NORTH CANAAN NUTRIENT MANAGEMENT FEASIBILITY STUDY

CANAAN VALLEY AGRICULTURAL COOPERATIVE, INC.

Eastern Connecticut RC&D Resource Conservation and Development Area, Inc.

FINAL REPORT
AUGUST 2006

Wright-Pierce
Civil and Environmental Engineering Services

NORTH CANAAN NUTRIENT MANAGEMENT FEASIBILITY STUDY

FOR THE

CANAAN VALLEY AGRICULTURAL COOPERATIVE, INC.,

AND THE

EASTERN CONNECTICUT RESOURCE CONSERVATION AND DEVELOPMENT AREA, INC.

FINAL REPORT
AUGUST 2006

Prepared By:

Wright-Pierce
169 Main Street
700 Plaza Middlesex
Middletown, CT 06457

SECTION 1
EXECUTIVE SUMMARY

Northwest Connecticut has an active dairy farming community. Some of the farms in this region produce more manure nutrients than can be agronomically and economically handled on the available fields in the surrounding areas. This excess manure has the potential to be a source of pollution for area lakes and streams. To prevent this possibility, there is a need to convert manure nutrients into a form and/or product that can be exported off the farm. A value-added product such as compost provides a method for moving manure nutrients into non-dairy farm markets and has the potential to produce an income stream for the farmer.

The Canaan Valley Agricultural Cooperative, Inc. is a group of seven dairy farms located in northwestern Connecticut and neighboring Massachusetts. This group has been working to develop value-added products from excess dairy manure as a method to move nutrients into another sector and to prevent over-application of nutrients to their fields. The Canaan Valley Agricultural Cooperative, Inc. has had discussions with a private company to develop a regional manure anaerobic digester to generate power. While the project could provide a source of income from the manure, it would not address the nutrient surplus issue facing the farms since the anaerobic digester effluent would be returned to the Cooperative farms. The Canaan Valley Agricultural Cooperative, Inc. is interested in the potential opportunity of composting the solids fraction of the digester effluent as a nutrient management option with the potential for additional income from the compost end products. This feasibility study evaluates two regional facility options: composting the solids fraction of the anaerobic digester effluent and, in case the digester project does not go forward, composting excess dewatered manure directly from the farms.

In order to size the facility and estimate the quantity of available manure, the members of the Canaan Valley Agricultural Cooperative, Inc. were interviewed and a survey of each farm was completed. The data collected was used as the design basis of the composting facility, equipment selection, and estimates of finished compost volume.

The manure and amendment volumes used as the basis for the analysis and facility design are given in Table 1-1. The maximum and minimum cases are based on the number of farms contributing to the facility. The minimum case assumes that only the three largest farms would use the regional composting facility; the maximum case assumes six of the farms would use the regional composting facility. In all cases the manure would be dewatered at the farm or at the anaerobic digester before being trucked to the regional composting facility.

TABLE 1-1

COMPOSTING OPERATION FEED QUANTITIES

	With Anaerobic Digester		**Without Anaerobic Digester**	
	Minimum	Maximum	Minimum	Maximum
Manure				
Volume (CY/day)	51	56	92	107
Volume (CY/year)	18,700	20,400	33,500	39,000
Density (lb/CY)	1,600	1,600	1,600	1,600
% Solids	25	25	26	25
% Volatile Solids	14.5	14.5	21	20.8
Wet Solids (tons/year)	15,000	16,300	26,800	31,200
Amendment				
Woodchips				
New:				
% Solids	60	60	60	60
Wet Solids, (ton/yr)	2,800	3,000	4,800	5,750
Recycle:				
% Solids	60	60	60	60
Wet Solids, (ton/yr)	8,500	9,200	14,300	17,000
Or				
Horse Manure				
% Solids	60	60	60	60
Wet Solids, (ton/yr)	11,300	12,200	19,100	22,750
Total Feed Mixture				
Total Mass (Tons/year)	26,000	28,500	46,000	54,000
Total Volume (CY/year)	57,000	62,000	100,000	118,000

The feed quantities presented in Table 1-1 were used to predict the volume and quality of compost product that would be produced at the facility. Table 1-2 provides the expected quantity of salable material under the two design conditions.

TABLE 1-2
FINISHED COMPOST CHARACTERISTICS

	With Anaerobic Digester	Without Anaerobic Digester
Volume (CY/day)	35	54
Volume (CY/year)	13,000	20,000
Density (lb/CY)	945	945
% Solids	60	60
Wet Solids (tons/year)	6,100	9,400

Based on the quantity and quality of compost product expected, a market analysis was conducted to identify realistic sale prices and potential costumers. The analysis identified a strong market demand among landscapers and landscape and nursery suppliers for a high quality, manure-based compost that is available year-round. Bulk compost of any grade is currently not widely available in the northwestern part of Connecticut—the primary market area for the North Canaan facility. High freight costs have limited the range of compost suppliers from out-of-state and improved the prospects for local suppliers. Consumers have also been exhibiting a preference for purchasing locally-produced goods and have demonstrated a willingness to pay slightly more for these products. Consequently, there appears to be a demand that is not being met and a market opportunity. In addition, composted cow manure is considered a superior product to most other types of compost and should be marketed as such.

The best market opportunity for the North Canaan dairy manure composting facility is distributing the composted material to local landscaping operations and home gardeners in Litchfield County. The following options exist for this market:

- Bulk Compost. Wholesale suppliers to the landscape market including Shemin Nurseries and GreenCycle have expressed an interest in carrying bulk cow manure compost from the North Canaan facility.
- Bagged Compost: Consolidation in the composting industry and high freight costs have created a niche for a premium, locally-produced bagged cow manure compost. However, price competition from high volume suppliers like Scotts makes entry into the retail market more difficult for a small operation that cannot benefit from economies of scale.

Bulk compost provides a more realistic and dependable market opportunity and it is recommended that the compost be screened to a 3/8 inch size to provide the highest quality and most desirable product possible, improving the potential viability of the facility. Offering delivery to the job site could expand the available market. However, trucks and personnel would be required to handle these orders. The most reliable marketing strategy for the regional composting facility is to sell the material as high quality compost, at a wholesale price averaging $17 per cubic yard, to the local landscaping market.

Composting can be achieved through a number of proven methods, and several of these were considered in this study. Specifically, the financial and operational feasibility of windrow, covered pile (Ag-Bag), and agitated bin composting systems were compared for this analysis. While all three options are proven methods of achieving acceptable compost product, the cost, land area required, and maintenance demands differentiate the systems. Early in the analysis the agitated bin system was found to be cost prohibitive due to the number bins and turners required. As a result, the agitated bin system was not evaluated further. The windrow and Ag-Bag systems were considered more viable options.

Technically both technologies are feasible. They both have been used successfully at other locations, they require about the same amount of land, and much of the process is the same for all of the options. The most significant differences include the following:

- The windrow system provides periodic agitation to break up the "hot spots" during the active composting phase. The Ag-Bag system is a static pile system and may produce a less uniform product. Proper curing would be important with the Ag-Bag system.
- The Ag-Bag system is enclosed and would provide some level of odor control while the windrow system is open to the atmosphere.
- The Ag-Bag system requires handling and disposal of the bags.

The availability and price of amendment material can significantly impact the cost of operating the composting facility. High grade horse manure can be considered as an alternative to woodchips and may be available in the area at no cost. The horse manure would not be recycled but would remain in the material as part of the finished compost, increasing the volume of product available for sale and increasing revenue.

Economically, the analysis indicates that none of the options would produce sufficient income to cover all of the costs of the operations. The costs associated with each system are presented in Table 1-3. Even when avoided costs are considered, it is unlikely that any of these options will be a revenue producing operation. Of the options reviewed, the Ag-Bag and horse manure options are the most cost effective. Grant funding and low interest loan options can have a significant effect on the overall project cost. If the capital cost can be substantially covered, then the costs are reduced to the operating costs of the project, increasing the viability of the facility. However, no sinking fund was included in these estimates. A sinking fund would be equivalent to the annualized capital cost. Therefore, the totals given can also be used as an estimate of the costs with grant funding and a sinking fund. In each case, the operating costs also exceeded the annual income. Therefore in no case does it appear that income will be generated via a regional composting facility.

TABLE 1-3

COST SUMMARY

	Dewatered Digested Manure			Dewatered Whole Manure		
	Windrow		Ag-Bag	Windrow		Ag-Bag
	Woodchips	Horse Manure		Woodchips	Horse Manure	
Capital Cost	$5,100,000	$5,250,000	$2,240,000	$7,586,000	$7,975,000	$3,175,000
Annualized Capital Cost	$442,000	$458,000	$196,000	$661,000	$695,000	$277,000
O&M Cost	$343,000	$295,000	$410,000	$475,000	$391,000	$654,000
Annual Revenue	$218,000	$413,000	$218,000	$335,000	$646,000	$335,000
Annual Net O&M Cost	$125,000	($117,460)	$192,000	$141,000	($255,000)	$319,000
Total Annual Cost	$567,000	$341,000	$388,000	$802,000	$440,000	$596,000
$ / wet Ton	$38	$23	$26	$30	$16	$22
$ / Cow	$311	$187	$213	$440	$241	$327

SECTION 2
INTRODUCTION

2.1 INTRODUCTION

Northwest Connecticut has an active dairy farming community. Some of the farms in this region produce more manure nutrients than can be agronomically and economically handled on the available fields in the surrounding areas. This excess manure has the potential to be a source of pollution for area lakes and streams. To prevent this possibility, there is a need to convert manure nutrients into a form and/or product that can be exported off the farm. A value-added product such as compost provides a method for moving manure nutrients into non-dairy farm markets and has the potential to produce an income stream for the farmer.

The Canaan Valley Agricultural Cooperative, Inc. is a group of seven dairy farms located in northwestern Connecticut and neighboring Massachusetts. This group has been working to develop value-added products from excess dairy manure as a method to move nutrients into another sector and to prevent over-application of nutrients to their fields. The Canaan Valley Agricultural Cooperative, Inc. has had discussions with a private company to develop a regional manure anaerobic digester to generate power. While the project could provide a source of income from the manure, it would not address the nutrient surplus issue facing the farms since the anaerobic digester effluent would be returned to the Cooperative farms. The Canaan Valley Agricultural Cooperative, Inc. is interested in the potential opportunity of composting the solids fraction of the anaerobic digester effluent as a nutrient management option with the potential for additional income from the compost end products. This feasibility study would evaluate two regional facility options: composting the solids fraction of the anaerobic digester effluent and, in case the anaerobic digester project does not go forward, composting excess dewatered manure directly from the farms.

2.2 SCOPE OF SERVICES

This feasibility study was completed under the direction of the Eastern Connecticut Resource Conservation and Development Area, Inc. (RD&C) which works with farming groups throughout the state to address manure management and nutrient surplus issues. In addition an Advisory Board made of representatives from the following groups provided guidance during this feasibility study:

- University of Connecticut
- Natural Resources Conservation Service of USDA
- Eastern Connecticut Resource Conservation and Development Area, Inc.
- US EPA
- Canaan Valley Agricultural Cooperative, Inc.
- Connecticut Department of Environmental Protection

The purpose of this report is to present the results of the feasibility and market analysis of a regional composting facility for the North Canaan area and specifically the Canaan Valley Agricultural Cooperative, Inc.. This report has purposefully been kept brief to focus on conveying the critical information. Organization of the report is as follows:

- Section 1 provides an Executive Summary.
- Following this Introduction (Section 2), Section 3 presents the design basis including the survey of farms, manure quantity estimates and finished compost estimates.
- Section 4 presents the conceptual design of two options: regional composting of dewatered whole manure and composting of dewatered anaerobically digested manure. The presentation of each option includes three composting systems: windrows composting, bag composting and bin composting.
- Section 5 discusses the market analysis for the sale of finished compost.
- Section 6 focuses on the economic feasibility of the options presented in Section 4.
- Section 7 summarizes the feasibility of the options including a comparison of the advantages and disadvantages of each system.
- Section 8 provides an overall summary.

SECTION 3
DESIGN BASIS

The purpose of this Section is to outline the feed design basis for the proposed North Canaan Regional Compost Facility and the methods and assumptions that were used to develop the design basis. Since the Canaan Valley Agricultural Cooperative, Inc. is currently assessing the feasibility of a regional anaerobic digester, two cases are being considered in the Regional Compost Facility Feasibility Study:

- Composting of dewatered manure and
- Composting of dewatered anaerobically digested manure.

In the dewatered manure case, it is recommended that the manure be separated at each farm using a new mobile separator unit for those farms which currently do not dewater their manure. The feed to the regional composting facility would be the solids fraction of the manure. In the regional anaerobic digester case, the anaerobic digester facility would receive the manure feeds from each of the farms without prior separation. Separation would take place after the anaerobic digester and the solids fraction of the anaerobically digested manure would be the feed to the compost facility. It is assumed that the anaerobic digester would remove 30% of the volatile solids present in the manure.

3.1 MANURE SOURCES

In order to determine to quantity and content of the manure produced at the seven farms in the Canaan Valley Agricultural Cooperative, Inc., a survey and interview at each farm was conducted to collect information about the operation of each of the farms. The individual nutrient needs of the farms, and methods employed to manage the manure at each farm vary due to the broad range in size of the farms, from 30 cows to 900 cows. While two of the largest farms currently dewater their manure, most of the farms utilize large holding tanks, or storage areas, to collect the manure and related material. Bedding material utilized at the farms was typically found to be straw, saw dust, or sand, and all bedding material is collected with the manure. At some of the facilities the milk house water is used for rinsing or washing the barn, or otherwise is added to the manure, contributing to the liquid content of the final manure mixture.

Surveys and site visits were done with six of the farms in the Canaan Valley Agricultural Cooperative, Inc. The seventh farm, Sunset Hill, indicated that they did not want to be included in a regional composting facility and no data was collected from this farm. Based on the data collected in the surveys, it appears that the three largest farms, Elm Knoll Farm, Laurel Brook Farm, and Freunds Farm could obtain the most significant benefit from utilizing a composting facility as part of their nutrient management strategy. A number of the smaller farms indicated that adequate land area was available, at reasonable and affordable distance, to allow for full disposal of all farm produced nutrients, and that they would likely contribute minor, if any manure, to a regional composting facility. In order to define the upper and lower limits of the size and capacity of a potential composting facility, it was assumed that at least the three largest farms would contribute 100% of the solids portion of their manure, and at most all seven farms would contribute all of their manure.

The quantity of manure produced at each farm was estimated using two different methods:

- A method based on research by Wilkerson, et. al., which utilizes both the average weight of the cows as well as the average milk production.
- The American Society of Agricultural and Biological Engineers method using a standard value of manure produced per dairy cow per day. This method can also be used for estimating manure production by heifers and dry cows using a smaller value of daily manure production per cow.

The Wilkerson calculation provides slightly higher estimates of manure production, which more closely matched the estimates provided by some of the farmers. As a result, the Wilkerson calculation has been applied to each farm and the values have been used to determine the manure feed quantities to the composting facility. If estimates were provided by the farmers they were used to verify the calculated values, to ensure reasonable accuracy. The references for the calculations can be found in Appendix A. A summary of the total quantity of manure produced, and estimates of the liquid stream and dewatered manure volumes after separation, can be found in Table 3-1. If a regional anaerobic digester is not used the liquid portion of the manure will remain on the farm for disposal. Should an anaerobic digester be included at the regional facility, the liquid stream resulting from separation after anaerobic digestion will require land disposal at the farms.

TABLE 3-1

MANURE QUANTITIES

	With Anaerobic Digester		**Without Anaerobic Digester**	
	Minimum	Maximum	Minimum	Maximum
Manure (tons/year)	54,000	60,000	54,000	60,000
Liquid Manure				
Tons/year	39,000	44,000	27,000	29,000
Million gallons/year	9.5	10.5	6.6	7
Dewatered Manure (tons/yr)	15,000	16,000	27,000	31,000

A composting facility which sells the product to buyers outside the traditional farm fields would remove nutrients from the farms. The composting facility would only remove nutrients that are present in the dewatered manure after separation. All nutrients in the liquid stream would be returned to farms and remain in the Canaan Valley. Published values for nitrogen and phosphorus removal resulting from mechanical manure separators are 20% and 50% by weight, respectively. (An additional 40% of the nitrogen goes to the atmosphere in this operation.) As a result, the composting facility can be expected remove 20% of the nitrogen and 50% of the phosphorus from the farms for the composting dewatered manure option. For the anaerobic digester followed by dewatering and composting, it is estimated that 67% of the nitrogen and 50% of the phosphorus would be removed from the farms either in the compost or lost to the atmosphere.

3.2 COMPOST SYSTEM FEED DESIGN BASIS

Ideal composting conditions require that solids content of the feed material be approximately 40%. In order to achieve this solids content, the manure from each participating farm or from the potential regional anaerobic digestion system would be dewatered and mixed with wood chips prior to entering the composting process. The dewatering step would take place at different points for the case without anaerobic digestion than the case with anaerobic digestion as outlined below.

- **Dewatered Raw Manure.** In order to reduce transportation costs, manure would be separated at each of the farms and only the solids portion would be delivered to the regional facility. Two of the largest farms already have separation equipment in operation and achieve approximately a 25% solids stream. Separation could be achieved at the other farms by installing separators at each facility or by utilizing a mobile separator unit which could be transported between farms, as necessary. The cost for a separator is estimated between $3,500 and $5,600, depending on the size and throughput capabilities of the unit. The thickened feed solids would be combined with wood chips at the compost facility to achieve the desired 40% solids content.

- **Anaerobically Digested Manure Feed.** If an anaerobic digester was implemented as part of a regional facility, the feed stream to the anaerobic digester would consist of the un-separated or manure streams from the participating farms, with a solids content of approximately 12 to 18%. Farms that currently dewater would discontinue doing so as the anaerobic digester is intended to handle only liquid manure feeds. As a result, the anaerobic digester would receive the full manure content of all of the participating farms as opposed to just the dewatered portion that would be delivered to the facility without an anaerobic digester. The anaerobic digestion process would reduce the volatile organic solids content of the manure. We have assumed a 30% destruction of volatile solids by the anaerobic digester. A separator would then be used to dewater the anaerobically digested manure to approximately 25% solids and the liquid portion of the manure would be returned to the farms for land application.

In both cases, the optimal compost feed solids content of 40% would be achieved through the addition of wood chips to the thickened and anaerobically digested manure. The quantity of woodchips or other amendment required depends on the water content of the amendment. For this study we have assumed woodchips at 60% solids content. At higher levels of solids content, less woodchips would be required. To maintain a high level of solids content (or dryness), the woodchips should be stored under cover.

The maximum and minimum manure feed quantities for a regional facility, with and without an anaerobic digester, are summarized on Table 3-2. Since the minimum volume (3 farms) and maximum volume (6 farms) of the volumes are similar for each individual case, only the minimum volume values will be used for facility sizing and cost estimating portions of the study. The feasibility of the project will be similar for the slightly larger sized facility if more farms were to elect to participate.

TABLE 3-2

FEED QUANTITIES

	With Anaerobic Digester		**Without Anaerobic Digester**	
	Minimum	Maximum	Minimum	Maximum
Dewatered Manure				
Volume (CY/day)	51	56	92	107
Volume (CY/year)	18,700	20,400	33,500	39,000
Density (lb/CY)	1,600	1,600	1,600	1,600
% Solids	25	25	26	25
% Volatile Solids	14.5	14.5	21	20.8
Wet Solids (tons/year)	15,000	16,000	27,000	31,000
Woodchips				
New:				
% Solids	60	60	60	60
Wet Solids, (ton/yr)	2,800	3,000	4,800	5,750
Recycled:				
% Solids	60	60	60	60
Wet Solids, (ton/yr)	8,500	9,200	14,300	17,000
Total Feed Mixture				
Total Mass (Tons/year)	26,000	28,500	46,000	54,000
Total Volume (CY/year)	57,000	62,000	100,000	118,000

3.3 TARGET COMPOSTED MATERIAL

The marketability of the finished compost material depends highly on the quality and content of the product produced. The solids composition is a critical factor in determining the quality of the product as the compost should have a consistency that allows it to be easily moved offsite and handled by the end user. Typically a solids content of 60% is targeted for finished compost. As discussed further in Section 5, a higher price can be obtained for compost material that passes a 3/8 inch screen. To provide this higher quality product and improve the potential viability of the facility, a 3/8 inch screen is recommended following composting and curing. The quantities of finished compost produced per day for a facility with and without an anaerobic digester are summarized in Table 3-3. While the use of an anaerobic digester will change the characteristics of the compost feed, the quality of the final compost product will not deviate significantly from material produced from undigested manure. For each scenario the values calculated represent compost quantities produced by processing manure from only the three largest farms, who are the most likely to consistently contribute to the facility.

TABLE 3-3

FINISHED COMPOST CHARACTERISTICS

	With Anaerobic Digester	**Without Anaerobic Digester**
Volume (CY/day)	35	54
Volume (CY/year)	13,000	20,000
Density (lb/CY)	945	945
% Solids	60	60
Wet Solids (tons/year)	6,100	9,400

SECTION 4
MEANS OF PRODUCTION

This section discusses the means of producing the compost. It includes a brief introduction to composting and then design details of each of the options considered.

4.1 INTRODUCTION TO COMPOSTING

Composting is perhaps the most effective technology for transferring nutrients out of the agricultural sector in that there are no by-products remaining from the process that are not a marketable product. Nitrogen contained in the composted manure will either be consumed in the decomposition of organic materials, or remain in the finished composted product. The majority of the phosphorus contained in composted manure is anticipated to remain in the finished product.

In general, the composting process requires a feedstock with forty percent solids content by weight. Most raw material feedstocks do not have this level of solids. Therefore, bulking agents, such as saw dust or wood chips, and other amendments are added. For the purposes of this study both woodchips and horse manure were considered as amendment material. Horse manure offers significant cost advantages as it can likely be obtained locally at no cost. However, it must be at least 60% dry solids and contain wood shavings, or similar material, to allow for adequate and predictable composting.

The ratio of the amount of carbon to nitrogen (C:N) in the material being composted is also critical. The addition of bulking agents and amendments helps to adjust the C:N ratio for feedstocks with less than optimum carbon or nitrogen contents. Typically, optimum composting occurs when the C:N ratio is between 20:1 and 40:1. Raw dairy manure typically has a C:N ratio of between 10:1 and 15:1. Addition of a carbon source such as wood chips or sawdust will increase the carbon to nitrogen ratio. The typical solids content for the finished compost will be approximately sixty percent solids by weight.

