386	518	913	
June	19	7	13		555	205	341		767	289	529		0	0	0		1,341	501	884	
July	20	7	14		573	212	353		793	299	547		0	0	0		1,386	518	913	
August	20	7	14		573	212	353		793	299	547		0	0	0		1,386	518	913	
September	19	7	13		555	205	341		767	289	529		0	0	0		1,341	501	884	
Annual	435	165	305		10,806	4,020	6,943		5,075	1,913	3,504		0	0	0		16,316	6,098	10,752	

OREGON ANIMAL WASTE MANAGEMENT DESIGN AID (ORAWM)

Version 3.6

CLIENT: Ryan & Freyne Lancaster
ASSISTED BY: Pedersen

ANIMAL WASTE MANAGEMENT SYSTEM STORAGE

MONTHLY INFLOWS INTO TANK										
TANK	Value	Month	Number of days	Rain-Evap on Tank CF	Rain-Evap on Existing Storage, CF	Normal Runoff CF	Washwater CF	Manure CF	Solids CF	Waste to Store CF
Tank Parameters										
Storage Period, Days=	56	October	31	0	0	0	937	88	101	1,125
Tank Width, Feet=	10	November	30	0	0	0	906	127	146	1,179
Tank Length, Feet=	45	December	31	0	0	0	937	131	151	1,218
Existing Storage, Cubic Feet=	0	January	31	0	0	0	937	131	151	1,218
Surface Area of Existing Storage, SF=	0	February	28	0	0	0	846	118	136	1,100
25 Year-24 Hour Storm Runoff, CF=	0	March	31	0	0	0	937	88	101	1,125
Volume Needed, Cubic Feet=	2,238	April	30	0	0	0	906	85	98	1,089
Design Volume, Cubic Feet=	2,238	May	31	0	0	0	937	44	51	1,032
Is Tank Covered? YES	▼	June	30	0	0	0	906	43	50	999
Tank Dimensions? Rectangular	▼	July	31	0	0	0	937	44	51	1,032
		August	31	0	0	0	937	44	51	1,032
		September	30	0	0	0	906	43	50	999
		Annual	365	0	0	0	11,028	985	1,136	13,150

1.0 Feet

Depth = 4.97 Feet

Minimum Freeboard = 1.0 Feet

25Yr-24Hr Storm Precipitation = 0 Inches

25Yr-24Hr Storm Runoff = 0 Cubic Feet

56 Day Precip - Evap = 0 Inches

Runoff from Normal Precipitation = 0 Cubic Feet

Washwater = 1718 Cubic Feet

Manure = 239 Cubic Feet

Width = 10 Feet

OREGON ANIMAL WASTE MANAGEMENT, DESIGN AID (ORAWM) Version 3.6

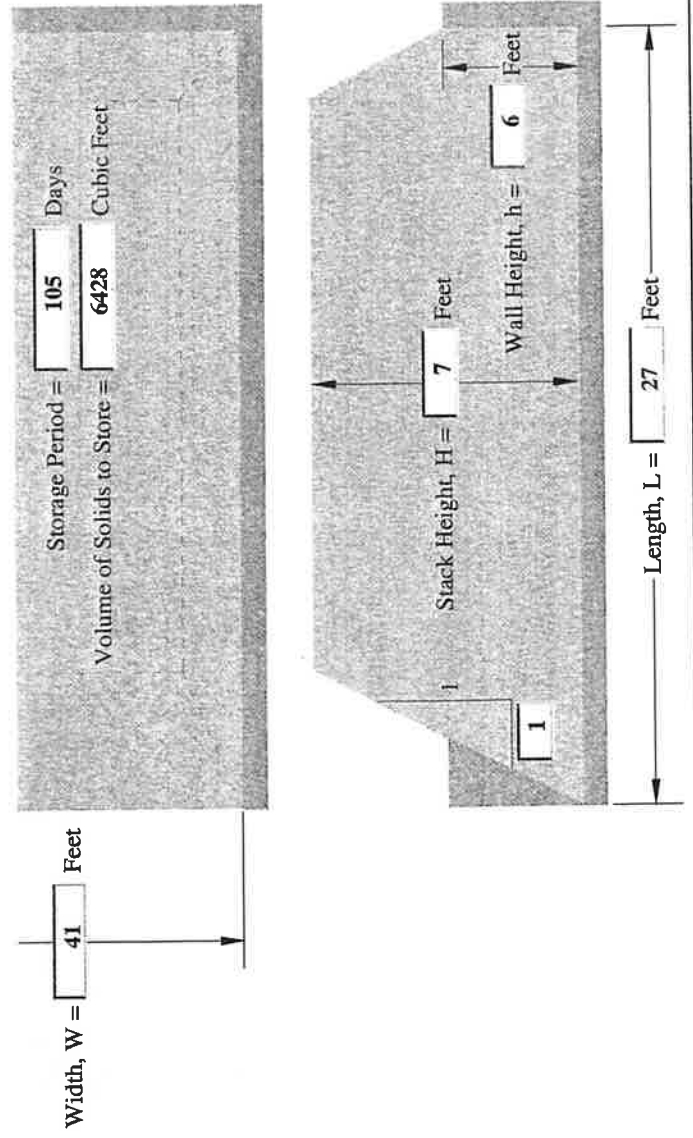
CLIENT: Ryan & Freyne Lancaster
ASSISTED BY: Pedersen

ANIMAL WASTE MANAGEMENT SYSTEM STORAGE

SOLIDS STACKING FACILITY

MONTHLY SOLIDS VOLUME STACKED IN FACILITY

Solids Storage Facility Parameters	Value	Month	Number of Days	Manure CF	Bedding CF	Solids to Store CF	Normal Runoff CF
Storage Period, Days=	105	October	31	2315	396	1,355	0
Stacking Width, W in Feet=	41	November	30	3124	514	1,819	0
Stacking Height, H in Feet=	7.00	December	31	3228	532	1,880	0
Wall Height, h in Feet=	6.00	January	31	3228	532	1,880	0
Stack Side Slope (X:1)=	1.00	February	28	2916	480	1,698	0
Existing Storage, Cubic Feet=	0	March	31	2409	406	1,407	0
Surface Area of Existing Storage, SF=	0	April	30	2331	393	1,362	0
25 Year-24 Hour Storm Runoff, CF=	0	May	31	1495	270	883	0
Volume Needed, Cubic Feet=	6,428	June	30	1447	262	854	0
Design Volume, Cubic Feet=	6,704	July	31	1495	270	883	0
Is Facility Covered? YES	▼	August	31	1495	270	883	0
		September	30	1447	262	854	0
		Annual	365	26,929	4,586	15,757	0



CLIENT: Ryan & Freyne Lancaster
ASSISTED BY: Pedersen

ANIMAL WASTE MANAGEMENT SYSTEM APPLICATION

MANAGEMENT CRITERIA FOR TRACTOR SPREADER APPLICATION OF SOLIDS

To apply 31,515 cubic feet of solids generated from the operation it will take approximately 119 trips annually. Based on applying NITROGEN, N at agronomic rate use the application depths, travel lengths, and loads per acre listed below for each crop.													
Field Number	Acres	Crop	Tractor Spreader Capacity		Spread Width Feet	NITROGEN, N Concentration in Storage Facility		Pounds of Nutrients to be Applied	Number of Applications Needed to meet Crop Demand	Tons per Acre of Solids to Apply	Travel Length per Load Needed in Feet	Loads per Acre	Assumed Solids Density lbs/CF
			Bushels	CF		PPM	Lbs/Ton						
T318 1	5.4	Perennial Hay/Pasture(Med-High Intensity)	212	264	15	7,144	14.29	348	1.00	42.4	325	9	36
2	9.6	Perennial Hay/Pasture(Med-High Intensity)	212	264	15	7,144	14.29	348	1.00	42.4	325	9	36
3	2.8	Perennial Hay/Pasture(Med-High Intensity)	212	264	15	7,144	14.29	348	1.00	42.4	325	9	36
4	24.6	Perennial Hay/Pasture(Med-High Intensity)	212	264	15	7,144	14.29	348	1.00	42.4	325	9	36
5	6.6	Perennial Hay/Pasture(Med-High Intensity)	212	264	15	7,144	14.29	348	1.00	42.4	325	9	36

MANAGEMENT CRITERIA FOR BIG GUN SPRINKLER APPLICATION OF LIQUIDS

To apply 98,359 gallons of liquids generated from the operation it will take approximately 5 hours of pumping annually. Based on applying NITROGEN, N at agronomic rate use the application depths, set times, and travel rates listed below for each crop.													
Field Number	Acres	Crop	Sprinkler Flowrate GPM	Wetted Diameter Feet	Portion of Wetted Diameter Receiving Liquids	NITROGEN, N Concentration in Storage Facility		Pounds of Nutrients to be Applied	Number of Applications Needed to meet Crop Demand	Inches of Liquids to Apply	Application Rate in Inches/Hour	Set Time Needed in Hours	Travel Rate Feet/Minute
						PPM	Lbs/1000Gal						
T318 1	5.4	Perennial Hay/Pasture(Med-High Intensity)	300	250	1/2 Circle ▼	424	3.54	348	1.00	5.89	1.45	9.99	0.33
2	9.6	Perennial Hay/Pasture(Med-High Intensity)	300	250	1/2 Circle ▼	424	3.54	348	1.00	5.89	1.45	9.99	0.33
3	2.8	Perennial Hay/Pasture(Med-High Intensity)	300	250	1/2 Circle ▼	424	3.54	348	1.00	5.89	1.45	9.99	0.33
4	24.6	Perennial Hay/Pasture(Med-High Intensity)	300	250	1/2 Circle ▼	424	3.54	348	1.00	5.89	1.45	9.99	0.33
5	6.6	Perennial Hay/Pasture(Med-High Intensity)	300	250	1/2 Circle ▼	424	3.54	348	1.00	5.89	1.45	9.99	0.33
					▼								
					▼								
					▼								
					▼								

OREGON ANIMAL WASTE MANAGEMENT DESIGN AID (ORAWM) Version 3.6

CLIENT: Ryan & Freyne Lancaster
ASSISTED BY: Pedersen

ANIMAL WASTE MANAGEMENT SYSTEM APPLICATION

MANAGEMENT CRITERIA FOR TANK WAGON APPLICATION OF LIQUIDS

To apply 98,359 gallons of liquids generated from the operation it will take approximately 141 trips annually. Based on applying NITROGEN, N at agronomic rates use the application depths, travel lengths, and loads per acre listed below for each crop.											
Field Number	Acres	Crop	Tank Wagon Capacity Gallons	Spread Width Feet	NITROGEN, N Concentration in Storage Facility		Pounds of Nutrients to be Applied	Number of Applications Needed to meet Crop Demand	Inches of Liquids to Apply	Travel Length per Load Needed in Feet	Loads per Acre
					PPM	Lbs/1000Gal					
T318 1	5.4	Perennial Hay/Pasture(Med-High Intensity)	700	15		424	348	1.00	2.23	34	86.4
2	9.6	Perennial Hay/Pasture(Med-High Intensity)	700	15		424	348	1.00	2.23	34	86.4
3	2.8	Perennial Hay/Pasture(Med-High Intensity)	700	15		424	348	1.00	2.23	34	86.4
4	24.6	Perennial Hay/Pasture(Med-High Intensity)	700	15		424	348	1.00	2.23	34	86.4
5	6.6	Perennial Hay/Pasture(Med-High Intensity)	700	15		424	348	1.00	2.23	34	86.4

COMPUTED NUTRIENT CONCENTRATIONS IN STORAGE

Storage Facility	Annual Volume Production	Concentration of Nutrients in Storage				
		Units	N	P ₂ O ₅	K ₂ O	Units
	98,359	Gallons	3.54	1.51	2.79	lbs/ft Gal
Solids Storage Facility (Roofed)	284	Tons	14.29	6.38	11.02	lbs/Ton

CLIENT: Ryan & Freyne Lancaster
 ASSISTED BY: Pedersen

ANIMAL WASTE MANAGEMENT SYSTEM UTILIZATION

NUTRIENTS AVAILABLE AFTER STORAGE

Nutrient Source	Type of Operation	Pounds of Nutrients Available			Percent Nutrients Retained After Storage			Pounds of Nutrients Retained After Storage		
		N	P2O5	K2O	N	P2O5	K2O	N	P2O5	K2O
Liquids	Tank (Covered)	435	165	305	80%	90%	90%	348	149	275
Solids	Solids Storage Facility (Roofed)	10,806	4,020	6,943	75%	90%	90%	8,105	3,618	6,249
Grazing	NONE	5,075	1,913	3,504	100%	100%	100%	5,075	1,913	3,504

NUTRIENTS AVAILABLE AFTER APPLICATION

Nutrient Source	Type of Application System	Pounds of Nutrients Available			Percent Nutrients Retained After Application			Pounds of Nutrients Retained After Application		
		N	P2O5	K2O	N	P2O5	K2O	N	P2O5	K2O
Liquids	Sprinkling	348	149	275	75%	100%	100%	261	149	275
Solids	Broadcast (Incorporated 7 or more days after application)	8,105	3,618	6,249	70%	100%	100%	5,673	3,618	6,249
Grazing	Grazing	5,075	1,913	3,504	85%	100%	100%	4,313	1,913	3,504

NUTRIENTS AVAILABLE AFTER DENITRIFICATION

Nutrient Source	Location	Pounds of Nutrients Available			Percent Nutrients Retained After Denitrification			Pounds of Nutrients Retained After Denitrification		
		N	P2O5	K2O	N	P2O5	K2O	N	P2O5	K2O
Liquids	Coast	261	149	275	82%	100%	100%	214	149	275
Solids	Soil Drainage Class	5,673	3,618	6,249	82%	100%	100%	4,652	3,618	6,249
Grazing	Moderately Well Drained	4,313	1,913	3,504	82%	100%	100%	3,537	1,913	3,504
TOTAL								8,403	5,680	10,027

PERCENT OF MANURE TO BE APPLIED TO FIELD AND UTILIZATION ACRES NEEDED BASED ON

Field Number	Acres	Crop	LIQUIDS			SOLIDS			GRAZING		
			Percent to be Applied	Pounds of Nutrients to be Applied	Acres Needed for Utilization of Nutrients	Percent to be Applied	Pounds of Nutrients to be Applied	Acres Needed for Utilization of Nutrients	Percent to be Applied	Pounds of Nutrients to be Applied	Acres Needed for Utilization of Nutrients
1	5.4	Perennial Hay/Pasture(Med-High Intensity)	11%	24	0	11%	513	1	11%	390	1
2	9.6	Perennial Hay/Pasture(Med-High Intensity)	20%	42	0	20%	911	3	20%	693	2
3	2.8	Perennial Hay/Pasture(Med-High Intensity)	6%	12	0	6%	266	1	6%	202	1
4	24.6	Perennial Hay/Pasture(Med-High Intensity)	50%	107	0	50%	2,336	7	50%	1,776	5
5	6.6	Perennial Hay/Pasture(Med-High Intensity)	13%	29	0	13%	627	2	13%	476	1
Off Farm			0%	0		0%	0		0%	0	
TOTALS	49		100%	214	1	100%	4,652	13	100%	3,537	10

OREGON ANIMAL WASTE MANAGEMENT DESIGN AID (ORAWM)

Version 3.6

CLIENT: Ryan & Freyne Lancaster
 ASSISTED BY: Pedersen

ANIMAL WASTE MANAGEMENT SYSTEM UTILIZATION

NUTRIENT BALANCE BASED ON AVAILABLE ACRES

NUTRIENT BALANCE BASED ON AVAILABLE ACRES											
Field Number	Acres	Crop	NUTRIENTS APPLIED			NUTRIENTS REMOVED			NUTRIENT BALANCE		
			Nitrogen, N Lbs/Acre	Phosphorous, P ₂ O ₅ Lbs/Acre	Potassium, K ₂ O Lbs/Acre	Nitrogen, N Lbs/Acre	Phosphorous, P ₂ O ₅ Lbs/Acre	Potassium, K ₂ O Lbs/Acre	Nitrogen, N Lbs/Acre	Phosphorous, P ₂ O ₅ Lbs/Acre	Potassium, K ₂ O Lbs/Acre
T318 1	5.4	Perennial Hay/Pasture(Med-High Intensity)	171	116	205	348	110	289	-177	6	-85
2	9.6	Perennial Hay/Pasture(Med-High Intensity)	171	116	205	348	110	289	-177	6	-85
3	2.8	Perennial Hay/Pasture(Med-High Intensity)	171	116	205	348	110	289	-177	6	-85
4	24.6	Perennial Hay/Pasture(Med-High Intensity)	171	116	205	348	110	289	-177	6	-85
5	6.6	Perennial Hay/Pasture(Med-High Intensity)	171	116	205	348	110	289	-177	6	-85

TILLAMOOK COUNTY
SOIL AND WATER CONSERVATION DISTRICT

**OPERATION AND MAINTENANCE WORKSHEET
ROOF RUNOFF MANAGEMENT**

CODE 558

For: Landowner/Operator Ryan & Freyne Lancaster

Job Location: T1S; R9W Sec.32

County Tillamook SWCD Tillamook

Farm/Tract No. 318

Prepared By Pedersen Date 04/11

Gutters and Downspouts

Operation and Maintenance Items

Properly operated and maintained roof runoff facilities are an asset to the farm. Roof runoff facilities were designed and installed to control roof runoff. Estimated life span of this installation is at least 10 years. Facility life can be assured and usually increased by developing and carrying out a good operation and maintenance program.

This practice will require periodic maintenance and may require operational items to maintain satisfactory performance. A good operation and maintenance plan includes:

- ⇒ Perform weekly inspections of gutters, downspouts and above ground pipelines, and appurtenances for proper operation. Repair or replace if needed.
- ⇒ Periodically remove debris from gutters, downspouts and outlet facilities.
- ⇒ Protect downspouts from damage by livestock and equipment. Repair or replace damaged components as needed.
- ⇒ Keep gutters, downspouts, conveyance pipelines and ditches and appurtenances in good operating condition.

TILLAMOOK COUNTY
SOIL AND WATER CONSERVATION DISTRICT

OPERATION AND MAINTENANCE WORKSHEET

**WASTE STORAGE FACILITY (ROOF)
CODE 313**

For: Landowner/Operator Ryan & Freyne Lancaster

Job Location: T1S; R9W Sec. 32

County Tillamook SWCD Tillamook

Farm/Tract No. T-318

Prepared By Pedersen Date: 04/11

Operation and Maintenance Items

A properly operated and maintained roof is an asset to your farm. These roofs were designed and installed for preventing manure runoff from manure accumulation areas. The estimated life span of this installation is at least 10 years. The life of this installation can be assured and usually increased by developing and carrying out a good operation and maintenance program.

This practice will require you to perform periodic operation and maintenance to maintain satisfactory performance. A good operation and maintenance plan includes:

- ⇒ Roof will be inspected weekly.
- ⇒ All roof sections that are rusted and leaking will be replaced or repaired to prevent rainwater from entering the liquid waste storage system.
- ⇒ Loose roof sections will be secured.
- ⇒ Broken trusses, beams, poles, gutters and downspouts will be repaired or replaced.

May 28, 2002

Bob Pedersen
Tillamook NRCS Field Office
6415 Signal St.
Tillamook, OR 97141



OREGON
STATE
UNIVERSITY

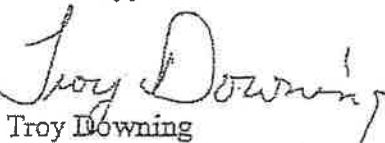
2204 Fourth Street
Tillamook, Oregon
97141

Dear Bob,

Over the past five years, I have had the opportunity to study nutrient cycling dynamics on dairies in the Tillamook area. It has been observed that pastures will vary in productivity based on environment, grazing management and soil fertility. Nitrogen utilization has been a major focus of my work looking specifically at nitrogen up takes by the pasture plant. I have seen pastures remove as little as 200 lbs of N per acre a year to as high as 750. Average pastures on dairies will use between 300 and 400 lbs of nitrogen per acre each year.

With this understanding, it makes logical sense to me to use nitrogen utilization numbers in our animal waste management planning of 300 pounds nitrogen per year as a reasonable starting point. I think this is a conservative guess and would not hesitate adjusting this number if the landowner has other data indicating they are using N at higher levels. For example, yield data, grazing rotation records with removal data, and/or soil test data.

Sincerely,


Troy Downing
Area Dairy Extension Agent

Telephone
503-842-3433



Agriculture, Home Economics, 4-H Youth, Forestry, Community Development, Energy, and Extension Sea Grant Programs. Oregon State University, United States Department of Agriculture, and Tillamook County cooperating. The Extension Service offers its programs and materials equally to all people.

NUTRIENT MANAGEMENT DESIGN AND SPECIFICATIONS

Producer:	Ryan & Freyne Lancaster	Tract(s):	318	Field(s):	T318 1
Assisted by:	Pedersen	Date:	October 4, 2004		

PURPOSE (Check all that apply)			
Budget and supply for plant production	☒	Utilize manure/organic materials as a nutrient source	☒
Minimize agricultural non-point source pollution (water quality)	☒	Maintain or improve soil condition	☒

Table 1. Field Conditions and Recommendations

CROP SEQUENCE/ROTATION (circle current crop)					EXPECTED YIELD
Perennial Hay/Pasture(Med-High Intensity)					20
CURRENT SOIL TEST LEVELS (ppm or lb/ac)					
N	P	K	pH	S.O.M. %	EC
NA	3	758	5.7		
RECOMMENDED NUTRIENTS/AMENDMENTS TO MEET EXPECTED YIELD					
N (lbs/ac)		P ₂ O ₅ (lbs/ac)	K ₂ O (lbs/ac)	LIME	Other
Trial A	Trial B	Trial A	Trial B	Trial A	Trial B
348		110		289	
				7 tons	

Table 2. Nutrient Sources

Table 1. Nutrient Sources

Credits		N		P ₂ O ₅		K ₂ O	
		pounds per acre					
1. Nitrogen credits from previous legume crop		0					
2. Residual from long-term manure application		0					
3. Irrigation water		0		0		0	
4. Other (e.g., atmospheric deposition)		0		0			
5. Total Credits-		0		0		0	
Plant-Available Nutrients Applied to Field		N		P ₂ O ₅		K ₂ O	
(Circle column that is landuser's decision)		Trial A	Trial B	Trial A	Trial B	Trial A	Trial B
6. Credits (from row 5, above)		0	0	0	0	0	0
7. Fertilizer	Starter						
	Other Commercial Fertilizer or Additional Manure	177		0		0	
8. Manure / Organic Materials (Source-) Dairy		171	0	116	0	205	0
9. Subtotal (sum of lines 6, 7 and 8)		348	0	116	0	205	0
10. Nutrients Recommended (from Table 1)		348	0	110	0	289	0
11. Nutrient Status (subtract line 10 from line 9)		0	0	6	0	-84	0
If line 11 is a negative number, this is the amount of additional nutrients needed to meet the crop recommendation.							
If line 11 is a positive number, this is the amount by which the available nutrients exceed the crop requirements.							

PLANNED NUTRIENT APPLICATIONS

Amount to be Applied (lb/ac)	N	348	P ₂ O ₅	116	K ₂ O	205
Method, Form, and Timing of Application						
Recommend a new soil test. The 758 ppm of potassium in the soil is high. High potassium levels in the soil may cause livestock health problems. Recommend forage tests to evaluate the potassium level in the forage. The 3 ppm of phosphorus is low. Recommend 177 lbs of additional nitrogen be applied to achieve the 20 tons at 30% dry matter per acre per year. See attached letter from the Dairy Extension Agent. Manure and fertilizer should be applied in split applications. Apply 50-70 lbs of nitrogen per acre per application. No manure shall be applied to high risk runoff fields during the wet season. Apply nutrient material uniformly to the application areas. See attached Nutrient Specification Sheet, the Manure Distribution Sheet Section, for the manure application rates per field. Recommend soil test in mid September to mid October to evaluate how well the biosolid application rate matches the nitrogen needs of the forage. SEE ATTACHED WASTE SPECIFICATION SHEET FOR ADDITIONAL MANURE APPLICATION GUIDANCE.						