There are many types and configurations of composting systems; however, they can be grouped into several basic categories including windrow systems, agitated bin systems, and aerated static pile systems. All of these composting systems have basic features in common:

- A feedstock area where the woodchips and manure is stored
- A composting area where the mixed feed decomposes into a compost product
- An odor control system to treat the exhaust from the system if needed
- A curing area to allow the compost to cure to a finished product
- A storage area to stockpile finished compost produced during the off-season (e.g. during the winter when demand for compost is low)
- A screening area where the product is screened to remove large size pieces such as partially decomposed woodchips (These woodchips can be recycled back into the basic feed mix)

Many of these features are the same for the various composting systems. The curing, storage, and screening systems are assumed to be the same for purposes of comparing the systems. These activities would take place outdoors on a paved surface. The wood chip storage would be in an open-sided building to keep the woodchips dry. Thirty-days of storage are provided for all cases. The incoming manure would be weighed and dumped on the paved surface. Incoming manure should be incorporated into the compost system the day it is received, so no storage area has been included in this analysis.

The odor control system generally depends on the size and site location of the composting system. For the composting systems included in this analysis, we have assumed that the composting system would be located at the Laurel Brook Farm and that odor control would not be necessary. If odor control was later determined to be necessary, a recommended odor control system would be a biofilter or a packed-bed scrubber followed by a biofilter.

For this feasibility study, three composting systems were evaluated: Windrow composting under a building cover, Ag-bag Composting system, and agitated bin composting system. Each of the composting system types is discussed below.

4.2 WINDROW SYSTEMS

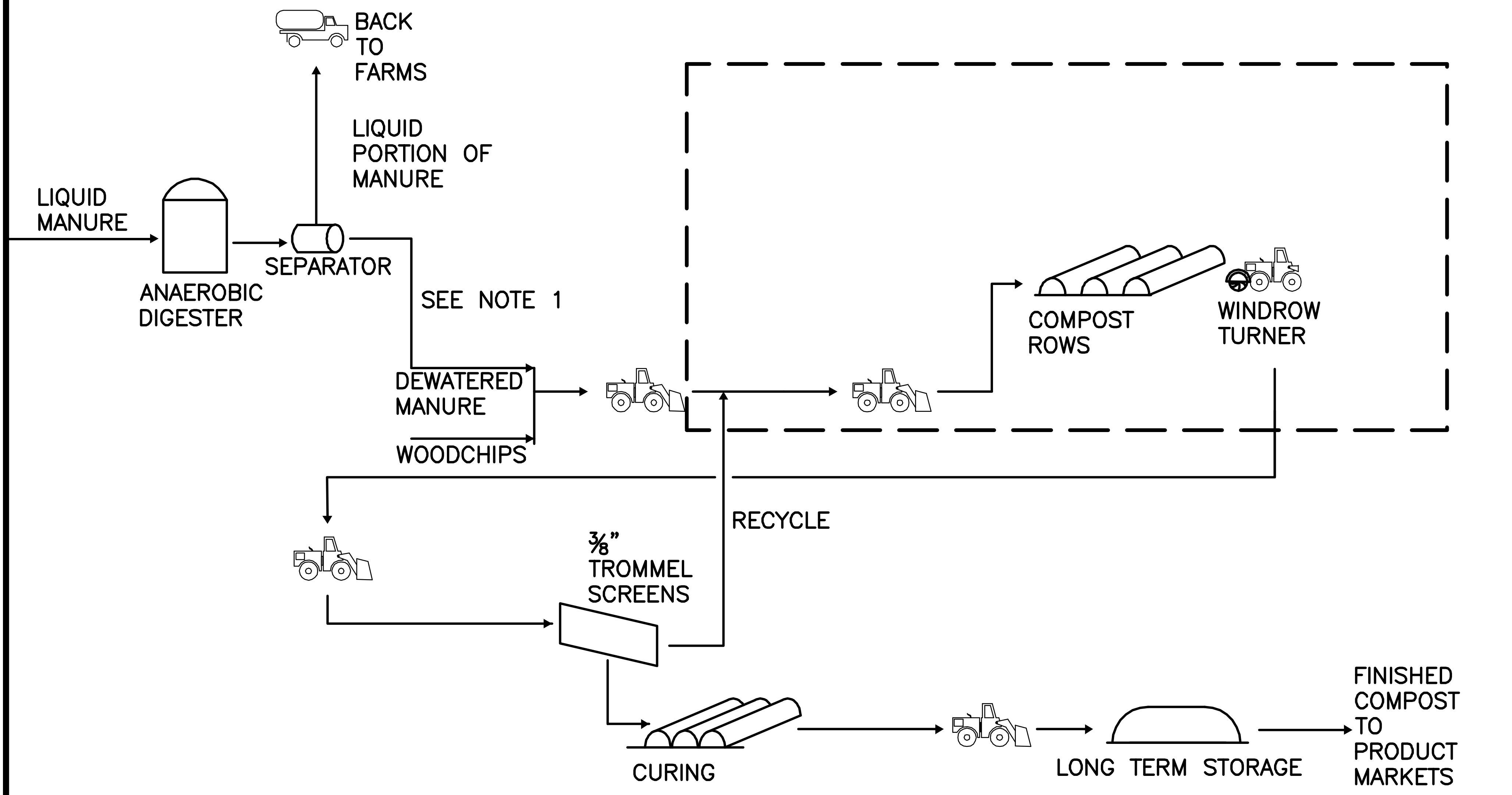
A windrow system consists of large piles of the mixed feed which are aerated using a windrow turner. This type of system does not compost as quickly as systems which are aerated continuously and therefore requires a longer time in composting piles and a larger composting area. Various types of windrow turners are available, including turners towed by a tractor and self propelled turners. The size of the windrow turners determine the size of the windrows that can be built (width and height). In general, windrow turners have relatively large turning radii and require significant space to turn around at each end of the windrow. Because of this, windrow systems are frequently not enclosed in a building but are used at more remote sites where composting can occur outdoors. For this study, an open-sided building is proposed, offering the following advantages:

- Reduced building size since the windrow turner can turn around outside of the building.
- No need for building ventilation as the air will move freely through the building.
- Control of water addition to maintain a high quality product.

The windrows would be turned based on the temperature and oxygen levels in the windrow, likely two or three times a week. Particularly during the summer season, water would need to be added to the windrows to maintain optimal moisture content. Several methods of water addition are possible including the following:

- Spraying the piles with hose reel systems or sprinkler systems.
- Forming a trough in the top of the windrow and using a water truck to fill it with water.
- Use of drip irrigation lines on the windrows.
- Addition of water while turning the pile.

The quality of water added does not need to be of drinking water quality but should be free of pathogens in order to avoid reintroducing pathogens to the compost after the composting process has destroyed them. For the purpose of this analysis it was assumed that irrigation lines would be used on the windrow. Figure 4-1 presents a process flow diagram of the windrow composting system. Dewatered manure (or dewatered anaerobically digested manure) would be mixed with woodchips by layering the two feeds in the windrow. This would be mixed when the windrow



NOTES:

1. ANAEROBIC DIGESTER AND SEPARATOR NOT INCLUDED IN COMPOST FACILITY SCOPE.

NORTH CANAAN NUTRIENT MANAGEMENT FEASIBILITY STUDY	
PROCESS FLOW DIAGRAM WINDROW COMPOSTING SYSTEM	
PROJ NO: 10744A	FIGURE: 4-1
DATE: JULY 2006	
SCALE: AS NOTED	Wright-Pierce

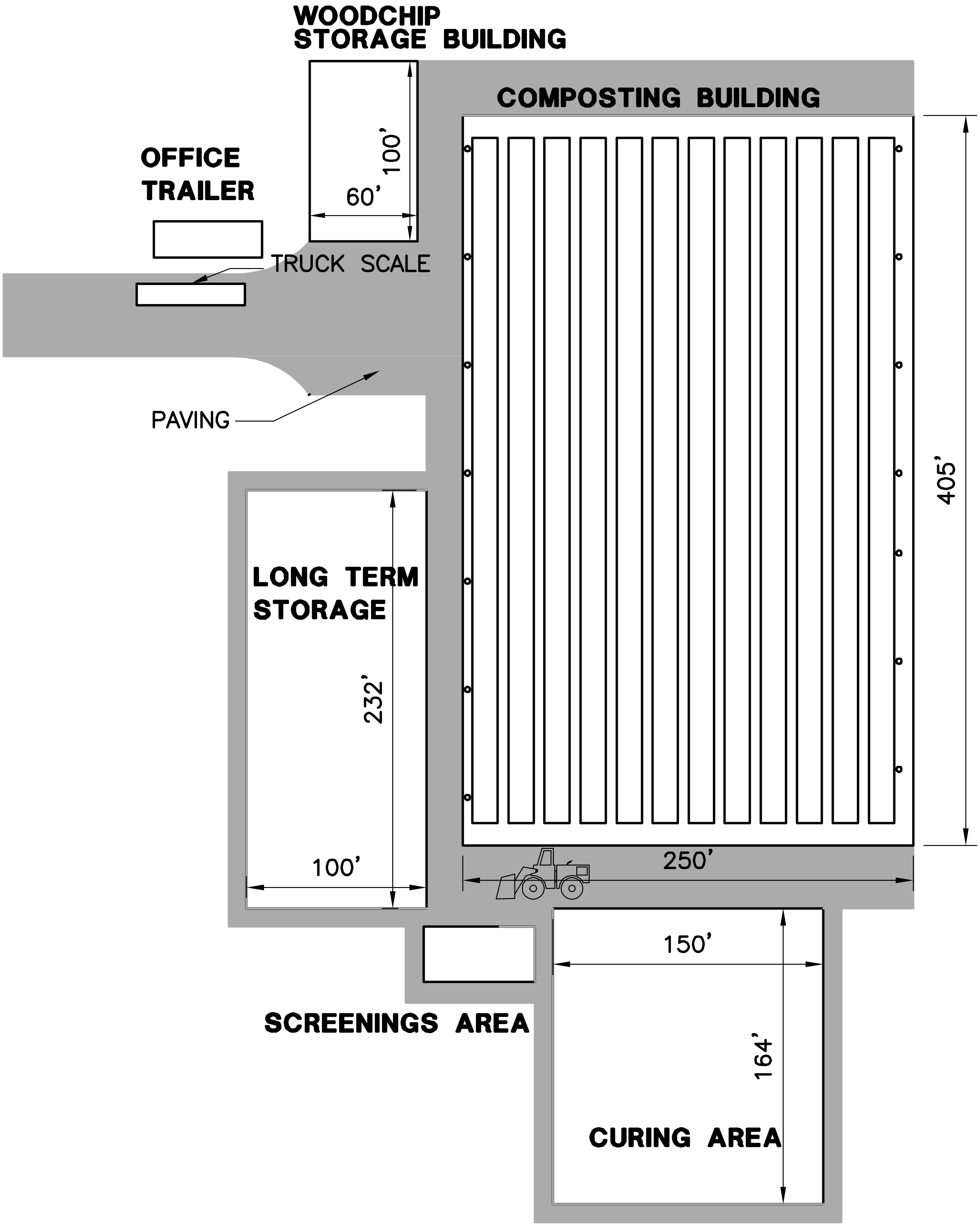
turner is used the first time. The composting mixture would remain in these windrows for 30 days. After the active composting phase, the material is screened and placed in curing piles located outside to complete the composting process (approximately 60 days). The over-sized material is recycled to the feed mixture. From the curing piles, the material is consolidated and stored in the product storage area until it is sold. The product storage area is sized for 180 days to allow compost to be sold during the optimum season at the best prices. Table 4-1 lists the approximate sizes needed for the windrows, curing piles and storage area.

TABLE 4-1
WINDROW COMPOSTING SIZE PARAMETERS

Parameter	Dewatered Manure Case	Dewatered Anaerobically Digested Manure Case
Composting Windrow Size:		
No. of Windrows	12	12
Length of Windrow	385 ft	220
Size of windrow	6-ft tall by 14-ft wide	6-ft tall by 14-ft wide
Curing Windrow Size:		
No. of Windrows	10	10
Length of Windrow	164	109
Size of windrow	8-ft tall	8-ft tall
Storage Pile size		
Length	232 ft	151 ft
Width	100 ft	100 ft

Figure 4-2 present a possible layout of the windrow composting facility. The sizes given are for the dewatered manure case. A similar but slightly smaller layout could be used for the dewatered anaerobically digested manure case. The layout can be adjusted to fit a different shaped lot as needed. The layout includes a truck scale to allow measurement of incoming/outgoing materials. In addition, a small office trailer is proposed for office space.

Appendix B provides equipment list for each option and Appendix C provides vendor details.



NORTH CANAAN NUTRIENT MANAGEMENT FEASIBILITY STUDY

PRELIMINARY LAYOUT WINDROW COMPOSTING SYSTEM

PROJ NO:	10744A	Wright-Pierce	FIGURE:
DATE:	JULY 2006		4-2
SCALE:	AS NOTED		

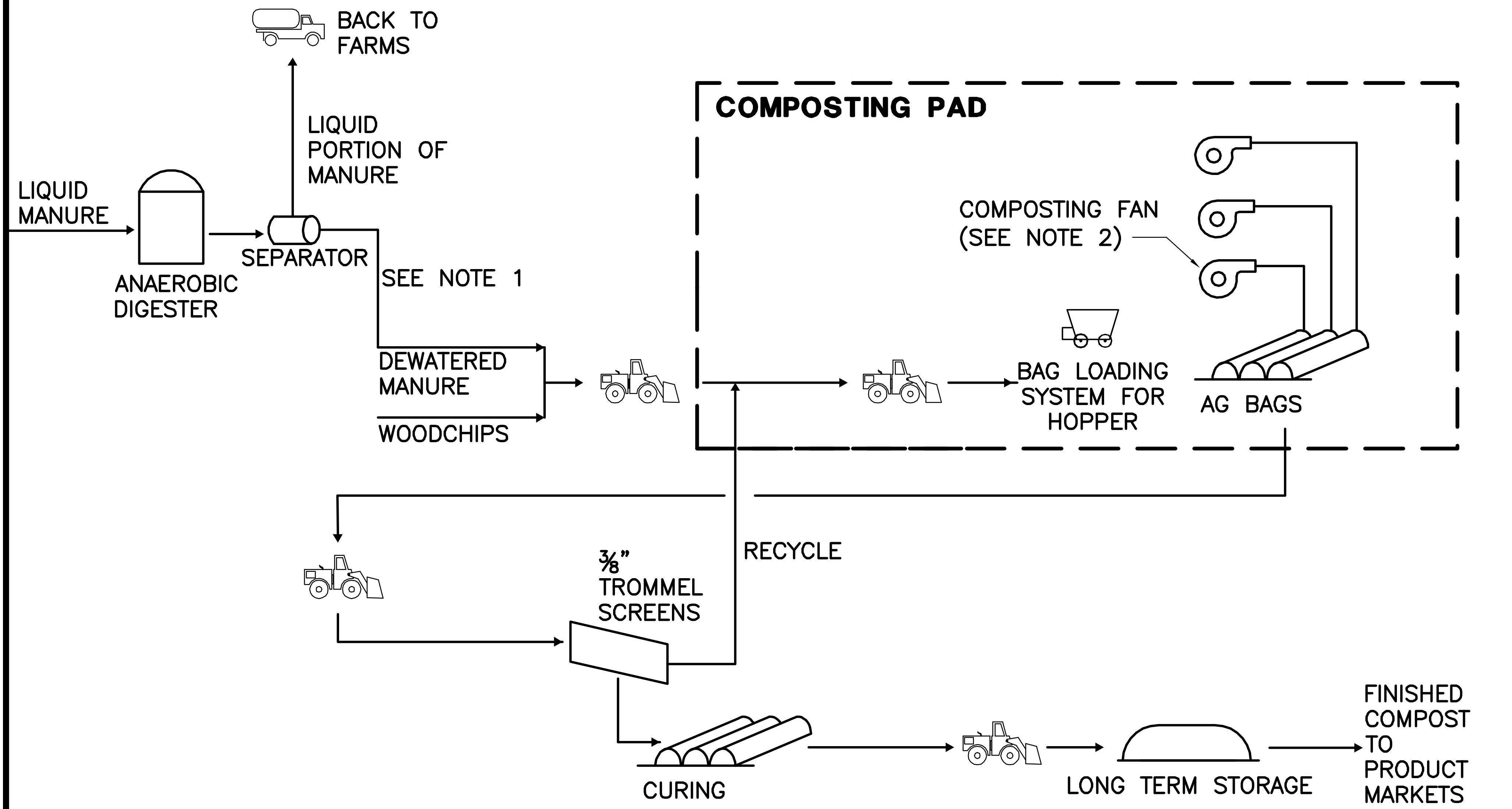
4.3 COVERED COMPOSTING SYSTEMS

There are a number of available covered composting systems, including systems which entirely enclose the composting material in large aerated bags and systems that use a geotextile material as a barrier over the top of a composting pile. The Ag-Bag enclosed system has been evaluated for this study, and potential layouts, equipment requirements, and costs have been developed. Gore Cover Systems manufactures a laminate membrane intended for composting applications and were also contacted as part of this study. Gore Cover Systems would not provide detailed product, system design, or cost information during the study phase of a project, and prefers not to provide this information to a third party client representative. General information about the Gore Cover System can be found in Appendix C; however, a conceptual design and costs could not be developed without more detailed information.

The Ag-Bag composting system is a type of aerated static pile involving placing the compost feed mixture in a long plastic tube and blowing air through the composting material along the entire length of the bag. These bags are not disturbed during the active composting period. This bag composting system is similar to the bag silage systems used at some farms, except that aeration has been added. The bags can lie directly on the paved ground and can help contain the odor.

Figure 4-3 presents a process flow diagram of the Ag-Bag composting system. The manure would be mixed with wood chips, sawdust, recycled compost or other organic material to both increases the carbon content and the solids level of the mix, and the mixture would then be fed into the Ag-Bag. Each Ag-Bag has a small 1/3HP fan which aerates the composting mixture through an aeration pipe running inside the bag. There are vents located on the side of the bag to release the air. The fan cycles on for 4 minutes/off for 10 minutes to both maintain proper temperatures and to conserve energy.

Similar to the windrow composting system, the material would be composted in the Ag-bag for 60 days, placed in curing windrows for 60 days and stored for up to 180 days. Between composting and curing stages the material would be screened. The overs (woodchips which have not fully degraded) would be recycled to mix with the incoming manure.



NOTES:

1. ANAEROBIC DIGESTER AND SEPARATOR NOT INCLUDED IN COMPOST FACILITY SCOPE.

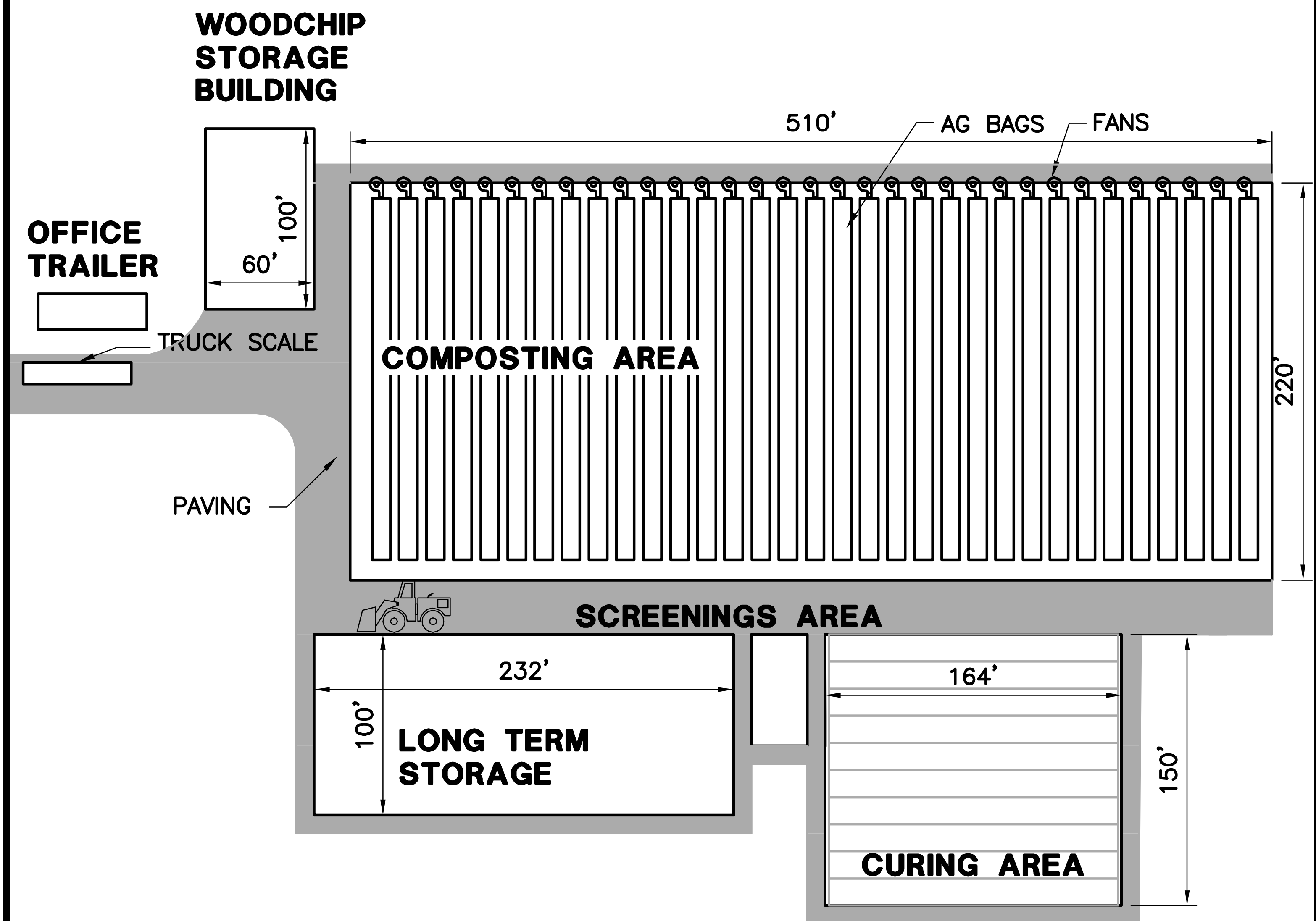
2. EACH BAG HAS ITS OWN FAN TO AERATE THE COMPOSTING MIXTURE.

NORTH CANAAN NUTRIENT MANAGEMENT FEASIBILITY STUDY

PROCESS FLOW DIAGRAM AG–BAG SYSTEM

PROJ NO:	10744A
DATE:	JULY 2006
SCALE:	AS NOTED
FIGURE:	4-3

Wright-Pierce



NORTH CANAAN NUTRIENT MANAGEMENT FEASIBILITY STUDY

PRELIMINARY LAYOUT AG-BAG SYSTEM

PROJ NO:	10744A
DATE:	JULY 2006
SCALE:	AS NOTED

Wright-Pierce

FIGURE: **4-4**

Figure 4-4 present a possible layout of the Ag-Bag composting facility. The sizes given are for the dewatered whole manure case. A similar but slightly smaller layout could be used for the dewatered anaerobically digested manure case. The layout can be adjusted to fit a different shaped lot as needed. The layout includes a truck scale to allow measurement of incoming/outgoing materials. In addition, a small office trailer is proposed for office space.

Table 4-2 lists the approximate sizes needed for the Ag-Bag composting, curing piles and storage area.

TABLE 4-2

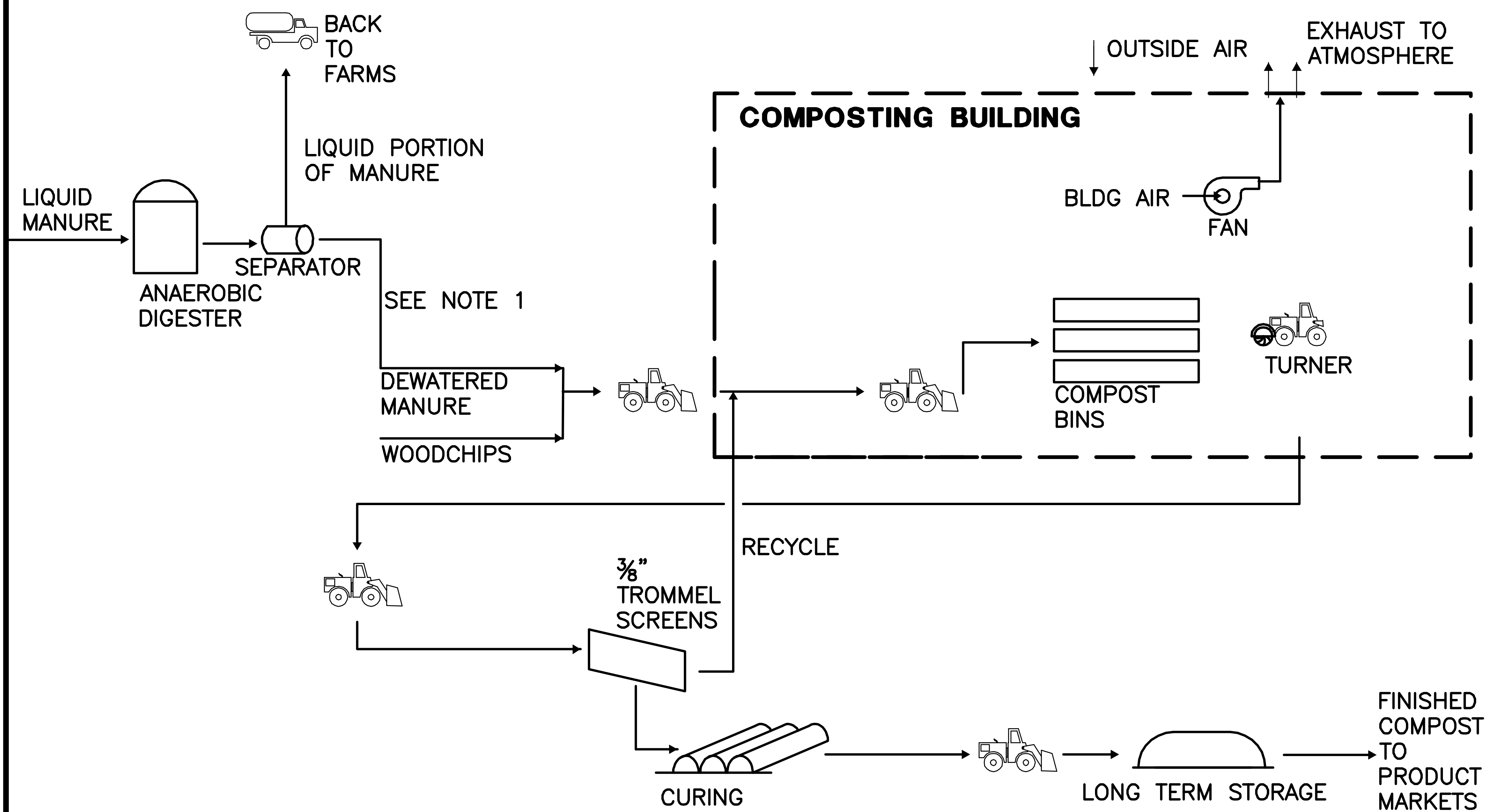
AG-BAG COMPOSTING SIZE PARAMETERS

Parameter	Dewatered Whole Manure Case	Dewatered Anaerobically Digested Manure Case
Ag-Bag System Size:		
No. of Ag-Bags	34	18
Length of Ag-Bag	200 ft	200
Size of Ag-Bag	10-ft diameter	10-ft diameter
Curing Windrow Size:		
No. of Windrows	10	10
Length of Windrow	164	109
Size of windrow	8-ft tall	8-ft tall
Storage Pile size		
Length	232 ft	151 ft
Width	100 ft	100 ft

4.4 AGITATED BIN

An agitated bin system consists of bins with concrete walls and aerated floors in which the compost is loaded. The bin walls support a compost turner that travels down the length of the bin, turning the compost and moving it down the length of the bin. With this system the feed is loaded into one end of the bin and it is moved down the length of the bin by the compost turner until it is finally moved out of the bin on the discharge end. From here it is removed for curing, screening and storage. While there are many manufactures of compost turners for agitated bins, these turners are primarily designed for larger facilities. Farmer Automatic manufactures a system which is designed specifically for use with manure.

Figure 4-5 presents a process flow diagram of the windrow composting system. The material is layered into the front of the bins and mixed by the bin turner as it moves the material down the length of the bin. Once material exits the end of the bin, it is screened and moved to the curing piles and ultimately the storage pile. During our discussion with the vendor on this option, it became evident that the bin composting system would be significantly more expensive than the windrow or Ag-Bag composting systems. Therefore it was not pursued further and the complete capital and operational costs for the bin composting system were not calculated.



NOTES:

1. ANAEROBIC DIGESTER AND SEPARATOR NOT INCLUDED IN COMPOST FACILITY SCOPE.

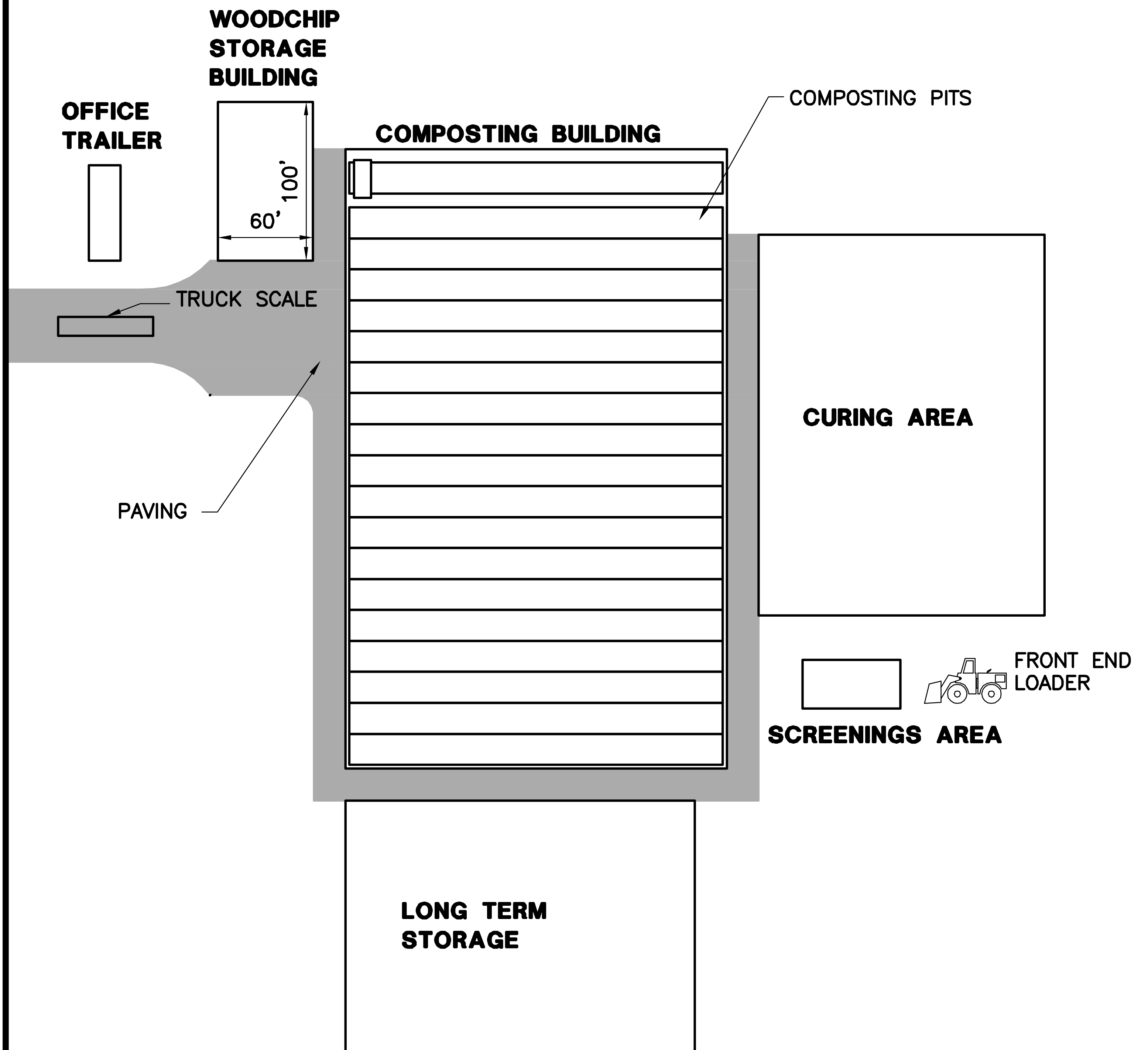
NORTH CANAAN NUTRIENT MANAGEMENT FEASIBILITY STUDY

PROCESS FLOW DIAGRAM BIN COMPOSTING

PROJ NO:	10744A
DATE:	JULY 2006
SCALE:	AS NOTED

Wright-Pierce

FIGURE: **4-5**



NORTH CANAAN NUTRIENT MANAGEMENT FEASIBILITY STUDY
PRELIMINARY LAYOUT
BIN COMPOSTING

PROJ NO:	10744A	Wright-Pierce	FIGURE: 4-6
DATE:	JULY 2006		
SCALE:	AS NOTED		

SECTION 5

POTENTIAL PRODUCTS/MARKETS

5.1 MARKET OPPORTUNITY OVERVIEW

The primary markets for high quality compost are consumers, landscapers, and nursery growers. Compost products are sold typically in 20 lb., 25 lb., 40 lb., or 50 lb. bags, in bulk, or occasionally in bulk bags. Bagged goods are sold primarily through retail outlets, while bulk products are sold through wholesale nursery and landscape suppliers, retailers, and directly from producers.

Ten percent of the estimated 90 million households in the United States with a yard or garden use only all-natural or organic fertilizers, according to the *2004 Environmental Lawn & Garden Survey* conducted by the National Gardening Association (NGA). In its *National Gardening Survey 2004*, the NGA also reports that 9 million households purchase manure every year and 29 million households purchase top soil. As can be seen from these statistics, consumers prefer less expensive top soil by more than a three-to-one margin over manure.

There has been very little price movement in bagged top soil and composted manure at the retail level in the past 10 years due to the highly competitive nature of the market, downward pressure on prices by market dominant mass merchants, and the lack of consumer education about product differentiation. Top soil retail prices range generally from $1.50 to $2.50 for a 40 lb. bag, depending on the outlet, while composted manure ranges from $2.50 to $3.00. Wholesale prices for the same products are approximately $1.20 and $1.75, respectively. As reported by Jean Bonhotal in the article "Compost Markets: Are They There?" which appeared in the April 2002 issue of *DairyBusiness Communications*, "To cover the cost of making this compost product, you need to sell a 30- to 50- pound bag for $3 to $5." And that was before the cost of freight doubled. One of the major soil products manufacturers interviewed for this report, who asked to remain anonymous, stated that they are currently either breaking even or losing money on these items.

The lowest prices for bagged soil and compost products are found at mass merchants such as Wal-Mart, Home Depot, and Lowe's, while the highest prices are found at high-end independent regional garden centers such as Salisbury Garden Center or White Flower Farm. Prices for "certified organic" compost products are significantly higher, but distribution is minimal. Most readily available products at retail are not labeled as "certified organic."

Master gardeners do differentiate between top soil and composted manure, compost blends and cow manure. These consumers are willing to pay upwards of $7.00 or $8.00 a bag for pure cow manure compost. However, only 3 percent of garden center shoppers are in the master gardener class, so it is more difficult to gain shelf space for a premium cow manure compost since it is in much less demand than generic top soil.

In order to profitably operate a compost bagging line, a facility needs to be processing between 20,000 and 30,000 tons of material per year, according to Tim Sellew, president of Growell and former Executive Vice President of Earthgro. In the March 2006 issue of *Biocyle* magazine, Fred Schumpert of Creative Packaging, Inc. explains that low volume bagging equipment designed for a small operation that cannot be upgraded runs between $35,000 and $60,000. A semi-automated line would cost around $75,000, while a fully automated line designed for high volume would require an initial investment of around $120,000.

Economies of scale, capital, and labor costs are not the only issues that should enter into the decision of whether or not to bag compost for the retail market. Logistics is also extremely important. The high cost of freight and the low prices that can be earned for the products make it desirable to deliver full truckloads, or 18 pallets, to each outlet. Most retailers, however, are not able or willing to purchase this quantity of one product. Consequently, the supplier would need to offer complementary products in order to fill out the truck, such as potting soil, top soil, mulch, fertilizer, and soil amendments. Using 'backhaulers' (trucks that have delivered a load and are now willing to deliver another load for a lower price in order to avoid running empty on their way home) is one way to hold down freight costs. However, North Canaan is off the favored truck routes, far from a major metropolitan area, and not ideally situated for finding 'backhauls'.

The bulk compost market in Connecticut offers a more favorable outlook for a compost facility in North Canaan. The market is dominated by municipal leaf and yard waste compost followed by biosolids compost. Prices vary considerably depending upon the location of the composting facility and whether it is privately or publicly operated. Average price for customer pick-up at this type of production facility is approximately $17/cubic yard for leaf and yard waste compost. Top soil, generally a blend of leaf and yard waste compost and loam, carries a higher price of $20 to $27 per cubic yard picked up at the facility by the customer. However, some municipal facilities give material away to local residents, while others charge only a nominal fee. The primary goal for a municipal facility is to unload the material, not to make a profit.

Wholesale suppliers to the landscape market including Shemin Nurseries and GreenCycle have expressed an interest in carrying bulk cow manure compost from the North Canaan facility. Price, quantity, availability, particle size, moisture content, compost quality, odor, pH, and salts content are some of the key attributes they look at when evaluating a compost product.

There is a strong market demand among landscapers and landscape and nursery suppliers for a high quality, manure-based compost that is available year-round. The market is saturated with lower quality, lower priced leaf and biosolids compost, but it is difficult for landscapers to find premium compost in bulk. There is little bulk compost of any grade available in the northwestern part of Connecticut—the primary market area for the North Canaan facility. Consequently, there appears to be a demand that is not being met and a market opportunity.

5.2 DESCRIPTION OF PRODUCT/PRODUCT DIFFERENTIATION

The product that would be created at a composting facility in North Canaan would be a premium, "Class 1" compost screened to ½" minus. The compost substrate would be cow manure from local dairy farms and screened, small wood chips. Due to the projected high quality of the finished material, there should be no restrictions on sale. The endproduct would be suitable for use on food crops as well as in garden and landscape applications.

The compost product does not need to be labeled as "certified organic" in order to be sold to organic farmers and landscapers. It does, however, need to be produced according to the standards set forth by the *National Organic Program,* which are provided in the "Government Regulations" section below.

Composted cow manure is considered a superior product to most other types of compost and should be marketed as such. Unlike municipal composting facilities, the North Canaan facility has the ability to control the source of the raw material and can offer guarantees that no heavy metal or pesticide residue will be present.

The higher the quality of the finished compost; the higher the price that can be obtained. Provided that the material is kept dry before sale, is free of pieces of plastic or other contaminants, and is relatively free of weed seeds or odor, the compost will be suitable for use by the most price-resistant customers.

5.3 MARKET ANALYSIS

Macroenvironment. The high price of oil is having a significant impact on the composting and lawn & garden industries in both a positive and a negative way. On the plus side, the price of gasoline is keeping more consumers at home this summer. There has been an increase in the number of people canceling reservations at vacation properties throughout New England. Historically, during periods of economic crisis or when rising prices put downward pressure on disposable incomes, more people spend their vacations at home and the demand for lawn & garden products rises.

On the down side, an increase in demand for soil and compost products does not translate into a willingness to pay more for these items. Most consumers do not understand that there can be a quality difference between competing brands and types of compost or soils. As long as there is $1.00 a bag top soil available, it continues to be difficult to command a profitable price for premium grade products. Freight costs have risen dramatically in the past few years and now comprise 30 to 40 percent of the wholesale price for a bag of composted manure or top soil. At the same time, manufacturers have found it nearly impossible to raise their prices enough to cover this added cost and still maintain the same profit margins.

Industry/Trade. Tight margins, increased competition, and the doubling of freight costs have kept compost prices low at the retail level. Many local and regional composters have sold out or merged with larger entities. Scotts/Hyponex is now the largest commercial composting operation in the country, with 10 large production facilities that it needs to keep operating at full capacity. As a result, the company has been willing to keep its prices low to maintain shelf space at the box stores and mass market retailers, squeezing out the smaller compost suppliers.

High freight costs have limited the range of compost suppliers from out-of-state and improved the prospects for local suppliers. It has become more difficult to find MooDoo on the shelves of Connecticut retailers, for example, creating an opening for a premium bagged cow manure produced within the state. Consumers have also been exhibiting a preference for purchasing locally-produced goods and have demonstrated a willingness to pay slightly more for these products.

Two major bulk compost producers in Connecticut have left the business in the past year—Franklin Mushroom Farms and Nestlé's New Milford Farms. Franklin Mushroom Farms had been producing between 20,000 and 30,000 tons of spent mushroom compost per year. It has now moved the bulk of its mushroom production to Pennsylvania. New Milford Farms produced a volume of around 20,000 cubic yards of food waste compost. It is not known at this time how Nestlé's plans to dispose of the organic waste from its food processing operations in the future. Removing these products from the market may increase the market potential for North Canaan compost.

Competition. A manure composting facility in North Canaan selling bulk material would face competition from leaf and yard waste, biosolids, and food waste composting operations; other manure composting facilities; and 'scraped loam' suppliers. There is currently a glut of biosolids on the market, but representatives of the landscaping industry report that there is still a shortage of high quality manure compost. In the northwestern portion of Connecticut, there is a shortage of compost in general. To meet demand, wholesalers from other parts of the state have been shipping in to the North Canaan market area at a high freight cost for the customer.

There are three composting facilities in Litchfield County (Barkhamsted, Canaan, and Litchfield) permitted to accept leaf and yard waste. The potential combined total of compost that could be produced per year at these facilities is less than 1,000 cubic yards and is therefore not a significant competitive problem. The nearest high volume composting facility is in West Hartford.

Wheeler's in Northfield is the only composting facility in close proximity to North Canaan that offers a manure-based compost product. Wheeler's *Compsoil*, a blend of composted manure and loam, is sold direct to landscapers for $35/cu. yd.—freight included when delivered to one of the 8 surrounding towns. Additional freight charges apply for deliveries beyond that area. They allow pickups by appointment only and will not accommodate any vehicle other than dump trucks.

Snow's Farm in Easton also sells bulk manure compost at $20/cu. yd. for customer pickups. They require a minimum purchase of 1½ cubic yards. They are well-known in the market but do not have much reach beyond their close geographic area.

Premium bagged dairy manure compost certified for use on organic farms and landscaping projects is available from Vermont Ag Products (MooDoo) of Middlebury, VT, and Vermont Compost Company of Montpelier, VT. The high prices of these brands, the added cost of freight, and their limited product lines have made it difficult for these companies to compete effectively at the retail level in southern New England.

Seasonality. The compost business is highly seasonal, with the preponderance of sales occurring during the three spring months. This is particularly true for bagged retail sales. Selling to the bulk markets helps to flatten the seasonality somewhat, as professional landscapers do more planting in the autumn than do home gardeners. It is often difficult for them to find high quality compost in the fall as most retailers sell through their inventory in the spring and don't reorder much for fall. Developing a customer base of nursery growers would also help extend the selling season as they pot into the summer months and earlier in the spring.

5.4 CHANNELS OF DISTRIBUTION

There are four main channels of distribution for bulk composted manure products: direct to endusers (landscapers, organic farmers, and home gardeners), to independent retailers with bulk yards, to wholesalers such as GreenCycle or Shemin Nurseries, and to bagging manufacturers such as Scotts or Growell.

Home gardeners are the least price sensitive but they use the smallest quantity of material. Marketing to this consumer segment has proven to be a problem for other dairy farms with a composting operation when they have advertised locally. Cars of customers seeking to purchase one yard at a time have lined up around the block, disrupting traffic flow in the area and requiring additional personnel at the farm to process the orders. If the facility is not designed to handle a high volume of traffic, the home gardener can be reached by selling the product to garden centers with small bulk yards.

Landscapers and organic farmers are also relatively price insensitive and purchase in larger volumes, but they will typically not travel beyond 10 or 15 miles to pick up the material, which limits the target market to the towns in the immediate surrounding area. By offering delivery to the job site, a North Canaan facility could expand this market. However, it would need to have the trucks and personnel available to handle these orders.

Wholesalers sell huge volumes of compost and compost blends and are the best market to move material in quantity. Shemin Nurseries, Northern Nurseries, L & L Evergreen, and GreenCycle are the largest bulk suppliers to the landscape market in Connecticut.