NUTRIENT MANAGEMENT DESIGN AND SPECIFICATIONS

Producer: Ryan & Freyne Lancaster	Tract(s): 318	Field(s): 2
Assisted by: Pedersen		Date: October 4, 2004

PURPOSE (Check all that apply)			
Budget and supply for plant production	☒	Utilize manure/organic materials as a nutrient source	☒
Minimize agricultural non-point source pollution (water quality)	☒	Maintain or improve soil condition	☒

Table 1. Field Conditions and Recommendations

Table 1. Field Conditions and Recommendations

CROP SEQUENCE/ROTATION (circle current crop)					EXPECTED YIELD			
Perennial Hay/Pasture(Med-High Intensity)					20			
CURRENT SOIL TEST LEVELS (ppm or lb/ac)								
N		P		K		pH	S.O.M.%	EC
NA		35		761		5.7		
RECOMMENDED NUTRIENTS/AMENDMENTS TO MEET EXPECTED YIELD								
N (lbs/ac)		P ₂ O ₅ (lbs/ac)		K ₂ O (lbs/ac)		LIME	Other	Other
Trial A	Trial B	Trial A	Trial B	Trial A	Trial B	6 tons		
348		110		289				

Table 2. Nutrient Sources

		N		P ₂ O ₅		K ₂ O	
Credits		pounds per acre					
1. Nitrogen credits from previous legume crop		0					
2. Residual from long-term manure application		0					
3. Irrigation water		0		0		0	
4. Other (e.g., atmospheric deposition)		0		0		0	
5. Total Credits-		0		0		0	
Plant-Available Nutrients Applied to Field		N		P ₂ O ₅		K ₂ O	
(Circle column that is landuser's decision)		Trial A	Trial B	Trial A	Trial B	Trial A	Trial B
6. Credits (from row 5, above)		0	0	0	0	0	0
7. Fertilizer	Starter						
	Other Commercial Fertilizer or Additional Manure	177		0		0	
8. Manure / Organic Materials (Source-) Dairy		171	0	116	0	205	0
9. Subtotal (sum of lines 6, 7 and 8)		348	0	116	0	205	0
10. Nutrients Recommended (from Table 1)		348	0	110	0	289	0
11. Nutrient Status (subtract line 10 from line 9)		0	0	6	0	-84	0
If line 11 is a negative number, this is the amount of additional nutrients needed to meet the crop recommendation.							
If line 11 is a positive number, this is the amount by which the available nutrients exceed the crop requirements.							

PLANNED NUTRIENT APPLICATIONS

Amount to be Applied (lb/ac)	N	348	P ₂ O ₅	116	K ₂ O	205
Method, Form, and Timing of Application						
<p>Recommend a new soil test. The 761 ppm of potassium in the soil is high. High potassium levels in the soil may cause livestock health problems. Recommend forage tests to evaluate the potassium level in the forage. The 35 ppm of phosphorus is medium. Recommend 176 lbs of additional nitrogen be applied to achieve the 20 tons at 30% dry matter per acre per year. See attached letter from the Dairy Extension Agent. Manure and fertilizer should be applied in split applications. Apply 50-70 lbs of nitrogen per acre per application. No manure shall be applied to high risk runoff fields during the wet season. Apply nutrient material uniformly to the application areas. See attached Nutrient Specification Sheet, the Manure Distribution Sheet Section, for the manure application rates per field. Recommend soil test in mid September to mid October to evaluate how well the biosolid application rate matches the nitrogen needs of the forage. SEE ATTACHED WASTE SPECIFICATION SHEET FOR ADDITIONAL MANURE APPLICATION GUIDANCE.</p>						

NUTRIENT MANAGEMENT DESIGN AND SPECIFICATIONS

Producer: Ryan & Freyne Lancaster	Tract(s): 318	Field(s): 3
Assisted by: Pedersen	Date: October 4, 2004	

PURPOSE (Check all that apply)			
Budget and supply for plant production	x	Utilize manure/organic materials as a nutrient source	x
Minimize agricultural non-point source pollution (water quality)	x	Maintain or improve soil condition	x

Table 1. Field Conditions and Recommendations

CROP SEQUENCE/ROTATION (circle current crop)						EXPECTED YIELD	
Perennial Hay/Pasture(Med-High Intensity)						20	
CURRENT SOIL TEST LEVELS (ppm or lb/ac)							
N		P		K		pH	
NA		6		553		5.3	
RECOMMENDED NUTRIENTS/AMENDMENTS TO MEET EXPECTED YIELD							
N (lbs/ac)		P ₂ O ₅ (lbs/ac)		K ₂ O (lbs/ac)		LIME	
Trial A	Trial B	Trial A	Trial B	Trial A	Trial B	8 tons	
348		110		289			

Table 2. Nutrient Sources

Credits		N		P ₂ O ₅		K ₂ O	
		pounds per acre					
1. Nitrogen credits from previous legume crop		0					
2. Residual from long-term manure application		0					
3. Irrigation water		0		0		0	
4. Other (e.g., atmospheric deposition)		0		0		0	
5. Total Credits-		0		0		0	
Plant-Available Nutrients Applied to Field		N		P ₂ O ₅		K ₂ O	
(Circle column that is landuser's decision)		Trial A	Trial B	Trial A	Trial B	Trial A	Trial B
6. Credits (from row 5, above)		0	0	0	0	0	0
7. Fertilizer	Starter						
	Other Commercial Fertilizer Or Additional Manure	177		0		0	
8. Manure / Organic Materials (Source-) Dairy		171	0	116	0	205	0
9. Subtotal (sum of lines 6, 7 and 8)		348	0	116	0	205	0
10. Nutrients Recommended (from Table 1)		348	0	110	0	289	0
11. Nutrient Status (subtract line 10 from line 9)		0	0	6	0	-84	0

If line 11 is a negative number, this is the amount of additional nutrients needed to meet the crop recommendation.
 If line 11 is a positive number, this is the amount by which the available nutrients exceed the crop requirements.

PLANNED NUTRIENT APPLICATIONS						
Amount to be Applied (lb/ac)		N	348	P ₂ O ₅	116	K ₂ O
Method, Form, and Timing of Application						
<p>Recommend a new soil test. The 553 ppm of potassium in the soil is high. High potassium levels in the soil may cause livestock health problems. Recommend forage tests to evaluate the potassium level in the forage. The 6 ppm of phosphorus is low. Recommend 176 lbs of additional nitrogen be applied to achieve the 20 tons at 30% dry matter per acre per year. See attached letter from the Dairy Extension Agent. Manure and fertilizer should be applied in split applications. Apply 50-70 lbs of nitrogen per acre per application. No manure shall be applied to high risk runoff fields during the wet season. Apply nutrient material uniformly to the application areas. See attached Nutrient Specification Sheet, the Manure Distribution Sheet Section, for the manure application rates per field. Recommend soil test in mid September to mid October to evaluate how well the biosolid application rate matches the nitrogen needs of the forage. SEE ATTACHED WASTE SPECIFICATION SHEET FOR ADDITIONAL MANURE APPLICATION GUIDANCE.</p>						

NUTRIENT MANAGEMENT DESIGN AND SPECIFICATIONS

Producer: Ryan & Freyne Lancaster	Tract(s): 318	Field(s): 4
Assisted by: Pedersen		Date: October 4, 2004

PURPOSE (Check all that apply)			
Budget and supply for plant production	☒	Utilize manure/organic materials as a nutrient source	☒
Minimize agricultural non-point source pollution (water quality)	☒	Maintain or improve soil condition	☒

Table 1. Field Conditions and Recommendations

CROP SEQUENCE/ROTATION (circle current crop)										EXPECTED YIELD	
Perennial Hay/Pasture(Med-High Intensity)										20	
CURRENT SOIL TEST LEVELS (ppm or lb/ac)											
N		P		K		pH		S.O.M. %		EC	
NA		15		716		5.5					
RECOMMENDED NUTRIENTS/AMENDMENTS TO MEET EXPECTED YIELD											
N (lbs/ac)		P ₂ O ₅ (lbs/ac)		K ₂ O (lbs/ac)		LIME		Other		Other	
Trial A	Trial B	Trial A	Trial B	Trial A	Trial B	7 tons					
348		110		289							

Table 2. Nutrient Sources

		N		P ₂ O ₅		K ₂ O	
Credits		pounds per acre					
1. Nitrogen credits from previous legume crop		0					
2. Residual from long-term manure application		0					
3. Irrigation water		0		0		0	
4. Other (e.g., atmospheric deposition)		0		0		0	
5. Total Credits-		0		0		0	
Plant-Available Nutrients Applied to Field		N		P ₂ O ₅		K ₂ O	
(Circle column that is landuser's decision)		Trial A	Trial B	Trial A	Trial B	Trial A	Trial B
6. Credits (from row 5, above)		0	0	0	0	0	0
7. Fertilizer	Starter						
	Other Commercial Fertilizer or Additional Manure	177		0		0	
8. Manure / Organic Materials (Source-) Dairy		171	0	116	0	205	0
9. Subtotal (sum of lines 6, 7 and 8)		348	0	116	0	205	0
10. Nutrients Recommended (from Table 1)		348	0	110	0	289	0
11. Nutrient Status (subtract line 10 from line 9)		0	0	6	0	-84	0
If line 11 is a negative number, this is the amount of additional nutrients needed to meet the crop recommendation.							
If line 11 is a positive number, this is the amount by which the available nutrients exceed the crop requirements.							

PLANNED NUTRIENT APPLICATIONS							
Amount to be Applied (lb/ac)	N	348	P ₂ O ₅	116	K ₂ O	205	
Method, Form, and Timing of Application							
<p>Recommend a new soil test. The 716 ppm of potassium in the soil is high. High potassium levels in the soil may cause livestock health problems. Recommend forage tests to evaluate the potassium level in the forage. The 15 ppm of phosphorus is low. Recommend 176 lbs of additional nitrogen be applied to achieve the 20 tons at 30% dry matter per acre per year. See attached letter from the Dairy Extension Agent. Manure and fertilizer should be applied in split applications. Apply 50-70 lbs of nitrogen per acre per application. No manure shall be applied to high risk runoff fields during the wet season. Apply nutrient material uniformly to the application areas. See attached Nutrient Specification Sheet, the Manure Distribution Sheet Section, for the manure application rates per field. Recommend soil test in mid September to mid October to evaluate how well the biosolid application rate matches the nitrogen needs of the forage. SEE ATTACHED WASTE SPECIFICATION SHEET FOR ADDITIONAL MANURE APPLICATION GUIDANCE.</p>							

NUTRIENT MANAGEMENT DESIGN AND SPECIFICATIONS

Producer: Ryan & Freyne Lancaster	Tract(s): 318	Field(s): 5
Assisted by: Pedersen	Date: May 17, 2011	

PURPOSE (Check all that apply)			
Budget and supply for plant production	x	Utilize manure/organic materials as a nutrient source	x
Minimize agricultural non-point source pollution (water quality)	x	Maintain or improve soil condition	x

Table 1. Field Conditions and Recommendations

CROP SEQUENCE/ROTATION (circle current crop)						EXPECTED YIELD	
Perennial Hay/Pasture(Med-High Intensity)						20	
CURRENT SOIL TEST LEVELS (ppm or lb/ac)							
N		P		K		pH	
RECOMMENDED NUTRIENTS/AMENDMENTS TO MEET EXPECTED YIELD							
N (lbs/ac)		P ₂ O ₅ (lbs/ac)		K ₂ O (lbs/ac)		LIME	
Trial A	Trial B	Trial A	Trial B	Trial A	Trial B	Other	
348		110		289			

Table 2. Nutrient Sources

Credits		N		P ₂ O ₅		K ₂ O	
		pounds per acre					
1. Nitrogen credits from previous legume crop		0					
2. Residual from long-term manure application		0					
3. Irrigation water		0		0		0	
4. Other (e.g., atmospheric deposition)		0		0		0	
5. Total Credits-		0		0		0	
Plant-Available Nutrients Applied to Field		N		P ₂ O ₅		K ₂ O	
(Circle column that is landuser's decision)		Trial A	Trial B	Trial A	Trial B	Trial A	Trial B
6. Credits (from row 5, above)		0	0	0	0	0	0
7. Fertilizer	Starter						
	Other						
8. Manure / Organic Materials (Source-) Dairy		171		116		205	
9. Subtotal (sum of lines 6, 7 and 8)		171	0	116	0	205	0
10. Nutrients Recommended (from Table 1)		348	0	110	0	0	289
11. Nutrient Status (subtract line 10 from line 9)		-177	0	6	0	205	-289

If line 11 is a negative number, this is the amount of additional nutrients needed to meet the crop recommendation.
If line 11 is a positive number, this is the amount by which the available nutrients exceed the crop requirements.

PLANNED NUTRIENT APPLICATIONS							
Amount to be Applied (lb/ac)		N	172	P ₂ O ₅	116	K ₂ O	205
Method, Form, and Timing of Application							
No soil test data available. Recommend a soil test. See attached letter from the Dairy Extension Agent. Manure and fertilizer should be applied in split applications. Apply 50-70 lbs of nitrogen per acre per application. No manure shall be applied to high risk runoff fields during the wet season. Apply nutrient material uniformly to the application areas. See attached Nutrient Specification Sheet, the Manure Distribution Sheet Section, for the manure application rates per field. Recommend soil test in mid September to mid October to evaluate how well the biosolid application rate matches the nitrogen needs of the forage. SEE ATTACHED WASTE SPECIFICATION SHEET FOR ADDITIONAL MANURE APPLICATION GUIDANCE.							

TILLAMOOK COUNTY
SOIL AND WATER CONSERVATION DISTRICT

**NUTRIENT MANAGEMENT SPECIFICATION SHEET
CODE 590**

EXISTING HERD SIZE

Landowner/Operator: Ryan & Freyne Lancaster

Job Location: T 1S; R 9W; Sec. 29,32

County: Tillamook

SWCD: Tillamook County

Farm/Tract No. 318

Field No. 1-5

Prepared By: Pedersen

Date: 05/11

Purpose:

- ☐ To budget and supply nutrients for plant production.
- ☐ To properly utilize manure and organic by-products as a plant nutrient source.
- ☐ To minimize agricultural non-point source pollution of surface and ground water resources.
- ☐ To maintain or improve the physical, chemical and biological condition of soil.

Specifications:

- ☐ Manure is applied to the surface of permanent pastures in accordance with the enclosed Waste Utilization Conservation Practice Jobsheet.
- ☐ A target yield of 20 tons at 30% dry matter per acre per yield is planned to utilize the nitrogen in the manure and/or commercial applied fertilizer.
- ☐ Manure and commercial fertilizer is applied in accordance with soil tests.
- ☐ Manure and/or commercial fertilizer is applied in split applications.
- ☐ Soil tests are taken at least every 3 years.
- ☐ Manure test are taken every 3 years. Samples will be collected from the equipment that applies the manure and wastewater to the fields.
- ☐ No more than 348 lbs. of nitrogen is applied per acre per year in accordance with the below Nutrient Distribution, Soil and forage tests will be used to justify the rates.

Manure Application Equipment to be used:

75- 1,000 lb. animal units , 700 Gallon Manure Tank Wagon & 212 Bushel Manure Spreader.

Date 05/11

Manure is not applied within 50 feet of an open watercourse during the winter months and 30 feet during the summer months.

SIGN APPROVAL:

Design approved by: /s/ [Signature] Date: 5-5-11
Job Title: CEO Planner

CLIENTS ACKNOWLEDGEMENT STATEMENT:

The client acknowledges that:

- a. They have received a copy of this specification and under-stands the contents and requirements.
- b. The following information must be provided NRCS by the client before this practice can be certified as applied:
 - ☐ Nutrient management application records including soil, water, plant and organic by-product test results.
 - ☐ Documentation showing amount, rate, form and application method of nutrient applied
 - ☐ Annual review of nutrient management including adjustments made.
- c. It shall be the responsibility of the client to obtain all necessary permits and/or rights, and to comply with all ordinances and laws pertaining to the application of this practice.
- d. Maintain records of nutrient application as required by state and local regulations.

Accepted by: /s/ [Signature] Fuynne Date: 5-5-11

CERTIFICATION;

I have completed a review of the nutrient management and the specification's application and certify this practice has been applied.

Certification by: /s/ _____ Date: _____

Job Title: _____

TILLAMOOK COUNTY
SOIL AND WATER CONSERVATION DISTRICT
WASTE UTILIZATION SPECIFICATION SHEET

Client Ryan & Freyne Lancaster

Location: 1206 Marolf Loop Road; Tillamook, Oregon

Tillamook SWCD

Tract No. 318

Prepared By Pedersen

Date 04/11

Perform the following operations:

- ☐ Have your technical assistance provider review the resource management system plan for your operation at least once every 5 years.
- ☐ Maintain records for all waste applications.
- ☐ Calibrate application equipment to apply wastes in accordance with the recommended amount and timing specified on the nutrient budget specification sheet, NRCS practice code 590, for the crop being grown.
- ☐ Chemical analysis of soils, plant tissue and waste should be used annually to monitor and adjust amounts of waste applied. Refer to Oregon State University Extension Service publication EC1478, "Soil Test Interpretation Guide" for guidance in getting soil tested and interpreting soil test results. Refer to Oregon State University Extension publication EM8585, "Manure Application Rates for Forage Production" and EM8768, "Calculating Dairy Manure Nutrient Application Rates" for guidance in getting animal waste tested for nutrient concentrations and computing application rates.
- ☐ Apply waste in a manner that will cover no more than 25 percent of the leaf surface with solids unless clean water applications are planned immediately after wastes are applied. For pasture/hayland it is best to apply waste 7 days after harvesting forage by haying or grazing.
- ☐ To reduce odor problems, apply waste in mid morning when temperatures are warming and air is rising rather than in the afternoon or evening when air is cooling and settling. Avoid applications during periods of fog.
- ☐ Do not apply waste directly into an open watercourse or where waste is likely to enter an open watercourse. Observe all waste application setbacks identified in the resource management system plan.
- ☐ Do not apply waste to fields where there is no growing crop. If applications are needed during fall and winter periods due to unforeseen circumstances, such as the storage facilities being full, use the following guidelines for waste applications:
 - a) Only spread waste on fields that are growing a crop, preferably grass.
 - b) Increase all waste application setbacks identified in the resource management system plan by at least 15 feet.
 - c) Don't apply waste during any rainfall event that will cause runoff.
 - d) Use maximum travel rates for the traveling big gun sprinkler and solids spreader.
 - e) Use soil tests, such as the Pre-sidedress Soil Nitrate test, to determine if additional applications of waste are needed on those fields receiving emergency winter applications.
- ☐ Do not apply waste to fields with frozen or snow covered soil conditions unless provisions are made to control runoff.
- ☐ Do not spread waste on fields where soils are saturated, ponded, flooded and/or during times when waste is likely to runoff into open watercourses.
- ☐ Be aware of the location of sensitive areas, concerns of neighbors or concerns of the public which require special application procedures
- ☐ Handle all waste material with caution. Wear appropriate protective clothing.
- ☐ Clean up residual materials from equipment and dispose of properly.
- ☐ Equipment used in waste utilization should be regularly inspected and maintained as needed in accordance with equipment operation and maintenance guidelines from the manufacturer or provided by NRCS.

Additional Guidance and Notes: Any manure discharge into an open water course will be reported to Oregon Department of Agriculture (ODA) within 24 hours. Within 5 days a written statement describing the manure discharge will be submitted to ODA. Annual CAFO permit reports will be submitted on time to ODA.

DESIGN APPROVAL:Design Approved by: /s/ Robert A. Pedersen

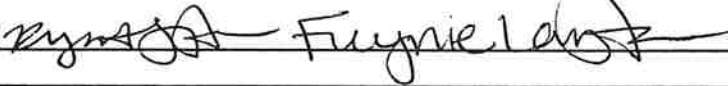
Date:

5/5/11Job Title: CAFO PLANNER

CLIENTS ACKNOWLEDGEMENT STATEMENT:

The Client acknowledges that:

- a. They have received a copy of the specification and understand the contents and requirements.
- b. The following information must be provided to SWCD by the client before this practice can be certified as applied:
 - ☐ Waste application records which include the date, crop, type of waste applied, and amount of waste applied.
 - ☐ Calibration records for waste application equipment.
 - ☐ Analysis of nutrient concentrations in solid and liquid wastes.
- c. It shall be the responsibility of the client to obtain all necessary permits and/or rights, and to comply with all ordinances and laws pertaining to the application of this practice.

Accepted by: /s/ 

Date:

5-5-11

CERTIFICATION:

I HAVE COMPLETED A REVIEW OF THE INFORMATION PROVIDED BY THE CLIENT AND CERTIFY THIS PRACTICE HAS BEEN APPLIED.

Certification by: /s/ _____

Date: _____

Job title: _____

EMERGENCY RESPONSE PLAN

In Case of a Storage Facility Spill, Leak, or Failure

- a. Stop all other activities to address the emergency.
- b. Stop all flow into the storage facility.
- c. If the storage facility is at maximum capacity or overtopping, draw the waste level in the facility down by making an application to the emergency application area shown on the plan map in accordance with the Waste Utilization instructions found in the Operations section of this plan.
- d. Assess the extent of the emergency and determine how much help is needed to correct the problem.
- e. Call for help & excavator if needed.
- f. If possible, use a skid loader or tractor with blade to contain or divert spill or leak away from environmentally sensitive areas.
- g. If containment material is needed, excavate soil from appropriate areas away from the storage facility.
- h. If possible, begin applying the stored waste to the utilization fields at the prescribed application rates described in Section 6 of this plan.
- i. Complete the clean-up and repair the necessary components.

In Case of a Manure/Waste Discharge

- a. Stop all other activities to deal with the emergency.
- b. Call for help if needed.
- c. Call sheriffs office if spilled on road for traffic control and clean the spill immediately from the road and roadside if needed.
- d. Contain the spill or runoff from entering the stream or waterway using straw bales, saw dust, or soil material.
- e. If flow is coming from a tile, plug the tile with a tile plug immediately.
- f. Assess the extent of the emergency and determine how much help is needed.

Contacts to be made within 24 Hours of a Discharge

(SEE NEXT PAGE FOR REQUIREMENTS FOR FILING A WRITTEN REPORT)

Organization	Phone
Oregon Department of Agriculture	1-503-986-4700
Oregon Emergency Response System (ORES)	1-800-452-0311

Be prepared to provide the following information:

- a. Your Name (See next page)
- b. Farm Identification (See next page)
- c. Description of emergency.
- d. Estimate of the amounts, area covered, and distance traveled.
- e. Has manure reached surface waters or major field drains?
- f. Is there any obvious damage: employee injury, fish kill, or property damage?
- g. What is currently in progress to contain situation?