Nursery growers who create their own potting and planting mixes are another potential customer base. This is a difficult market to penetrate, however, and will be the most demanding in terms of product quality and attributes. It also has the highest liability due to the potential to injure or destroy whole crops. There are several large woody ornamental growers in the state including

Clinton Nurseries, Prides Corner Farms, Imperial Nurseries, and The Robert Baker Company (a division of Northern Nurseries).

Scotts in Lebanon, Connecticut, has the largest commercial composting facility and bagging operation in the region. They would be able to handle large volumes of material and would also be willing to take in unfinished material for final composting and screening at their site. Their specs call for a material that has been dried out in a static pile for a few months and turned two or three times during that period. For such a product, they have offered to pay only $8 to $10/cu. yd. delivered. At the current cost of freight, this would most likely not be a viable option. The advantage to such an arrangement might be only that they have the ability to take in material year-round.

5.5 PRICING ANALYSIS

Premium grade compost of consistent quality and reliable availability can command a direct-to-enduser price of up to $35/yard for smaller orders when customers pick up the material at the production facility. In order to obtain this price, however, the product must be differentiated from lower grade competitive products and be well-marketed to the right potential customers. High volume purchasers would expect to receive a significant volume discount, and resellers would expect to pay a price that would allow them to sell the product to their customers at $25 to $35/yard depending on their location and customer base (figure $15 to $21/yard delivered).

Manufacturers of bagged goods such as Scotts and Growell are operating on tight margins and seek to keep their material costs as low as possible. In the consumer retail market, composted manure has only a slightly higher value than top soil. The North Canaan facility could expect to move volume into this market, but only at a price of $8 to $10 per cubic yard.

5.6 GOVERNMENT REGULATIONS

In Connecticut, fertilizers and soil amendments are regulated by the Department of Agriculture. Alton Blodgett, Agricultural Commodities Control Officer, clarified for this study the product registration requirements for compost. If any claims are made as to nutrient content within the compost, the compost is considered a fertilizer and must be registered as such with the CT

Department of Agriculture. Tonnage and registration fees are required to be paid annually for all fertilizer products, whether sold in bags or in bulk. A Guaranteed Analysis must be obtained and stated for the product and provided in written form to all customers. If no claims are made as to nutrient content, however, the compost is considered a soil amendment and is not required to be registered.

Certified organic farmers could use the North Canaan compost in their operations provided that the material has been produced according to the National Organic Program standards excerpted below:

> **PRODUCTION AND HANDLING — REGULATORY TEXT**
> **Subpart C - Organic Production and Handling Requirements**
>
> ***§ 205.203 Soil fertility and crop nutrient management practice standard.***
>
> *(c) The producer must manage plant and animal materials to maintain or improve soil organic matter content in a manner that does not contribute to contamination of crops, soil, or water by plant nutrients, pathogenic organisms, heavy metals, or residues of prohibited substances. Animal and plant materials include:*
>
> *(1) Raw animal manure, which must be composted unless it is:*
>
> *(i) Applied to land used for a crop not intended for human consumption;*
>
> *(ii) Incorporated into the soil not less than 120 days prior to the harvest of a product whose edible portion has direct contact with the soil surface or soil particles; or*
>
> *(iii) Incorporated into the soil not less than 90 days prior to the harvest of a product whose edible portion does not have direct contact with the soil surface or soil particles;*
>
> *(2) Composted plant and animal materials produced though a process that*
>
> *(i) established an initial C:N ratio of between 25:1 and 40:1; and*
>
> *(ii) maintained a temperature of between 131 F and 170 F for 3 days using an in-vessel or static aerated pile system; or*
>
> *(iii) maintained a temperature of between 131F and 170F for 15 days using a windrow composting system, during which period, the materials must be turned a minimum of five times.*

5.7 ADVERTISING/PROMOTION

One of the primary reasons dairy farmers have not been more successful with composting operations is the lack of resources devoted to marketing their products. Demand for the product exists, but customers need to know the product is available, what differentiates this product from other similar products such as top soil or leaf and yard waste compost, and where they can purchase the product. One of the least expensive ways to get the word out to customers is through a direct mail piece.

Advertising in specialized trade publications is another low cost method for getting the word out to potential customers. The Connecticut Nursery and Landscape Association (CNLA) puts out a newsletter for its members five times per year in which display advertising can be placed. Rates are $6.25 per column inch for a B&W ad or $10.75 per column inch for a color ad. A ½ page color ad would run $161.25 per issue; a ½ page B&W ad $93.75.

The Northeast Organic Farming Association accepts display ads for its quarterly publication *The Natural Farmer.* A ½ page ad in a single issue costs $155. Discounts up to 25% are available for running in multiple issues.

The lowest cost way to reach consumers in the area is to run an ad in the local newspaper or flyer. The *Lakeville Journal, Millerton News,* and *Winsted Journal* are all owned by the same company. The purchase of one 2 col. by 7 inch ad to run one time in all three publications costs approximately $182.

5.8 TRADE ASSOCIATIONS

Following are the primary industry associations that might be most helpful to a manure composting company:

Mulch and Soil Council
10210 Leatherleaf Ct., Manassas, VA 20111-4245
Phone: (703) 257-0111
Fax: (703) 257-0213
http://www.mulchandsoilcouncil.org

US Composting Council
4250 Veterans Memorial Highway, Suite 275
Holbrook, NY 11741
Phone: (631) 737-4931
Fax: (631) 737-4939
http://www.compostingcouncil.org

Connecticut Nursery and Landscape Association (CNLA)
P.O. Box 414
Botsford, CT 06404
Phone: (203) 445-0110
Toll-Free in Connecticut: (800) 562-0610
Fax: (203) 261-5429
http://www.flowersplantsinct.com/index.htm

Northeast Organic Farmers Association (NOFA)
c/o Bill Duesing
Box 135
Stevenson, CT 06491
Phone: (203) 888-5146
http://www.nofa.org
http://www.ctnofa.org

National Gardening Association
1100 Dorset Street
South Burlington, VT 05403
Phone: (802) 863-5251
http://assoc.garden.org/about

5.9 METHODOLOGY

The information contained within this report was gleaned from both primary and secondary research. For up-to-date information on trends in the compost industry, interviews were conducted with key principals at composting companies and facilities including Scotts/Hyponex, Growell (formerly Benick Brands), GreenCycle, VermontCompost, ASG Developments (a major bulk compost supplier on the West Coast), and Paul Sellew—one of the nation's foremost authorities on commercial composting, former President of Earthgro, Inc. and of Synagro, Inc., and the developer of several regional manure composting facilities around the country.

Interviews were also conducted with Alton Blodgett, Agricultural Commodities Control Officer at the Connecticut Department of Agriculture, and with representatives of the Connecticut Nursery and Landscape Association, the Organic Landscaper program within the Northeast Organic Farming Association, and Shemin Nurseries in order to obtain information on the current registration requirements for manure compost and on the potential markets for bulk products,. Both independent and mass merchant retailers were visited to review product offerings and current prices.

The Internet was employed as the primary tool for secondary research. Articles on dairy manure composting success stories, bagging equipment, and compost markets were reviewed, competitors' websites were analyzed, and a list of potential customers was compiled from a variety of sources.

Some information contained in this report comes directly from the author's personal knowledge and records compiled during her 18 years' experience in the production and marketing of compost and compost-based products.

5.10 SUMMARY/RECOMMENDATIONS

The best market opportunity for the North Canaan dairy manure composting facility is the bulk market to landscapers and home gardeners. There is existing demand in this market for a high quality compost in bulk that is not being met, particularly in Litchfield County. Access to this market can be achieved either through direct sales or through sales to wholesale suppliers and retailers. Direct sales to landscapers is somewhat limited by the number of potential customers within a 10 to 15 mile radius of the production facility in sparsely populated northwestern Connecticut. However, a landscaper working on a large commercial job could conceivably have a need for 1000 cubic yards or more of material at one time. Consequently, it is possible to move all of the material produced annually directly. Selling through wholesalers will move a larger volume of material, but at a much lower price to the North Canaan operation.

Direct sales to price insensitive home gardeners will return the highest prices. However, it might not be advisable to market too heavily to this market segment, as the number of cars coming to the facility in the spring to purchase one or two yards at a time might pose a logistical nightmare. Developing arrangements with local garden centers to carry the North Canaan compost and then directing consumers to those locations in advertising and promotional materials might be more feasible (if somewhat less profitable).

Consolidation in the composting industry and high freight costs have created a niche for a premium, locally-produced bagged cow manure compost. However, price competition from high volume suppliers like Scotts makes entry into the retail market more difficult for a small operation that cannot benefit from economies of scale. Without a full product line to offer, direct distribution is too costly, forcing the small supplier to utilize two-step distribution to reach the retailer, greatly inhibiting profits.

SECTION 6
FINANCIAL ANALYSIS

6.1 COST ESTIMATES

Economic models were developed for the two cases outlined in Section 3 and the two options discussed in Section 4. The economic models include a capital cost estimate and operations and maintenance costs for the composting facility. It does not include the costs for transport of the dewatered manure to the composting facility, but those costs are estimated at $51 per cubic yard transported for a 2-mile haul distance. Based on the Market Analysis, the average yearly compost sale price was estimated to be $17 per cubic yard of finished compost. Each of the models calculates the cost per ton of dewatered manure processed. The capital cost for each scenario, both total and annualized, is summarized in Tables 6-1 through 6-6at the end of this section. Detailed cost tables are provided in Appendix B.

These planning-level costs were developed using standard cost estimating procedures consistent with industry standards utilizing concept layouts, unit cost information, and planning-level cost curves, as necessary. Total project capital costs include an allowance of 46% of the estimated construction costs to account for construction contingency, design and construction engineering, permitting, as well as financing, administrative and legal expenses. The project cost information presented herein is in current dollars and is based on an ENR Index 7721 from July 2006.

As indicated in Tables 6-1 to 6-6, the composting options have an overall cost which ranges from $16 to $38 per ton of manure processed, and $187 to $440 per cow per year. Grant funding and low interest loan options can have a significant effect on the overall project cost. If the capital cost can be substantially covered, then the costs are reduced to the operating costs of the project. However, no sinking fund was included in these estimates. A sinking fund would be equivalent to the annualized capital cost. Therefore, the totals given can also be used as an estimate of the costs with grant funding and a sinking fund. In each case, the operating costs also exceeded the annual income. Therefore in no case does it appear that income will be generated via a regional composting facility.

Although composting in the Ag-Bags required nearly twice the composting time as a windrow system, the capital investment for the Ag-Bag system is less than the cost for a windrow facility. A significant portion of the additional cost for the windrow system is due to the building and asphalt paving required to house and contain the composting material. Without the building, the windrow system becomes the less expensive option.

Considering just the composting facility costs does not address the whole picture. One factor that is not included in the cost model is the reduction in cost due to the cost avoidance of the current manure management system. For instance, the manure sent to the composting facility has no cost for land application. Each farm will have a different cost requirement for the break even point; however, the estimated cost per ton for the composting systems is likely higher than farms are currently spending for manure handling/reuse.

For both systems the cost per wet ton for the composting system is greater when an anaerobic digester is part of the system. While the amount of material being composted is reduced under the anaerobic digester scenarios, the same equipment is required to handle, process, and move the material. A facility of this nature often benefits from economy of scale. Processing more material will raise the capital investment and operational costs, but will reduce the cost per unit of material, increasing the economic viability of the operation.

The woodchips proposed for use as an amendment in the composting process represent a significant portion of the yearly operation and maintenance costs. Other amendment options, including the high grade horse manure, may be available in the area. High grade horse manure can be considered as an alternative to woodchips if it is at least 60% dry solids and is mixed with wood shavings or similar material. Table 6-5 and 6-6 provide the capital and operational costs of the windrow system composting system utilizing horse manure as amendment.

Horse manure may be available at no cost as equestrienne facilities are often looking for a local disposal location. If all of the amendment costs could be eliminated, the yearly operations and maintenance costs could be reduced by $50,000 to $100,000, or 12.5% to 20%, depending on the volume of dairy manure being processed at the compost facility. In addition, unlike woodchips, the horse manure and associated wood shavings would remain in the final compost product, therefore little recycle would be produced. Adequate sources would need to be identified to ensure that the full amendment volume, of 10,000 to 18,000 cubic yards per day, would be available. Utilizing horse manure as the amendment would nearly double volume of finished compost produced. This would double the revenue projections for the facility, assuming the product could be sold for the same average price as pure dairy manure compost, but would also require twice the curing and storage area, increasing the required capital investment. Operating the facility with horse manure as an amendment would reduce the cost from approximately $440 to $241 per cow, or by about 45% (under the dewatered, whole manure option).

6.2 METHODOLOGY

These estimates have been developed primarily for comparing alternative solutions and are generally reliable for determining the relative costs of various options. Many factors arise during final design and project implementation (e.g. foundation conditions, owner selected features and amenities, code issues, etc.) that can not be definitively identified and estimated at this time. These factors are typically covered by the 46% allowance described above; however, this allowance may not be adequate for all circumstances.

These estimates also include a 35% of equipment cost allowance for installation for stationary installed equipment such as the Ag-Bag system fans. It also includes a minimal electrical systems estimate since electrical costs are anticipated to not factor significantly into the total project cost. These allowances may be different for installations where an outside contractor is not used for installation or electrical service modifications are not needed.

Annual operating and maintenance costs have also been developed for each scenario and include such items as labor, power, fuel, chemicals and laboratory costs. Indirect operating expenses such as overhead, utilities, taxes, insurance and administration costs are included in the operating expenses as a percentage of the scenario project cost. It is assumed in the estimate that all buildings will have an effective operating life of 20 years. Since the equipment is only a fraction of the total capital cost the operating life of the system was assumed to be 20 years.

For the windrow and Ag-Bag options, it was assumed that the active composting, curing and storage areas would need to be paved and that suitable subgrade material would need to be imported. Concrete flooring could also be used for the active composting area as an alternative to asphalt, in order to provide greater resistance to corrosion and increased durability. However, utilizing concrete in the composting area will significantly increase the capital cost of the facility. Under the windrow composting scenario, without the digester installed, the cost per cow would increase from $440 to $512, or approximately 16%.

Some of the equipment recommended for these systems can be obtained used, at a discounted price. In general, the cost for new equipment was included for this analysis, with the exception of the windrow turner which is commonly available used, in reliably, refurbished condition. A feed mixer for combining the manure and amendment material has not been included in either system as both the compost turner and Ag-Bag loader should provide adequate mixing.

For both type of installations a cost has been included for land purchase. It is assumed that the compost facility would be owned by the Canaan Valley Agricultural Cooperative, Inc. and that the cooperative would purchase the required land at the market value of the property, currently estimated at $20,000 per acre. In addition to the land required for active composting, storage of amendment, the administrative building, and driveways, a 200 foot buffer has been including around the perimeter of the site and is also included in the land purchase cost.

TABLE 6-1
CAPITAL AND OPERATING COSTS
WINDROW COMPOSTING SYSTEM WITH DIGESTER

Capital Costs			
Equipment Costs			$512,500
Direct Installation Costs			$218,000
Site Preparation, Buildings & Tanks Costs			$2,543,193
Indirect Installation Costs (Land, Legal, Engineering, Permitting, Contingency)			$1,795,600
		Total Capital Cost	$5,069,293
Annualized Capital Cost (6%, 20yrs)			$442,000
Annual Costs			
Labor & Maintenance Costs			$204,000
Bulking Agents/Wood Chips	10,500 yd		$52,500
Fuel Costs	21,450 gallons		$70,785
Indirect Costs (Overhead, utilities, taxes, insurance, administration)			$15,200
		Total Annual Costs $	342,485
Direct Annual Income			
Compost Sales	12,806 yd	($17.00)	($217,696)
		Total Annual Income $	(217,696)
Net Costs			
Net Annual O&M Cost			$124,789
Annual Capital Cost (6%, 20yrs)			$442,000
Total Annual Cost			$566,789
Net Cost per Wet Ton	14,900 wet tons		$38.04
Cost per Cow per Year	1,823 cows*		**$242.46**

*Dairy cows plus half the number of heifers (assuming 2 heifers equals 1 dairy cow)

TABLE 6-2
CAPITAL AND OPERATING COSTS
WINDROW COMPOSTING SYSTEM WITHOUT DIGESTER

Capital Costs			
Equipment Costs			$512,500
Direct Installation Costs			$328,000
Site Preparation, Buildings & Tanks Costs			$4,108,132
Indirect Installation Costs (Land, Legal, Engineering, Permitting, Contingency)			$2,636,600
		Total Capital Cost	$7,585,232
Annualized Capital Cost (6%, 20yrs)			$661,000
Annual Costs			
Labor & Maintenance Costs			$276,800
Bulking Agents/Wood Chips	18,250 yd		$91,250
Fuel Costs	25,000 gallons		$82,500
Indirect Costs (Overhead, utilities, taxes, insurance, administration)			$24,800
		Total Annual Costs $	475,350
Direct Annual Income			
Compost Sales	19,696 yd	($17.00)	($334,828)
		Total Annual Income $	(334,828)
Net Costs			
Net Annual O&M Cost			$140,522
Annual Capital Cost (6%, 20yrs)			$661,000
Total Annual Cost			$801,522
Net Cost per Wet Ton	26,800 wet tons		$29.91
Cost per Cow per Year	1,823 cows*		**$439.67**

*Dairy cows plus half the number of heifers (assuming 2 heifers equals 1 dairy cow)

TABLE 6-3
CAPITAL AND OPERATING COSTS
AG-BAG COMPOSTING SYSTEM WITH DIGESTER

Capital Costs			
Equipment Costs			$626,214
Direct Installation Costs			$119,000
Site Preparation, Buildings & Tanks Costs			$632,288
Indirect Installation Costs (Land, Legal, Engineering, Permitting, Contingency)			$865,400
		Total Capital Cost	$2,242,902
Annualized Capital Cost (6%, 20yrs)			$196,000
Annual Costs			
Labor & Maintenance Costs			$161,700
AG-BAGS			$115,500
Bulking Agents/Wood Chips	10,500 yd		$52,500
Fuel Costs	21,200 gallons		$69,960
Indirect Costs (Overhead, utilities, taxes, insurance, administration)			$10,264
		Total Annual Costs $	409,924
Direct Annual Income			
Compost Sales	12,806 yd	($17.00)	($217,696)
		Total Annual Income $	(217,696)
Net Costs			
Net Annual O&M Cost			$192,228
Annual Capital Cost (6%, 20yrs)			$196,000
Total Annual Cost			$388,228
Net Cost per Wet Ton	14,900 wet tons		$26.06
Cost per Cow per Year	1,823 cows*		$212.96

*Dairy cows plus half the number of heifers (assuming 2 heifers equals 1 dairy cow)

TABLE 6-4
CAPITAL AND OPERATING COSTS
AG-BAG COMPOSTING SYSTEM WITHOUT DIGESTER

Capital Costs			
Equipment Costs			$843,959
Direct Installation Costs			$157,000
Site Preparation, Buildings & Tanks Costs			$960,707
Indirect Installation Costs (Land, Legal, Engineering, Permitting, Contingency)			$1,212,800
		Total Capital Cost	$3,174,467
Annualized Capital Cost (6%, 20yrs)			$277,000
Annual Costs			
Labor & Maintenance Costs			$210,600
AG-BAGS			$241,500
Bulking Agents/Wood Chips	18,250 yd		$91,250
Fuel Costs	28,000 gallons		$92,400
Indirect Costs (Overhead, utilities, taxes, insurance, administration)			$18,028
		Total Annual Costs $	653,778
Direct Annual Income			
Compost Sales	19,696 yd	($17.00)	($334,828)
		Total Annual Income $	(334,828)
Net Costs			
Net Annual O&M Cost			$318,950
Annual Capital Cost (6%, 20yrs)			$277,000
Total Annual Cost			$595,950
Net Cost per Wet Ton	26,800 wet tons		$22.24
Cost per Cow per Year	1,823 cows*		$326.91

*Dairy cows plus half the number of heifers (assuming 2 heifers equals 1 dairy cow)

TABLE 6-5
CAPITAL AND OPERATING COSTS
WINDROW COMPOSTING SYSTEM WITH DIGESTER, USING HORSE MANURE AS AMENDMENT

Capital Costs			
Equipment Costs			$512,500
Direct Installation Costs			$224,000
Site Preparation, Buildings & Tanks Costs			$2,626,393
Indirect Installation Costs (Land, Legal, Engineering, Permitting, Contingency)			$1,887,200
		Total Capital Cost	$5,250,093
Annualized Capital Cost (6%, 20yrs)			$458,000
Annual Costs			
Labor & Maintenance Costs			$86,800
Bulking Agents/Wood Chips	0 yd		$0
Fuel Costs	21,450 gallons		$70,785
Indirect Costs (Overhead, utilities, taxes, insurance, administration)			$17,800
		Total Annual Costs $	175,385
Direct Annual Income			
Compost Sales	24,285 yd	($17.00)	($412,845)
		Total Annual Income $	(412,845)
Net Costs			
Net Annual O&M Cost			($117,460)
Annual Capital Cost (6%, 20yrs)			$458,000
Total Annual Cost			$340,540
Net Cost per Wet Ton	14,900 wet tons		$22.86
Cost per Cow per Year	1,823 cows*		$186.80

*Dairy cows plus half the number of heifers (assuming 2 heifers equals 1 dairy cow)

TABLE 6-6
CAPITAL AND OPERATING COSTS
WINDROW COMPOSTING SYSTEM WITHOUT DIGESTER, USING HORSE MANURE AS AMENDMENT

Capital Costs			
Equipment Costs			$512,500
Direct Installation Costs			$339,000
Site Preparation, Buildings & Tanks Costs			$4,267,782
Indirect Installation Costs (Land, Legal, Engineering, Permitting, Contingency)			$2,854,600
		Total Capital Cost	$7,973,882
Annualized Capital Cost (6%, 20yrs)			$695,000
Annual Costs			
Labor & Maintenance Costs			$282,600
Bulking Agents/Wood Chips	0 yd		$0
Fuel Costs	25,000 gallons		$82,500
Indirect Costs (Overhead, utilities, taxes, insurance, administration)			$25,900
		Total Annual Costs $	391,000
Direct Annual Income			
Compost Sales	38,013 yd	($17.00)	($646,219)
		Total Annual Income $	(646,219)
Net Costs			
Net Annual O&M Cost			($255,219)
Annual Capital Cost (6%, 20yrs)			$695,000
Total Annual Cost			$439,781
Net Cost per Wet Ton	26,800 wet tons		$16.41
Cost per Cow per Year	1,823 cows*		$241.24

*Dairy cows plus half the number of heifers (assuming 2 heifers equals 1 dairy cow)

SECTION 7
FEASIBILITY

This section discusses the advantages and disadvantages of both the windrow composting system and the Ag-Bag composting system. It also discusses the economic feasibility of each option.

7.1 ADVANTAGES AND DISADVANTAGES.

Windrow Composting System

Advantages:

- The windrow turner provides agitation to break-up hot spots and clumps of material.
- The windrow system has a smaller footprint than the Ag-Bag system due to the larger windrow piles which can be formed.
- Has been successfully used at many other sites.

Disadvantages:

- No odor control is provided for the active composting phase. However, the odor generated is likely to be similar to other operations on an active dairy farm.

Ag-Bag Composting System

Advantages:

- Ag-Bag systems provide some odor control during the active composting phase.
- Has been successfully used at other sites.

Disadvantages:

- Static pile systems may not be well suited for manure based composting systems. Static piles are not mixed and do not benefit from the agitation of other systems in breaking up clumps or hot spots in the compost pile. Therefore static piles may produce a more inconsistent product with portions that have not been fully composted.

- Requires that power be provided at the composting site.
- Overall the Ag-Bag system requires a slightly larger footprint than windrow composting.
- May require slightly more operating time due to handling and disposal of the bags, and set up of the aeration piping and fan connections.

Both systems require similar levels of expertise to operate and a similar level of staffing. They also both require about the same amount of land.

7.2 FEASIBILITY

Technically both options are feasible. They both have been used successfully at other locations, they require about the same amount of land, and much of the process is the same for all of the options.

Economically, none of the options produce sufficient income to cover all of the costs of the operations. However, there are some cost savings that result from the operation of a composting facility. Some of the manure handling procedures currently conducted at the individual farms could be eliminated or reduced, creating a savings at the farms. If a regional composting facility was implemented anaerobic digestion and composting of manure at individual farms could be eliminated, and some equipment use would be reduced allowing for cost savings. In addition, depending on the specific disposal strategies utilized at each farm, the amount of manure that must be hauled to fields for spreading and the distance it must be hauled may also be reduced, decreasing transportation costs. Based on information provided by the farmers during the interview process, the potential cost savings has been estimated at $8.00 per wet ton of manure. Table 7-1 below calculates the net cost of composting under the scenarios considered, given the expected savings. While including the avoided handling costs does improve the economics, in no case does it provide a positive income for the facility. Of the options presented, the Ag-Bag options are the most cost effective.

TABLE 7-1

COSTS PER WET TON INCLUDING AVOIDED HANDLING COSTS

	Dewatered Digested Manure			Dewatered Whole Manure		
	Windrow		Ag-Bag	Windrow		Ag-Bag
	Woodchips	Horse Manure		Woodchips	Horse Manure	
Composting System $ / wet Ton	$38	$23	$26	$30	$16	$22
Manure Handling Savings, $ / wet Ton	$8	$8	$8	$8	$8	$8
Net cost, $ / wet Ton	$30	$15	$18	$22	$8	$14

If none of these options are considered feasible and the capital investment cannot be made for a regional facility the Canaan Valley Agricultural Cooperative, Inc., may consider purchasing mobile equipment that will allow composting to be conducted at each farm. Required equipment would include a screener and windrow turner that could be transported over public roads. The cost to maintain the equipment and the operator's salary would be shared by the participating farms, and the compost produced would be considered a uniform product and sold under a single name for marketing purposes. This type of jointly supported, decentralized composting system may provide lower manure hauling costs than a regional facility, while still allowing for shared equipment usage and alternative manure disposal.

SECTION 8
SUMMARY

The purpose of this evaluation is to determine the feasibility of operating a regional composting facility in North Canaan, Connecticut. In order to size the facility and estimate the quantity of available manure, the members of the Canaan Valley Agricultural Cooperative, Inc. were interviewed and a survey of each farm was completed. The data collected was used as the design basis of the composting facility, equipment selection, and estimates of finished compost volume. The Canaan Valley Agricultural Cooperative, Inc. is also considering a regional anaerobic digester as a nutrient management strategy and an anaerobic digester could be used in conjunction with a composting operation. As a result, the feasibility analysis considered two scenarios - with the installation of an anaerobic digester or without the installation of an anaerobic digester.

The manure and amendment volumes used as the basis for the analysis and facility design are given in Table 8-1. The maximum and minimum cases are based on the number of farms contributing to the facility. The minimum case assumes the three largest farms will use the regional composting facility; the maximum case assumes six of the farms will use the regional composting facility. In all cases the manure will be dewatered at the farm or at the anaerobic digester before being trucked to the regional composting facility.

The feed quantities presented in Table 8-1 were used to predict the volume and quality of compost product that would be produced at the facility. Table 8-2 provides the expected quantity of salable material under the two design conditions.

TABLE 8-1

FEED QUANTITIES

	With Anaerobic Digester		Without Anaerobic Digester	
	Minimum	Maximum	Minimum	Maximum
Manure				
Volume (CY/day)	51	56	92	107
Volume (CY/year)	18,700	20,400	33,500	39,000
Density (lb/CY)	1,600	1,600	1,600	1,600
% Solids	25	25	26	25
% Volatile Solids	14.5	14.5	21	20.8
Wet Solids, (tons/year)	15,000	16,300	26,800	31,200
Amendment **Woodchips**				
New:				
% Solids	60	60	60	60
Wet Solids, (ton/yr)	2,800	3,000	4,800	5,750
Recycle:				
% Solids	60	60	60	60
Wet Solids, (ton/yr)	8,500	9,200	14,300	17,000
Or **Horse Manure**				
% Solids	60	60	60	60
Wet Solids, (ton/yr)	11,300	12,200	19,100	22,750
Total Feed Mixture				
Total Mass, (Tons/year)	26,000	28,500	46,000	54,000
Total Volume, (CY/year)	57,000	62,000	100,000	118,000

TABLE 8-2

FINISHED COMPOST CHARACTERISTICS

	With Anaerobic Digester	**Without Anaerobic Digester**
Volume (CY/day)	35	54
Volume (CY/year)	13,000	20,000
Density (lb/CY)	945	945
% Solids	60	60
Wet Solids (tons/year)	6,000	9,000

Based on the quantity and quality of compost product expected a market analysis was conducted to identify realistic sale prices and potential costumers. The analysis identified a strong market demand among landscapers and landscape and nursery suppliers for a high quality, manure-based compost that is available year-round. Bulk compost of any grade is currently not widely available in the northwestern part of Connecticut—the primary market area for the North Canaan facility. High freight costs have limited the range of compost suppliers from out-of-state and improved the prospects for local suppliers. Consumers have also been exhibiting a preference for purchasing locally-produced goods and have demonstrated a willingness to pay slightly more for these products. Consequently, there appears to be a demand that is not being met and a market opportunity. In addition, composted cow manure is considered a superior product to most other types of compost and should be marketed as such.

The best market opportunity for the North Canaan dairy manure composting facility is distributing the composted material to local landscaping operations and home gardeners in Litchfield County. The following options exist for this market:

- <u>Bulk Compost.</u> Wholesale suppliers to the landscape market including Shemin Nurseries and GreenCycle have expressed an interest in carrying bulk cow manure compost from the North Canaan facility.

- <u>Bagged Compost:</u> Consolidation in the composting industry and high freight costs have created a niche for a premium, locally-produced bagged cow manure compost. However, price competition from high volume suppliers like Scotts makes entry into the retail market more difficult for a small operation that cannot benefit from economies of scale.

Bulk compost provides a more realistic and dependable market opportunity and it is recommended that the compost be screened to a 3/8 inch size to provide the highest quality and most desirable product possible, improving the potential viability of the facility. Offering delivery to the job site could expand the available market. However, trucks and personnel would be required to handle these orders. The most reliable marketing strategy for the regional composting facility is to sell the material as a high quality compost, at a wholesale price averaging $17 per cubic yard, to the local landscaping market.

Composting can be achieved through a number of proven methods, and several of these were considered in this study. Specifically, the financial and operational feasibility of windrow, covered pile (Ag-Bag), and agitated bin composting systems were compared for this analysis. While all three options are proven methods of achieving acceptable compost product, the cost, land area required, and maintenance demands differentiate the systems. Early in the analysis the agitated bin system was found to be cost prohibitive due to the number bins and turners required and not evaluated further. The windrow and Ag-Bag systems were considered more viable options.

Technically both technologies are feasible. They both have been used successfully at other locations, they require about the same amount of land, and much of the process is the same for all of the options. The most significant differences include the following:

- The windrow system provides agitation to break up the "hot spot" during the active composting phase. The Ag-Bag system is a static pile system and may produce a less uniform product. Proper curing will be important with the Ag-Bag system.

- The Ag-Bag system is enclosed and will provide some level of odor control while the windrow system is open to the atmosphere.
- The Ag-Bag system requires handling and disposal of the bags.

The availability and price of amendment material can significantly impact the cost of operating the composting facility. High grade horse manure can be considered as an alternative to woodchips and may be available in the area at no cost. The horse manure would not be recycled but would remain in the material as part of the finished compost, increasing the volume of product available for sale and increasing revenue.

Economically, none of the options produce sufficient income to cover all of the costs of the operations. The costs associated with each system are presented in Table 8-3. Even when avoided costs are considered, it is unlikely that any of these options will be a revenue producing operation. Of the options reviewed, the Ag-Bag horse manure options are the most cost effective. It is important to note that grant funding and low interest loan options can have a significant effect on the overall project cost. If the capital cost can be substantially covered, then the costs are reduced to the operating costs of the project, increasing the viability of the facility. However, no sinking fund was included in these estimates. A sinking fund would be equivalent to the annualized capital cost. Therefore, the totals given can also be used as an estimate of the costs with grant funding and a sinking fund. In each case, the operating costs also exceeded the annual income. Therefore in no case does it appear that income will be generated via a regional composting facility.

TABLE 8-3

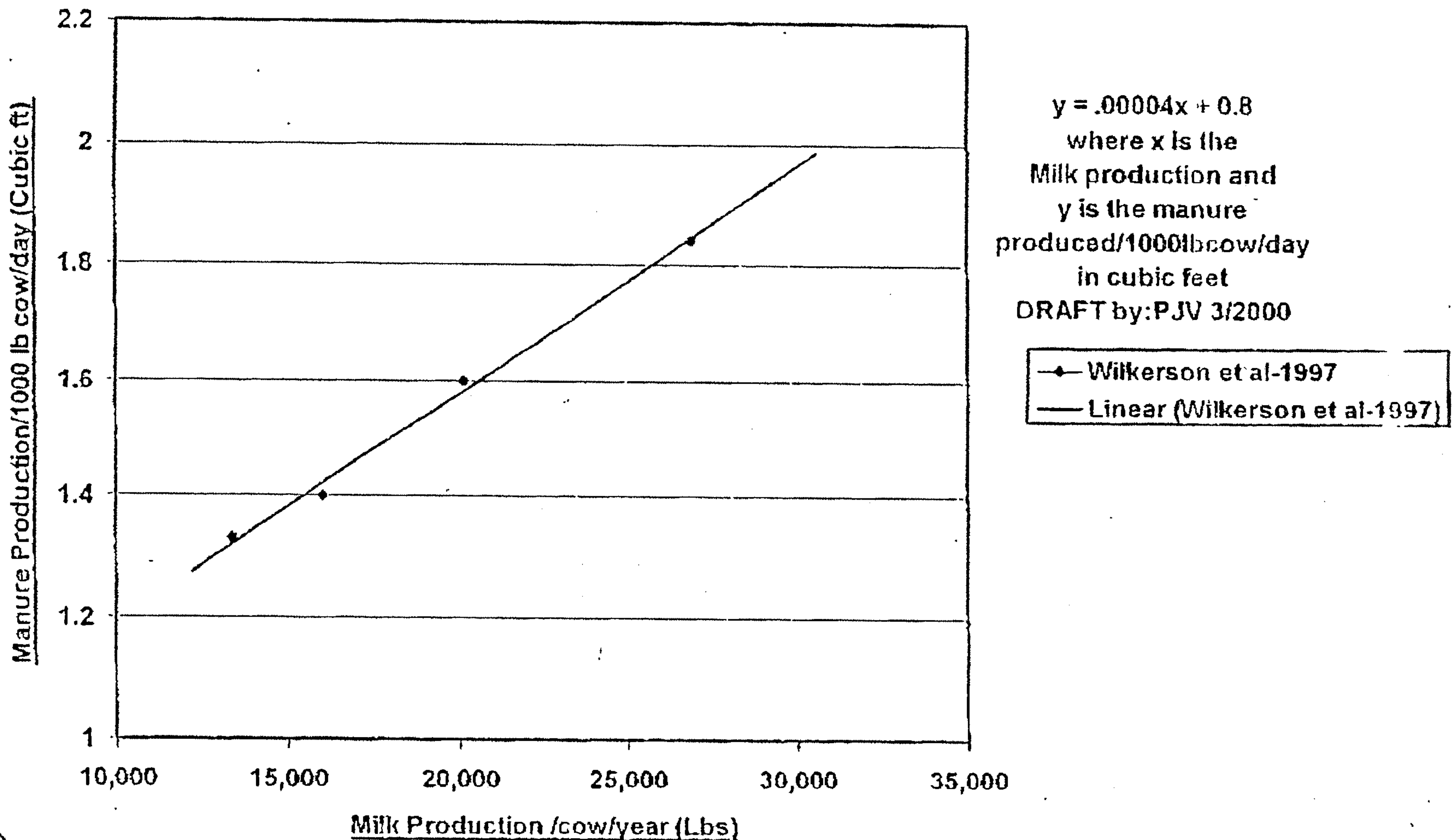
COST SUMMARY

	Dewatered Digested Manure			Dewatered Whole Manure		
	Windrow		Ag-Bag	Windrow		Ag-Bag
	Woodchips	Horse Manure		Woodchips	Horse Manure	
Capital Cost	$5,100,000	$5,250,000	$2,240,000	$7,586,000	$7,975,000	$3,175,000
Annualized Capital Cost	$442,000	$458,000	$196,000	$661,000	$695,000	$277,000
O&M Cost	$343,000	$295,000	$410,000	$475,000	$391,000	$654,000
Annual Revenue	$218,000	$413,000	$218,000	$335,000	$646,000	$335,000
Annual Net O&M Cost	$125,000	($117,460)	$192,000	$141,000	($255,000)	$319,000
Total Annual Cost	$567,000	$341,000	$388,000	$802,000	$440,000	$596,000
$ / wet Ton	$38	$23	$26	$30	$16	$22
$ / Cow	$311	$187	$213	$440	$241	$327

Consideration should be given to a decentralized composting operation that would allow each farm to compost manure using jointly owned and maintained equipment, and operated by a one or two operators dedicated the composting operation. Composting at each farm may reduce manure handling and hauling costs while still providing a joint marketing effort and shared operational costs.

APPENDIX A
Manure Production References

Milk Production vs Manure Production



y = .00004x + 0.8
where x is the
Milk production and
y is the manure
produced/1000lbcow/day
in cubic feet
DRAFT by:PJV 3/2000

MANURE PRODUCTION AND CHARACTERISTICS

Developed by the Engineering Practices Subcommittee of the ASAE Agricultural Sanitation and Waste Management Committee; approved by the Structures and Environment Division Standards Committee; adopted by ASAE December 1976; reconfirmed December 1981, December 1982, December 1983, December 1984, December 1985, December 1986, December 1987; revised June 1988; revised editorially and reaffirmed December 1993.

SECTION 1—PURPOSE AND SCOPE

1.1 Data on livestock manure production and characteristics are presented to assist in the planning, design and operation of manure collection, storage, pretreatment and utilization systems for livestock enterprises.

1.2 These data are combined from a wide base of published and unpublished information on livestock manure production and characterization. Users of this information should recognize that the mean values for each parameter are determined by an arithmetic average consisting of one data point per reference source per year. The values represent fresh (as voided) feces and urine. Actual values vary due to differences in animal diet, age, usage, productivity and management. Whenever site specific data are available or actual sample analyses can be performed, such information should be considered in lieu of the mean values presented here.

TABLE 1—FRESH MANURE PRODUCTION AND CHARACTERISTICS PER 1 000 kg LIVE ANIMAL MASS PER DAY

E Parameter	Units*		Animal Type†										
			Dairy	Beef	Veal	Swine	Sheep	Goat	Horse	Layer	Broiler	Turkey	Duck
Total manure‡	kg	mean §	86	58	62	84	40	41	51	64	85	47	110
		std. deviation	17	17	24	24	11	8.6	7.2	19	13	13	**
Urine	kg	mean	26	18	**	39	15	**	10	**	**	**	**
		std. deviation	4.3	4.2	**	4.8	3.6	**	0.74	**	**	**	**
Density	kg/m^3	mean	990	1 000	1 000	990	1 000	1 000	1 000	970	1 000	1 000	**
		std. deviation	63	75	**	24	64	**	93	39	**	**	**
Total solids	kg	mean	12	8.5	5.2	11	11	13	15	16	22	12	31
		std. deviation	2.7	2.6	2.1	6.3	3.5	1.0	4.4	4.3	1.4	3.4	15
Volatile solids	kg	mean	10	7.2	2.3	8.5	9.2	**	10	12	17	9.1	19
		std. deviation	0.79	0.57	**	0.66	0.31	**	3.7	0.84	1.2	1.3	**
Biochemical oxygen demand, 5-day	kg	mean	1.6	1.6	1.7	3.1	1.2	**	1.7	3.3	**	2.1	4.5
		std. deviation	0.48	0.75	**	0.72	0.47	**	0.23	0.91	**	0.46	**
Chemical oxygen demand	kg	mean	11	7.8	5.3	8.4	11	**	**	11	16	9.3	27
		std. deviation	2.4	2.7	**	3.7	2.5	**	**	2.7	1.8	1.2	**
pH		mean	7.0	7.0	8.1	7.5	**	**	7.2	6.9	**	**	**
		std. deviation	0.45	0.34	**	0.57	**	**	**	0.56	**	**	**
Total Kjeldahl nitrogen‖	kg	mean	0.45	0.34	0.27	0.52	0.42	0.45	0.30	0.84	1.1	0.62	1.5
		std. deviation	0.096	0.073	0.045	0.21	0.11	0.12	0.063	0.22	0.24	0.13	0.54
Ammonia nitrogen	kg	mean	0.079	0.086	0.12	0.29	**	**	**	0.21	**	0.080	**
		std. deviation	0.083	0.052	0.016	0.10	**	**	**	0.18	**	0.018	**
Total phosphorus	kg	mean	0.094	0.092	0.066	0.18	0.087	0.11	0.071	0.30	0.30	0.23	0.54
		std. deviation	0.024	0.027	0.011	0.10	0.030	0.016	0.026	0.081	0.053	0.093	0.21
Orthophosphorus	kg	mean	0.061	0.030	**	0.12	0.032	**	0.019	0.092	**	**	0.25
		std. deviation	0.005 8	**	**	**	0.014	**	0.007 1	0.016	**	**	**
Potassium	kg	mean	0.29	0.21	0.28	0.29	0.32	0.31	0.25	0.30	0.40	0.24	0.71
		std. deviation	0.094	0.061	0.10	0.16	0.11	0.14	0.091	0.072	0.064	0.080	0.34
Calcium	kg	mean	0.16	0.14	0.059	0.33	0.28	**	0.29	1.3	0.41	0.63	**
		std. deviation	0.059	0.11	0.049	0.18	0.15	**	0.11	0.57	**	0.34	**
Magnesium	kg	mean	0.071	0.049	0.033	0.070	0.072	**	0.057	0.14	0.15	0.073	**
		std. deviation	0.016	0.015	0.023	0.035	0.047	**	0.016	0.042	**	0.007 1	**
Sulfur	kg	mean	0.051	0.045	**	0.076	0.055	**	0.044	0.14	0.085	**	**
		std. deviation	0.010	0.005 2	**	0.040	0.043	**	0.022	0.066	**	**	**
Sodium	kg	mean	0.052	0.030	0.086	0.067	0.078	**	0.036	0.10	0.15	0.066	**
		std. deviation	0.026	0.023	0.063	0.052	0.027	**	**	0.051	**	0.012	**
Chloride	kg	mean	0.13	**	**	0.26	0.089	**	**	0.56	**	**	**
		std. deviation	0.039	**	**	0.052	**	**	**	0.44	**	**	**
E Iron	g	mean	12	7.8	0.33	16	8.1	**	16	60	**	75	**
		std. deviation	6.6	5.9	**	9.7	3.2	**	8.1	49	**	28	**
E Manganese	g	mean	1.9	1.2	**	1.9	1.4	**	2.8	6.1	**	2.4	**
		std. deviation	0.75	0.51	**	0.74	1.5	**	2.1	2.2	**	0.33	**
E Boron	g	mean	0.71	0.88	**	3.1	0.61	**	1.2	1.8	**	**	**
		std. deviation	0.35	0.064	**	0.95	0.30	**	0.48	1.7	**	**	**
E Molybdenum	g	mean	0.074	0.042	**	0.028	0.25	**	0.083	0.30	**	**	**
		std. deviation	0.012	**	**	0.030	0.38	**	0.033	0.057	**	**	**

TABLE 1—FRESH MANURE PRODUCTION AND CHARACTERISTICS PER 1 000 kg LIVE ANIMAL MASS PER DAY (cont'd)

Parameter	Units*		Dairy	Beef	Veal	Swine	Sheep	Goat	Horse	Layer	Broiler	Turkey	Duck
			Animal Type†										
Zinc	g	mean	1.8	1.1	13	5.0	1.6	**	2.2	19	3.6	15	**
		std. deviation	0.65	0.43	**	2.5	1.0	**	2.1	33	**	12	**
Copper	g	mean	0.45	0.31	0.048	1.2	0.22	**	0.53	0.83	0.98	0.71	**
		std. deviation	0.14	0.12	**	0.84	0.066	**	0.39	0.84	**	0.10	**
Cadmium	g	mean	0.003 0	**	**	0.027	0.007 2	**	0.005 1	0.038	**	**	**
		std. deviation	**	**	**	0.028	**	**	**	0.032	**	**	**
Nickel	g	mean	0.28	**	**	**	**	**	0.62	0.25	**	**	**
		std. deviation	**	**	**	**	**	**	**	**	**	**	**
Lead	g	mean	**	**	**	0.084	0.084	**	**	0.74	**	**	**
		std. deviation	**	**	**	0.012	**	**	**	**	**	**	**
Total coliform bacteria	colonies#	mean	1 100	63	**	45	20	**	490	110	**	**	**
		std. deviation	2 800	59	**	33	26	**	490	100	**	**	**
Fecal coliform bacteria	colonies	mean	16	28	**	18	45	**	0.092	7.5	**	1.4	180
		std. deviation	28	27	**	12	27	**	0.029	2.0	**	**	180
Fecal streptococcus bacteria	colonies	mean	92	31	**	530	62	**	58	16	**	**	590
		std. deviation	140	45	**	290	73	**	59	7.2	**	**	**

*All values wet basis.