EMERGENCY RESPONSE PLAN

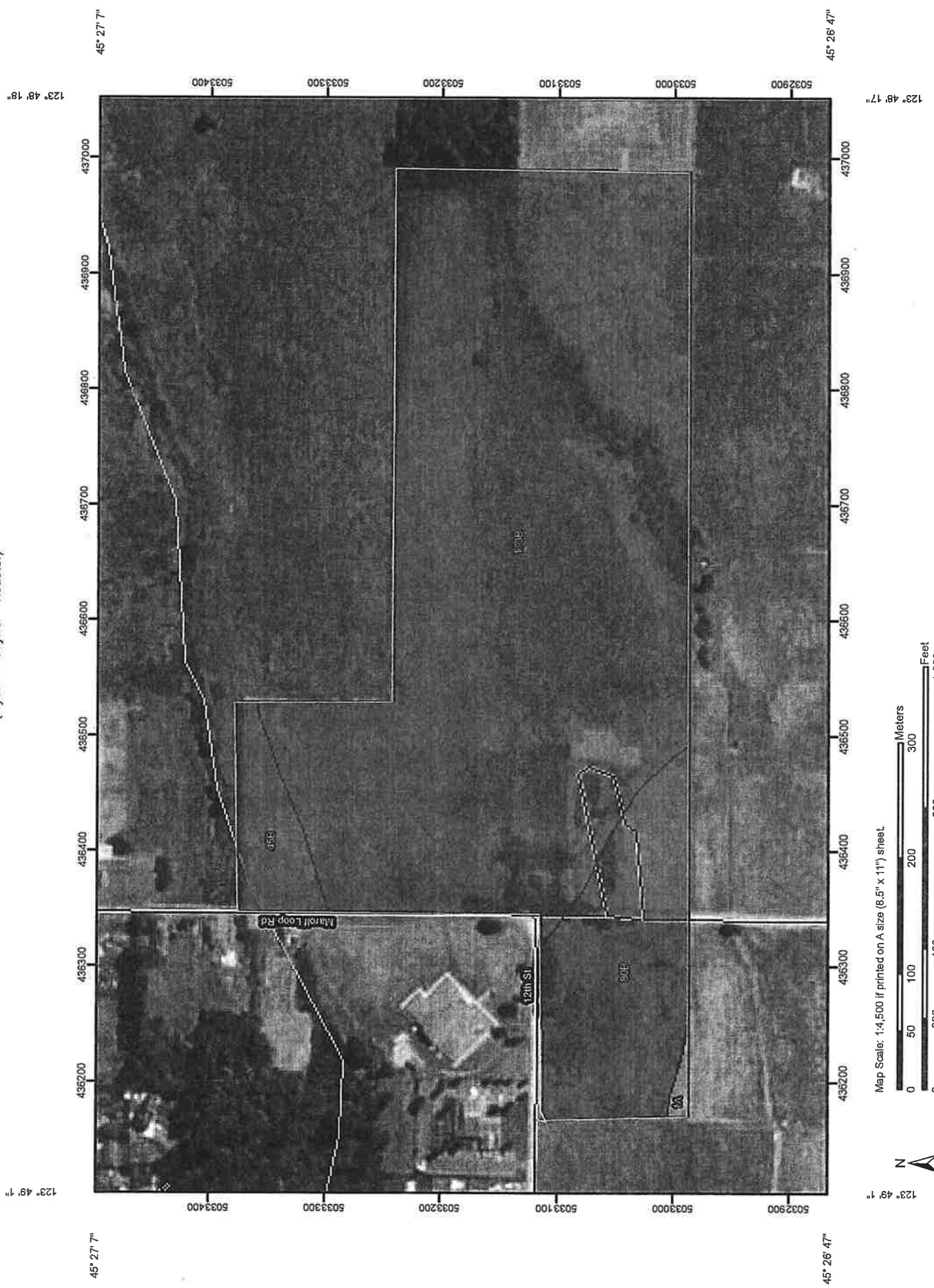
Emergency Contact Information

Farm Name	
Address	
Farm Phone	
Permit #	
DIRECTIONS TO FARM	
Emergency Phone Numbers:	
Alan Wachlin home	
Alan Wachlin cell	
FIRE or AMBULANCE	911

If a Discharge Occurs a Written Report is to be made by Owner or Operator to Oregon Department of Agriculture within 5 Days that contains the following information:

- a. A description and cause of the discharge.
- b. The period of discharge including exact dates, times and duration of discharge.
- c. An estimate of discharge volume.
- d. Name or location of receiving water.
- e. Corrective steps taken, if appropriate, to reduce, eliminate or prevent reoccurrence of the discharge.

Flooding Frequency Class—Tillamook County, Oregon
(Ryan & Freyne Lancaster)



MAP LEGEND

Area of Interest (AOI)
 Area of Interest (AOI)

Soils
 Soil Map Units

Soil Ratings
 None
 Very Rare
 Rare
 Occasional
 Frequent
 Very Frequent

Political Features
 Cities

Water Features
 Oceans
 Streams and Canals

Transportation
 Rails
 Interstate Highways
 US Routes
 Major Roads
 Local Roads

MAP INFORMATION

Map Scale: 1:4,500 if printed on A size (8.5" x 11") sheet.
 The soil surveys that comprise your AOI were mapped at 1:24,000.
 Please rely on the bar scale on each map sheet for accurate map measurements.
 Source of Map: Natural Resources Conservation Service
 Web Soil Survey URL: <http://websoilsurvey.nrcs.usda.gov>
 Coordinate System: UTM Zone 10N NAD83
 This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.
 Soil Survey Area: Tillamook County, Oregon
 Survey Area Data: Version 3, Feb 8, 2010
 Date(s) aerial images were photographed: 7/19/2005
 The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Flooding Frequency Class

Flooding Frequency Class— Summary by Map Unit — Tillamook County, Oregon				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
1A	Brenner silt loam, 0 to 1 percent slopes	Frequent	0.2	0.4%
45B	Hebo silty clay loam, 0 to 5 percent slopes	None	2.1	4.1%
80B	Quillamook medial silt loam, 0 to 7 percent slopes	None	7.5	14.3%
173B	Tillamook-Ginger medial silt loams, 0 to 7 percent slopes	None	42.3	81.2%
Totals for Area of Interest			52.1	100.0%

Description

Flooding is the temporary inundation of an area caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, and water standing in swamps and marshes is considered ponding rather than flooding.

Frequency is expressed as none, very rare, rare, occasional, frequent, and very frequent.

"None" means that flooding is not probable. The chance of flooding is nearly 0 percent in any year. Flooding occurs less than once in 500 years.

"Very rare" means that flooding is very unlikely but possible under extremely unusual weather conditions. The chance of flooding is less than 1 percent in any year.

"Rare" means that flooding is unlikely but possible under unusual weather conditions. The chance of flooding is 1 to 5 percent in any year.

"Occasional" means that flooding occurs infrequently under normal weather conditions. The chance of flooding is 5 to 50 percent in any year.

"Frequent" means that flooding is likely to occur often under normal weather conditions. The chance of flooding is more than 50 percent in any year but is less than 50 percent in all months in any year.

"Very frequent" means that flooding is likely to occur very often under normal weather conditions. The chance of flooding is more than 50 percent in all months of any year.

Rating Options

Aggregation Method: Dominant Condition

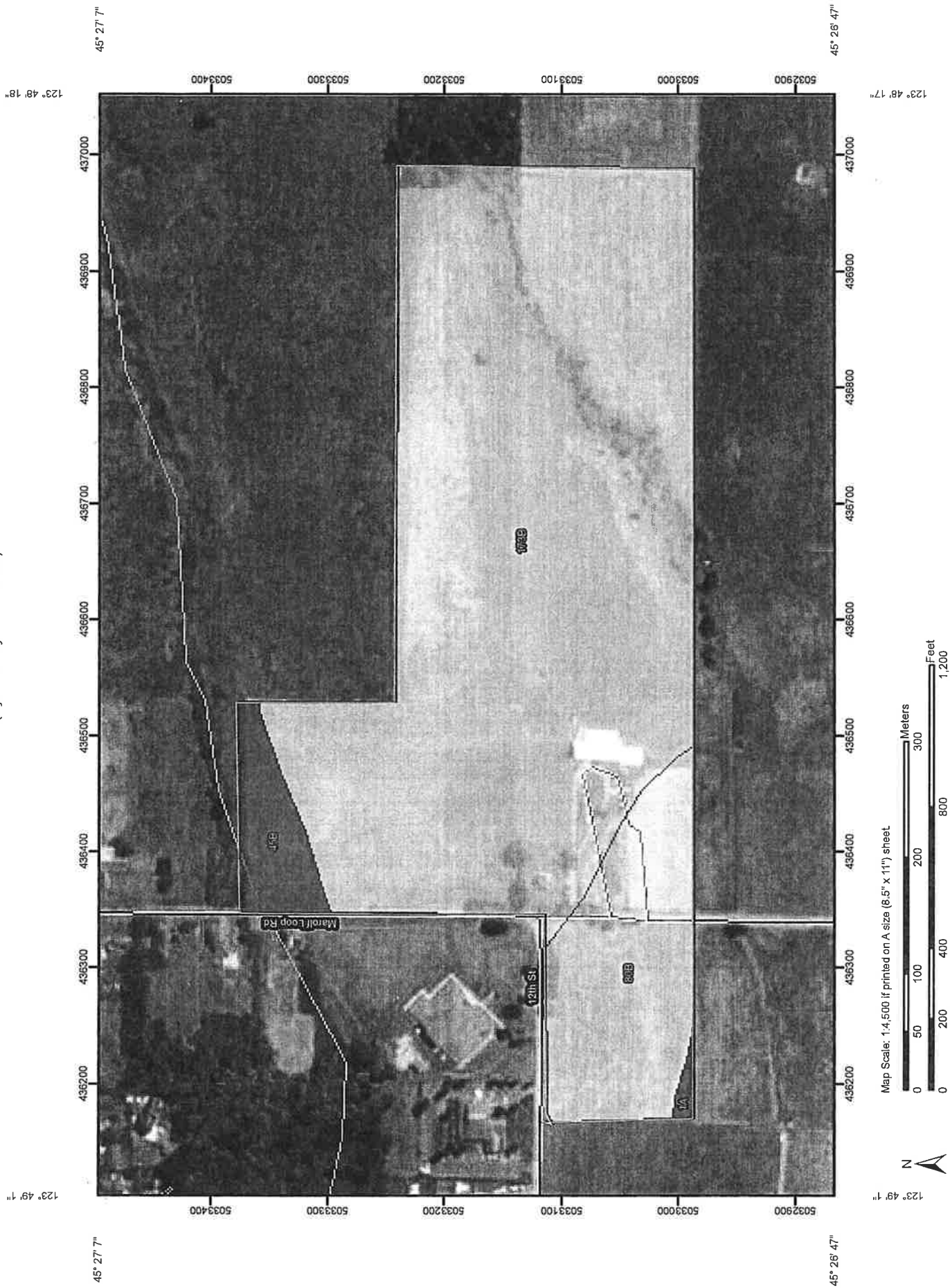
Component Percent Cutoff: None Specified

Tie-break Rule: More Frequent

Beginning Month: January

Ending Month: December

Manure and Food-Processing Waste—Tillamook County, Oregon
(Ryan & Freyne Lancaster)



Map Scale: 1:4,500 if printed on A size (8.5" x 11") sheet.

MAP LEGEND

Area of Interest (AOI)	
	Area of Interest (AOI)
Soils	
	Soil Map Units
Soil Ratings	
	Very limited
	Somewhat limited
	Not limited
	Not rated or not available
Political Features	
	Cities
Water Features	
	Oceans
	Streams and Canals
Transportation	
	Rails
	Interstate Highways
	US Routes
	Major Roads
	Local Roads

MAP INFORMATION

Map Scale: 1:4,500 if printed on A size (8.5" x 11") sheet.
The soil surveys that comprise your AOI were mapped at 1:24,000.
Please rely on the bar scale on each map sheet for accurate map measurements.
Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: <http://websoilsurvey.nrcs.usda.gov>
Coordinate System: UTM Zone 10N NAD83
This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.
Soil Survey Area: Tillamook County, Oregon
Survey Area Data: Version 3, Feb 8, 2010
Date(s) aerial images were photographed: 7/19/2005
The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Manure and Food-Processing Waste

Manure and Food-Processing Waste— Summary by Map Unit — Tillamook County, Oregon						
Map unit symbol	Map unit name	Rating	Component name (percent)	Rating reasons (numeric values)	Acres in AOI	Percent of AOI
1A	Brenner silt loam, 0 to 1 percent slopes	Very limited	Brenner (85%)	Depth to saturated zone (1.00)	0.2	0.4%
				Flooding (1.00)		
				Ponding (1.00)		
				Slow water movement (0.81)		
				Runoff (0.40)		
45B	Hebo silty clay loam, 0 to 5 percent slopes	Very limited	Hebo (80%)	Slow water movement (1.00)	2.1	4.1%
				Depth to saturated zone (1.00)		
				Ponding (1.00)		
				Too acid (0.68)		
				Runoff (0.40)		
80B	Quillamook medial silt loam, 0 to 7 percent slopes	Somewhat limited	Quillamook (80%)	Too acid (0.18)	7.5	14.3%
173B	Tillamook-Ginger medial silt loams, 0 to 7 percent slopes	Somewhat limited	Tillamook (45%)	Depth to saturated zone (0.99)	42.3	81.2%
				Too acid (0.73)		
				Slow water movement (0.30)		
Totals for Area of Interest					52.1	100.0%

Manure and Food-Processing Waste— Summary by Rating Value		
Rating	Acres in AOI	Percent of AOI
Somewhat limited	49.8	95.5%
Very limited	2.3	4.5%
Totals for Area of Interest	52.1	100.0%

Description

The application of manure and food-processing waste not only disposes of waste material but also can improve crop production by increasing the supply of nutrients in the soils where the material is applied. Manure is the excrement of livestock and poultry, and food-processing waste is damaged fruit and vegetables and the peelings, stems, leaves, pits, and soil particles removed in food preparation. The manure and food-processing waste are solid, slurry, or liquid. Their nitrogen content varies. A high content of nitrogen limits the application rate. Toxic or otherwise dangerous wastes, such as those mixed with the lye used in food processing, are not considered in the ratings.

The ratings are based on the soil properties that affect absorption, plant growth, microbial activity, erodibility, the rate at which the waste is applied, and the method by which the waste is applied. The properties that affect absorption include saturated hydraulic conductivity (Ksat), depth to a water table, ponding, the sodium adsorption ratio, depth to bedrock or a cemented pan, and available water capacity. The properties that affect plant growth and microbial activity include reaction, the sodium adsorption ratio, salinity, and bulk density. The wind erodibility group, soil erosion factor K, and slope are considered in estimating the likelihood that wind erosion or water erosion will transport the waste material from the application site. Stones, cobbles, a water table, ponding, and flooding can hinder the application of waste. Permanently frozen soils are unsuitable for waste treatment.

The ratings are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect agricultural waste management. "Not limited" indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. "Somewhat limited" indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. "Very limited" indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

The map unit components listed for each map unit in the accompanying Summary by Map Unit table in Web Soil Survey or the Aggregation Report in Soil Data Viewer are determined by the aggregation method chosen. An aggregated rating class is shown for each map unit. The components listed for each map unit are only those that have the same rating class as listed for the map unit. The percent composition of each component in a particular map unit is presented to help the user better understand the percentage of each map unit that has the rating presented.

Other components with different ratings may be present in each map unit. The ratings for all components, regardless of the map unit aggregated rating, can be

viewed by generating the equivalent report from the Soil Reports tab in Web Soil Survey or from the Soil Data Mart site. Onsite investigation may be needed to validate these interpretations and to confirm the identity of the soil on a given site.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

TILLAMOOK COUNTY
SOIL AND WATER CONSERVATION DISTRICT

**FILTER STRIP SPECIFICATION SHEET
CODE 393**

Landowner/Operator: Ryan & Freyne Lancaster

Job Location: T 1S; R 9W; Sec.32

County: Tillamook SWCD Tillamook Farm/Tract No. T-318

Field No. 4,5

Prepared By: Pedersen Date: 04/11

Purpose: To reduce manure runoff into an adjacent open watercourse and the resulting fecal and organic contamination in the watercourse.

Specifications:

- ⇒ A grass filter strip will be maintained adjacent to all open water courses. From April through October a five foot wide buffer strip will be maintained for solid manure applications and manure tank wagon applications that flow through the operations. A 45 foot wide filter strip for solid manure applications with a manure spreader and a liquid manure tank wagon will be maintained during the winter months.
- ⇒ No manure will be applied to the filter strip area.
- ⇒ Noxious weeds such as Tansy Ragwort and Canada Thistle are controlled in accordance with an Integrated Pesticide Management Plan.
- ⇒ Excessive accumulation of sediment and/or manure will be removed. The filter strip will be harrowed at least once each year prior to May 1st to shape and maintain at least a 1 % grade sloping away from the existing open water courses. Filter strip grade will be maintained to allow the runoff to occur along the entire length of the filter strip and not occur in only certain areas of the filter strip.
- ⇒ Depressions will be prevented from forming in the filter strip area where manure and sediment can be trapped.
- ⇒ Debris will not be allowed to accumulate in the filter strip.
- ⇒ Filter strips will be clipped, dragged, and or grazed at least twice during the growing season.
- ⇒ Grass will be at least 3 inches high by October 15th.

DESIGN APPROVAL

Design approved by: Robert A. Pedersen Date: 5-5-11

Job Title: CAFO PLANNER

Client Acknowledgement Statement:

The client acknowledges that:

- a. They have received a copy of this specification and under-stands the contents and requirements.
- b. It shall be the responsibility of the client to obtain all necessary permits and/or rights, and to comply with all ordinances and laws pertaining to the application of this practice.

Accepted by: /s/ [Signature] Date: 5-5-11

Certification:

I have completed a review and checked out the filter strip practice specifications and certify that the practice has been applied in accordance with specifications.

Certified by: /s/ _____ Date: _____

Job Title: _____

TILLAMOOK COUNTY
SOIL AND WATER CONSERVATION DISTRICT

**PRESCRIBED GRAZING SPECIFICATION SHEET
CODE 528**

Landowner/Operator: Ryan & Freyne Lancaster

Job Location: T 1S; R 9W; Sec. 28.32

County: Tillamook SWCD Tillamook County Farm/Tract No. T-318

Field No. 1-5

Prepared By: Pedersen

Date: 04/11

⇒ **Purpose:**

- ⇒ Improve or maintain the health and vigor of the forage stand
- ⇒ Maintain and improve water quality
- ⇒ Maintain or improve animal health and productivity.
- ⇒ Attain grazing and management efficiency to promote economic stability.

Specifications:

- ⇒ Pastures are managed to assure at least 20 tons at 30% dry matter is produced per acre per year.
- ⇒ Pastures are reestablished when forage yields fall below 12 tons at 30% dry matter per acre per year.
- ⇒ A rotational grazing system is used. A 21 day re-growth period is used during the normal years. During low rainfall years, the re-growth period varies between 30 to 35 days.
- ⇒ Noxious weeds such as Tansy Ragwort and Canada Thistle are controlled in accordance with an Integrated Pesticide Management Plan.
- ⇒ Pastures are clipped and dragged at least twice during the growing season.
- ⇒ Manure and commercial fertilizer applications are based on soil tests. Soil tests will be taken at least every 3 years. Nitrogen applications will not exceed 348 lbs. of nitrogen per acre per year unless soil tests and forage production justifies higher application rates.
- ⇒ Manure is applied to pastures in accordance with the enclosed Waste Utilization Conservation Practice and Nutrient Management Specification Sheets.
- ⇒ Spring grazing is delayed until the grasses have at least 6 inches of growth and the soil is firm.
- ⇒ Pastures are not grazed below 2 inches any time during the growing season.
- ⇒ Livestock are removed from the pastures in the fall when the ground becomes wet and the grasses have at least 3 inches of growth going into the winter.

DESIGN APPROVAL:

Design approved by: /s/ Robert A. Pedersen

Date: 5/5/11

Job Title: CAFO PLANNER

CLIENTS ACKNOWLEDGEMENT STATEMENT:

The client acknowledges that:

- a. They have received a copy of this specification and understands the contents and requirements.
- b. It shall be the responsibility of the client to obtain all necessary permits and/or rights, and to comply with all ordinances and laws pertaining to the application of this practice.

Accepted by: /s/ Ryan A. Frymire Date: 5-5-11

CERTIFICATION;

I have completed a review of the prescribed grazing practice and the specification's application and certify this practice has been applied.

Certification by: /s/ _____ Date: _____ b Title: _____

SOIL AND MANURE SAMPLING INSTRUCTIONS FOR ANIMAL WASTE MANAGEMENT SYSTEMS

SOIL SAMPLES

Job Sheet 5

Spring Soil Samples

- Spring soil samples are to be collected the last 2 weeks of March or the first 2 weeks in April when soils are not saturated.
- Soil samples are to be collected on fields that have not received manure applications within the last 30 days.
- Collect several samples (about 10 one-fourth cup samples) of soils from just below the thin sod layer to a depth of 6 to 9 inches and add to bucket.
- Mix the samples in the bucket and remove about 1 cup from the mixture and place into a sample bag.
- The bag should be labeled with ;
 - farm or operator name
 - sample date
 - field and tract (see NRCS plan map)
 - sample depth (0 to 9 inches)
 - soil type if determined
- Keep soil sample cool (small cooler with some ice) in the field until sample can be put in refrigerator or into freezer. Soil can be stored in refrigerator for up to 1 week or can be stored in a freezer for longer periods.
- Ship samples to lab (see shipping instructions below).

Fall Soil Samples

- Fall soil samples are to be collected during the last 2 weeks in September or the first 2 weeks in October on soils that are not saturated.
- Soil samples are to be collected on fields that have received normal manure applications during the current year.
- Sample soils and ship as outlined in the spring soil sample section above.

MANURE SAMPLES

Liquid Manure Samples

- Liquid manure samples should be sampled after agitating the storage facility for the first application made in the spring (March-April) and for the last application in the fall (September-October).
- Put a bucket in the path of the gun or carefully take bucket sample of liquid manure from the liquid manure tank wagon .
- Fill a sample bottle with some of the liquid manure from the bucket and keep cool while in the field. (you can put the sample in a small cooler with some ice)
- Label the sample with the farm or operator name, date, and liquid manure sample.
- Freeze the sample until ready to ship to the lab.

MANURE SAMPLES

Solid Manure Samples

- Solid manure samples should be sampled during the first application made in the spring(March-April).
- Lay a piece of tarp or plastic on the pasture and make a pass over or next to it to obtain a representative sample from the spreader.
- Scoop up enough material to fill the sample bag about half full.
- Label the sample with the farm or operator name, date, and solid manure sample.
- Keep the sample cool while in the field. (You can put the sample in a small cooler with some ice.)
- Freeze the sample until ready to ship to the lab.

SHIPPING INSTRUCTIONS

- Nitrogen is heat sensitive. Keeping the samples cool in shipping helps to improve reliability of data.
- Ship frozen soil samples in small cooler.
- If shipping refrigerated soil samples, it is recommended that these be shipped in a small cooler with ice.
- Ship frozen liquid or solid manure samples in a small cooler.
- Ship frozen soil samples or refrigerated soil samples with frozen liquid and/or solid samples in a small cooler. Lab should send cooler back to you if request them to do so.
- Ship any or all samples on Monday, Tuesday, or Wednesday using any parcel post service.
- Include a note with the samples for the analysis needed.

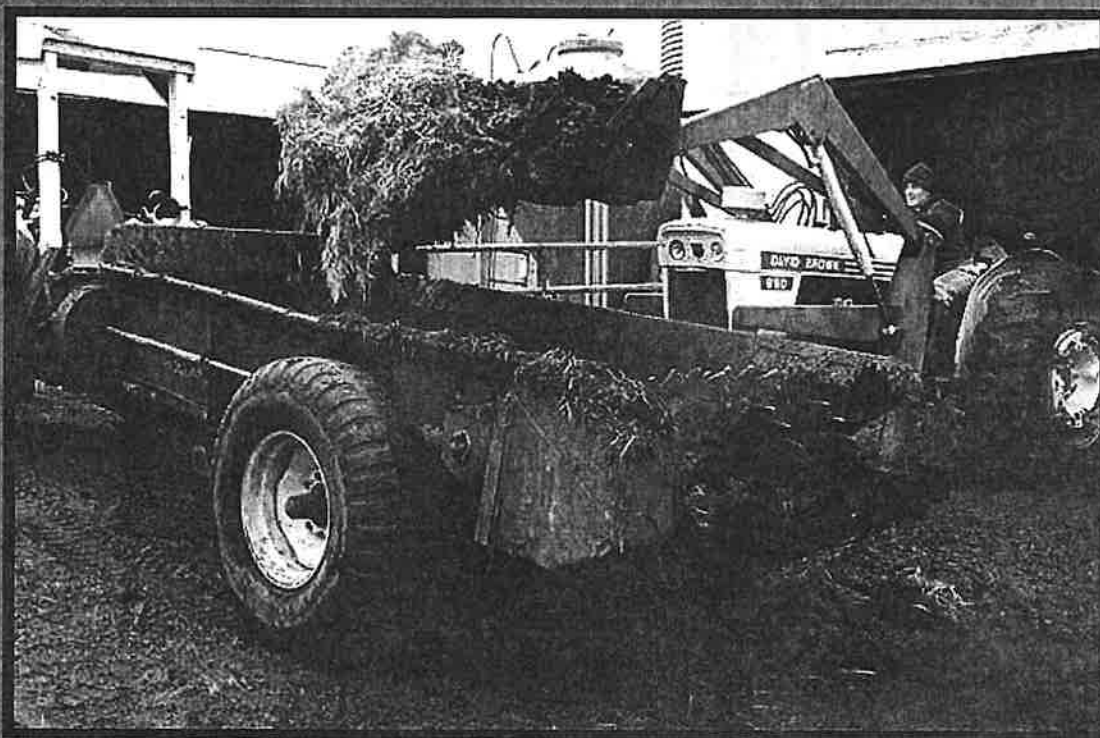
Soils Analysis Needed;

pH
P---Phosphorus (Weak Bray)
K---Potassium
NH₄-N---Ammonium
NO₃-N---Nitrate

Liquid and Solid Manure Analysis Needed;

Total Nitrogen, Phosphorus, & Potassium plus Ammonium and Solids

Estimating Plant-available Nitrogen from Manure



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Prepared by Dan M. Sullivan, Extension soil scientist, Oregon State University.

Nutrient management plans for crops require estimates of plant-available nitrogen (PAN) provided by application of manure or compost. Recent developments have stimulated interest in utilizing manure nitrogen (N) as a resource. These factors include the following:

- Increased cost of N fertilizers
- Increased value of PAN from manure on farms using certified organic methods to produce crops or animal products
- Greater concern for the environmental effects of ammonia and nitrate loss
- Development of manure application equipment that can reduce ammonia loss (increase retention of PAN)
- Federal cost-share programs (usually administered by the Natural Resources Conservation Service) that pay producers to adopt practices that reduce N loss to the environment
- Efforts to reduce phosphorus buildup in manure-fertilized soils (when manure N is used more efficiently, the manure application rate to meet P needs can be reduced)

How to Use This Publication

This publication focuses on how to estimate PAN provided by manure. We do not address management of other nutrients or other aspects of manure

management, such as manure sampling, calibration of application equipment, record-keeping, or post-application monitoring. See “For More Information” (page 19) for resources on these topics.

This publication is primarily designed for use by planners (agricultural professionals that assist farmers with nutrient management). We focus primarily on cropping systems west of the Cascades in Oregon and Washington.

This publication has two main parts:

1. Worksheet for calculating available nutrients supplied by manure application
2. Management practices that increase crop N utilization

The Worksheet can be used to do the following:

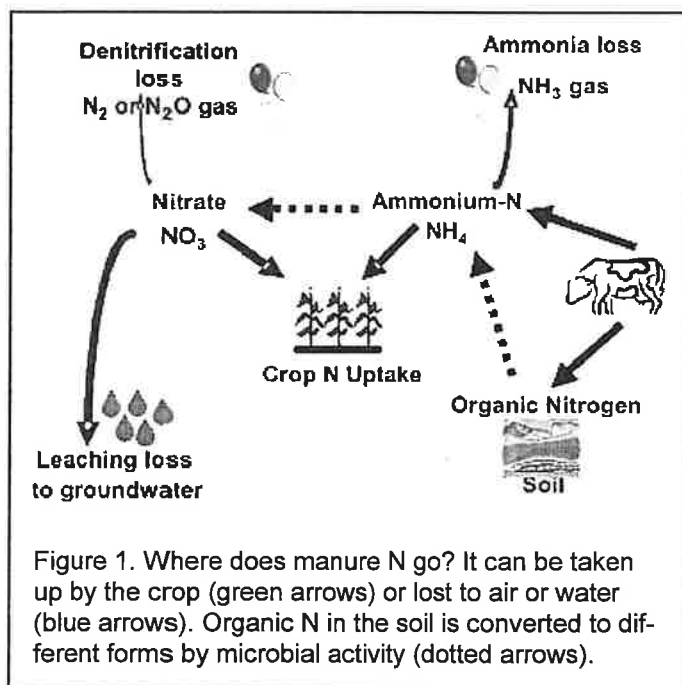
- Determine the manure application rate needed to supply a target amount of PAN
- Estimate the dollar value of PAN from the current year’s manure application
- Estimate the value of additional PAN retained by immediate tillage or direct application (injection, banding, etc.)
- Assess the balance between PAN, P, and K supplied by manure
- Get a rough, long-term (10-year) estimate of PAN availability from manure
- Evaluate management options to increase crop N utilization

Management practices discussed in the second section of this publication can help farmers reduce N loss to the environment (water and air) and may provide economic benefit to some farmers.

Nitrogen Forms and Cycling

The goal of N management is to efficiently deliver plant-available N (PAN) to a crop by maximizing crop utilization and minimizing losses to the environment. Plant roots take up nitrate and ammonium-N. Major losses of N to the environment occur when ammonia gas (NH_3) is lost to the air or nitrate (NO_3) is leached to groundwater. Losses of N via denitrification as N_2 or N_2O gas can be important under some conditions, but are generally small enough to be ignored in estimating PAN from manure.

Manures that contain mostly ammonium-N contain much PAN that is subject to volatilization (loss to the atmosphere) shortly after manure application. Manures that contain mostly organic N release much



less PAN in the short term, and must be managed as a long-term investment in soil building.

Efficient manure N management matches N supply to crop needs. Management can reduce ammonia loss to the atmosphere and nitrate leached to groundwater.

Introduction to the Worksheet

The Worksheet estimates:

- Nutrients supplied this year and their dollar value
- Ammonia-N lost and its value
- Amount of organic N stored in the soil from this year's manure application

The Worksheet uses manure N analyses for ammonium-N ($\text{NH}_4\text{-N}$) and organic N as starting points for calculations (instead of a "total N" book value). This approach allows site-specific adaptation of calculations.

To use the Worksheet, you will need:

- This year's manure analysis
- Planned manure application rate for this year
- Manure application rate and manure N analyses from previous years

If you don't have manure analysis data, you can still use the Worksheet, but the results will not be customized for your farm.

The Worksheet does have some limitations.

- It is not a complete planning tool for long-term nutrient management. The Worksheet is most useful for quick, "ballpark" estimates. It can be used by farm managers to adjust in-season application rates based on manure analyses.
- It is not a nitrogen recommendation or nitrogen budget (N budgets are used to estimate crop N need). You need to know how much PAN the crop needs before using the Worksheet.
- It allows input for only one kind of manure for the current year. If two types of significantly different manure will be applied, you can use the Worksheet twice and add the results together. (Take credit for manure applied in previous years only one time.) For complicated scenarios, the calculation method presented here is compatible with several software packages that are available for nutrient management planning.
- Worksheet estimates of PAN from manure should be regarded as rough estimates. Post-application

monitoring (crop yield, plant tissue tests, soil tests) are needed before adjusting manure management practices to fit site-specific conditions.

Nutrient Analysis of Manure

Typical values for manure nutrient content (book values) can be used for a general comparison of the nutrient content of different manure sources (e.g., chicken vs. horse manure). Manure nutrient composition depends on management practices, such as:

- Source and quality of livestock feed
- Water added to manure
- Type and amount of livestock bedding
- Manure storage method and length of storage

Because management practices vary substantially among farms, it is important to sample and test manure to determine its nutrient content.

For livestock farms that utilize manure on their own acreage, we recommend that you sample and analyze manure several times a year to develop a "running average" of manure nutrient content. Usually, it takes 2 to 4 years to develop a reliable estimate of average manure nutrient content and of the variability of nutrient content during the year. Several "quick test" meters can be used for on-farm monitoring of manure $\text{NH}_4\text{-N}$. The "Agros Meter" has been used in western Oregon and has accurately determined $\text{NH}_4\text{-N}$ in dairy manure. See "On-Farm Quick Tests" in the "For More Information" section for details.

The best time to sample manure is at the time of field application, because:

- Manure is well-mixed, so the sample is representative.
- The analysis will reflect changes in manure N concentration that occur during storage (volatilization) or in preparation for field application (agitation, mixing, and dilution with water).

For Worksheet input, you may choose to separate manure test results into two or more different groups (instead of averaging test results over the entire year). For example, you may want to average early-spring manure tests separately from midsummer tests.

To locate a suitable analytical laboratory, see *Laboratories Serving Oregon: Soil, Water, Plant Tissue, and Feed Analysis*, EM 8677 (listed in "For More Information").

Ask the laboratory to perform these analyses:

1. **Nitrogen:** total N and ammonium-N ($\text{NH}_4\text{-N}$). For compost only, also request an analysis for nitrate-N ($\text{NO}_3\text{-N}$). Other manures contain insignificant amounts of $\text{NO}_3\text{-N}$. To obtain an accurate value for manure $\text{NH}_4\text{-N}$, make sure the laboratory determines $\text{NH}_4\text{-N}$ on a fresh sample (not a dried sample). Most of the manure $\text{NH}_4\text{-N}$ is lost when samples are oven-dried.
2. **Phosphate and potash:** total P and total K. You will need analyses of P_2O_5 and K_2O for the Worksheet. Some labs report values in these units. If the lab reports only P, multiply P x 2.29 to calculate P_2O_5 . If the lab reports only K, multiply by 1.2 to calculate K_2O .
3. **Manure dry matter (DM) or total solids.** The laboratory determines this value by oven-drying manure. This value enables you to express manure nutrient content on a dry weight or wet weight basis. Also, if manure analyses using wet weight fluctuate over time, manure DM can be used to determine whether the variation is due to changes in moisture or changes in nutrient content.

Manure N Availability Values

The worksheet estimates plant-available N (PAN) as:

$$\text{PAN} = \text{NH}_4\text{-N retained after application} + \text{N mineralized from manure organic N in soil}$$

The amount of manure $\text{NH}_4\text{-N}$ retained is determined within the first week after application. In contrast, PAN is released from mineralization of manure organic N over a much longer period (Figure 2, page 7).

Estimating PAN from manure $\text{NH}_4\text{-N}$

Under some conditions, ammonium (NH_4) is readily transformed to ammonia (NH_3) and is lost as a gas (Figure 1, page 3). Nitrogen lost as ammonia reduces PAN supplied by manure.

Management practices affect the amount of ammonium-N retained after manure application (Table 1):

- **Time to manure incorporation.** The sooner manure is incorporated into soil, the more ammonium-N is retained. After manure is in contact with soil, it is held as non-volatile ammonium-N ($\text{NH}_4\text{-N}$).
- **Manure dry matter (DM).** When manure is not incorporated or injected, the proportion of

dry matter in manure determines the amount of ammonium-N retained. Solid manures remain on the soil surface, where most of the $\text{NH}_4\text{-N}$ is lost to the atmosphere. Lagoon water, on the other hand, infiltrates soil rapidly, retaining almost all of its manure $\text{NH}_4\text{-N}$. With slurries, some of the $\text{NH}_4\text{-N}$ infiltrates into the soil, and some remains with manure solids on the soil surface. The thicker the slurry, the less ammonium-N is retained.

Composting. The pH value of finished compost is near 7 (usually 6.5 to 7.5). At pH values below 7.5, N remains in the ammonium form and is not subject to loss as ammonia gas.

Table 1 estimates the amount of ammonium-N retained after field application. To use this table, you will need information on:

- Manure dry matter
- Method of application
- Number of days before manure is incorporated

To use Table 1, find the column representing the kind of manure (lagoon water, slurry, solid, or compost) you will apply. Use the “lagoon water” column for water pumped from secondary lagoons, even if the dry matter content is above 1 percent. Use the “thick slurry” column if manure has greater than 5 percent dry matter, but can still be pumped as a liquid. Use the “solid” or “solid poultry” column for manures that are applied with a solid manure spreader. Use the “compost” column for well-composted materials that have an earthy odor with no discernable ammonia odor. If you smell ammonia in a material sold as compost, use the “solid” manure column in Table 1.

Next, find the “time to incorporation” (left column in Table 1) that best describes the typical time elapsed between manure application and tillage. Because ammonia is lost rapidly after application, immediate shallow incorporation often conserves $\text{NH}_4\text{-N}$ more effectively than more intensive tillage the next day. When manure is broadcast, subsequent application of a half-inch of water via sprinkler irrigation or rainfall is considered as effective as tillage for moving $\text{NH}_4\text{-N}$ into soil (provided the soil is not saturated).

If you use a directed application method (injection or banding), choose one of the application options at the bottom of Table 1. See “Conserve $\text{NH}_4\text{-N}$ at application” (page 13) for additional information on directed incorporation methods.

Table 1. Estimated fraction of manure ammonium-N retained after application. Use the appropriate value from this table in Worksheet Step 3, "PAN from $\text{NH}_4\text{-N}$."

Time to incorporation ^a	Manure type and dry matter (DM) content					
	Lagoon water (< 1% DM)	Thin slurry (1–5 % DM)	Thick slurry (5–10% DM)	Solid (> 10% DM)	Compost	Solid poultry (> 10% DM)
	-----Fraction of manure $\text{NH}_4\text{-N}$ retained ^b -----					
Immediate incorporation (1 hr)	0.95	0.95	0.95	0.95	1.00	0.95
Incorporation 1 day after	0.95	0.70	0.60	0.50	1.00	0.70
Incorporation 2 days after	0.95	0.60	0.45	0.30	1.00	0.50
Incorporation 7 days after	0.95	0.55	0.40	0.20	1.00	0.40

Directed application methods:

Subsurface injection	0.95	0.95
Surface band (partial incorporation)	0.85	0.70
Surface band (no incorporation)	0.75	0.60

^a Tillage with harrow, cultivator, plow, etc. to incorporate manure, or overhead sprinkler irrigation (0.5 inch) after manure application.

^b Ammonium-N retention estimates for lagoon water, slurry, solid manure, and compost apply to all livestock manures except solid poultry.

Table 2. Estimating PAN from manure organic N. Use the appropriate value in Worksheet Step 3, "PAN from organic N."

PAN from organic N						
Manure	Manure dry matter (as applied)	Organic N applied this year	Organic N applied in previous years			
			1 year ago	2 years ago	3 years ago	4 to 9 years ago
-----Fraction mineralized to PAN-----						
Dairy cattle or other livestock						
Lagoon water	< 1% DM	0.40	0.15	0.07	0.03	0.02 per year
Thin slurry	1 to 5 % DM	0.40	0.15	0.07	0.03	0.02 per year
Thick slurry	5 to 10% DM	0.30	0.15	0.07	0.03	0.02 per year
Solid	> 10% DM	0.30	0.15	0.07	0.03	0.02 per year
Separated dairy solids or horse manure ^a		0.10	0.05	0.05	0.03	0.02 per year
Compost ^b		0.10	0.05	0.05	0.03	0.02 per year
Solid poultry						
	> 10% DM	0.50	0.15	0.07	0.03	0.02 per year

^aPAN for dairy solids from a mechanical separator. If separated solids come from gravity separation (settling basin or evaporation basin), use PAN values for the type of manure (lagoon water or slurry) that flows into the settling basin.

^b Stable or finished compost. A finished compost does not smell like ammonia, has a pile temperature less than 95°F (35°C), and often contains significant amounts of nitrate-N. Not all materials sold as compost meet these criteria.

Estimating PAN from mineralization of manure organic N

PAN is released from manure organic N through microbial activity in soil in a process called mineralization. This process is more rapid in soils that are warm and moist, and it is slower in soils that are cold or dry. Table 2 estimates the fraction of manure organic N that is released as PAN by mineralization.

Organic N mineralizes most rapidly during the first months after manure application. With time, the manure N mineralization rate slows. Figure 2 shows cumulative N mineralization for a variety of manures. The amount of N mineralized during the first year is strongly affected by the composition of manure (see "How Manure Composition Affects N Mineralization"). Mineralization rates for residual organic N (1 or more years after application) from many manures and composts are similar. However, it takes much longer for all of the manure organic N to mineralize from compost than from other manures.

The Worksheet (pages 11–12) tracks PAN from manure organic N over a 10-year period (Table 2). For the current year and for 1, 2, and 3 years ago, annual mineralization estimates are given. Long-term mineralization (4 to 9 years ago) is estimated at 2 percent per year and summed over the number of years (years manure applied $\times$ 0.02 per year). Table 3 shows examples of estimated N mineralization for manure (page 8) applied 4 to 9 years ago.

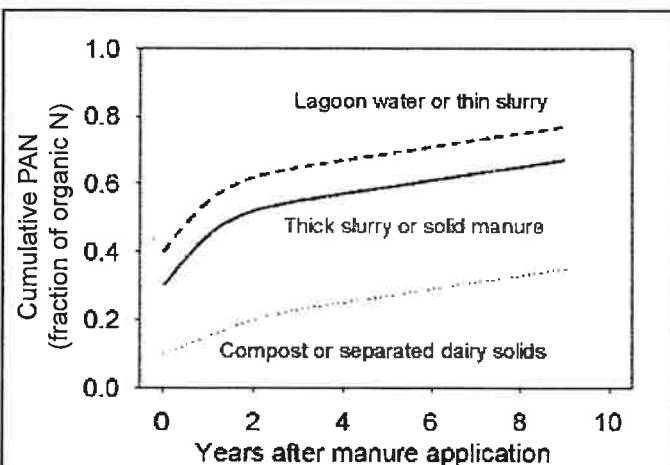


Figure 2. Cumulative PAN supplied by manure organic N, using the mineralization factors presented in Table 2. For this example, manure was applied in Year 0, with no subsequent manure applications. Slow release of PAN from mineralization continues beyond the 10-year period shown in the graph.

How Manure Composition Affects N Mineralization

The rate of mineralization in soil depends upon the "digestibility" of manure organic matter and its carbon:nitrogen (C:N) ratio. Separation of whole manure into liquids and solids segregates coarse and fine manure particles that have different organic composition and different mineralization rates. Fine particles in manure contain organic compounds with low C:N ratios (high protein) and are rapidly decomposed in soil. Coarse particles have higher C:N ratios (lower protein) and are more slowly decomposed in soil.

Because thin slurry and lagoon water contain the finest organic particles, these materials have the most rapid N mineralization rate. Thick slurry and solid manures contain a mixture of fine and coarse particles, so they have a lower N mineralization rate.

Solids separated from liquid manure by a mechanical separator (separated dairy solids) contain mostly coarse particles (bedding plus undigested feed). These solids have a unique pattern of mineralization over time in soil. Separated solids typically have negative N mineralization rates (PAN in soil decreases) for 4 to 8 weeks after application. After that, PAN is mineralized very slowly. Cumulative PAN from separated solids is much lower than for other fresh manures. The timing and amount of PAN release from horse manure is similar to that from separated dairy solids.

Separation of solids from liquid manure by gravity separation (settling basin or evaporation basin) does not change PAN, because the fine organic particles in the manure are recovered from the basin.

Composting manure reduces manure volume by 50 percent or more. During composting, some of the manure N is lost as ammonia gas, and some is transformed to more stable organic compounds. Compost organic matter decomposes very slowly in soil. Cumulative PAN for compost organic matter is similar to that of separated dairy solids.

Fresh poultry manure or broiler litter contains some organic N in the form of uric acid (similar to urea). In soil, uric acid is converted to PAN in 1 to 2 weeks. Most broiler litter sold as "compost" in western Oregon contains uric acid and behaves more like fresh litter than compost in terms of N availability. If you can smell ammonia in broiler litter, it probably is not thoroughly composted. Dry-stacking of broiler litter does not provide adequate moisture for composting.

Table 3. Examples: Mineralization factors for estimating PAN from manure applied 4 to 9 years ago.

Manure application frequency	Calculation	Mineralization factor to use for "4 to 9 years ago" in Worksheet
Annual (6 out of 6 years)	0.02 per year x 6 years	0.12
5 out of 6 years	0.02 per year x 5 years	0.10
3 out of 6 years	0.02 per year x 3 years	0.06
1 out of 6 years	0.02 per year x 1 year	0.02

Worksheet Instructions and Example Data Inputs

Input your data in the yellow worksheet cells. The Worksheet automatically calculates the values in the green cells.

The Worksheet shows "example" calculations for dairy slurry. The example is provided to help you follow the steps in the calculation. It is **not** a recommendation for manure application rate.

The mini-worksheets below include only the input data. You can use these mini-worksheets to assemble your manure and field management data before using the Worksheet. **The Worksheet has six steps.**

Step 1. Enter manure data.

Instructions

- Enter the kind of manure and the measurement units used for manure application. The Worksheet is not designed for use with more than one kind of manure for "this year." If you will apply more than one kind of manure this year, repeat the process with additional blank Worksheets.
- Enter analysis values for manure on an "as-is" or wet weight basis. If laboratory analysis units are different than field application units, see Table 5 (page 18) for conversion factors. For compost only: enter the compost $\text{NH}_4\text{-N} + \text{NO}_3\text{-N}$ analysis value in the Worksheet " $\text{NH}_4\text{-N}$ " box.
- Enter solids fraction in manure: 5% DM (dry matter) = Solids fraction of 0.05

Example input data (Step 1)

	Example	Your information
Kind of manure	Thin dairy slurry	
Field application units (choose one)		
Per ton (solid or semi-solid manure)		
Per 1,000 gallons (slurry)	X	
Per acre-inch (lagoon or holding pond effluent)		
This year's manure analysis ^{a, b, c}		
Total N	10 lb/1,000 gal	
Ammonium-N ($\text{NH}_4\text{-N}$)	6 lb/1,000 gal	
Phosphate (P_2O_5)	7 lb/1,000 gal	
Potash (K_2O)	16 lb/1,000 gal	
Manure solids fraction (dry matter percentage ÷ 100)	0.03	

^a Input "as-is" or wet weight manure analysis data.

^bEnter only "lb nutrient" if the manure analysis is in units of "lb nutrient per 1,000 gallons." For example, you would enter total N of "8" for a manure analysis of "8 lb/1,000 gallons."

^c If laboratory analysis units are different than field application units, see Table 5 for conversion factors.

^dThe Worksheet calculates this figure automatically for this year's manure application.

Step 2. Calculate manure N applied.

Instructions

- Enter the manure application rate planned for this year and this year's manure organic N analysis.
- Enter manure application rate and organic N analyses for manure applied in previous years.

Example input data (Step 2)

This year's manure application:

Rate = 20,000 gal/acre

Manure organic N applied in previous years:



	Example	Example	Your information	Your information
	Manure application rate	Manure organic N analysis ^a	Manure application rate	Manure organic N analysis
Year	(units/acre)	(lb/unit)	(units/acre)	(lb/unit)
1 year ago	25,000 gal/acre	9 lb/1,000 gal		
2 years ago	15,000 gal/acre	5 lb/1,000 gal		
3 years ago	10,000 gal/acre	7 lb/1,000 gal		
4 to 9 years ago	15,000 gal/acre	6 lb/1,000 gal		

^aEstimate from past manure analyses. Organic N = total N - $\text{NH}_4\text{-N}$.

Step 3. Estimate plant-available N (PAN) supplied by manure.

Instructions

Enter appropriate fractions for $\text{NH}_4\text{-N}$ retention (Table 1, page 6) and fraction of organic N mineralized (Table 2, page 6).