†Differences within species according to usage exist, but sufficient fresh manure data to list these differences was not found. Typical live animal masses for which manure values represent are: dairy, 640 kg; beef, 360 kg; veal, 91 kg; swine, 61 kg; sheep, 27 kg; goat, 64 kg; horse, 450 kg; layer, 1.8 kg; broiler, 0.9 kg; turkey, 6.8 kg; and duck, 1.4 kg.

‡Feces and urine as voided.

§Parameter means within each animal species are comprised of varying populations of data. Maximum numbers of data points for each species are: dairy, 85; beef, 50; veal, 5; swine, 58; sheep, 39; goat, 3; horse, 31; layer, 74; broiler, 14; turkey, 18; and duck, 6.

‖ All nutrients and metals values are given in elemental form.

#Mean bacteria colonies per 1 000 kg animal mass multiplied by 10^{10}. Colonies per 1 000 kg animal mass divided by kg total manure per 1 000 kg animal mass multiplied by density (kg/m^3) equals colonies per m^3 of manure.

**Data not found.

TABLE 2—FRESH MANURE PRODUCTION AND CHARACTERISTICS PER 1,000 lb LIVE ANIMAL MASS PER DAY

Parameter	Units*		Dairy	Beef	Veal	Swine	Sheep	Goat	Horse	Layer	Broiler	Turkey	Duck
			Animal Type†										
Total manure‡	lb	mean§	86	58	62	84	40	41	51	64	85	47	110
		std. deviation	17	17	24	24	11	8.6	7.2	19	13	13	**
Urine	lb	mean	26	18	**	39	15	**	10	**	**	**	**
		std. deviation	4.3	4.2	**	4.8	3.6	**	0.74	**	**	**	**
Density	lb/ft^3	mean	62	63	62	62	64	63	63	60	63	63	**
		std. deviation	4.0	4.7	**	1.5	4.0	**	5.8	2.4	**	**	**
Total solids	lb	mean	12	8.5	5.2	11	11	13	15	16	22	12	31
		std. deviation	2.7	2.6	2.1	6.3	3.5	1.0	4.4	4.3	1.4	3.4	15
Volatile solids	lb	mean	10	7.2	2.3	8.5	9.2	**	10	12	17	9.1	19
		std. deviation	0.79	0.57	**	2.3	0.31	**	3.7	0.84	1.2	1.3	**
Biochemical oxygen demand, 5-day	lb	mean	1.6	1.6	1.7	3.1	1.2	**	1.7	3.3	**	2.1	4.5
		std. deviation	0.48	0.75	**	0.72	0.47	**	0.23	0.91	**	0.46	**
Chemical oxygen demand	lb	mean	11	7.8	5.3	8.4	11	**	**	11	16	9.3	27
		std. deviation	2.4	2.7	**	5.3	2.5	**	**	2.7	18	1.2	**
pH		mean	7.0	7.0	8.1	7.5	**	**	7.2	6.9	**	**	**
		std. deviation	0.45	0.34	**	0.57	**	**	**	0.56	**	**	**
Total Kjeldahl nitrogen‖	lb	mean	0.45	0.34	0.27	0.52	0.42	0.45	0.30	0.84	1.1	0.62	1.5
		std. deviation	0.096	0.073	0.045	0.21	0.11	0.12	0.063	0.22	0.24	0.13	0.54
Ammonia nitrogen	lb	mean	0.079	0.086	0.12	0.29	**	**	**	0.21	**	0.080	**
		std. deviation	0.083	0.052	0.016	0.10	**	**	**	0.18	**	0.018	**
Total phosphorus	lb	mean	0.094	0.092	0.066	0.18	0.087	0.11	0.071	0.30	0.30	0.23	0.54
		std. deviation	0.024	0.027	0.011	0.10	0.030	0.016	0.026	0.081	0.053	0.093	0.21
Orthophosphorus	lb	mean	0.061	0.030	**	0.12	0.032	**	0.019	0.092	**	**	0.25
		std. deviation	0.058	**	**	**	0.014	**	0.0071	0.016	**	**	**
Potassium	lb	mean	0.29	0.21	0.28	0.29	0.32	0.31	0.25	0.30	0.40	0.24	0.71
		std. deviation	0.094	0.061	0.10	0.16	0.11	0.14	0.091	0.072	0.064	0.080	0.34
Calcium	lb	mean	0.16	0.14	0.059	0.33	0.28	**	0.29	1.3	0.41	0.63	**
		std. deviation	0.059	0.11	0.049	0.18	0.15	**	0.11	0.57	**	0.34	**
Magnesium	lb	mean	0.071	0.049	0.033	0.070	0.072	**	0.057	0.14	0.15	0.073	**
		std. deviation	0.016	0.015	0.023	0.035	0.047	**	0.016	0.042	**	0.0071	**
Sulfur	lb	mean	0.051	0.045	**	0.076	0.055	**	0.044	0.14	0.085	**	**
		std. deviation	0.010	0.0052	**	0.040	0.043	**	0.022	0.066	**	**	**
Sodium	lb	mean	0.052	0.030	0.086	0.067	0.078	**	0.036	0.10	0.15	0.066	**
		std. deviation	0.026	0.023	0.063	0.052	0.027	**	**	0.051	**	0.012	**
Chloride	lb	mean	0.13	**	**	0.26	0.089	**	**	0.56	**	**	**
		std. deviation	0.039	**	**	0.052	**	**	**	0.44	**	**	**
Iron	lb	mean	0.012	0.0078	0.00033	0.016	0.0081	**	0.016	0.060	**	0.075	**
		std. deviation	0.0066	0.0059	**	0.0097	0.0032	**	0.0081	0.049	**	0.028	**

TABLE 2—FRESH MANURE PRODUCTION AND CHARACTERISTICS PER 1,000 lb LIVE ANIMAL MASS PER DAY (cont'd)

Parameter	Units*		Animal Type†										
			Dairy	Beef	Veal	Swine	Sheep	Goat	Horse	Layer	Broiler	Turkey	Duck
Manganese	lb	mean	0.0019	0.0012	**	0.0019	0.0014	**	0.0028	0.0061	**	0.0024	**
		std. deviation	0.00075	0.00051	**	0.00074	0.0015	**	0.0021	0.0022	**	0.00033	**
Boron	lb	mean	0.00071	0.00088	**	0.0031	0.00061	**	0.0012	0.0018	**	**	**
		std. deviation	0.00035	0.000064	**	0.00095	0.00030	**	0.00048	0.0017	**	**	**
Molybdenum	lb	mean	0.000074	0.000042	**	0.000028	0.00025	**	0.000083	0.00030	**	**	**
		std. deviation	0.000012	**	**	0.000030	0.00038	**	0.000033	0.000057	**	**	**
Zinc	lb	mean	0.0018	0.0011	0.013	0.0050	0.0016	**	0.0022	0.019	0.0036	0.015	**
		std. deviation	0.00065	0.00043	**	0.0025	0.0010	**	0.0021	0.033	**	0.012	**
Copper	lb	mean	0.00045	0.00031	0.000048	0.0012	0.00022	**	0.00053	0.00083	0.00098	0.00071	**
		std. deviation	0.00014	0.00012	**	0.00084	0.000066	**	0.00039	0.00084	**	0.00010	**
Cadmium	lb	mean	0.0000030	**	**	0.000027	0.0000072	**	0.0000051	0.000038	**	**	**
		std. deviation	**	**	**	0.000028	**	**	**	0.000032	**	**	**
Nickel	lb	mean	0.00028	**	**	**	**	**	0.00062	0.00025	**	**	**
		std. deviation	**	**	**	**	**	**	**	**	**	**	**
Lead	lb	mean	**	**	**	0.000084	0.000084	**	**	0.00074	**	**	**
		std. deviation	**	**	**	0.000012	**	**	**	**	**	**	**
Total coliform bacteria	colonies#	mean	500	29	**	21	9.0	**	220	50	**	**	**
		std. deviation	1300	27	**	15	12	**	220	46	**	**	**
Fecal coliform bacteria	colonies	mean	7.2	13	**	8.0	20	**	0.042	3.4	**	0.62	81
		std. deviation	13	12	**	5.4	12	**	0.013	0.91	**	**	81
Fecal streptococcus bacteria	colonies	mean	42	14	**	240	28	**	26	7.4	**	**	270
		std. deviation	63	21	**	130	33	**	27	3.3	**	**	**

*All values wet basis.

†Differences within species according to usage exist, but sufficient fresh manure data to list these differences was not found. Typical live animal masses for which manure values represent are: dairy, 1400 lb; beef, 800 lb; veal, 200 lb; swine, 135 lb; sheep, 60 lb; goat, 140 lb; horse, 1000 lb; layer, 4 lb; broiler, 2 lb; turkey, 15 lb; and duck, 3 lb.

‡Feces and urine as voided.

§Parameter means within each animal species are comprised of varying populations of data. Maximum numbers of data points for each species are: dairy, 85; beef, 50; veal, 5; swine, 58; sheep, 39; goat, 3; horse, 31; layer, 74; broiler, 14; turkey, 18; and duck, 6.

‖ All nutrients and metals values are given in elemental form.

#Mean bacteria colonies per 1,000 lb animal mass multiplied by 10^{10}. Colonies per 1,000 lb animal mass divided by lb total manure per 1,000 lb animal mass multiplied by density (lb/ft^3) equals colonies per ft^3 of manure.

**Data not found.

APPENDIX B
Equipment Lists & Detailed Costs

WINDROW FACILITY MASTER EQUIPMENT LIST - WITH DIGESTER

EQUIPMENT NAME	NO. OF UNITS	LOCATION	PROCESS CRITERIA (VALUE)	PROCESS CRITERIA (UNITS)	HP	VENDORS	COST (QUOTE)	COMMENTS
DIRECT-PURCHASE								
FRONT END LOADER	1		4	CY		CATERPILLAR	$170,000	DIESEL
SUBTOTAL							$170,000	
COMPOST SCREENING								
SCREEN	1	SCREENING AREA	45	CY/HR	45	NORTON	$180,000	DIESEL
SUBTOTAL							$180,000	
WINDROWS		COMPOSTING AREA						
TURNER (USED)	1	WINDROW AREA	2,000	T/HR		KING OF WINDROW	$100,000	DEISEL, 300 HP 6' X 14' TUNNEL
WATER SYSTEM	1	WINDROW AREA	2,639	LF			$46,051	
SUBTOTAL							$146,051	
MISCELLANEOUS								
TRUCK SCALE	1	RECEIVING AREA					$50,000	
INSTALLATION, OH & PROFIT - 25%							$12,500	
SUBTOTAL							$62,500	
GRAND TOTAL							$558,551	

WINDROW FACILITY MASTER EQUIPMENT LIST - WITHOUT DIGESTER

EQUIPMENT NAME	NO. OF UNITS	LOCATION	PROCESS CRITERIA (VALUE)	PROCESS CRITERIA (UNITS)	HP	VENDORS	COST (QUOTE)	COMMENTS
DIRECT-PURCHASE								
FRONT END LOADER	1		4	CY		CATERPILLAR	$170,000	DIESEL
SUBTOTAL							$170,000	
COMPOST SCREENING								
SCREEN	1	SCREENING AREA	45	CY/HR	45	NORTON	$180,000	DIESEL
SUBTOTAL							$180,000	
WINDROWS		COMPOSTING AREA						
TURNER (USED)	1	WINDROW AREA	2,000	T/HR		KING OF WINDROW	$100,000	DEISEL, 300 HP 6' X 14' TUNNEL
WATER SYSTEM	1	WINDROW AREA	4,623	LF			$80,676	
SUBTOTAL							$180,676	
MISCELLANEOUS								
TRUCK SCALE	1	RECEIVING AREA					$50,000	
INSTALLATION, OH & PROFIT - 25%							$12,500	
SUBTOTAL							$62,500	
GRAND TOTAL							$593,176	

AG BAG COMPOSTING FACILITY MASTER EQUIPMENT LIST - DEWATERED DIGESTED MANURE

EQUIPMENT NAME	NO. OF UNITS	LOCATION	PROCESS CRITERIA (VALUE)	PROCESS CRITERIA (UNITS)	HP	VENDORS	COST (QUOTE)	COMMENTS
DIRECT-PURCHASE								
FRONT END LOADER	1		4	CY		CATERPILLAR	$170,000	DIESEL
SUBTOTAL							$170,000	
COMPOST SCREENING								
SCREEN	1	SCREENING AREA	100	CY/HR	45	NORTON	$180,000	DIESEL
SUBTOTAL							$180,000	
AG BAG COMPOSTING SYSTEM								
HOPPER/BAG LOADER	1	COMPOSTING AREA	180	T/HR		AG BAG	$160,000	DEISEL, 55 HP
FIRST SET OF BAGS/AIR PIPING SYSTEM	18	COMPOSTING AREA				AG BAG	$26,352	34 BAGS (8 WEEKS SUPPLY)
AERATION FANS	18	COMPOSTING AREA			1/3	AG BAG	$20,268	34 FANS (1/BAG)
INSTALLATION, OH & PROFIT - 35%							$7,094	FANS ONLY
SUBTOTAL							$213,714	
MISCELLANEOUS								
TRUCK SCALE	1	DRIVEWAY					$50,000	
INSTALLATION, OH & PROFIT - 25%							$12,500	
SUBTOTAL							$62,500	
GRAND TOTAL							$626,214	

AG BAG COMPOSTING FACILITY MASTER EQUIPMENT LIST - WITHOUT DIGESTER

EQUIPMENT NAME	NO. OF UNITS	LOCATION	PROCESS CRITERIA (VALUE)	PROCESS CRITERIA (UNITS)	HP	VENDORS	COST (QUOTE)	COMMENTS
DIRECT-PURCHASE								
FRONT END LOADER	2		4	CY		CATERPILLAR	$170,000	DIESEL
SUBTOTAL							$340,000	
COMPOST SCREENING								
SCREEN	1	SCREENING AREA	100	CY/HR	45	NORTON	$180,000	DIESEL
SUBTOTAL							$180,000	
AG BAG COMPOSTING SYSTEM								
HOPPER/BAG LOADER	1	COMPOSTING AREA	180	T/HR		AG BAG	$160,000	DEISEL, 55 HP
FIRST SET OF BAGS/AIR PIPING SYSTEM	34	COMPOSTING AREA				AG BAG	$49,776	8 WEEKS SUPPLY)
AERATION FANS	34	COMPOSTING AREA			1/3	AG BAG	$38,284	1 FAN PER BAG
INSTALLATION, OH & PROFIT - 35%							$13,399	FANS ONLY
SUBTOTAL							$261,459	
MISCELLANEOUS								
TRUCK SCALE	1	DRIVEWAY					$50,000	
INSTALLATION, OH & PROFIT - 25%							$12,500	
SUBTOTAL							$62,500	
GRAND TOTAL							$843,959	

TABLE B-1
NORTH CANAAN REGIONAL COMPOSTING FACILITY
WINDROW COMPOSTING SYSTEM
DEWATERED DIGESTED MANURE
CAPITAL COST ESTIMATE

Item	Quantity	Unit	Unit Cost	Total Cost
Capital Costs				
Structural/Architectural				
Foundation/Concrete				
Woodchip Building	0.08	acres		
Footings	71	cu. yd.	$350.00	$24,889
Slabs	133	cu. yd.	$500.00	$66,667
Piers	7	cu. yd.	$550.00	$3,911
Composting Building	1.4	acres		
Footings	289	cu. yd.	$350.00	$101,198
Slabs		cu. yd.	$500.00	$0
Piers	29	cu. yd.	$550.00	$15,902
Office Building	0.02	acres		
Slabs	30	cu. yd.	$500.00	$14,815
Subtotal				$227,381
Woodchip Building				
Building	3,600	sq ft	$25.00	$90,000
Misc. Building Systems	0	%		$0
Subtotal				$90,000
Composting Building				
Building	59,499	sq ft	$30.00	$1,784,980
Misc. Building Systems	0	%		$0
Subtotal				$1,784,980
Office Building				
Office/Garage	800	sq ft	$25.00	$20,000
Misc. Building Systems	10	%		$3,481
Subtotal				$23,481
Total Architectural/Structural				**$2,125,843**
Heating and Ventilating	lump sum	%		$3,000
Plumbing	lump sum	%		$1,000
Electrical, Instrumentation and SCADA	Lump Sum	%		$0
Process Equipment				
Compost Screening				$180,000
Front End Loaders				$170,000
Turner				$100,000
Truck Scale				$62,500
Total Process				**$512,500**
Sitework -	3.2	acre		
Clearing	0.00	acre	$2,500	$0
Grubbing	3.2	acre	$2,500	$8,050
Bulk Excavation	0	CY	$5	$0
Fill	0	CY	$5	$0
Fine Grading		SY	$1.50	$0
Erosion Control	1	lump sum		$10,000
Site Drainage	1	lump sum		$20,000
Gravel Subbase	7,550	cu yd	$17.00	$128,400
Pavement	3,279	Ton	$75.00	$245,900
Surface Restoration, Loam & Seed	1	lump sum		$5,000
Total Sitework				**$417,350**
Bond & Mobilization	7	%		$214,000
Base Construction Cost				$3,274,000
Legal, & administrative	6	%		$196,000
Engineering	20	%		$654,800
Contingency	20	%		$654,800
Land	4	acres	$20,000.00	$80,000
200 foot buffer around site	11	acres	$20,000.00	$210,000
Total Capital Cost				**$5,069,600**
Annualized Capital Cost	20yrs @ 6% interest		$0.0872	**$442,000**

TABLE B-2
NORTH CANAAN REGIONAL COMPOSTING FACILITY
WINDROW COMPOSTING SYSTEM
DEWATERED DIGESTED MANURE
OPERATING AND MAINTENANCE COST ESTIMATE

Item	Quantity	Unit	Unit Cost	Total Cost
Labor				
Managers	1.0	People	$50,000	$50,000
Workers	2.0	People	$35,000	$70,000
Power - electric				$0
Fuel - diesel	21,450	gallons	$3.30	$70,785
Amendment	10,500	yd	$5.00	$52,500
System repair/replacement	1.5	%		$76,000
Laboratory				$5,000
Supplies				$3,000
Insurance	0.3	%		$15,200
Utilities - water/sewer for Office				$0
Product Revenue	12,806	yd	($17.00)	($217,696)
Total				$124,789
Processing Cost				
Annual Capital Cost	0.087	A/P(6%, 20 yr.)		$442,000
Annual O&M cost				$124,789
Total Annual Cost				$566,789
Cost per wet ton	14,900	wet tons		**$38.04**
Cost per Cow per Year	1,823	cows*		**$310.91**

*Dairy cows plus half the number of heifers (assuming 2 heifers equals 1 dairy cow)

TABLE B-3
NORTH CANAAN REGIONAL COMPOSTING FACILITY
WINDROW COMPOSTING SYSTEM
DEWATERED WHOLE MANURE
CAPITAL COST ESTIMATE

Item	Quantity	Unit	Unit Cost	Total Cost
Capital Costs				
Structural/Architectural				
Foundation/Concrete				
Woodchip Building	0.14	acres		
Footings	95	cu. yd.	$350.00	$33,185
Slabs	222	cu. yd.	$500.00	$111,111
Piers	9	cu. yd.	$550.00	$5,215
Composting Building	2.3	acres		
Footings	387	cu. yd.	$350.00	$135,494
Piers	39	cu. yd.	$550.00	$21,292
Office Building	0.02	acres		
Slabs	30	cu. yd.	$500.00	$14,815
Subtotal				$321,112
Woodchip Building				
Building	6,000	sq ft	$25.00	$150,000
Misc. Building Systems	0	%		$0
Subtotal				$150,000
Composting Building				
Building	100,508	sq ft	$30.00	$3,015,238
Misc. Building Systems	0	%		$0
Subtotal				$3,015,238
Office Building				
Office/Garage	800	sq ft	$25.00	$20,000
Misc. Building Systems	10	%		$3,481
Subtotal				$23,481
Total Architectural/Structural				**$3,509,832**
Heating and Ventilating	lump sum	%		$3,000
Plumbing	lump sum	%		$1,000
Electrical, Instrumentation and SCADA	Lump Sum	%		$0
Process Equipment				
Compost Screening				$180,000
Front End Loaders				$170,000
Turner				$100,000
Truck Scale				$62,500
Total Process				**$512,500**
Sitework -	4.6	acre		
Clearing	0.00	acre	$2,500	$0
Grubbing	4.60	acre	$2,500	$11,500
Bulk Excavation	0	CY	$5	$0
Fill	0	CY	$5	$0
Fine Grading		SY	$1.50	$0
Erosion Control	1	lump sum		$10,000
Site Drainage	1	lump sum		$20,000
Gravel Subbase	11,132	cu yd	$17.00	$189,200
Pavement	4,835	Ton	$75.00	$362,600
Surface Restoration, Loam & Seed	1	lump sum		$5,000
Total Sitework				**$598,300**
Bond & Mobilization	7	%		$324,000
Base Construction Cost				$4,949,000
Legal, & administrative	6	%		$297,000
Engineering	20	%		$989,800
Contingency	20	%		$989,800
Land	5	acres	$20,000.00	$100,000
200 foot buffer around site	13	acres	$20,000.00	$260,000
Total Capital Cost				**$7,585,600**
Annualized Capital Cost	20yrs @ 6% interest		$0.0872	**$661,000**

TABLE B-4
NORTH CANAAN REGIONAL COMPOSTING FACILITY
WINDROW COMPOSTING SYSTEM
DEWATERED WHOLE MANURE
OPERATING AND MAINTENANCE COST ESTIMATE