Example input data (Step 3)

- Method of manure application: surface broadcast (splash plate)
- Time to incorporation by tillage or by 0.5 inch overhead sprinkler application: no incorporation within 7 days
- Fraction $\text{NH}_4\text{-N}$ retained at application (Table 1) = 0.55
- Fraction of organic N mineralized (Table 2)

Fraction of $\text{NH}_4\text{-N}$ retained at application	
Example	Your information
0.55	

	Fraction of organic N mineralized	
Year	Example	Your information
This year	0.40	
1 year ago	0.15	
2 years ago	0.07	
3 years ago	0.03	
4 to 9 years ago (application every year)	0.02 per year x every year (6 years) = 0.12	

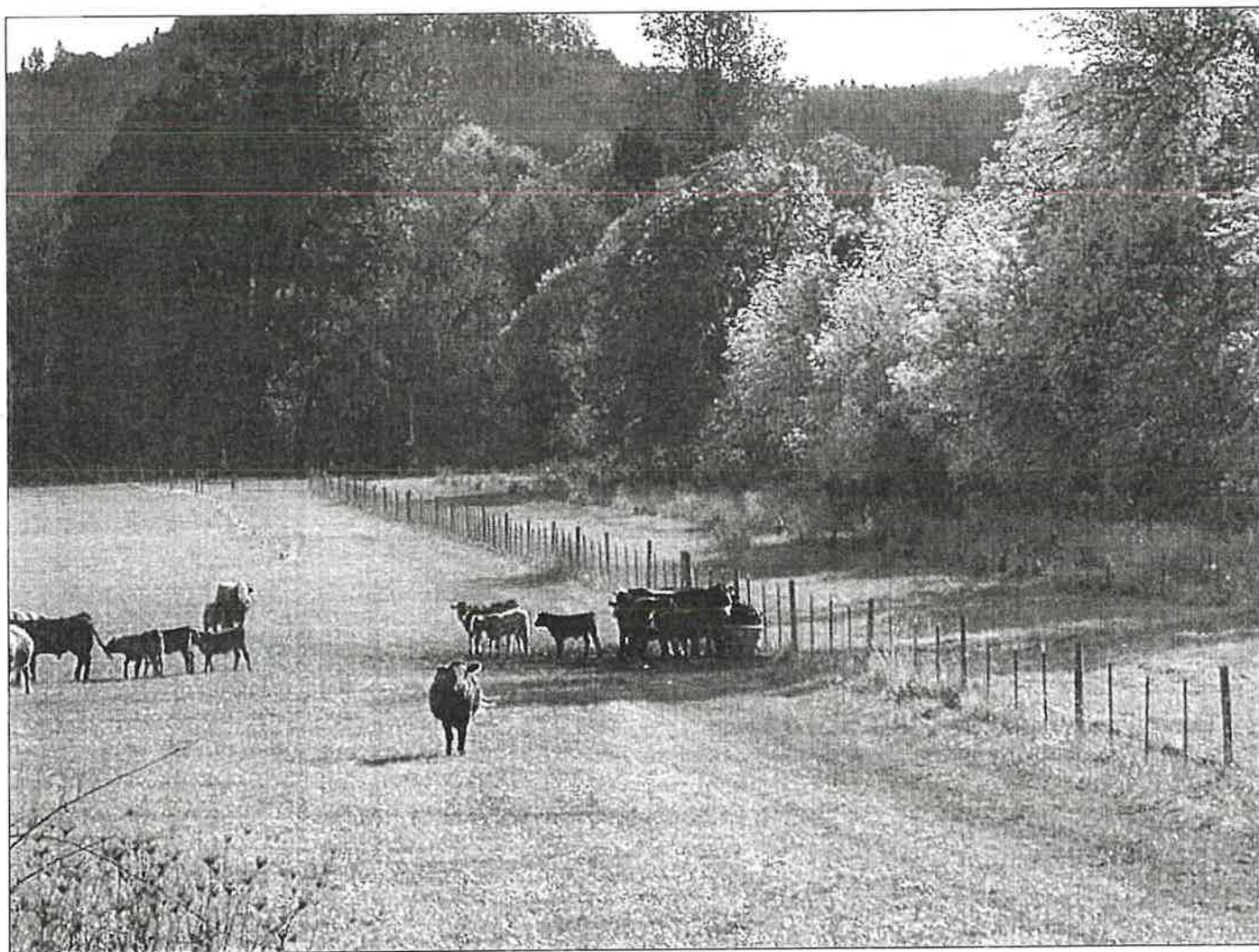
Steps 4–6. Plant available nutrients and their values.

Instructions

These steps show plant-available N, P, and K provided at the selected manure application rate. You can enter local values for cost of nutrients from commercial fertilizer to get an estimate of the value of manure nutrients. Because manure is an excellent source of P and K, it has the greatest value when applied to soils that test “low” or “medium” in plant-available P and K. If your soil test values are “high” or “excess,” adding additional P or K will not have economic benefit.

Example input data

	Example	Your information
Nutrient	Nutrient price (\$/lb nutrient)	Nutrient price (\$/ lb nutrient)
Phosphate (P_2O_5)	\$0.40/lb	
Potash (K_2O)	\$0.24/lb	
Nitrogen (N)	\$0.50/lb	



Worksheet: Estimating plant-available N from manure

Input cells are yellow.

(Calculations are done for you in green boxes. (These cells contain equations.)
Final results for total PAN, P_2O_5 , and K_2O are highlighted in blue text.

Note: The yellow cells contain example data. Replace the information in these cells with your own data. Before entering your data in the yellow cells, we recommend entering "0" in all yellow cells (to make sure you don't accidentally use the "example" data).

Step 1. Enter manure data

Instructions: Choose the manure application units that will be used throughout this worksheet.

Kind of manure

Choose manure application unit

Is wet manure measured in :

- ☐ ton (solid or semisolid manure)?
☒ 1000 gallons (slurry or liquid)?
☐ acre-inches (lagoon or holding pond effluent)?

Instructions: Enter "as-is" or "wet weight" manure analysis. If units are "lb nutrient/1000 gal," enter only "lb nutrient" in the boxes below.

This year's manure analysis

Nitrogen (N), lb/unit

Your values	Example
Total N	10 lb/1000 gal
NH_4-N	6
Organic N	4

This year's manure analysis

Phosphate (P_2O_5) and potash (K_2O), lb/unit

Your values	Example
P_2O_5	7
K_2O	16

This year's manure analysis

Manure solids and moisture

Fraction	Your values	Example
Solids or DM	0.03	0.03
Moisture	0.97	0.97
Total	1.00	1.00

Your information

Thin dairy slurry

Example

Thin dairy slurry

Step 2. Calculate manure N applied.

Instructions: Enter manure application rate for this year. Use application units chosen in Step 1.

Your value

units/acre

Example

20,000 gallons

Instructions: Enter manure rate and manure analysis for 1–9 years ago.

Application rate selected

Ammonium-N applied this year

Manure rate (units/acre)	NH_4-N analysis (lb/unit)	NH_4-N applied (lb/acre)
20,000 gal x 6 lb/1000 gal =	6	120

From manure analysis (this year):

6 lb NH_4-N per 1000 gallons

Organic N applied this year

Manure rate (units/acre)	Organic-N analysis (lb/unit)	Organic-N applied (lb/acre)
20,000 gal x 4 lb/1000 gal =	4	80

From manure analysis (this year):

4 lb organic N/1000 gal

Organic N applied in previous years

Year	Manure rate (units/acre)	Organic N analysis (lb/unit)	Organic N residual (lb/acre)
1 year ago	25,000 gal x 9 lb/1000 gal =	9	225
2 years ago	15,000 gal x 5 lb/1000 gal =	5	75
3 years ago	10,000 gal x 7 lb/1000 gal =	7	70
4 to 9 years ago	15,000 gal x 6 lb/1000 gal =	6	90

Manure organic N analysis (lb/1000 gal):

9 (1 year ago), 5 (2 year ago), 7 (3 year ago)

Estimated manure organic N 4 to 9 years ago = 6 lb/1000 gal

Note: We recommend turning off the following

options in Acrobat Reader:

- Show border hover color for fields
- Auto-complete

To turn off these options, choose Preferences from the

Edit menu (PC) or File menu (Mac). In the Preferences dialog box, choose Forms from the left-hand menu. Then make sure the buttons for these options are clicked OFF.

ate plant-available N (PAN) supplied by manure
Instructions: Consult Tables 1 and 2, and choose appropriate values for manure $\text{NH}_4\text{-N}$ retained and organic-N mineralized.

PAN (from $\text{NH}_4\text{-N}$)			
$\text{NH}_4\text{-N}$ applied (lb/acre)	Fraction retained (Table 1)	PAN (lb/acre)	
120	0.55	66	
120	0.55	66	

Surface applied
 not incorporated

PAN (from organic N applied this year)			
Organic N applied (lb/acre)	Fraction mineralized to PAN (Table 2)	PAN (lb/acre)	
80	0.4	32	
80	0.40	32	

Thin dairy slurry

PAN (from residual organic N)			
Year	Organic N residual (lb/acre)	Fraction mineralized to PAN (Table 2)	PAN (lb/acre)
1 year ago	225	0.15	34
2 years ago	75	0.07	5
3 years ago	70	0.03	2
4 to 9 years ago	90	0.12	11
4 to 9 years ago	90	0.12	11

4 to 9 years ago: manure applied annually
 Years 4 to 9, fraction mineralized = $0.02/\text{year} \times 6 \text{ years} = 0.12$

Step 4. Sum plant-available N (PAN) supplied by manure application

(PAN from this year + PAN from residual manure organic N)	
PAN from NH ₄ -N (lb/acre)	PAN from this year's organic-N (lb/acre)
66	32
66	32
+	+
PAN from residual organic N (lb/acre)	Total PAN (lb/acre)
52	150
52	150

Step 5. Phosphate (P_2O_5) and potash (K_2O) supplied by this year's manure application, and its fertilizer value

Instructions: Enter local \$ value for phosphate (P_2O_5) and potash (K_2O).

Instructions: Enter local \$ value for phosphate (P_2O_5) and potash (K_2O).
 Note: Manure P and K have value when soil test values are "low" or "medium." When P and K soil test values are "high" or "excess," value of P and K is zero or negative.

Phosphate (P ₂ O ₅)			Potash (K ₂ O)		
Manure rate (7/lac)	P ₂ O ₅ analysis (lb/unit)	P ₂ O ₅ applied (lb/acre)	Manure rate (7/lac)	K ₂ O analysis (lb/unit)	K ₂ O applied (lb/acre)
20,000 gal × 7	140	140	20,000 gal × 20	320	320
	× \$0.40	× \$0.40		× 16 lb/1000 gal	× \$0.24
	= \$56	= \$56			= \$77
					= \$77

Step 6. Estimated fate of this year's manure N, and its fertilizer value

Instructions: Enter local \$ value for fertilizer N.

[illegible]

Management to Increase Crop N Utilization

Conserve manure $\text{NH}_4\text{-N}$ at application

Directed application methods reduce exposure of slurry to the atmosphere, which reduces ammonia loss. When properly done, directed application increases $\text{NH}_4\text{-N}$ retention, reduces odor, decreases the risk of manure runoff from the field, and allows for greater manure application uniformity. Directed application methods do not require a separate tractor trip across the field for slurry incorporation. Directed application methods (Figures 3 and 4) include:

- Injection below the soil surface
- Surface banding; placement of slurry in a line (band) on the soil surface
- Surface banding with partial incorporation of slurry into soil with a tillage implement

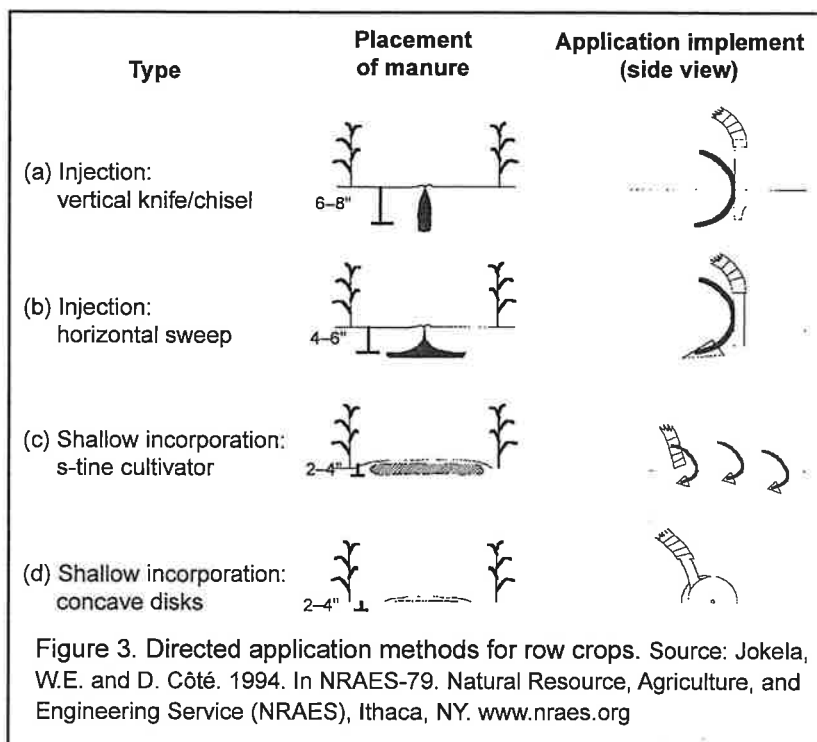
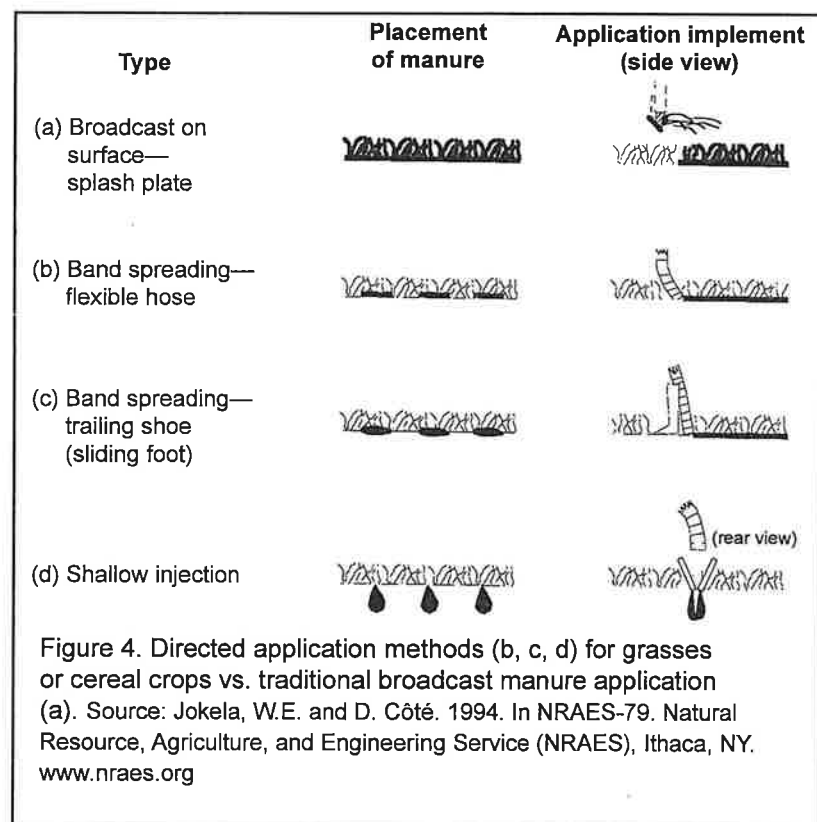
Many equipment configurations are available. Slurry is supplied to tractor-mounted application equipment through a drag hose or from a tanker. Many directed application methods are suitable for use with no-till or reduced tillage cropping systems.

Because surface banding does not completely cover slurry with soil, it does not increase $\text{NH}_4\text{-N}$ retention as much as does injection (Table 1). However, surface banding methods require less power, are faster, and cause less damage to established grass than injection. An excellent discussion of advantages and limitations of various directed application systems (with photos) is provided in *Advanced Silage Corn Management* (Bittman and Kowelenko, 2004).

Equipment alternatives are discussed below and illustrated in Figures 3 and 4.

Preplant or side-dress for row crops (Figure 3). With this kind of equipment, one injection slot is made for each crop row. Options include:

- Deep injection (4 to 8 inches) into soil with a hose mounted on a knife or chisel (Figure 3a).



- Injection with a sweep (4 to 6 inches depth)—this kind of injection has a wider application zone (Figure 3b).
- Shallow injection (2 to 4 inches) into soil, followed by shallow tillage with tines or discs (Figure 3c and 3d).

Surface band application in established grass (Figure 4). Slurry is placed in a line (band) on the soil surface. For best results, surface bands need to be close together (3 to 6 inches apart) and placed under crop residues. A “sleigh foot applicator” is one type of surface banding implement that has been tested extensively in coastal British Columbia. (The “sleigh” is pulled across the soil surface like Santa in his sleigh.) The “sleigh foot” applicator is similar to a “trailing shoe” or “sliding foot” applicator (Figure 4c). A recent innovation has combined aerator tines with sleigh foot application (Bittman and Kowelenko, 2004). The aerator tines make small holes or slots that encourage rapid slurry infiltration and improve $\text{NH}_4\text{-N}$ retention.

Limitations of directed application methods include:

- More labor, fuel, equipment, and expertise are required than for broadcast surface application.
- Requires driving on the field, which may be impractical during wet spring months.
- When manure is supplied by a tanker, row length must be matched to tanker volume to avoid “driving empty.”
- Requires closely spaced bands (3 to 6 inches between bands) when application is made to grass.
- When injection slots are spaced far apart, injected slurry may move deeper than desired, or may move to the soil surface. This problem can be overcome by limiting the slurry application rate.
- If manure is supplied by a tanker, an equipment turn-around area usually is needed at the top and bottom of the field.
- Injection may increase N loss from leaching and denitrification in some situations.
- Injection slots may channel runoff, causing increased erosion.

Schedule manure applications to minimize N leaching loss

The manure application date affects the efficiency of crop uptake of PAN supplied by manure (Table 4, page 15). The PAN values estimated in the Worksheet (pages 11–12) assume that manure is applied during months when crop N utilization is “medium” to “high.” When crop utilization is “low” or “very low” (Table 4), a substantial portion of PAN is likely to be lost by leaching before it can be utilized by the crop. Crop N utilization estimates given in Table 4 assume that:

- Manure application rate is not excessive.
- Manure application does not cause significant damage to soil (compaction) or crop (smothering).

Most crops have the greatest ability to take up N before it can be lost by leaching below the root zone when manure is applied in spring or summer. Nitrate-N already present in the soil in the fall usually is sufficient to support winter cover crop establishment, so applying manure to cover crops in the fall generally is not an efficient use of manure N. However, winter crops often can utilize manure N applied in early spring (February–March). Crop utilization of manure PAN is lowest when manure is applied in fall to fallow ground or corn stubble.

Crop N utilization values given in Table 4 do not apply to well-composted manures or to dairy solids removed by a mechanical separator. These materials release PAN slowly and in small amounts, reducing the importance of season of application.

Although crop N utilization is “medium” for fall or winter application to grass, manure or compost application may cause excessive runoff of phosphorus or bacteria from the field. Consider contacting a crop consultant or the Natural Resources Conservation Service for help in identifying grass fields that are suitable for winter manure application.

Table 4 does not specify a method of manure application. At times of the year when crop N utilization is “medium,” “high,” or “very high,” you can gain the most benefit from manure application methods that conserve $\text{NH}_4\text{-N}$. When crop N utilization is “low” or “very low” (Table 4), changing the manure application method will **not** improve crop N utilization.

Table 4. Effect of the timing of manure application on crop N utilization for crops grown west of the Cascades.^a Best utilization of manure N = “high.”

Crop	Manure application date				
	March	April–June	July	August	September–February ^b
Crop N uptake utilization of first-year PAN ^{c, d}					
Corn for silage	Medium	High	Medium	Low	Very low
Grass pasture or grass for silage	High	High	High	Medium	Medium
Cereal or grass winter cover crop	High	Medium (April), very low (May–June)			Low
Grass seed crop	High	Medium (April), very low (May–June)	Medium (postharvest)	Medium	Medium
Summer annual forage crop (e.g., sudangrass)	Medium	High	High	Medium	Very low

^a Excludes mechanically separated dairy solids and composts. These materials have “medium” or “high” crop N utilization because they release PAN slowly and in small amounts.

^b September–February applications are not recommended where significant surface runoff is expected.

^c PAN = First-year plant-available N from manure application.

^d PAN utilization estimate given assumes that manure application rate is adequate, but not excessive, and that manure application does not cause significant damage to soil (compaction) or crop (smothering).

Take advantage of increased soil N mineralization rates

Repeated manure applications gradually increase the amount of PAN supplied from mineralization of residual organic N (manure organic N applied 1 or more years ago). This process is part of “soil building.” The annual quantity of N mineralized from manured soils (in the absence of current-season manure application) typically is 1.5–2 times greater than from unmanured soils with similar soil and crop management regimes. This boost in soil N mineralization is accounted for in the Worksheet (pages 11–12) as “PAN from residual organic N.”

Studies of soil biota (soil animals, nematodes, fungi, bacteria, etc.) show adaptation to repeated manure application. Biota communities adapted to manured soil typically have greater capacity to break down organic N compounds in manure that generally are resistant to decomposition. The proliferation of soil biota in manured soils also often improves soil tilth, which can increase root growth and crop N utilization. These changes in soil biota and tilth also contribute to “residual” manure effects (increasing PAN supply for the crop).

The rate of PAN release from residual organic N (1 or more years after manure application) is strongly affected by soil moisture and soil temperature, but it is not affected much by the kind of manure or compost applied the previous year. With irrigation, N mineralization rates are 2 to 4 times faster during the summer than during the cool season (October–March). Because soil is moist but not frozen for most of the winter at sites west of the Cascades, a small, but significant, amount of N mineralizes between October and March.

To take full advantage of PAN from soil organic matter mineralization, the field must have vegetative cover during the October–March period. Otherwise, nitrate-N released via mineralization during this period is likely to be lost by leaching. On fields with a history of frequent manure application, perennial grass growth typically continues for several weeks longer in the fall, and begins earlier in the spring, than on unmanured fields (even if manure was not reapplied in the early spring). The most significant long-term impact of manure application is evident in early spring (February and March) grass growth.

Crop rotation strongly affects PAN release from residual organic N. When rotating from perennial

The Environment and N Loss from Manures—Why Do We Care?

Plant-available N (PAN) losses from the soil represent lost fertilizer value. Nitrogen can be lost as ammonia, nitrate, or nitrous oxides (Figure 1, page 3). Besides losing a valuable resource, the lost PAN can contribute to off-site problems.

Ammonia lost to the atmosphere is an air pollution problem in some areas of the western U.S., particularly in winter when atmospheric inversions prevent air mixing. In the atmosphere, ammonia can react with dust and other compounds to reduce visibility and to acidify rain or fog. Ammonia emissions may contribute to:

- Human health problems (inhalation hazard)
- Changes in natural plant communities in forests and rangeland. (Nitrogen deposited in N-poor ecosystems can alter the balance between adapted species and N-loving invasive species.)
- Acid fog or rain damage to limestone buildings or cultural artifacts (for example, petroglyphs on limestone)
- Reduction in visibility (haze)

Nitrate moves with soil water. Nitrate lost from soil enriches groundwater or surface water and can contribute to:

- Human health problems (blue baby syndrome, elevated cancer risk)
- Algae blooms in lakes or other slow-moving bodies of water
- Reduced survival and reproduction of some amphibians

Nitrous oxides lost to the atmosphere through denitrification can contribute to:

- Human health problems (inhalation hazard)
- Global warming (A molecule of nitrous oxide (N_2O) traps approximately 300 times more heat than a molecule of carbon dioxide.)
- Increased N deposits in sensitive ecosystems, resulting in soil acidification or change in plant communities
- Reduction in visibility (haze)

grass or alfalfa to a row crop, a large amount of PAN is mineralized during the first 6 months following tillage. Tillage aerates the soil and breaks up soil aggregates that protect organic N from soil biota. Lower rates of PAN addition are required for most row crops following plow-down of a perennial grass sod. When grass sod is plowed down in the fall, a substantial amount of N is lost over the winter through leaching.

Supply only a portion of crop N need from manure

One of the most efficient N management strategies for row crops is to supply only 50 to 70 percent of planned crop N need with manure. Then, side-dress with N fertilizer at midseason if needed (based on soil nitrate test results). This practice improves crop N utilization by:

- Supplying PAN when the crop needs it
- Minimizing the accumulation of PAN at the end of the growing season
- Allowing some margin for error in estimating PAN release from manure

Because less manure is applied, this practice will also reduce accumulation of manure P and K in soil. See OSU Extension publication EM 8832 (listed in "For More Information") to learn how to collect and interpret data from a midseason soil nitrate test.

Questions and Answers

Is the calculation method used for PAN in this publication different from that used in the "Organic Fertilizer Calculator"?

The Organic Fertilizer Calculator (OSU Extension publication EM 8936-E) is primarily designed to assist organic farmers who are purchasing manure or other organic fertilizers. The Calculator provides an estimate of first-season N availability, assuming all of the manure NH_4 -N is retained after application. The Calculator is based on a linear regression equation (generated from local research) between manure total N (organic + ammonium-N) and first-season PAN.

Because the Calculator uses a different approach to PAN estimates, the PAN values from the Calculator and from this publication are not directly comparable. PAN estimates from this publication's Worksheet and from the Organic Fertilizer Calculator are most similar for manures that contain mostly organic N.

Should denitrification loss estimates be included in N budgets for manure utilization?

The denitrification process (Figure 1, page 3) requires:

- Anaerobic soil conditions (lack of oxygen)
- Microbial activity
- Soil nitrogen in the nitrate form

Research conducted west of the Cascades has demonstrated that N loss via denitrification is typically less than 10 percent of N applied. Nitrate-N loss in the fall and winter is caused mainly by leaching. In spring, denitrification is limited by low concentrations of soil nitrate. In western Oregon and Washington, denitrification loss is not necessarily related to soil drainage class because seasonal high water tables usually occur in winter and spring when soil nitrate-N is low (e.g., it has already been leached out).

Because the amount of PAN lost by denitrification is generally small relative to other processes that affect PAN (timing and rate of manure application, $\text{NH}_4\text{-N}$ retained at application, organic-N mineralized, nitrate-N leached) it is ignored in the Worksheet.

What can be done to conserve N on a whole-farm basis?

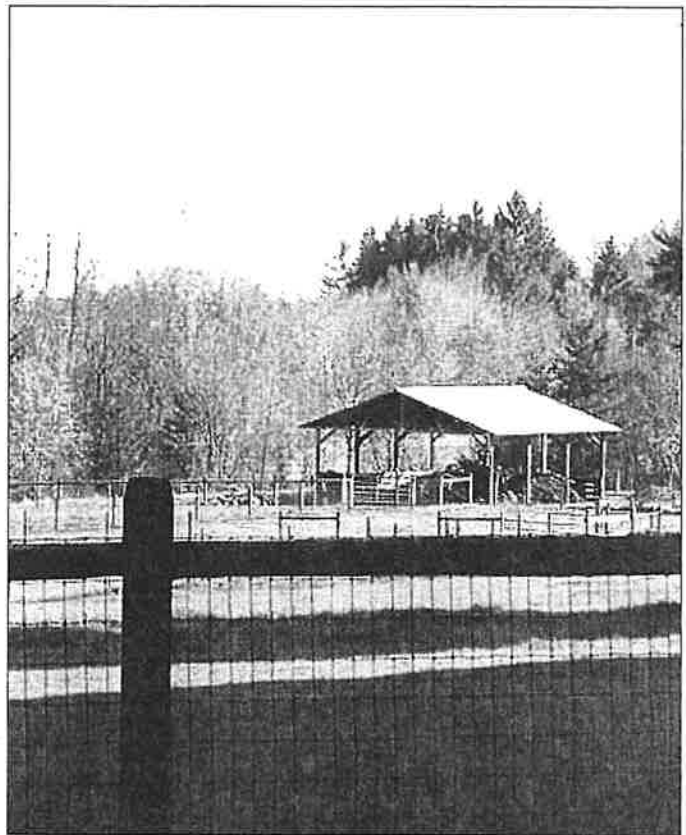
Much of the N lost from manure occurs prior to field application. An N-efficient whole-farm system includes:

- Feeding practices that maximize animal utilization of N
- Minimizing N loss in the barn
- Minimizing N loss in manure storage

Resources for improving whole-farm N utilization are available from the Livestock Poultry Environmental Stewardship program at: www.lpes.org

If manure is applied in fall, does it count as manure applied “this year” in the Worksheet?

The Worksheet allows you to define a “year” any way you wish. If you apply manure in the fall to perennial grasses, you may want to begin your “manure application year” after the last forage cut in the fall, since this manure N will be utilized by grass the following spring.



For crops other than perennial grasses, it is best to avoid fall application of manure because crop N utilization is low (Table 4, page 15). Most of the first-year PAN is lost from manure applied in the fall when crop N utilization is “low” or “very low” (Table 4).

Is the Worksheet a nitrogen budget or nitrogen recommendation?

The Worksheet provided in this publication is **not** a complete nitrogen budget or recommendation. The Worksheet focuses only on N supplied by manure application. A nitrogen recommendation considers other factors, including:

- N uptake/removal by crops
- N supplied from other sources (irrigation water, fertilizer, legumes)
- Typical mineralization rate for soil organic matter (unmanured soil)

Conversion Factors

Nutrient concentrations in manure can be expressed in different units or in different chemical forms. Use the unit conversion table on the next page to convert laboratory analysis units to field application units.

Carefully examine your laboratory report to determine whether nutrient concentration is expressed on an "as-is" basis (moist manure) or on a dry matter basis (no moisture).

Table 5. Conversion factors. To convert from units in column 2 (blue) to those in column 5 (orange), multiply by the conversion factor in column 4. To convert from units in column 5 to units in column 2, divide by the conversion factor. For example, to convert P₂O₅ to P, divide by 2.29.

Measurement	Unit	Symbol	Multiply by	To obtain	Symbol
Volume	acre-inch	ac-in	27000	gallon	gal
	gallon	gal	8.35	pound	lb
Concentration	parts per million	ppm or mg/kg	0.002	pound/ton	lb/t
	parts per million	ppm or mg/L	0.00835	pound/1,000 gallon	lb/1,000 gal
	parts per million	ppm or mg/L	0.227	pound/acre-inch	lb/ac-in
	percent	%	20	pound/ton	lb/t
	percent	%	83.5	pound/1,000 gallon	lb/1,000 gal
	percent	%	2,266	pound/acre-inch	lb/ac-in
	percent	%	10,000	parts per million	ppm
	pound/1,000 gallon	lb/1000 gal	27	pound/acre-inch	lb/ac-in
Dry or wet					
	percent dry matter (total solids)	% DM	0.01	solids fraction	DM
	percent moisture	% moisture	0.01	moisture fraction	MF
	manure, dry wt. basis		100/(%DM)	manure, "as-is" basis	
Nutrients					
	phosphorus	P	2.29	phosphate	P ₂ O ₅
	potassium	K	1.20	potash	K ₂ O
	nitrogen in nitrate form	NO ₃ -N	1	nitrogen	N
	nitrogen in ammonium form	NH ₄ -N	1	nitrogen	N
	nitrogen in organic form	org-N	1	nitrogen	N

For More Information

OSU Extension publications

Manure management

- Bary, A.I., C.G. Cogger, and D.M. Sullivan. 2000. *Fertilizing with Manure*. PNW 533.
- Downing T., D. Sullivan, J. Hart, and M. Gamroth. 2007. *Manure Application Rates for Forage Production*. EM 8585-E.

Laboratories

- Hart, J. 2006. *Laboratories Serving Oregon: Soil, Water, Plant Tissue, and Feed Analysis*. EM 8677.

Tracking nutrients on the farm

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- Marx, E.S., N.W. Christensen, J. Hart, M. Gangwer, C.G. Cogger, and A.I. Bary. 1997. *Nutrient Management for Dairy Production: The Pre-sidedress Soil Nitrate Test (PSNT) for Western Oregon and Western Washington*. EM 8650.
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- Sullivan, D.M. and R.G. Stevens. 2003. *Agricultural Phosphorus Management Using the Oregon/Washington Phosphorus Indexes*. EM 8848-E.

Additional Extension publications on manure and nutrient management are available at <http://extension.oregonstate.edu/catalog/>

Other resources

On-Farm quick tests for manure

- Chadwick, D.R., S.K.E. Brookman, J. Williams, K.A. Smith, B.J. Chambers, I.M. Scotford, and T.R. Cumby. 2004. On-Farm Quick Tests for Manure. In: *Advanced Silage Corn Management*. <http://www.farmwest.com>

Manure application methods to reduce ammonia loss

- Bittman, S. and C.G. Kowalenko, eds. 2004. *Advanced Silage Corn Management: a Production Guide for Coastal British Columbia and the Pacific Northwest*. Pacific Field Corn Association, Agassiz, BC.

Effects of weather and direct application methods on ammonia loss

An online calculator, Ammonia Loss from Applied Slurry Manure, is available at www.farmwest.com

Organic fertilizer calculator

- Andrews, N. and J. Foster. 2007. *Organic Fertilizer Calculator: A Tool for Comparing the Cost, Nutrient Value, and Nitrogen Availability of Organic Materials*. Oregon State University Extension Service publication EM 8936-E, available at <http://smallfarms.oregonstate.edu/organic-fertilizer-calculator>

Whole-farm nutrient management

- Livestock and Poultry Environmental Stewardship Curriculum, available at <http://www.lpes.org>
- National Livestock and Poultry Environmental Learning Center, available online at <http://lpe.unl.edu>



Research references

The references listed below were consulted by the author in preparation of this publication. Much of the field research cited below was conducted in western Oregon, Washington, and British Columbia (the target region for this publication). Where local research was not available, best professional judgment was used to select applicable research from other regions. To determine the rationale behind existing Extension recommendations, the author also interviewed authors of state Extension publications that utilize a similar calculation method for PAN (PAN = $\text{NH}_4\text{-N}$ retained at application + organic N mineralized after application).

Extension estimates of PAN from manure

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Post-harvest Soil Nitrate Testing for Manured Cropping Systems West of the Cascades

D.M. Sullivan and C.G. Cogger

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What's in this publication?

This publication describes the use of post-harvest soil nitrate testing as a tool for assessment of nitrogen (N) management in manured cropping systems west of the Cascade Mountains in Oregon, Washington, and south coastal British Columbia.

The first section of this publication gives general information on the test and is designed for use by growers and dairy operators. This section gives a brief introduction to soil sampling, but does not provide all of the technical details. The focus is on how to use the post-harvest test to improve nutrient management. This section describes:

- ◆ What the post-harvest test measures
- ◆ How to collect soil samples
- ◆ Units used in soil nitrate testing
- ◆ How to interpret soil nitrate test results for grass and silage corn crops

In addition, background information explains the rationale for the test:

- ◆ How to use the post-harvest test as a management tool (page 3)
- ◆ Crop and soil response to excess plant-available N (page 4)

The second section of this publication is designed primarily for use by conservation planners and other agricultural professionals working with farmers to implement nutrient management plans. This section is also designed for dairy operators who do their own soil sampling. This section includes detailed suggestions for the following:

- ◆ Collecting, preserving, and analyzing the soil sample
- ◆ Developing a long-term soil sampling plan

The post-harvest test and how to use it

What the post-harvest test measures

The post-harvest soil nitrate test measures the quantity of plant-available nitrogen present in the nitrate form in the surface foot of soil in the late summer or early fall. The test measures nitrate-N not utilized by the recently harvested crop. Because crops differ in their ability to remove nitrate-N from the soil, test interpretation is crop-specific.

The test looks backward in time. It evaluates the balance between N supply and crop uptake for the crops produced during the summer. Nitrate-N accumulates in the soil when more plant-available N is supplied than can be utilized by the summer crop (see "Crop and soil response to excess plant-available N," page 4).

Use the post-harvest test to:

- ◆ Get a general idea of balance between N supply from manure and other sources and crop N demand
- ◆ Identify imbalances in N supply among fields on a farm
- ◆ Identify fields that may respond to changes in timing or amount of manure application or other agronomic practices

Soil sampling protocols

Sampling depth

Sample the 0- to 12-inch depth for the post-harvest test. This shallow sampling depth is a good predictor of nitrate in the rest of the soil profile when (1) in-season irrigation is not excessive, and (2) samples are taken prior to heavy rains in the fall.

Composite soil sample

Collect a composite soil sample consisting of a mixture of 15 to 30 soil cores from each field or management unit. See "Collecting, preserving, and analyzing the soil sample" (page 9) for detailed sampling instructions and suggestions for special situations.

What fields to sample

In general, it is not necessary to sample every field on a farm every year. Consult with your farm advisor to determine any regulatory requirements for sampling frequency. We recommend that you sample selected fields that represent typical manure and crop management practices each year to track long-term trends in post-harvest soil nitrate values. See "Developing a sampling plan" (page 11) for more information.

When to sample

In general, samples for the post-harvest test should be collected as soon as possible after a crop harvest. Avoid sampling a field that has had manure application within the past 30 days.

Samples must be taken before heavy fall rains move nitrate below the 12-inch depth. Because the timing of fall rainfall is unpredictable, the best strategy is to sample fields before October 1 whenever possible.

Collect samples from medium- to fine-textured soils (loams, clay loams, and clays) prior to 5 inches of cumulative fall rainfall. Sandy soils (sand, loamy sand, or sandy loam soil texture) have lower water-holding capacities and should be sampled prior to

continues on page 5

How to use the post-harvest test as a management tool

Sampling depth and timing are critical. Interpretation tables for this test apply only to samples taken to a 12-inch depth. Surface soil (0 to 12 inches) typically contains the highest nitrate-N levels and requires the least time and effort for sample collection. Samples must be taken before heavy fall rains move nitrate below the 12-inch depth. The target sampling period generally is August 15 to October 15.

To get the most value from this test, it is important to understand:

- ◆ How the test fits into an overall nutrient management program
- ◆ Limitations to interpretation of test results
- ◆ How *not* to use the test

Using the test as part of a nutrient management program

The post-harvest test is but one measure of success in nutrient management. Post-harvest nitrate test data should be assessed in the context of the current N management plan and records of manure application. Successful N management involves a number of components, including:

- ◆ Assessing crop N needs
- ◆ Planning manure application to meet crop N needs
- ◆ Applying manure according to the plan
- ◆ Recording manure application amount and estimated plant-available N amount
- ◆ Measuring crop yield and N content
- ◆ Monitoring success of the plan

All components of the nutrient management system should be evaluated together.

Limitations to test results

Interpretive values for post-harvest soil nitrate are:

- ◆ Calibrated only for high-rainfall portions of the Pacific Northwest (west of the Cascades). Extrapolation to other environments is not recommended.

- ◆ Provided only for corn silage and grass hay/silage crops. Field research has been used as the basis for interpretive levels for these crops. Applicable research data are not available for other crops to determine post-harvest nitrate-N levels associated with good crop and nutrient management practices. However, the test may be used for relative comparisons among fields planted to another crop (e.g., comparisons among grass pasture fields).
- ◆ Based on the assumption that summer irrigation is less than, or close to, evapotranspiration to ensure that significant nitrate leaching does not occur before the fall test.
- ◆ Designed for fields with a history of applied manure (more than 3 consecutive years of regular manure application). Lower post-harvest soil nitrate test values are attainable where only fertilizer N is used, or where manure is applied infrequently.
- ◆ Based on good management of the crop and normal yields. Crop moisture stress, insect damage, or plant disease will reduce crop yield and crop uptake of nitrogen, thus increasing post-harvest soil nitrate test levels.

How not to use the post-harvest test

The test will *not*:

- ◆ Detect a shortage of plant-available nitrogen for crop production. Continual mineralization of nitrogen (conversion of organic N forms to plant-available N forms in the soil) can provide enough plant-available nitrogen for a crop without accumulation of nitrate-N in soil.
- ◆ Determine the source(s) of excess plant-available N. Sources of N may include manure slurry, lagoon water, fertilizer, soil organic matter, or previous crop residues.
- ◆ Predict crop response to fall manure or N fertilizer applications. The test does not predict the amount of plant-available N that will be mineralized from soil organic matter or crop residues in the fall.

Crop and soil response to excess plant-available N

Crop response to applied N. Crop N uptake is controlled by the environment, crop N uptake potential, and management. Crops respond to plant-available nitrogen supply (ammonium + nitrate-N) by the law of diminishing returns (Figure 1). Without added N, some crop yield is produced from N supplied by soil organic matter, residual plant-available N, and other non-fertilizer sources (e.g., mineralization of crop residues). Additional N supplied from manure or fertilizer increases crop yield until site yield potential is reached.

The application rate of manure or N fertilizer needed to reach near-maximum yield is termed the *agronomic rate*. Rather than a single agronomic rate, the crop response to N is best described as an *agronomic rate range* (Figure 1). The agronomic rate range concept allows for variability in crop performance among years and for crop uptake of N beyond the yield maximum (increased protein).

Post-harvest soil nitrate test measures nitrate-N not used by the crop. At excessive plant-available N supply levels, crop yield and crop N uptake do not respond to further N additions. The extra soil N not used by the crop accumulates as nitrate-N.

Elevated post-harvest soil nitrate-N concentrations are an indicator of one or more of the following: (1) excess plant-available N, (2) N supplied too late in the season for crop utilization, or (3) poor crop growing conditions due to insect infestation, moisture/heat stress, plant disease, or other cultural problems. If crop yields are acceptable and crop protein is at typical levels, then the most likely explanation is that plant-available N was supplied in excess of crop needs.

Because grass is more efficient than corn at N uptake, target post-harvest soil nitrate levels given in this publication are lower for grass than for corn. There are two key reasons that grass is more efficient than corn in N removal.

- ◆ Grass has a greater capacity to take up N supplied in excess of that needed for maximum yield. After enough N has been supplied

for maximum yield, grass protein content increases in response to increased N supply. With grass, soil nitrate increases only when the available N supply exceeds that required to produce near-maximum protein. Corn does not take up additional N after the maximum yield is reached. Corn silage protein does not increase much in response to excess N supply.

- ◆ Grass utilizes N mineralized late in the growing season more efficiently. Grass managed for silage or hay continues to take up N until harvest. Corn grown for silage completes its N uptake approximately 4 weeks before harvest. Some of the soil nitrate measured after corn harvest is produced by mineralization of soil organic N to available forms during the final weeks of the growing season.

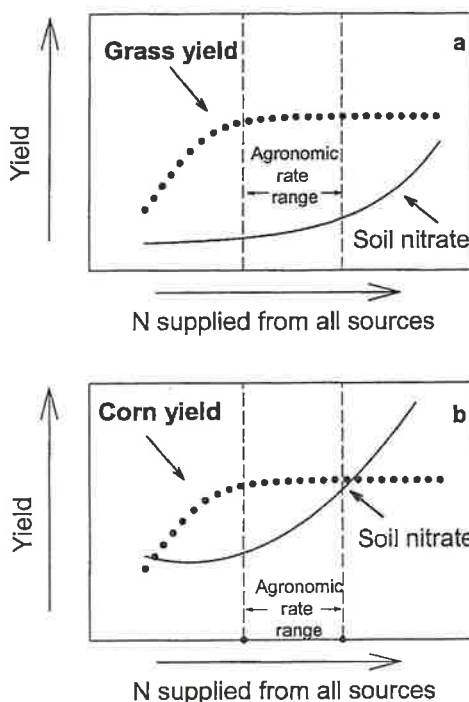


Figure 1.—Crop yield and soil nitrate response to increased N supply. Agronomic rate range = range of N supplied from all sources that results in near-maximum crop yield with acceptable post-harvest nitrate accumulation. Above the agronomic rate range, excess N accumulates as nitrate in soil. More nitrate accumulates in the agronomic rate range with corn (b) than with grass (a).

Table 1.—Average calendar date when cumulative rainfall (after September 1) reaches 5 inches west of the Cascades.^a

Cumulative rainfall after Sept. 1 (inches)	Calendar date to reach specified cumulative rainfall							
	Medford (OR)	Salem (OR)	Tillamook (OR)	Coupeville (WA)	Centralia (WA)	Lynden (WA) Abbotsford (BC)	Agassiz (BC)	Comox (BC)
3	10 Nov	20 Oct	26 Sep	31 Oct	8 Oct	1 Oct	26 Sep	10 Oct
5	29 Nov	1 Nov	8 Oct	24 Nov	23 Oct	15 Oct	9 Oct	25 Oct
7	16 Dec	13 Nov	18 Oct	15 Dec	4 Nov	27 Oct	19 Oct	6 Nov

^aAverage daily precipitation data for many other locations is available at: Western Regional Climate Center (<http://wrcc.dri.edu>) or Environment Canada (http://www.msc-smc.ec.gc.ca/climate/climate_normals/index_e.cfm).

3 inches of cumulative fall rainfall. The starting date for calculating cumulative fall rainfall is September 1. Include inches of irrigation water applied after September 1 in your estimate of cumulative rainfall.

Table 1 shows the average calendar date when cumulative fall rainfall (after September 1) reaches 5 inches at a variety of locations. For most locations, sampling prior to October 15 is acceptable in an average year. In high rainfall areas (coastal areas and the Cascade foothills), plan to sample earlier. A late October sampling date usually is acceptable in lower rainfall areas of southern Oregon, the Puget Sound islands, Olympic Peninsula, or Vancouver Island.

Units used in soil nitrate testing

In this publication, interpretation of a post-harvest soil nitrate test (Tables 3 and 4) is based on units of parts per million (ppm). Some labs report soil test nitrate-N in units of lb/acre by assuming a standard value for soil bulk density. If the lab reports nitrate-N results in pounds per acre, ask them to provide a conversion factor to express data in units of ppm. The conversion factor assumed by laboratories usually is between 3 and 4, because 1 acre-foot of dry soil usually weighs

Table 2.—Units used to report soil nitrate analyses.

Name	Interpretation	Equivalent units
nitrate-N or NO ₃ -N	N present in the nitrate form, soil dry weight basis	mg/kg or ppm (dry weight basis)

about 3.5 million pounds (3.5 lb per acre-foot = 1 ppm).

Interpreting soil nitrate test results

Data quality and variability

The first step in evaluating your soil nitrate data is to verify data quality. Determine whether the sample collection method, timing of sample collection, sample preservation, and laboratory analysis methods are acceptable. Reject data that did not result from reasonable protocols. For example, Tables 3 and 4 should not be used for soil samples collected in November after heavy fall rains.

Make sure that you understand the units used to report test results. See Table 2 for an explanation of units found in soil test reports.

Response of post-harvest soil test N to changes in management

Success in N management is indicated by long-term trends in post-harvest soil nitrate (at least 3 to 5 years). **Because of the large pool of readily mineralizable N in manured soils, fall soil nitrate values may not decline for 3 to 5 years in response to improved management.** For multiyear comparisons, sampling methods and timing must be consistent.

Some portions of a crop rotation will have higher fall nitrate values because of rapid N mineralization stimulated by tillage or incorporation of crop residues. For example, soil nitrate concentrations typically are high, regardless of overall N management, after a perennial grass sod is plowed down and reseeded.

Reductions in fall soil N are most likely to be measured when (1) commercial N fertilizer amounts are reduced or eliminated, (2) cropping systems that maximize N removal in late summer and fall (August to October) are used, and (3) manure or N application is eliminated after August 1. It is more difficult to attain post-harvest soil nitrate-N values of less than 20 ppm for corn than for grass (see "Crop and soil response to excess plant-available N," page 4).

Interpretation for individual fields

Interpretations of soil test nitrate-N should be made first at the field level. You may be able to discover a probable cause for differences in test values among fields. Questions to ask include:

- ◆ Are relationships present between known management factors (e.g., manure application rate or timing, crop yield and quality, irrigation frequency, distance to the barn) and soil test values?
- ◆ Is a large amount of variation present between fields? Is there a logical explanation for unusual values?
- ◆ Are values for grass and corn fields similar?

Annual averages across grass and corn crops

After looking at test values for individual fields, it may be useful to look at averages across all grass or corn fields. You may want to calculate averages only for fields under similar management.

Average nitrate-N test values are most useful for consideration of changes in whole farm nutrient management. Tables 3 and 4 present interpretive information separately for grass and corn fields.

If a few fields have unusual test values, you may be justified in excluding those fields from an average. Although you may want to exclude unusually high test values from the farm average, you definitely should evaluate those fields further to determine the probable cause of the high soil test values. The unusually high test values may reflect the need for management changes or may reflect a soil sampling or analytical error.

Using the interpretive tables (Tables 3 and 4)

Interpretations and management suggestions given in Tables 3 and 4 (pages 7–8) are general in nature and should serve as only one portion of a nutrient management plan evaluation. Some of the management suggestions can be implemented for individual fields, while others need to be implemented on a whole farm basis.

Remember not to focus solely on post-harvest nitrate-N in evaluating N management. Include other important aspects of N management in your evaluation, such as success in following a plan for manure application, calibration of manure application equipment, maintaining good manure application records, and effective irrigation management.

Table 3.—Silage corn. Suggested interpretation for post-harvest soil nitrate-N (0- to 12-inch depth).^a

If post-harvest nitrate-N is less than 20 ppm (less than approximately 70 lb N per acre)

- ◆ Continue present N management.

If post-harvest nitrate-N is 20 to 45 ppm (approximately 70 to 160 lb N per acre)

- ◆ Reduce or eliminate sidedress N fertilizer application. Use the pre-sidedress nitrate test (PSNT). Apply sidedress N only when PSNT indicates a need.
- ◆ Reduce lagoon water application after August 1.
- ◆ Keep records to document crop yield, dry matter, and crop N removal. Total applied manure-N + fertilizer-N should be less than 125 percent of documented crop N removal.
- ◆ Reduce manure application on fields where corn follows grass sod plow-down.
- ◆ Plan to reduce manure-N application by 10 to 25 percent.
- ◆ Improve whole farm N balance.