Item	Quantity	Unit	Unit Cost	Total Cost
Labor				
Managers	1.0	People	$50,000	$50,000
Workers	3.0	People	$35,000	$105,000
Power - electric				$0
Fuel - diesel	25,000	gallons	$3.30	$82,500
Amendment	18,250	yd	$5.00	$91,250
System repair/replacement	1.5	%		$113,800
Laboratory				$5,000
Supplies				$3,000
Insurance	0.3	%		$22,800
Utilities - water/sewer for Office				$2,000
Product Revenue	19,696	yd	($17.00)	($334,828)
Total				$140,522
Processing Cost				
Annual Capital Cost	0.087	A/P(6%, 20 yr.)		$661,000
Annual O&M cost				$140,522
Total Annual Cost				$801,522
Cost per wet ton	26,800	wet tons		**$29.91**
Cost per Cow per Year	1,823	cows*		**$439.67**

*Dairy cows plus half the number of heifers (assuming 2 heifers equals 1 dairy cow)

TABLE B-5
NORTH CANAAN REGIONAL COMPOSTING FACILITY
AG BAG COMPOSTING SYSTEM
DEWATERED DIGESTED MANURE
CAPITAL COST ESTIMATE

Item	Quantity	Unit	Unit Cost	Total Cost
Capital Costs				
Structural/Architectural				
Foundation/Concrete				
Woodchip Building	0.08	acres		
Footings	71	cu. yd.	$350.00	$24,889
Piers	7	cu. yd.	$550.00	$3,911
Slabs	133	cu. yd.	$500.00	$66,667
Office Building				
Slabs	30	cu. yd.	$500.00	$14,815
Subtotal				$110,281
Woodchip Building				
Building	3,600	sq ft	$25.00	$90,000
Misc. Building Systems	0	%		$0
Subtotal				$90,000
Office Building				
Office/Garage	800	sq ft	$25.00	$20,000
Misc. Building Systems	10	%		$3,481
Subtotal				$23,481
Total Architectural/Structural				**$223,763**
Heating and Ventilating	lump Sum	%		$3,000
Plumbing	lump Sum	%		$1,000
Electrical, Instrumentation and SCADA	lump sum	%		$25,000
Process Equipment				
Compost Screening				$180,000
Front End Loaders				$170,000
Ag Bag Composting System				$213,714
Truck Scale				$62,500
Total Process				**$626,214**
Sitework -	3.05	acres		
Clearing	0.00	acre	$2,500	$0
Grubbing	3.05	acre	$2,500	$7,625
Bulk Excavation	0	CY	$5	$0
Fill	0	CY	$5	$0
Fine Grading	0	SY	$1.50	$0
Erosion Control	1	lump sum		$10,000
Site Drainage	1	lump sum		$20,000
Gravel Subbase	7,381	cu yd	$17.00	$125,500
Pavement	3,206	Ton	$75.00	$240,400
Surface Restoration, Loam & Seed	1	lump sum		$5,000
Total Sitework				**$408,525**
Bond & Mobilization	7	%		$90,000
Base Construction Cost				$1,378,000
Legal, & administrative	6	%		$83,000
Engineering	20	%		$275,600
Contingency	20	%		$275,600
Land	4	acres	$20,000.00	$80,000
200 foot buffer around site	7.6	acres	$20,000.00	$151,200
Total Capital Cost				**$2,243,400**
Annualized Capital Cost	20yrs @ 6% interest		$0.0872	**$196,000**

TABLE B-6
NORTH CANAAN REGIONAL COMPOSTING FACILITY
AG BAG COMPOSTING SYSTEM
DEWATERED DIGESTED MANURE
OPERATING AND MAINTENANCE COST ESTIMATE

Item	Quantity	Unit	Unit Cost	Total Cost
Labor				
Managers	1.0	People	$50,000	$50,000
Workers	2.0	People	$35,000	$70,000
Power - electric				$1,564
Fuel - diesel	21,200	gallons	$3.30	$69,960
Amendment	10,500	yd	$5.00	$52,500
Bags & Perforate Air Pipe	110		$1,050	$115,500
System repair/replacement	1.5	%		$33,700
Laboratory				$5,000
Supplies				$3,000
Insurance	0.3	%		$6,700
Utilities - water/sewer for Office				$2,000
Product Revenue	12,806	yd	($17.00)	($217,696)
Total				$192,228
Processing Cost				
Annual Capital Cost	0.087	A/P(6%, 20 yr.)		$196,000
Annual O&M cost				$192,228
Total Annual Cost				$388,228
Cost per wet ton	14,900	wet tons		**$26.06**
Cost per Cow per Year	1,823	cows*		**$212.96**

*Dairy cows plus half the number of heifers (assuming 2 heifers equals 1 dairy cow)

TABLE B-7
NORTH CANAAN REGIONAL COMPOSTING FACILITY
AG BAG COMPOSTING SYSTEM
DEWATERED WHOLE MANURE
CAPITAL COST ESTIMATE

Item	Quantity	Unit	Unit Cost	Total Cost
Capital Costs				
Structural/Architectural				
Foundation/Concrete				
Woodchip Building	0.17	acres		
Footings	95	cu. yd.	$350.00	$33,185
Piers	9	cu. yd.	$550.00	$5,215
Slabs	222	cu. yd.	$500.00	$111,111
Office Building				
Slabs	30	cu. yd.	$500.00	$14,815
Subtotal				$164,326
Woodchip Building				
Building	6,000	sq ft	$25.00	$150,000
Misc. Building Systems	0	%		$0
Subtotal				$150,000
Office Building				
Office/Garage	800	sq ft	$25.00	$20,000
Misc. Building Systems	10	%		$3,481
Subtotal				$23,481
Total Architectural/Structural				**$337,807**
Heating and Ventilating	lump su m	%		$3,000
Plumbing	lump su m	%		$1,000
Electrical, Instrumentation and SCADA	lump Sum	%		$25,000
Process Equipment				
Compost Screening				$180,000
Front End Loaders				$340,000
Ag Bag Composting System				$261,459
Truck Scale				$62,500
Total Process				**$843,959**
Sitework -	4.80	acres		
Clearing	0.00	acre	$2,500	$0
Grubbing	4.80	acre	$2,500	$12,000
Bulk Excavation	0	CY	$5	$0
Fill	0	CY	$5	$0
Fine Grading	0	SY	$1.50	$0
Erosion Control	1	lump sum		$10,000
Site Drainage	1	lump sum		$20,000
Gravel Subbase	11,616	cu yd	$17.00	$197,500
Pavement	5,045	Ton	$75.00	$378,400
Surface Restoration, Loam & Seed	1	lump sum		$5,000
Total Sitework				**$622,900**
Bond & Mobilization	7	%		$128,000
Base Construction Cost				$1,962,000
Legal, & administrative	6	%		$118,000
Engineering	20	%		$392,400
Contingency	20	%		$392,400
Land	5	acres	$20,000.00	$100,000
200 foot buffer around site	11	acres	$20,000.00	$210,000
Total Capital Cost				**$3,174,800**
Annualized Capital Cost	20yrs @ 6%	interest	$0.0872	**$277,000**

TABLE B-8
NORTH CANAAN REGIONAL COMPOSTING FACILITY
AG BAG COMPOSTING SYSTEM
DEWATERED WHOLE MANURE
OPERATING AND MAINTENANCE COST ESTIMATE

Item	Quantity	Unit	Unit Cost	Total Cost
Labor				
Managers	1.0	People	$50,000	$50,000
Workers	3.0	People	$35,000	$105,000
Power - electric				$2,528
Fuel - diesel	28,000	gallons	$3.30	$92,400
Amendment	18,250	yd	$5.00	$91,250
Bags & Perforate Air Pipe	230		$1,050	$241,500
System repair/replacement	1.5	%		$47,600
Laboratory				$5,000
Supplies				$3,000
Insurance	0.3	%		$9,500
Water for Process	0	gal	$0.00	$0
Product Revenue	19,696	yd	($17.00)	($334,828)
Total				$318,950
Processing Cost				
Annual Capital Cost	0.087	A/P(6%, 20 yr.)		$277,000
Annual O&M cost				$318,950
Total Annual Cost				$595,950
Cost per wet ton	26,800	wet tons		**$22.24**
Cost per Cow per Year	1,823	cows*		**$326.91**

*Dairy cows plus half the number of heifers (assuming 2 heifers equals 1 dairy cow)

TABLE B-9
NORTH CANAAN REGIONAL COMPOSTING FACILITY
WINDROW COMPOSTING SYSTEM
DEWATERED DIGESTED MANURE - USING HORSE MANURE AS AMENDMENT
CAPITAL COST ESTIMATE

Item	Quantity	Unit	Unit Cost	Total Cost
Capital Costs				
Structural/Architectural				
Foundation/Concrete				
Horse Manure Storage Building	0.08	acres		
Footings	71	cu. yd.	$350.00	$24,889
Slabs	133	cu. yd.	$500.00	$66,667
Piers	7	cu. yd.	$550.00	$3,911
Composting Building	1.4	acres		
Footings	289	cu. yd.	$350.00	$101,198
Slabs		cu. yd.	$500.00	$0
Piers	29	cu. yd.	$550.00	$15,902
Office Building	0.02	acres		
Slabs	30	cu. yd.	$500.00	$14,815
Subtotal				$227,381
Horse Manure Storage Building				
Building	3,600	sq ft	$25.00	$90,000
Misc. Building Systems	0	%		$0
Subtotal				$90,000
Composting Building				
Building	59,499	sq ft	$30.00	$1,784,980
Misc. Building Systems	0	%		$0
Subtotal				$1,784,980
Office Building				
Office/Garage	800	sq ft	$25.00	$20,000
Misc. Building Systems	10	%		$3,481
Subtotal				$23,481
Total Architectural/Structural				**$2,125,843**
Heating and Ventilating	lump sum	%		$3,000
Plumbing	lump sum	%		$1,000
Electrical, Instrumentation and SCADA	Lump Sum	%		$0
Process Equipment				
Compost Screening				$180,000
Front End Loaders				$170,000
Turner				$100,000
Truck Scale				$62,500
Total Process				**$512,500**
Sitework -	3.9	acre		
Clearing	0.00	acre	$2,500	$0
Grubbing	3.9	acre	$2,500	$9,750
Bulk Excavation	0	CY	$5	$0
Fill	0	CY	$5	$0
Fine Grading		SY	$1.50	$0
Erosion Control	1	lump sum		$10,000
Site Drainage	1	lump sum		$20,000
Gravel Subbase	9,196	cu yd	$17.00	$156,300
Pavement	3,994	Ton	$75.00	$299,500
Surface Restoration, Loam & Seed	1	lump sum		$5,000
Total Sitework				**$500,550**
Bond & Mobilization	7	%		$220,000
Base Construction Cost				$3,363,000
Legal, & administrative	6	%		$202,000
Engineering	20	%		$672,600
Contingency	20	%		$672,600
Land	4	acres	$20,000.00	$80,000
200 foot buffer around site	13	acres	$20,000.00	$260,000
Total Capital Cost				**$5,250,200**
Annualized Capital Cost	20yrs @ 6% interest		$0.0872	**$458,000**

TABLE B-10
NORTH CANAAN REGIONAL COMPOSTING FACILITY
WINDROW COMPOSTING SYSTEM
DEWATERED DIGESTED MANURE - USING HORSE MANURE AS AMENDMENT
OPERATING AND MAINTENANCE COST ESTIMATE

Item	Quantity	Unit	Unit Cost	Total Cost
Labor				
Managers	1.0	People	$50,000	$50,000
Workers	2.0	People	$35,000	$70,000
Power - electric				$0
Fuel - diesel	21,450	gallons	$3.30	$70,785
Amendment	0	yd	$5.00	$0
System repair/replacement	1.5	%		$78,800
Laboratory				$5,000
Supplies				$3,000
Insurance	0.3	%		$15,800
Utilities - water/sewer for Office				$2,000
Product Revenue	24,285	yd	($17.00)	($412,845)
Total				($117,460)
Processing Cost				
Annual Capital Cost	0.087	A/P(6%, 20 yr.)		$458,000
Annual O&M cost				($117,460)
Total Annual Cost				$340,540
Cost per wet ton	14,900	wet tons		**$22.86**
Cost per Cow per Year	1,823	cows*		**$186.80**

*Dairy cows plus half the number of heifers (assuming 2 heifers equals 1 dairy cow)

TABLE B-11
NORTH CANAAN REGIONAL COMPOSTING FACILITY
WINDROW COMPOSTING SYSTEM
DEWATERED WHOLE MANURE - USING HORSE MANURE AS AMENDMENT
CAPITAL COST ESTIMATE

Item	Quantity	Unit	Unit Cost	Total Cost
Capital Costs				
Structural/Architectural				
Foundation/Concrete				
Horse Manure Storage Building	0.14	acres		
Footings	95	cu. yd.	$350.00	$33,185
Slabs	222	cu. yd.	$500.00	$111,111
Piers	9	cu. yd.	$550.00	$5,215
Composting Building	2.3	acres		
Footings	387	cu. yd.	$350.00	$135,494
Piers	39	cu. yd.	$550.00	$21,292
Office Building	0.02	acres		
Slabs	30	cu. yd.	$500.00	$14,815
Subtotal				$321,112
Horse Manure Storage Building				
Building	6,000	sq ft	$25.00	$150,000
Misc. Building Systems	0	%		$0
Subtotal				$150,000
Composting Building				
Building	100,508	sq ft	$30.00	$3,015,238
Misc. Building Systems	0	%		$0
Subtotal				$3,015,238
Office Building				
Office/Garage	800	sq ft	$25.00	$20,000
Misc. Building Systems	10	%		$3,481
Subtotal				$23,481
Total Architectural/Structural				**$3,509,832**
Heating and Ventilating	lump sum	%		$3,000
Plumbing	lump sum	%		$1,000
Electrical, Instrumentation and SCADA	Lump Sum	%		$0
Process Equipment				
Compost Screening				$180,000
Front End Loaders				$170,000
Turner				$100,000
Truck Scale				$62,500
Total Process				**$512,500**
Sitework -	6.1	acre		
Clearing	0.00	acre	$2,500	$0
Grubbing	6.1	acre	$2,500	$15,150
Bulk Excavation	0	CY	$5	$0
Fill	0	CY	$5	$0
Fine Grading		SY	$1.50	$0
Erosion Control	1	lump sum		$10,000
Site Drainage	1	lump sum		$20,000
Gravel Subbase	14,278	cu yd	$17.00	$242,700
Pavement	6,201	Ton	$75.00	$465,100
Surface Restoration, Loam & Seed	1	lump sum		$5,000
Total Sitework				**$757,950**
Bond & Mobilization	7	%		$335,000
Base Construction Cost				$5,119,000
Legal, & administrative	6	%		$307,000
Engineering	20	%		$1,023,800
Contingency	20	%		$1,023,800
Land	7	acres	$20,000.00	$140,000
200 foot buffer around site	18	acres	$20,000.00	$360,000
Total Capital Cost				**$7,973,600**
Annualized Capital Cost	20yrs @ 6% interest		$0.0872	**$695,000**

TABLE B-12
NORTH CANAAN REGIONAL COMPOSTING FACILITY
WINDROW COMPOSTING SYSTEM
DEWATERED WHOLE MANURE - USING HORSE MANURE AS AMENDMENT
OPERATING AND MAINTENANCE COST ESTIMATE

Item	Quantity	Unit	Unit Cost	Total Cost
Labor				
Managers	1.0	People	$50,000	$50,000
Workers	3.0	People	$35,000	$105,000
Power - electric				$0
Fuel - diesel	25,000	gallons	$3.30	$82,500
Amendment	0	yd	$5.00	$0
System repair/replacement	1.5	%		$119,600
Laboratory				$5,000
Supplies				$3,000
Insurance	0.3	%		$23,900
Utilities - water/sewer for Office				$2,000
Product Revenue	38,013	yd	($17.00)	($646,219)
Total				($255,219)
Processing Cost				
Annual Capital Cost	0.087	A/P(6%, 20 yr.)		$695,000
Annual O&M cost				($255,219)
Total Annual Cost				$439,781
Cost per wet ton	26,800	wet tons		**$16.41**
Cost per Cow per Year	1,823	cows*		**$241.24**

*Dairy cows plus half the number of heifers (assuming 2 heifers equals 1 dairy cow)

APPENDIX C-1
Equipment Information:
Ag Bag Composting System

CT-10 *SIDE LOAD* COMPOST SYSTEM

	REQUIRES	PRICE AS EQUIPPED
As Described Below:		**$155,385**
	10' Compost EcoPOD	

DESCRIPTION:

- 10' Tunnel
- 55 hp John Deere Power Tech Diesel engine, 4 cylinder
- 50 gallon fuel tank
- Deluxe operator platform and control panel
- 23 yard hopper
- Remote control unit
- Self-contained hydraulics and controls
- 28 gpm hydraulic pressure compensated pump
- 6" 3 stage hydraulic cylinder
- 50 gallon hydraulic tank
- 6 – 14" x 17.5" wheels
- 6 – Wheel brakes
- Wheel drive
- High flotation tires with 1-ton hubs
- Aeration pipe punch
- Bag boom with electric winch
- Bag pan assembly
- Pipe reels and tube guides
- 27 gallon inoculum tank w/spray applicator & nozzle
- Accessories include: Masterseal tool, vent valve tool & temperature probe

DIMENSIONS:

HEIGHT	11' 7"
LENGTH	21' 8"
WIDTH (work position)	15'
WIDTH (transport)	11' 6"
WEIGHT	18,000
FILL RATE	3+ Tons Per Minute

CT-10

Side Load Encapsulator

Operator's Console

1. Tachometer / Hour Meter Gauge
2. Oil Pressure Gauge
3. Oil Pressure Warning Light
4. Water Temperature Gauge
5. Water Temperature Warning Light
6. Fuel Gauge
7. Remote Switch
8. Sprayer Switch
9. Brake Pressure Gauge
10. Ignition Switch
11. Brake Pressure Gauge
12. Air Brake Control (Right Rear)
13. Air Brake Control (Left Rear)
14. Remote Reset Button

Remote Control Transmitter

1. Remote ON

2. Remote OFF

3. Ram Control - Out

4. Ram Control - In

5. Lights ON/OFF

6. Sprayer ON/OFF

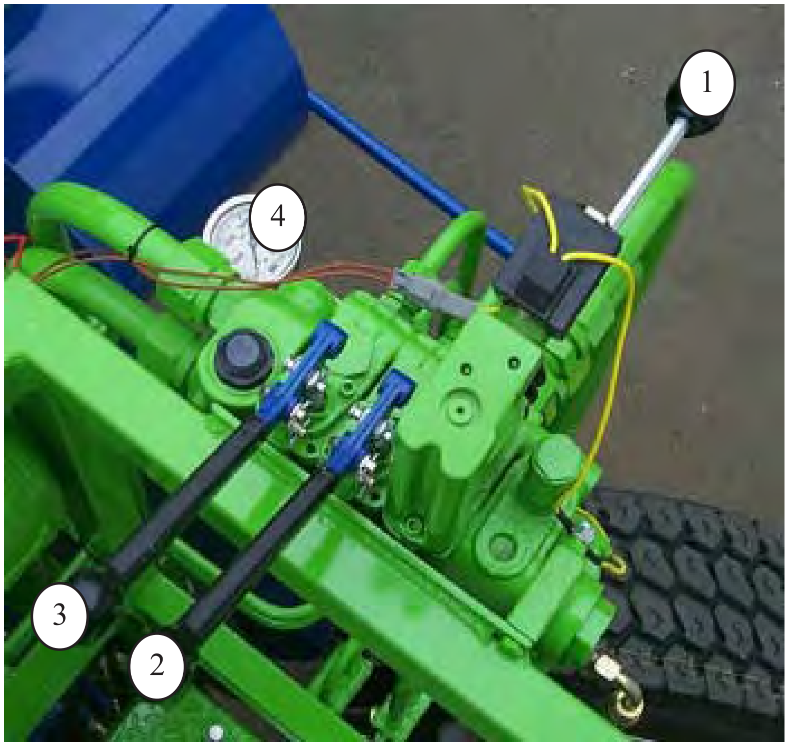
7. Remote ON Indicator - Yellow

8. Battery Low Indicator - Red Flashing

9. Steer Left Control

10. Steer Right Control

Operator's Controls



1. Ram In & Out
2. Steering Control
3. Wheel Drive Control
4. Air Pressure Gauge

Hydraulic Hand Pump

Use to control the breaks on the steering wheels.

1. Fill/Drain Cap
2. Handle Lock
3. Pump Handle
4. Pressure Gauge
5. Pressure Adjust Knob

Operator's Platform

Designed for ease of operations the Operator's Platform gives you the up close view of all operations. A Remote is also provided. *(see page 3)*

Inoculant Sprayer - Liquid

Your CT-10 may be equipped with an inoculant applicator. Pictured here is the 27 gallon Spotlite Liquid applicator which is designed for wet inoculant.

Hopper - Tunnel

To allow for a fill rate of 3 plus tons per minute, The CT-10 come with a 23 yard hopper and 10 foot tunnel.

Bag Pan

Located at the bottom of the tunnel the Bag Pan is used to hold the bag off the ground and control the bag as it is pulled from the tunnel.

Pipe Tube

The Pipe Tube runs under the material in the hopper and allows for the feeding of the pipe from the reel to the bag.

Pipe Reel

Used to hold the 4” perforated pipe and help feed it into the pipe tube, Pipe Reels are located on both sides of the CT-10.

Air Compressor & Tank

An electric Air Pump and Tank are provided to keep the air brake system up and working properly.

Bag Boom & Winch

Pictured is an Electric winch Bag Boom and Cradle. These are used in the placing of the bag on the tunnel.

Fuel Tank

The fuel tank is saddled on the left side of the hopper of the CT-10 and holds 45 - 48 gallons of diesel fuel.

Hydraulic Tank

Located on the right side of the CT-10 the hydraulic tank is saddled under the hopper. The tank holds approx 80 gallons of hydraulic oil,

Diesel Engine

The CT-10 is equipped with the John Deere Power Tech Diesel which is a 4 cylinder 55 hp motor.

Wheel Drive

The CT-10 is equipped with front wheel drive for ease of moving the Encapsulator and getting it ready for bagging. The drive wheels have hydraulic brakes controlled by a hand pump located at the operator's console.

Walking Beam

The CT-10 uses walking beams to distribute the weight of the feedstock over a larger area. This allows for bagging on softer ground with out the fear of sinking in to the soil.

Air Brakes

The CT-10 uses air brakes on each wheel on the walking beam, this allows for even pressure for the bagging operation.

Index

CT-10 Side Load Compost System

Specifications

The Ag-Bag Environmental **CT-10 SL** compost system is designed for the extra large volume operator who requires the convenience of a hopper and the capacity of the larger EcoPOD. The CT-10SL works in conjunction with the 10′ x 200′ EcoPOD, which has the storage capacity of 200 tons or 500 yards per EcoPOD.