If post-harvest nitrate-N is greater than 45 ppm (greater than approximately 160 lb N per acre)

- ◆ Apply only starter N (20 to 40 lb N/acre at planting).
- ◆ Plan not to sidedress N fertilizer in June. Apply sidedress N only when PSNT indicates a need.
- ◆ Eliminate lagoon water application after August 1.
- ◆ Keep records to document crop yield, dry matter, and crop N removal. Apply manure N at a rate less than or equal to crop N removal (approximately 200 lb total N per acre).
- ◆ Eliminate manure application on a few fields or a few strips within a field next year to determine the contribution of mineralized N vs. current-season application of manure.
- ◆ Plan to reduce manure-N application by 25 to 40 percent.
- ◆ Consult experts to improve whole farm nutrient balance.

^aThe post-harvest test values listed above are for the *end* of a growing season. Management changes (if needed) should be implemented in future years. Interpretive values assume near-optimum crop yields. If yield is below average, improve agronomic practices to increase crop yield and crop N uptake.

Table 4.—Grass for hay or silage. Suggested interpretation for post-harvest soil nitrate-N (0- to 12-inch depth).^a

If post-harvest nitrate-N is less than 15 ppm (less than approximately 55 lb N per acre)

- ◆ Continue present N management.

If post-harvest nitrate-N is 15 to 30 ppm (approximately 55 to 105 lb N/acre)

- ◆ Apply manure earlier in the growing season.
- ◆ Keep records to document crop yield, dry matter, and crop N removal. Total applied manure-N + fertilizer-N should be less than 125 percent of documented crop N removal.
- ◆ Check protein levels in forage. Grass crude protein greater than 21 percent is associated with increased potential for nitrate toxicity to cows.
- ◆ Plan to reduce manure-N application by 10 to 25 percent.
- ◆ Improve whole farm nutrient balance.

If post-harvest nitrate-N is greater than 30 ppm N (greater than approximately 105 lb N/acre)

- ◆ Apply manure earlier in the growing season. Reduce manure application after August 1.
- ◆ Keep records to document crop yield, dry matter, and crop N removal. Total manure-N + fertilizer-N should be less than or equal to crop N removal. Even if calculated crop removal exceeds 400 lb N per acre, apply manure-N + fertilizer-N not to exceed 400 lb N per acre per year.
- ◆ Consider reseeding or interseeding if grass yield is limited by poor stand or undesirable species.
- ◆ Check protein levels in forage. Grass crude protein greater than 21 percent is associated with increased potential for nitrate toxicity to cows.
- ◆ Plan to reduce manure-N application by 25 to 40 percent.
- ◆ Consult experts to improve whole farm nutrient balance and reduce danger of nitrate toxicity to cows.

^aThe post-harvest test values listed above are for the *end* of a growing season. Management changes (if needed) should be implemented in future years. Interpretive values assume near-optimum crop yields. If yield is below average, improve agronomic practices to increase crop yield and crop N uptake.

Detailed suggestions for soil sampling and planning

Collecting, preserving, and analyzing the soil sample

Tools for field sampling

Collect a sample that is representative of the entire sampling depth. For example, a representative sample for a 0- to 12-inch depth has the same amount of soil from the soil surface (0 to 6 inches) and from the bottom of the sampling depth (6 to 12 inches).

Always use a tool specifically designed for soil sampling. Don't use a shovel, because the samples won't be uniform with depth. Tools for soil sampling often are called soil probes or augers. There are several kinds available.

Push probes are tubes that you push into the soil. They have a T-shaped handle attached to a cylindrical tube (about 1 inch diameter) with a beveled tip. The tube collects a cylinder, or "core," of soil. Push probes work well in soft, uncompacted soils.

Hammer probes are designed for hard or compacted soils. They have a sliding weight (hammer) instead of a T-handle to drive the probe into soil.

Soil test consultants often use hydraulic probes mounted on a tractor or pickup to sample soils. These reduce the time and effort of sampling in hard soils. Gravelly and rocky soils are difficult to sample. A hydraulic probe with a rotating auger can sample some gravelly soils.

A mud auger or bucket auger is the best tool for hand-sampling at sites that are difficult to sample with push probes. Use an auger for compacted, muddy, rocky, or dry soils. Augers can be purchased from several manufacturers. A 2- to 4-inch diameter mud auger (open-sided) works best for most situations because it is easy to remove the sample from the bucket. Use a larger

diameter auger for soils with large rocks. Augers sample a 4- to 6-inch depth. You will need to take several bites from the same hole to sample to 12-inch depth. You will collect a larger sample volume, about 5 to 10 times that collected with a push tube. Because of the extra effort required for auger sampling, use this method only if other sampling methods are difficult or impossible.

Field sampling protocol

Plan ahead. Use field maps and soil maps to divide the farm into different management units. A management unit is usually a field, but you may want to subdivide a large field if sections can be managed separately for nutrient application. The simplest approach is to collect a composite sample from the entire management unit. You may choose to restrict sampling to the dominant soil type if the management unit has soils that differ markedly in visual appearance (soil color, texture, organic matter).

Alternatively, you can restrict your sampling to a representative area (usually about an acre in size) within the management unit. Choosing a representative area within the field where manure application rate, timing, and uniformity are well documented is essential. If you use the "representative area" sampling approach, record the sampling location using a GPS receiver or record the distance from a fixed location (e.g., fenceline).

Avoid large buffer zones that are sometimes present adjacent to water bodies or roads, especially with big gun manure applicators. Avoid small atypical areas such as:

- ◆ Swales
- ◆ Very rocky or shallow soil (less than 12 inches deep)
- ◆ Site of an old manure pile or a feeding, watering, or resting area for livestock
- ◆ Abandoned field roads
- ◆ Field edges

Collect 15 to 30 soil cores from each management unit or representative sampling area with a push probe or similar tool. If you use an auger, 10 holes per management unit or zone is sufficient.

Choose sampling locations in a zigzag pattern across the field. Your general route of travel should be across rows, rather than down one row in the field. Make sure you sample within the part of the field where manure is routinely applied. For grazed pastures, choose sampling locations that have average crop growth and productive forage species.

Scrape away loose crop residues or manure present on the soil surface. Sample only the soil. Including the accumulated organic debris from the soil surface in the soil sample will increase variability in test results.

Once you are satisfied with a sampling strategy, repeat the same procedure each year. This will increase the validity of year-to-year comparisons of results.

Obtaining a representative sample from fields where manure has been injected into soil or placed in bands on the soil surface is difficult. The depth of manure injection, the width of injection zone, and the spacing between bands depend on equipment, soil, and the applicator. Some injection equipment can place manure below the 12-inch sampling depth used for the post-harvest nitrate test. Manure may be injected or banded more than one time per year, with several orientations in a field (e.g., north-south or east-west). Because of the added variability associated with manure injection or banding, plan to collect a larger number of soil cores to obtain a representative composite sample.

Sample handling

Mixing. If it is not too hard to break up the soil cores, break them, mix them all together, and homogenize thoroughly. Take a 1-cup subsample for shipment to the lab. If

the soil cores are too hard to break apart, send the entire sample to the lab, where they can pass the sample through a mechanical grinder. Check with the lab to make sure they will grind and mix the *entire* sample before subsampling.

Preservation. Soils kept moist and warm continue to accumulate nitrate via biological activity after sampling. The simplest way to limit biological activity is to cool the soil after collection. Put the samples in plastic bags and place them in a cooler on ice while still in the field. Refrigerate them when you return from the field. Freeze the samples if they will be held longer than 48 hours before analysis.

Shipment. Keep the samples refrigerated or frozen until you deliver them to the lab. Contact the lab before you sample, so they will be prepared to receive the samples. Use a shipping method that will get the samples to the lab within 48 hours. You may want to freeze the samples before shipping to make sure they remain cool in transit.

Working with an analytical laboratory

Choose a laboratory that has experience with agricultural samples. Ask if they participate in the North American Proficiency Testing Program or a similar quality assurance program for agricultural testing labs. Find out what extraction and analytical procedures they use. Procedures should be consistent with those recommended for the western states (Gavlak et al., 1994).

Labs may use one of several colorimetric (color-based) lab procedures or they may use an electrode method to measure nitrate. Sample comparisons have shown that the colorimetric procedures usually are more precise than the electrode method.

Some testing labs also have sampling and consulting services. This can be convenient for people who have little experience in sampling or need help with sampling.

Find out how the lab reports soil test data. Standard units for soil nitrate-N are parts per million (ppm, Table 2). If you aren't familiar with the lab, it's a good idea to obtain a copy of a sample laboratory report.

Because you will use sample results to compare post-harvest soil nitrate across years, laboratory consistency over time is a major issue. A standard reference sample (soil sample with known concentration of nitrate) can help you assess laboratory variability. Consider submitting a standard reference sample (approximately 50 to 100 g dry weight) with a nitrate-N concentration of 20 to 45 ppm with each batch of soil samples. Keep track of test results for the standard reference sample over time. If you note a major error in the nitrate concentration reported for the standard reference sample, then the test data is questionable.

Standard reference samples are available from the North American Proficiency Testing Program (see "For more information," page 15). Standard reference samples must be dried, ground, and thoroughly mixed.

We do not recommend that you split a field sample to check laboratory consistency. The one-time nature of such comparisons, the uncertainty of obtaining a homogeneous sample, and the uncertainty of sample preservation in-transit to the lab limit the interpretation of split-sample data.

Developing a sampling plan

Nutrient management plans can be voluntary, required by regulatory agencies, or a part of an agreement with a conservation planning agency (e.g., Natural Resources Conservation Service or conservation district). If your nutrient management plan is not voluntary, consult the agency that supervises your nutrient management plan to determine whether they have specific requirements for how often fields must/should be sampled.

Suggestions given here for sampling frequency are general in nature and are not intended to serve as policy for any agency.

Representative fields for long-term monitoring

Representative fields are fields that you sample every year to track trends in sample values over time. Select fields that represent typical management practices. Criteria that can be used to choose representative fields include: (1) records or estimates of annual manure application rate, (2) number of years of continuous manure application, (3) soil test values for P and K. On dairies where P and K fertilizers are not routinely applied, soil test values above 75 ppm P (Bray P1 method) and 400 ppm K (ammonium acetate method) usually reflect substantial manure application in the past.

Sample the representative fields every year to assess trends over time. If you grow corn silage and perennial grass forage, plan to sample at least four grass fields and four corn fields each year. At a small dairy (fewer than four fields), sample all fields each year.

Other fields

Periodically, you will need to evaluate the fields not designated as "representative" fields. Consider sampling all fields every 3 years. Compare whole farm soil data to representative field data.

If you have only a few fields with elevated soil test N, then focus management on those fields. If all fields on the farm give similar test data, then focus your N management efforts at the whole farm level. If representative fields consistently have test values of less than 15 ppm (grass) or less than 20 ppm (corn) over a 3-year period, and all other fields sampled have similar test values, consider reducing the number of post-harvest soil nitrate tests.

Sampling priority

Prioritize fields for fall sampling ahead of time so that you get high-priority fields sampled at an appropriate time. Highest priority should be given to representative fields used to track long-term trends. Fields with high manure application rates or elevated soil test N the previous year should also have a high priority.

Corn fields can be sampled for soil nitrate in June (PSNT, pre-sidedress nitrate test) or in the fall (post-harvest test described in this publication). You will get the most management information by sampling your high-priority representative corn fields both in June (PSNT) and after harvest. You also may want to sample fields with PSNT values greater than 45 ppm nitrate-N again in the fall.

For other corn fields where only one soil test per year is planned, we recommend using the PSNT in preference to the post-harvest soil nitrate test. The PSNT is preferred because test results are applicable to in-season N management. Growers can save money and reduce post-harvest nitrate by omitting sidedress N fertilizer application on fields where sufficient soil nitrate-N is present in June.

Sampling corn fields at PSNT time also will reduce the number of post-harvest samples that need to be collected during the short interval between harvest and the end of the fall sampling window (approximately October 15). If you miss a planned fall sampling on a corn field, consider sampling next year using the PSNT.

Grass fields are best sampled in the fall, using the protocols described in this publication. Think carefully about the best way to achieve consistent timing of sample collection for your fields. The timing of manure application and the timing of grass harvest are key variables to consider.

Samples collected shortly after manure application are not a good indicator of the

balance between N supply and crop N demand over the entire growing season. If manure is applied late in the year, postpone soil sampling until after a fall grass harvest. Wait at least 30 days after a late-season manure application before sampling. Sampling need not be postponed until after the last manure application or until after the last grass harvest in the fall.

Questions and answers

Why is it difficult to achieve post-harvest nitrate-N less than 15 to 20 ppm with organic sources such as manure?

First, the timing and rate of application for organic sources is less flexible than for fertilizer N. Second, environmental processes that control the quantity and timing of N availability from organic sources are difficult to manage. The biggest factors controlling N availability are soil temperature and moisture. The timing of crop N uptake usually does not match the timing of N supplied from manure and other organic sources. Soil temperature and moisture often support continued release of available N after crop N uptake is complete.

Is there a relationship between soil organic matter content and potential N mineralization?

Research west of the Cascades has demonstrated a lack of correlation between soil organic matter content and N mineralization potential for soils having 3 to 8 percent organic matter. The active fraction of soil organic matter that controls annual N mineralization rates is a small proportion of total organic matter (usually less than 10 percent of total). Recent site management affects soil N mineralization potential; it does not have much effect on soil organic matter content. Because most soil total N is contained in soil organic matter, soil total N is also an unreliable indicator of mineralization potential.

What other soil tests can be used to provide information to guide N management for corn?

Soil nitrate testing in spring and early summer can assist with N management for silage corn. Test soil ammonium + nitrate-N several weeks after a spring manure application to track early-season N availability. Test soil nitrate when corn is at the four- to six-leaf stage (pre-sidedress nitrate test, PSNT) to determine the need for sidedress N application to corn.

How much variability should I expect in post-harvest nitrate-N test values for the same grass field sampled between August 15 and October 15?

It all depends on weather, soil biology, and crop management. A good stand of actively growing grass can maintain nitrate-N concentrations of less than 15 ppm throughout the post-harvest sampling period. Where soil is dry in late summer, increased N availability may occur for 2 or 3 weeks following the first heavy rain. It may be useful to take several soil nitrate tests from the same field in the fall to document changes in nitrate concentration with time. Soil nitrate values given in the interpretive table in this publication are for typical precipitation and sampling date.

Ammonium-N is plant-available. Why doesn't the post-harvest test include ammonium-N analysis?

Post-harvest ammonium-N analyses cost money, and they do not yield reliable interpretive information. Ammonium-N does not accumulate in soils supplied with an excess of plant-available N. It is rapidly converted to nitrate. Soil samples taken at least 30 days after manure application usually have negligible ammonium-N concentrations unless soil has remained dry.

Drying of soils after sampling releases ammonium-N from microbial biomass. Most dried soils have 2 to 20 ppm ammonium-N

that is caused by the soil drying process. Dry soil ammonium-N concentrations are poorly correlated with other indices of N availability in controlled experiments.

Should post-harvest nitrate tests be used for fields with organic soils?

Other methods should be used to assess the success of nutrient management plans on organic soils. Goals for post-harvest nitrate-N of less than 20 ppm are difficult if not impossible to attain on organic soils, which contain more than 20 percent organic matter. These soils formed as organic matter accumulated under natural poorly drained conditions. Soil organic matter decomposition and N mineralization processes are greatly accelerated under typical farming practices such as artificial drainage and tillage.

Should I measure or estimate soil bulk density to estimate post-harvest nitrate-N in units of pounds per acre?

The variation in bulk densities among soils typically is less than the variation associated with soil nitrate sampling and testing. Interpretive information in this publication is based on units of parts per million (ppm; mg per kg dry soil). You can approximate soil nitrate-N in the surface foot of soil by assuming typical bulk density ($\text{ppm} \times 3.5 = \text{lb/acre}$). This conversion factor is based on the weight of 1 acre-foot of soil at a bulk density of 1.3 g cm^{-3} (1 acre-foot = 3.5 million lb). Organic soils (more than 20 percent organic matter) have lower bulk density ($0.6 \text{ to } 0.8 \text{ g cm}^{-3}$).

What is whole farm nutrient management?

The goals of whole farm management are: (1) to move toward a balance of nutrient imports and exports, and (2) to utilize nutrients on the farm at agronomic rates that minimize nutrient losses to the environment. Managing nutrients at the whole farm level requires knowledge of the major nutrient imports, major nutrient exports, crop

utilization of nutrients on the farm, and nutrient losses to air and water.

The Livestock and Poultry Environmental Stewardship (LPES) Curriculum, available through the Midwest Plan Service, includes a Web presentation of whole farm nutrient management principles and a worksheet for evaluating whole farm nutrient balance. See "For more information" (page 15) for details.

What is the role of post-harvest nitrate testing in connection with Comprehensive Nutrient Management Plans (CNMPs)?

CNMPs, developed by the Natural Resources Conservation Service (NRCS) or other nutrient management professionals under NRCS supervision, are broader than just nutrient management. Other components of a CNMP are: (1) manure and wastewater handling and storage, (2) land treatment practices, (3) record-keeping, (4) feed management, and (5) other waste utilization options.

Post-harvest nitrate test values may be used as part of a process to develop a new CNMP or to update an existing CNMP. The CNMP typically includes a plan for regular

soil testing. Appropriate timing of the post-harvest nitrate test is critical (see "When to sample," page 2), while soil samples for P and K analysis may be collected any time of the year. Soil samples collected for the post-harvest nitrate test can be analyzed by routine agronomic soil testing procedures and used in developing plans for P and K utilization in a CNMP.

What are the implications of high nitrate concentrations in forages?

Nitrate in ensiled forages can interfere with normal fermentation processes, resulting in poor-quality forage. Forage nitrate affects the distribution of nitrogen compounds in silage. It is difficult to use the silage to formulate rations that meet cow needs for specific protein fractions. Enough nitrate is sometimes present in the silage itself to create a health risk to the animal. Grass silage that is greater than 21 percent crude protein should be tested for the level of nitrate-N. See Johnson et al. (2002) for interpretation of forage nitrate concentrations.

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Many OSU Extension Service publications, as well as additional gardening information, may be viewed or downloaded from the Web (<http://eesc.oregonstate.edu>).

Copies of many of our publications and videos also are available from OSU Extension and Experiment Station Communications. For prices and ordering information, visit our online catalog (<http://eesc.oregonstate.edu>) or contact us by fax (541-737-0817), e-mail (puborders@oregonstate.edu), or phone (541-737-2513).

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Soil Test Interpretation Guide

E.S. Marx, J. Hart, and R.G. Stevens



Regular soil testing is an important element in nutrient management. You can use soil tests as a diagnostic tool or to identify trends through time. To obtain meaningful test results, you must sample soil correctly, at the same time each year, and you must maintain records. For more information, see EC 628, *How to take a soil sample. . . and why* (see "For more information," page 7).

Soil testing laboratories use different test methods, which may influence results and sufficiency ranges. Therefore, the sufficiency ranges in this publication are accurate only for the test methods listed.

Soil tests used to evaluate fertility measure the soil nutrients that are expected to become plant-available. They do not measure total amounts of nutrients in the soil. Measurements of total nutrient content are not useful indicators of sufficiency for plant growth, because only a small portion of the nutrients are plant-available.

Adequate soil nutrient levels vary depending on plant species. Similarly, plant tolerance of excessive nutrient levels, nutrient imbalances, or less-than-optimum growing conditions varies. If excessive nutrient levels exist, review management to determine the cause.

Nutrient concentrations vary with soil depth. Depth of sampling, therefore, affects test results. To determine the proper sampling depth, you must consider the purpose of the soil test. To estimate nutrient availability for a crop prior to planting, sample soil to the depth where most root activity will occur. Shallow sampling sometimes is used to evaluate surface conditions in

perennial crops where fertilizers have been applied to the soil surface. Deep sampling may be necessary to diagnose problems in orchards.

Soil test values do not vary greatly from year to year. Drastic changes in test values may indicate an unrepresentative soil sample or a laboratory error. When in doubt, submit a new sample or ask the lab to repeat the analysis.

This publication provides general guidelines for interpreting soil test results. Fertilizer guides for many individual crops are available from your county office of the OSU Extension Service or Washington State University Cooperative Extension, or from Extension and Experiment Station Communications, Oregon State University (see "For more information").

Nitrogen (N)

Plant-available nitrogen (nitrate and ammonium)

Plant-available forms of nitrogen are nitrate (NO_3^- -N) and ammonium (NH_4^+ -N). Soil concentrations of NO_3^- -N and NH_4^+ -N depend on biological activity, and therefore fluctuate with changes in conditions such as temperature and moisture. Nitrate is easily leached from the soil with high rainfall or excessive irrigation. Soil tests can determine NO_3^- -N and NH_4^+ -N concentrations at the time of sampling, but do not reflect future conditions.

When you collect samples for nitrogen testing, keep them cold, or dry them immediately to prevent NO_3^- -N and NH_4^+ -N concentrations from changing.



OREGON STATE UNIVERSITY EXTENSION SERVICE

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Ammonium-nitrogen ($\text{NH}_4^+\text{-N}$)

Ammonium-nitrogen does not accumulate in the soil, as soil temperature and moisture conditions suitable for plant growth also are ideal for conversion of $\text{NH}_4^+\text{-N}$ to $\text{NO}_3^-\text{-N}$. Ammonium-nitrogen concentrations of 2–10 ppm are typical. Soil $\text{NH}_4^+\text{-N}$ levels above 10 ppm may occur in cold or extremely wet soils, or if the soil contains fertilizer residue.

Nitrate-nitrogen ($\text{NO}_3^-\text{-N}$)

West of the Cascades. Soil nitrate-nitrogen measurements are most useful as a post-harvest “report card” to evaluate N management. Nitrate remaining in the soil after harvest can leach during winter rains, contaminating surface and groundwater. If residual nitrate levels are consistently high, reduce fertilizer N inputs in future growing seasons.

Table 1.—Residual soil nitrate-nitrogen for evaluating N management.

$\text{NO}_3^-\text{-N}$ in surface foot (ppm)*	
low	<10
medium	10–20
high	20–30
excessive	>30

*See Table 13 (page 7) for conversion of ppm to lb/acre.

Mid-season measurement of soil nitrate is used for field corn production. See EM 8650, *The Pre-sidedress Soil Nitrate Test (PSNT) for Western Oregon and Western Washington*, for more information.

East of the Cascades. In arid regions, soil nitrate ($\text{NO}_3^-\text{-N}$) is evaluated by measuring $\text{NO}_3^-\text{-N}$ to the expected rooting depth of the crop to be grown. If test results are reported in ppm, convert to lb/acre using Table 13 (page 7). Then subtract the soil nitrate from the crop requirement to determine a fertilizer rate.

Failure to account for $\text{NO}_3^-\text{-N}$ in the soil can lead to over-application of nitrogen fertilizers. Also, irrigation water should be analyzed for $\text{NO}_3^-\text{-N}$ content, and fertilizer rates reduced accordingly. Proper irrigation increases N use efficiency and reduces nitrate leaching.

Total nitrogen

Total nitrogen analysis measures N in all organic and inorganic forms. Total nitrogen does *not* indicate plant-available N, and is not included in standard soil testing programs.

A typical agricultural soil in the Willamette Valley contains about 0.10 to 0.15 percent N, or approximately 5,000 lb N/acre in the surface foot. Only 1 to 4 percent of this total N becomes plant-available during a growing season. East of the Cascades, soils tend to have smaller amounts of total N.

Total N analysis, while not recommended as part of a standard soil testing program, may be better than organic matter analysis for estimating soil N supplying capability.

Phosphorus (P)

The Bray P1 (for acid soils) and the Olsen sodium bicarbonate (NaHCO_3) (for alkaline soils) tests estimate plant-available phosphorus. Soil testing laboratories also use several other extraction methods. For interpretation of results from other extraction methods, contact the laboratory that performed the analysis.

Phosphorus soil tests are an index of P availability. The test values cannot be used to calculate available lb P_2O_5 /acre.

When sampling soil, you must be aware of previous P management. Phosphorus is relatively immobile in soil. If phosphorus has been applied in a fertilizer band, concentrations of P may persist where the band was placed. Avoid fertilizer bands when collecting soil samples.

Table 2.—Phosphorus soil test.

	West of Cascades (Bray P1 test)	East of Cascades (Olsen test)
	ppm P	ppm P
low	<20	<10
medium	20–40	10–20
high	40–100	20–40
excessive	>100	>40

The phosphorus application rate necessary to correct P deficiencies varies depending on soil properties. Phosphorus availability decreases in cool, wet soils. In many situations, banded phosphorus applications are more effective than broadcast applications.

Phosphorus applications generally are not recommended if tests are high or excessive. High soil phosphorus combined with surface runoff can cause excessive growth of plants and algae in surface waters, damaging aquatic ecosystems.

Cations

Of the three primary cations (potassium, calcium, and magnesium), potassium requires the most management attention. Few crops have responded to calcium and magnesium in the Pacific Northwest.

If extremely high levels of a single cation exist, plant deficiencies of other cations may occur due to competition for plant uptake.

The soil test ranges in Tables 3, 4, and 5 are for the ammonium acetate extraction method. If a sodium bicarbonate (NaHCO_3) extraction is used, test values may be slightly lower.

Potassium (K)

Excessive soil potassium levels can result in elevated K levels in grass forage crops, which may be detrimental to animal health.

Table 3.—Extractable potassium (K).

	K
low	<150 ppm* <0.4 meq/100 g soil
medium	150–250 ppm 0.4–0.6 meq/100 g soil
high	250–800 ppm 0.6–2.0 meq/100 g soil
excessive	>800 ppm >2.0 meq/100 g soil

*See Table 13 (page 7) for conversions from ppm to meq/100 g soil.

Calcium (Ca)

Calcium deficiencies usually are found only on very acid soils. They can be corrected by liming with calcium carbonate (CaCO_3).

Table 4.—Extractable calcium (Ca).

	Ca
low	<1,000 ppm* <5 meq/100 g soil
medium	1,000–2,000 ppm 5–10 meq/100 g soil
high	>2,000 ppm >10 meq/100 g soil

*See Table 13 (page 7) for conversions from ppm to meq/100 g soil.

Magnesium (Mg)

Magnesium deficiencies on acid soils can be corrected by liming with dolomitic lime.

Magnesium toxicity can occur on serpentine soils in southwest Oregon.

Table 5.—Extractable magnesium (Mg).

	Mg
low	<60 ppm* <0.5 meq/100 g soil
medium	60–180 ppm 0.5–1.5 meq/100 g soil
high	>180 ppm > 1.5 meq/100 g soil

*See Table 13 (page 7) for conversions from ppm to meq/100 g soil.

Sulfate-sulfur ($\text{SO}_4^{2-}\text{-S}$)

Plants absorb sulfur in the sulfate ($\text{SO}_4^{2-}\text{-S}$) form. In high rainfall areas west of the Cascades, SO_4^{2-} is readily leached, and soil test data are not well correlated with plant growth. In arid regions east of the Cascades, soil test information may be useful. Also, irrigation water may contain significant amounts of sulfate-sulfur. Plant analysis often is useful for diagnosing sulfur deficiency.

Table 6.—Sulfate-sulfur, east of the Cascades.

	$\text{SO}_4^{2-}\text{-S}$ (ppm)
low	<2
medium	2–10
sufficient	>10

Micronutrients

Deficiencies of micronutrients other than boron and zinc are uncommon. Availability of most micronutrients is largely pH-dependent; availability decreases as pH increases (except for molybdenum, which becomes more available as pH increases). Deficiencies rarely occur in soils with pH below 6.5.

Soil testing for micronutrients other than boron and zinc is recommended only when a deficiency is suspected. If you suspect a micronutrient deficiency, plant tissue testing may be a better diagnostic tool than soil testing.

Boron (B)

Crops such as alfalfa, table beets, brassicas, caneberries, and root crops have responded to boron fertilization on B-deficient soils in western Oregon. Tree fruits and alfalfa are examples of crops sensitive to low boron levels east of the Cascades.

While low levels of boron may limit plant growth, high concentrations can be toxic. When applying boron, apply uniformly and mix thoroughly with the soil.

Table 7.—Boron by the hot water extraction method.*

	B (ppm)
low	<0.5
medium	0.5–2
high	>2

*The hot water extraction method for boron may result in incorrectly high values on soils with high organic matter content.

Zinc (Zn)

Zinc values above 1.0 ppm using the DTPA extraction method are sufficient. Zinc deficiencies have been identified in some crops in certain regions. Corn, beans, grapes, hops, onions, and deciduous fruit trees are especially sensitive to low levels of available zinc. Deficiencies sometimes are associated with high soil P concentrations, soils high in fine clay and silt, or soils with high pH.

Copper (Cu)

Copper values above 0.6 ppm using the DTPA extraction method are sufficient. Copper deficiencies are uncommon. Deficiencies have been identified on muck soils such as those in the Klamath area in Oregon and the Colville area in Washington.

Manganese (Mn)

Manganese values above 1.5 ppm using the DTPA extraction method are sufficient. Manganese deficiencies generally occur only in soils with pH 7.0 or above. Manganese toxicity may occur on acid soils. On alkaline soils east of the Cascades, Mn availability may increase in acidified microzones where fertilizers have been placed. These acidified microzones can alleviate Mn deficiencies sometimes encountered on high pH soils. In some instances, however, acidic microzones can result in Mn toxicity.

Iron (Fe)

Soil testing for iron is not recommended. Most test methods do not discern between forms of iron, and therefore have little meaning for plant nutrition.

Iron deficiencies are uncommon on acid soils in the Pacific Northwest. Where deficiencies occur, they often are associated with acid soil plants, such as azaleas or rhododendrons, growing on soils with unsuitably high pH. Acidifying fertilizers such as ammonium sulfate will help correct problems.

Iron applications on alkaline soils are inefficient unless a chelated form is used. Lowering soil pH to increase iron availability on a field scale is not economical. However, adding acidifying materials such as elemental sulfur to fertilizer mixes can acidify microzones around the fertilizer material and increase Fe availability.

Foliar applications of Fe sometimes are used to correct deficiencies in fruit, turf, and other high-value crops.

Molybdenum (Mo)

Soil Mo concentrations are too low for most labs to evaluate. Molybdenum deficiencies are rare, and are of concern mostly for leguminous crops. Molybdenum-deficient legumes appear chlorotic. Liming to raise soil pH may alleviate deficiencies. Molybdenum-coated seed also can be used.

Excessive molybdenum in forage can harm animal health. If you suspect excessive molybdenum in your forage, determine Mo content by forage analysis.

Chloride (Cl)

Soil testing for chloride is not a common practice, and little data exists for interpretation of test results. Evidence indicates that wheat sometimes benefits from chloride applications. The values in Table 8 are based on wheat research in Montana and South Dakota. Little information exists on chloride soil testing in Washington and Oregon.

Table 8.—Chloride soil test ranges for wheat in Montana and South Dakota, 2-foot sampling depth.

	ppm	lb/acre
low	0–4	0–32
medium	4–8	32–64
high	>8	>64

pH, lime requirement (LR)

Soil pH is a measure of soil acidity. Most crops grow best if the soil pH is between 6.0 and 7.5.

Table 9.—Soil pH ranges.

	pH
strongly acid	below 5.1
moderately acid	5.2–6.0
slightly acid	6.1–6.5
neutral	6.6–7.3
moderately alkaline	7.4–8.4
strongly alkaline	above 8.5

Soil pH can be increased by liming. The soil pH test indicates *if* lime is needed. The lime requirement test determines *how much* lime is needed. Accurate lime recommendations cannot be made without performing an SMP or similar test.

SMP* lime requirement test

The SMP lime requirement test is used to estimate the amount of lime required to raise the pH of 6 inches of soil. The SMP test is performed by mixing soil with a buffered pH 7.5 solution and determining the pH of the mixture. During the reaction, the soil's reserve acidity lowers the pH of the SMP solution. Soils with low SMP values have high reserve acidity and high lime requirements.

Some soils may have a low pH (<5.3) and a fairly high SMP buffer value (>6.2). This condition can be caused by the application of fertilizer. In this case, the low pH value is temporary, and the pH of the soil will increase as the fertilizer completes its reaction with the soil.

Sandy soils also may have a low pH and high SMP buffer value. This condition occurs because sandy soils have low amounts of reserve acidity due to low cation exchange capacity (CEC). In such cases, a light application of lime (1 to 2 t/a) should suffice to neutralize soil acidity.

Table 10 is used to determine the amount of lime required, based on the SMP test, to raise soil pH to a desired level. The target pH is determined by the crop to be grown and possibly by other factors.

*SMP stands for Shoemaker, MacLean, and Pratt—the people who developed the test.

Without an SMP or similar test, there is no way to know how much lime is required to adjust soil pH to a desired level. Accurate lime recommendations cannot be made solely on the basis of soil pH.

Table 10.—SMP lime requirement—field scale.

SMP buffer	Tons/acre of 100-score lime needed to raise pH of surface 6 inches of soil to the following pH's			
	5.3	5.6	6.0	6.4
6.7	—	—	—	—
6.6	—	—	—	1.1
6.5	—	—	1.0	1.7
6.4	—	—	1.1	2.2
6.3	—	—	1.5	2.7
6.2	—	1.0	2.0	3.2
6.1	—	1.4	2.4	3.7
6.0	1.0	1.7	2.9	4.2
5.9	1.4	2.1	3.3	4.7
5.8	1.7	2.5	3.7	5.3
5.7	2.0	2.8	4.2	5.8
5.6	2.3	3.2	4.6	6.3
5.5	2.6	3.6	5.1	6.8
5.4	2.9	3.9	5.5	7.3
5.3	3.2	4.3	6.0	7.8
5.2	3.6	4.7	6.4	8.3
5.1	3.9	5.0	6.9	8.9
5.0	4.2	5.4	7.3	9.4
4.9	4.5	5.8	7.7	9.9
4.8	4.8	6.2	8.2	10.4

Example: If the "SMP buffer" value is 5.9, the amount of lime needed to raise the pH to 6.0 is 3.3 tons of 100-score lime/acre.

Table 11.—SMP lime requirement—gardens.

If the SMP lime requirement test is	Apply this amount of lime (lb/1,000 ft ²)
5.4 or below	250
5.5–6.0	150–250
6.0–6.5	100–150
above 6.5	0

Some plants, such as blueberries, rhododendrons, azaleas, and cranberries, grow best in acid soils. Fertilizers such as ammonium sulfate can help maintain acidic conditions.

Sodium (Na)

Sodium is not a plant nutrient and therefore is not necessary for plant growth. High levels of sodium are detrimental to soil tilth and plant growth.

Sodium levels are evaluated based on Exchangeable Sodium Percentage (ESP). The ESP is the percent of the cation exchange capacity (CEC) occupied by Na.

ESP values above 10 percent are of concern. Excessive sodium levels can occur naturally or can result from irrigation with high-sodium water. Reclamation involves establishment of drainage followed by gypsum application and leaching with low-sodium water.

Soluble salts (SS)

Soluble salt problems usually are associated with arid regions such as eastern Oregon and Washington. Soils with high levels of soluble salts are called saline soils. Soils high in sodium are called sodic soils (see "Sodium"). Saline-sodic soils are high in both soluble salts and sodium. Soluble salts are measured by electrical conductivity (EC) of a saturated paste soil extract.

Table 12.—Soluble salts.

	Conductivity (mmhos/cm*)	ppm salt**
low	<1.0	<640
medium	1.0–2.0	640–1,280
high	>2.0	>1,280

*mmhos/cm is equivalent to decisiemen/m.

**Multiply mmhos/cm by 640 to estimate ppm salt.

Because salts move readily with water, salt problems often are transient. Salt toxicity can occur, and salts may leach before soil is tested. Low salt values, therefore, do not always rule out salt toxicity as a cause of problems.

Salt tolerance varies greatly among plant species. Seedlings are especially sensitive to high salt concentrations. Excessive salts may inhibit seed germination. Excessive fertilization and poor irrigation water quality are sources of salts.

Organic matter

Maintenance of soil organic matter is one of the most important goals of soil management. Accurate measurement of soil organic matter is difficult.

Many laboratory methods are used. Most methods are indirect; they measure soil carbon and make an assumption about the percent carbon content of organic matter. The Walkley-Black method is common and gives consistent results. The loss on ignition method can give inconsistent results and tends to overestimate organic matter.

When estimating potential nitrogen release of a soil, total N testing is preferred to organic matter determination. Neither approach provides accurate estimates of soil N availability. If you are monitoring changes in organic matter over time, use the same lab for all analyses.

Cation exchange capacity (CEC)

CEC is a measure of a soil's capacity to retain and release elements such as K, Ca, Mg, and Na. Soils with high clay or organic matter content tend to have a high CEC. Sandy soils have a low CEC. Soil CEC is relatively constant over time, so there is no need for repeated analyses.

CEC often is determined by the ammonium acetate (NH_4OAc) or sodium acetate (NaOAc) methods. While these methods are standard in many regions, there are potential sources of error. Errors are most likely to occur for soils containing appreciable amounts of CaCO_3 or gypsum.

Some labs estimate CEC based on soil texture, organic matter content, cations, and pH. Such estimates often are inaccurate. The "sum of bases" method for calculating CEC of alkaline soils can give inaccurate results, especially if there are significant amounts of free CaCO_3 .

CEC determination can be important for predicting behavior of pesticides and other chemicals in soils.

Base saturation

Base saturation is the percentage of the CEC that is occupied by cations other than hydrogen (H) and aluminum (Al). Soils with low base saturation generally are acidic. Base saturation and pH increase together.

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Table 13.—Conversions.

To convert column 1 into column 2, <i>divide by</i>	Column 1	Column 2	To convert column 2 into column 1, <i>multiply by</i>
390	ppm K	meq K/100 g soil	390
200	ppm Ca	meq Ca/100 g soil	200
121	ppm Mg	meq Mg/100 g soil	121
230	ppm Na	meq Na/100 g soil	230
1	meq/100 g soil	cmol/kg soil	1
2*	lb/acre (7 inch depth)	ppm	2*
3.65*	lb/acre (1 foot depth)	ppm	3.65*
43.56	lb/acre	lb/1,000 sq ft	43.56
43,560	square feet	acres	43,560
2.471	acres	hectares	2.471

*These values vary with soil bulk density.



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NUTRIENT MANAGEMENT
FOR DAIRY PRODUCTION

Manure application rates for forage production

T. Downing, D. Sullivan, J. Hart, and M. Gamroth

Most dairies can supply all the nitrogen, phosphorus, potassium, and other nutrients needed for forage production by applying manure to forage crops. As a manager, your goal is to match nutrient supply with crop needs by deciding when and how much manure to apply.

This publication explains how to estimate the amount of manure to apply for forage production. To do so, you need:

- A current manure analysis for your dairy (see *Dairy Manure as a Fertilizer Source*, EM 8586)
- A list of forage crops to be produced
- A soil test for phosphorus and potassium from each field where manure will be applied

Applying too much manure leads to several problems. First, plants take up excess amounts of nutrients such as potassium. High-potassium grass forages can lead to health problems, especially in dry cows. Second, excess manure can add nutrients and microorganisms to runoff or surface water, and can provide nitrogen that can leach into groundwater.

Application rates in this publication are based on soil tests and growing conditions in western Oregon.

Manure analysis

Analyzing manure is critical to determining the correct application rate. If you don't test your dairy's manure, you can only guess its nutrient value.

Manure testing in western Oregon has shown more variation among dairies than within one dairy. Develop a manure nutrient history for your dairy by testing manure two or three times a year for 2 or 3 years. These records will help you manage nutrient resources.

Have manure analyzed for total nitrogen (N), ammonium nitrogen ($\text{NH}_4\text{-N}$), phosphorus (P), and potassium (K). Laboratories often perform these as a standard analysis package.

Call your county office of the OSU Extension Service or your local USDA Natural Resources Conservation Service office for sampling directions. *Laboratories Serving Oregon: Soil, Water, Plant Tissue, and Feed Analysis* (EM 8677) lists laboratories that test manure.

Crop nitrogen requirements

Nitrogen (N) typically is the limiting nutrient for crop production on dairies. Table 1, page 3, shows the estimated nitrogen removal rate (or uptake) for average yields of the most common forage crops grown on dairies. Values in the upper part of the table are on a dry matter (DM) basis; in the lower part, as-harvested values are adjusted for moisture. For example, 1 ton of forage dry matter is equivalent to 4 tons of harvested forage if the silage is 25 percent DM. When discussing nutrient removal, you need to know whether you are dealing with as-harvested or dry-matter values so that you can interpret values correctly.

Troy Downing, Extension agriculture faculty (dairy), Tillamook County; Dan Sullivan, Extension soil scientist; John Hart, Extension soil scientist; and Mike Gamroth, Extension dairy specialist; all of Oregon State University. This publication replaces EC 1094, *Calculating the Fertilizer Value of Manure from Livestock Operations*.

Determining manure application rate

Your goal is to match manure nutrient application rates with crop removal rates. Table 1 and Figures 1 and 2 provide the information you need to determine nutrient removal for many annual and perennial crops. Instructions for using the table and figures follow.

1. In Table 1, find the crop you will grow. Let's assume it's perennial ryegrass. The table is arranged to help you separate different levels of intensity. For example, low-intensity harvesting might be only one or two cuttings per year, medium will be three to five cuttings per year, and high intensity is six to seven cuttings per year.
2. For our example, let's assume you harvest four times a year, and your ryegrass averages 15 percent protein. That is equivalent to 48 lb of nitrogen per ton of dry matter, yielding around 5 tons of dry matter (240 lb N) per year.
3. You need to replace 240 lb N/a/year from the four cuttings. This is equivalent to 60 lb/a of nitrogen per cutting.
4. Find the figure below (Figure 1 or 2) that represents the type of manure you want to apply. Let's assume you want to apply lagoon effluent, so you'll use Figure 2.

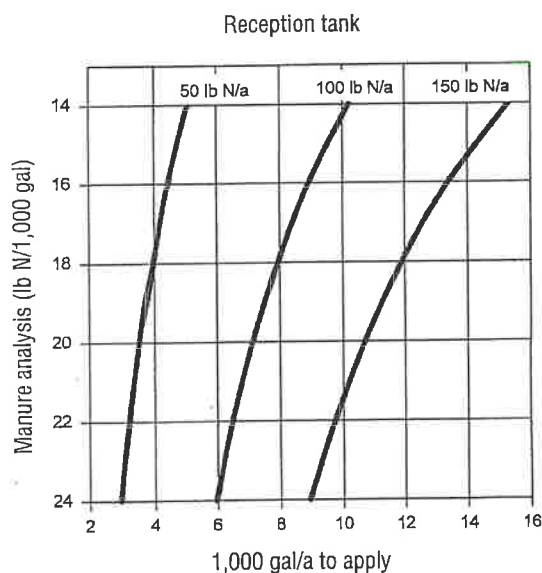


Figure 1.—Determining application rate for reception tank manure.

Note: For reception-tank manure, approximately 70 percent of the total N is considered available. For lagoon effluent, 100 percent of the total N is considered available.

5. Figure 2 contains three lines representing N application rates of 50, 100, and 150 lb N/a. Find the line closest to the rate you need to apply. In this example, you'll use the line for 50 lb/a.
6. Select the manure analysis from your dairy for nitrogen on the left side of the graph. Assume a manure test shows that the effluent contains 6 lb/1,000 gal or 750 ppm N. Move to the right across the graph until you meet the line for the application rate you have chosen (50 lb N/a).
7. Now move straight down to the line labeled "effluent acre-inches to apply" and estimate the number of acre-inches of effluent to apply (in this case, about 0.3 acre-inch). Remember that you will need about 20 percent more nitrogen because no line exists for 60 lb N/a. Your final result will be about 0.4 acre-inch.

Testing your soil for P and K

Test your soil for phosphorus (P) and potassium (K) before applying manure. Table 2 (back page) provides interpretations of P and K soil tests.

If you've applied manure for more than 5 years, additions of P and K usually are not needed. For example, potassium usually is not deficient in soils

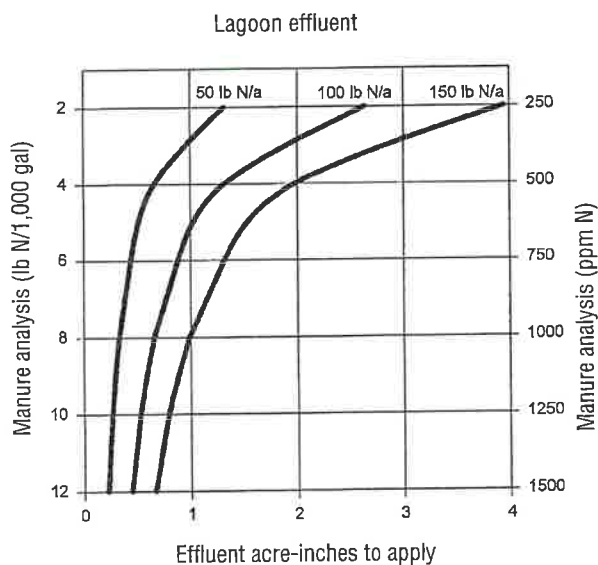


Figure 2.—Determining application rate for lagoon effluent.

Table 1.—Nitrogen, phosphorus, and potassium removal of common perennial and annual forage crops.

Crop (dry matter)	Cuttings (no.)	DM ¹ (%)	CP ¹ (%)	N (lb/t)	P (lb/t)	K (lb/t)	DM (t/a)	N used (lb/a)
Red clover	1	100	18	58	8	48	4	232
Alfalfa hay	3	100	20	64	8	42	5	320
Perennial grass (low intensity)	1–2	100	10	32	6	38	4	128
Perennial grass (medium to low intensity)	2–3	100	12	38	6	38	4.5	171
Perennial grass (medium intensity)	4–5	100	15	48	7	38	5	240
Perennial grass (medium to high intensity)	5–6	100	18	58	8	40	6	348
Perennial grass (high intensity)	6–8	100	20	64	8	40	7	448
Annual ryegrass	1	100	12	38	6	38	4	152
Annual ryegrass	2	100	15	48	7	40	5	240
Corn silage	1	100	8	25	4	20	8	200
Small grains (boot stage)	2	100	12	38	5	32	5	190
Small grains (soft dough)	1	100	8	25	5	30	4	100
Crop (as harvested)	Cuttings (no.)	DM ¹ (%)	CP ¹ (%)	N (lb/t)	P (lb/t)	K (lb/t)	AH ¹ (t/a)	N used (lb/a)
Red clover	1	25	5	14	2	12	16	232
Alfalfa	3	30	6	19	2	12	16	320
Perennial grass (low intensity)	1–2	30	3	10	2	11	13	128
Perennial grass (medium to low intensity)	2–3	30	4	11	2	11	15	171
Perennial grass (medium intensity)	4–5	30	5	14	2.1	11	17	240
Perennial grass (medium to high intensity)	5–6	30	5	17	2.4	12	20	348
Perennial grass (high intensity)	6–8	30	6	19	2.4	12	23	448
Annual ryegrass	1	30	4	11	1.8	11	13	152
Annual ryegrass	2	25	4	12	1.8	10	20	240
Corn silage	1	25	2	6.7	1	5	30	200
Small grains (boot stage)	2	30	4	11	1.5	10	16	190
Small grains (soft dough)	1	30	2	8	1.5	9	13	100

¹DM=dry matter; CP=crude protein; AH=as harvested

where manure has been applied unless the applications were light and a high yield of grass hay was removed. A manure application that meets crop N needs usually supplies sufficient amounts of P and K. Manure contains as much, if not more, K than N. For more information, see *Dairy Manure as a Fertilizer Source* (EM 8586).

In fact, fields that have received manure for a decade or more often have high soil test values for P and K. Fields with soil test K above 1,000 ppm can produce grass forage with a high K concentration. Dry cows fed grass forage containing more than 3 percent K may become seriously ill or die.

In some cases, a soil test shows excessive K, but N is needed. In this case, if another area is available for manure application, apply manure there and buy N fertilizer for the area that has excess K.

Contact your county office of the OSU Extension Service for additional information.

Soil and plant tissue testing for N

The tables and figures in this publication only estimate manure application rates. A soil test for nitrate nitrogen or a stalk nitrate test for silage corn can aid in adjusting manure application rates.

Table 2.—Interpretation of soil tests for P and K.

Soil status	Nutrient (ppm)	
	Phosphorus (P)	Potassium (K)
Deficient	below 25	below 150
Sufficient	25–50	150–500
High	50–75	500–1,000
Excess	above 75	above 1,000

For more information, see *The Presidedress Soil Nitrate Test* (EM 8650) and *Post-harvest Soil Nitrate Testing for Manured Cropping Systems West of the Cascades* (EM 8832).

For more information

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