DESCRIPTION:

The unique design incorporates a 6" hydraulic cylinder, which pushes the material through the tunnel and into the EcoPOD. It is equipped with a 55 hp John Deere Power Tech diesel engine to power the hydraulics. It features a remote control unit for the operator to control the system, permitting a one-man operation. The feed hopper will hold approximately 23 yards of material at one fill.

Standard equipment includes:

- 55hp John Deere Power Tech Diesel engine, 4 cylinder
- 10′ Tunnel
- Deluxe operator platform and control panel
- 50 gallon fuel tank
- 50 gallon hydraulic tank
- 23 yard hopper with UHMW lining
- Self-contained hydraulics and controls
- 28 gpm hydraulic pressure compensated pump
- 6 – 14" x 17.5" wheels
- High flotation tires with 1-ton hubs
- Bag boom with electric winch
- Pipe reels and tube guidesv
- Remote control unit
- 6" 3 stage hydraulic cylinder
- Complete air brake system
- Wheel drive
- Manual Lift Jack
- Bag pan assembly
- 27 gallon inoculum tank w/spray applicator & nozzle
- Accessories include: Masterseal tool, vent valve tool & temperature probe

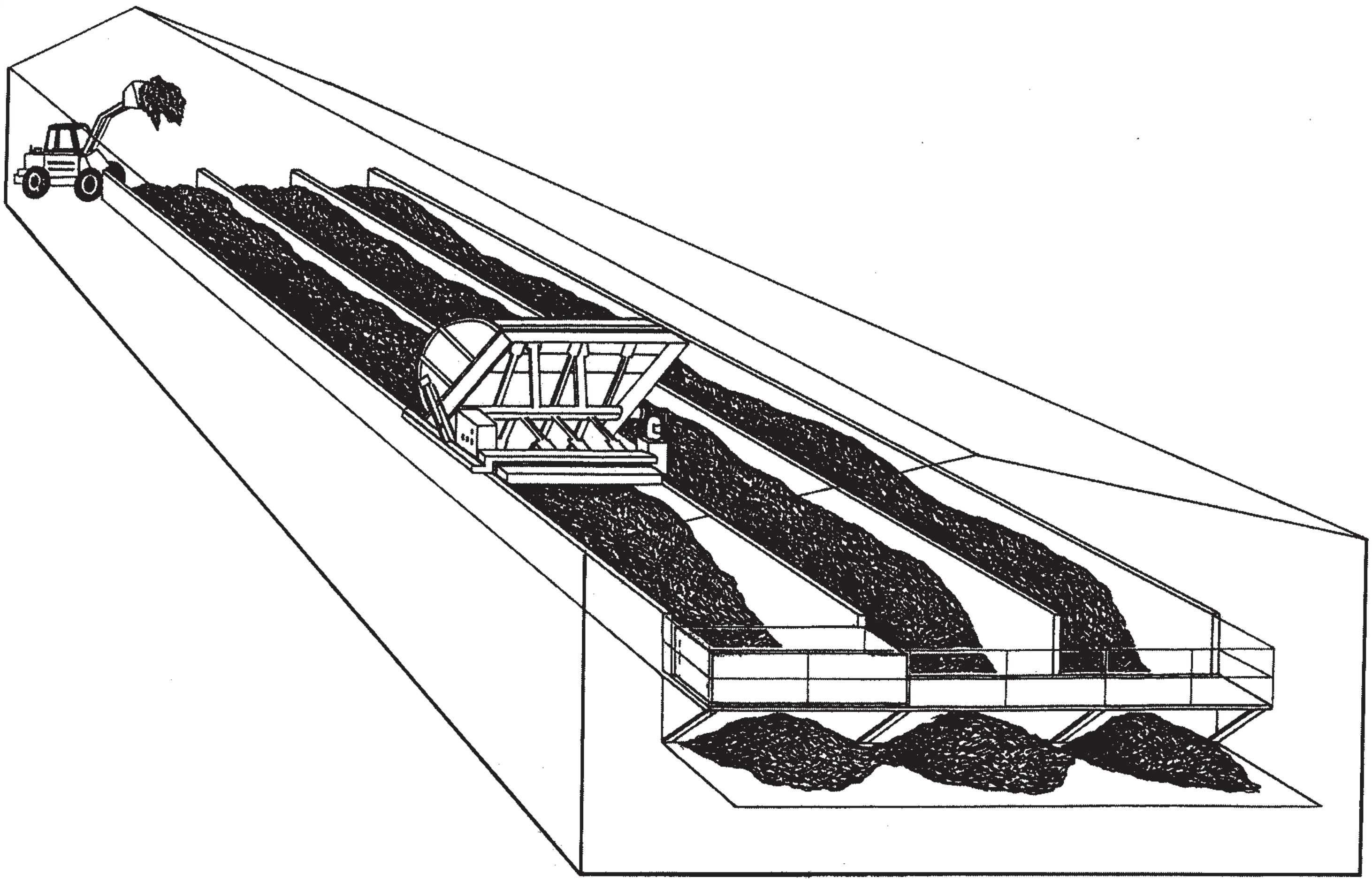
DIMENSIONS:

HEIGHT	11' 7"
LENGTH	21' 8"
WIDTH (work position)	15'
WIDTH (transport)	11' 4"
WEIGHT	18,000
FILL RATE	3 Tons Per Minute

APPENDIX C-2
Equipment Information:
Farmer Automatic Composting System

COMPOST-A-MATIC®

Automated Composting Systems



Farmer Automatic
OF AMERICA, INC.

In-vessel systems for organic waste processing

The Compost Process

Composting is not a new process. It has been occurring naturally for millions of years. The major difference in nature's process and today's technology is control.

Composting involves the microbial conversion of biodegradable organic materials into relatively stable humus by thermophilic organisms under controlled conditions.

Composting is generally conducted under aerobic conditions in which atmospheric oxygen is present. Aerobic decomposition by microorganisms converts biodegradable organic matter into oxidized end products, primarily carbon dioxide and water. Thermophilic temperatures of 130^{o} Fahrenheit to 160^{o} Fahrenheit are commonly achieved, providing pathogen kill and desiccation of weed seeds. Detrimental characteristics associated with the aerobic composting process are usually limited to odors in the initial stages. Aerobic composting generally produces a stabilized product with an inoffensive odor characterized as musty and sweetish.

Recipe for successful Composting

The composting process is well documented. It requires (5) key elements. They are as follows: proper **Nutrient Blend; Moisture; Oxygen; Temperature and pH** control.

(1) Nutrient Blend

The major sources of nutrients for composting are organic materials. However, it is almost impossible to find a single organic material with all the essential characteristics for successful composting. In order to compensate for the deficiencies it is necessary to blend/mix in the appropriate proportions of the other organic materials.

This blend of nutrients is referred to as a **Composting Recipe,** of which involves blending of carbonaceous and nitrogenous material together in order to form a desired **carbon: nitrogen ratio (C: N).** The carbon: nitrogen ratio of each nutrient source will vary from 10:1 to 40:1. The C: N ratio of the nutrient recipe will influence the decomposition rate.

Example:	manure	=	10:1
	broiler litter	=	18:1
	sawdust	=	500:1
	straw	=	80:1

In ratios lower than 15:1, nitrogen is lost, usually as ammonia, which can constitute an odor problem. Ratio's between 30:1 and 50:1 are acceptable, but the composting time will be longer.

Therefore, **the desired C: N ratio between 20:1 and 30:1 should be considered the optimum in formulating a compost recipe.**

(2) Moisture

Moisture is required for microbial activity that causes composting to occur. Moisture content for aerobic thermophilic composting should be between 40 to 60 percent initially. If composting material is too dry (below about 35%), the decomposition rate will be much slower than at 40 to 60% moisture. Supplemental water may need to be added to dry material to initiate composting.

High moisture manure, sludge or other organic material can be dried to below 60% moisture content by blending finished compost or carbonaceous bulking agents such as wood dust or shavings, cotton gin trash, cornstalks, hay, peanut hulls, paper, etc. Bulking agents that are used to absorb the excess moisture in the manure, sludge or other organic materials should be shredded into small particles to speed their decomposition as well as aid in their ability to absorb the excess moisture. The organic material may also be "seeded" with microorganisms from the finished compost to help initiate decomposition at the start of the composting cycle.

(3) Oxygen

Oxygen is a vital key in maintaining the composting process in an aerobic state. <u>Air within or exhausted from the composting material should contain 5 to 15% oxygen</u>.

Therefore, aeration is necessary to support aerobic microbial activity, remove released moisture and remove excess heat.

Aeration is normally provided by two methods. (1) The composting material can initially be turned several times per week, with the turning frequently reduced in subsequent weeks. (2) It may not be possible to supply the necessary oxygen requirement by just turning. Some systems may require supplemental forced air in combination with turning.

(4) Temperature

Temperature is generated in the compost by microorganisms. A good recipe blend that includes the correct moisture and oxygen will start the microorganism's metabolism process. The bacteria associated with this process are known as mesophilic (moderate heat loving) and thermophilic (high heat loving). Mesophilic bacteria work at temperatures less than 100°F. Thermophilic bacteria work within the 110° to 150°F temperature ranges. A good composting temperature range is 130° to 150°F. Composting temperatures of 150°F for manure is desirable to assure destruction of pathogenic bacteria and viral organisms.

(5) pH Control

The pH of the compost may become critical at times. If the compost has a pH of 8 or higher, ammonia/odors can become a problem. pH should be in the 6.5 to 7.2 range initially for the best composting results. In the beginning stages of composting, wet manure or sludge, the pH may drop below 6.0, thereby causing odor emissions. The pH of the finished compost will be in the 5.5 to 8.0 range or greater.

SUMMARY

Compost is produced by the activity of aerobic microorganisms. These microbes need oxygen, moisture and food to develop and multiply. Active microbes generate heat, water vapor and carbon dioxide as they convert raw minerals into a stable soil conditioner.

Organic material such as livestock and poultry manure, food waste, yard waste and sewage sludge can be composted to provide an improved product for soil application or upgraded use such as horticultural planting mixtures. Composting biologically stabilizes organic material, improves material handling characteristics, preserves nutrients, breaks the fly breeding cycle and reduces product odors.

The objective in composting should be to provide a proper nutrient balance and environment for the reproduction of aerobic thermophilic bacteria. Factors such as temperature, moisture content, structure and proper aeration are critical to efficient composting. Operating temperatures of 130 to 150 degrees Fahrenheit are desirable during aerobic compostmg. These temperatures kill fly larvae, pathogens, and weed seeds.

Composting can be carried out in numerous ways but this in-vessel method utilizing pits with mechanical equipment for turning are generally more efficient.

USED FOR THE FINISHED PRODUCT

Composted organic material is rich in plant nourishing nutrients. Some of the uses and potential markets for compost are:

- **Soil Buffer**
- **Soil Builder**
- **Disease Suppression**
- **Garden Centers**
- **Forest Products (seedlings)**
- **Turf-Sports Turf**
- **Roadway Grass Enhancement**
- **Top Soil Manufacture**
- **Reclamation/Restoration**
- **Fertilizer/Soil Conditioner**
- **Sod/Turf Farms**
- **Erosion Control**
- **Golf Courses**
- **Hydro Mulch Spray**
- **Athletic Fields**
- **Parks**
- **Cemeteries**
- **Landscape Soil**
- **Nursery**
- **Cattle Feed**

COMPOST-A-MATIC COMPOSTING SYSTEM

The Compost-A-Matic is an in-vessel system utilizing a shallow pit design to biologically stabilize organic material with/without forced aeration. The action of the agitator mixes, moves and incorporates air/oxygen into the pile.

The Compost-A-Matic system offers you the option of **"CONTINUOUS FLOW"** composting (putting material in the compost pit daily) or **"BATCH COMPOSTING"** (filling the entire pit with material and turning/ aerating the material until composted).

The unique **"CONTINUOUS FLOW"** option is frequently selected as the preferred method due to the simplicity of adding approximately 7 feet of organic material to each composting pit on a daily basis. The input material moves forward approximately 7 feet per run due to the action of the agitator, thereby, discharging approximately 7 feet of finished compost daily and at the same time makes room at the front of the pit for a new daily addition.

The Compost-A-Matic machine is manufactured in 5 different sizes: Model 210M (2M/6.5' wide), Model 3l0M (3M/9.8' wide), Model 410M (4M/13' wide), Model 5l0M (5M/16.4' wide) and Model 610M (6M/20' wide). Capacity for the **continuous flow method**, based on daily input, will be in the 5 cubic yard to 16 cubic yards of material range per day, with an option of operating up to four pits for each Compost-A-Matic composting machine. **Batch composting** capacities and number of pits vary with the size of the Compost-A-Matic composting machine used, the length of the pits and schedule. Normal pit length in continuous flow and batch composting operation is 250 feet.

The pit walls are constructed of 6 inch poured reinforced concrete. Footings should be below the frost line. The floors are poured concrete usually 3 or 4 inches thick. <u>The floor of the pit is poured and leveled after a Compost-A-Matic machine is in place</u>. This assures that the Compost-A-Matic paddle tips will clear the floor.

Hydraulic fluids propel the Compost-A-Matic in a forward and reverse motion while raising and lowering the composting paddles. The equipment uses time proven hydraulic components coordinated in a compact package that requires minimum maintenance while providing maximum performance.

The control panel features a solid-state programmable controller mounted in a NEMA 12 cabinet with IEC rated motor control to assure years of reliable service. A convenient set of manual override controls also enables the operator to move the machine for convenient maintenance.

COMPOSTING POULTRY CAGE MANURE

The Compost-A-Matic "Continuous FLOW" system is frequently selected as the preferred method to compost poultry manure due to the simplicity of adding approximately 7 feet of poultry cage manure to each composting pit on a daily basis. The input material moves forward approximately 7 feet per run due to the action of the agitator, thereby discharging approximately 7 feet of finished compost daily and at the same time makes room at the front of the pit for a new daily addition. The "BATCH" method should be selected for stack piled manure.

Determining Pit Space for Daily Input of Fresh Cage Manure

A - A 4 lb. bird produces approximately .25 lbs. of high moisture wet manure per day
B - 1,000 birds will produce 250 lbs. of manure per day
C - 250 lbs. of manure at 55 lbs. per cult. 4.5 cu.ft. of manure*
D - 4.5 cu.ft. divided by 27 cu.ft. .17 cu.yds. of manure per 1,000 birds per day

see pit space calculation work sheet (page 7)

Determining Pit Space for "Batch Composting" of Cage Manure

The "Batch Composting" method can be utilized for composting cage manure when stack piled or accumulated in the basement of a hi-rise cage layer house. When calculating the capacity, determine the cu.ft. of material for each batch in relation to the pit capacity from the chart on (page 7).

Determining Percent of Moisture in Cage Manure *

(1) Weigh wet manure in a 1 cu.ft. container

(2) 1 cult. wet manure = __________ lbs.

(3) x (multiply) 2.0188 = __________

(4) – (subtract) 34.4265 = __________ percent moisture

EXAMPLE: manure weighs 52 lbs. per cu.ft.
52 x 2.0188 104.98 minus 34.4265 = 70.5% moisture

TO DETERMINE THE AMOUNT OF DRY PRODUCT NEEDED TO REDUCE THE 70.5% MOISTURE TO 60%, REFER TO TABLE 1 (PAGE 8) - THE ANSWER IS 25%

* SEE OTHER METHODS ON (PAGE 9)

COMPOSTING POULTRY LITTER

The Compost-A-Matic **"BATCH SYSTEM"** is the preferred method to compost poultry litter with manure. The term poultry includes all floor type birds such as broilers, pullets, floor layers, turkeys, etc. Some type of bedding or litter material *(pine shavings, rice/peanut hulls, etc.)* is used on the floor of these poultry houses. Cage bird manure is free from litter material and generally has a higher moisture content than manure from floor houses. *Broiler manure with litter averages 20 – 30% moisture.*

A Compost-A-Matic machine will apply the needed amount of water (sprinkler method) to dry material under 40% when required, as it passes over the compost pit. *(Refer to TABLE 5 to determine the gallons needed).*

EXAMPLE: (5) Broiler Houses 40' x 400'

- **Each house – 40'x 400' with litter 6" deep**
- **Compost-A-Matic Model 610M with a trolley transfer on three pits**
- **Each pit is 3.28' deep x 19.68' wide x 250' in length**

FORMULA:

Each house 40' x 400' x .5' = 8,000 cu.ft. of litter. Batch processing – fill each of the pits *(all but first 8' and last 8' of pit)* with litter. Pits each hold 15,105 cu.ft./200 tons. Three pits will hold 45.315 cu.ft./600 tons. It is possible in 3 pits to hold the litter from 5 houses at a time.

Allow 4 days to load the pits. Allow 4 days to empty the pits and allow 26 days composting. 34 days total, per batch operations. One Compost-A-Matic can process manure litter from 53 houses in one years time. This is assuming house cleanup can be staggered throughout the year or the material can be stockpiled and processed when time permits.

COMPOSTING POULTRY LITTER

The Compost-A-Matic system offers you the option of **"CONTINUOUS FLOW"** composting (putting material in the compost pit daily) or **"BATCH COMPOSTING"** (filling the entire pit with material and turning/ aerating the material until composted). Please see the pit space calculation work sheet on page (7) and a Table (4) on page (10) to determine pit space in relation to available material.

Approximate Daily Animal Manure Production

	lbs.	cu.ft.	% Moisture
Beef Cattle	60	1	85%
Dairy Cattle	80	1.3	85%
Swine	7	0.14	85%

High Moisture Manure and Other Organic Waste

The moisture content for aerobic thermophilic composting should be between 40 to 60 percent initially. High moisture manure and other organic waste over 70% can be de-watered through a solids/liquid separation process, via a screw press or other types of separation equipment (see moisture content pages 9 and 10).

COMPOST-A-MATIC PIT SPACE CALCULATION WORK SHEET

Poultry Manure "CONTINUOUS FLOW PROCESSING"

Pit Capacity Requirements
(calculation based on a 4 lb. bird)

(1) ___________ thousand birds
(2) x **.17** ______ cu.yds. wet manure per 1000 birds (see D, page 5)
(3) =___________ total cu.yds. wet manure produced daily @ __________ % moisture
(4) x___________ % *percent of dry bulking product needed (table 3 - page 9)
(5) –___________ cu.yds. of dry bulking product daily
(6) +___________ total cu.yds. of wet manure produced (from (3) above)
(7) =___________ total capacity in cu.yds. needed per day

Recommendations _______ Model _______ w/ _______ pits, ______ ft. long, _______ cu.yd. Daily Input

Poultry Litter "BATCH PROCESSING"

Pit Capacity Requirements
(calculation based on 6" litter depth)

(1) ___________ sq.ft. per house x **.5** litter depth
(2) =___________ cu.ft. of litter per house
(3) x___________ number of houses
(4) =___________ total cu.ft. capacity needed

Recommendations _______ Model _______ w/ _______ pits, ______ ft. long, _______ cu.ft. Capacity Batch

Other Organic Material "CONTINUOUS FLOW/BATCH"

Pit Capacity Requirements

(1) ___________ total cu.yds. organic material produced daily @ __________ % moisture
(2) x___________ % *percent of dry bulking product needed (table 3 - page 9)
(3) =___________ cu.yds. of dry bulking product daily
(4) +___________ total cu.yds. of organic material produced (from (1) above)
(5) =___________ total capacity in cu.yds. needed per day
(6) =___________ total capacity cu.ft. needed monthly for **batch composting**

Recommendations _______ Model _______ w/ _______ pits, ______ ft. long, _______ cu.yd. Daily Input
_______ Model _______ w/ _______ pits, ______ ft. long, _______ cu.ft. Capacity Batch

Table 1

COMPOST-A-MATIC PIT CAPACITY

Model	Pit Width	Pit Length	Pit Depth	**Continuous Flow** Cu.Yds. Space/Day	**Batch** Total Cu.Ft. Space*
210M	77.5”	250’	39.37”	5	5000
310M	116.90”	250’	39.37”	8	7500
410M	156.25”	250’	39.37”	11	10000
510M	195.63”	250’	39.37”	14	12500
610M	235.00”	250’	39.37”	16	15000

*** Adjusted Volume** – fill all but the first 8’ and the last 8’ of pit

Table 2

CALCULATION OF MACHINE RUNNING TIME

Pit Length – “Batch” – any length up to 320 feet
“Daily Input” – 250 ft. 7 ft. daily = 35 days composting
– 320 ft. 7 ft. daily = 45 days composting
Agitate Speed – 18"/1 ½ ft. per minute
Return Speed – 10 ft. per minute (approximately)
Material Progression – 7 ft. per pass

One Model 610M with trolley transfer and controls for 3 pits needs the following time to complete its operation: Stirring time is 1.50’ per minute, with motors on 60Hz.

250’ pits length divided by 1.5’	=	166 minutes
Return fast speed at 10’ per minute	=	25 minutes
Total time per pit	=	191 minutes
Total time per 3 pits	=	573 minutes
Plus time for 2 trolley transfers	=	20 minutes
GRAND TOTAL TIMES	=	593 minutes
Total minutes divided by 60 minutes	=	9 hours, 53 minutes

One pit 250’ long divided by 7 ft. per trip – approximately 35 days to move the material from the receiving end to the discharge end. The 35 day cycle will allow adequate time for composting and drying under average conditions.

MOISTURE CONTROL

To start the composting of manure/sludge, the moisture must be kept below 60%. Some of the manure from poultry and livestock houses may have moisture more than 60%. In this case, the high moisture over the 60% is mixed with a dry hulking product to reduce the moisture to below 60%. We call it **MOISTURE CONTROL.** The following chart shows the Moisture Control Ratio when the **HIGH MOISTURE ORGANIC MATERIAL** is mixed with a **DRY BULKING PRODUCT** (with 20% moisture.)

Table 3

MOISTURE CONTROL RATION CHART

PERCENT OF DRY BULKING PRODUCT NEEDED*

Percnet Moisture in Wet Manure/ Sludge	5%	10%	15%	20%	**25%**	30%	35%	40%	45%	50%	55%	60%	65%
100%	–	–	–	–	–	–	–	–	–	–	–	–	–
95%	–	–	–	–	–	–	–	–	–	–	–	–	–
90%	–	–	–	–	–	–	–	–	–	–	–	–	–
85%	–	–	–	–	–	–	–	–	–	–	–	60	59
80%	–	–	–	–	–	–	–	–	60	59	58	57	56
75%	–	–	–	–	–	–	60	59	57	56	55	54	53
70%	–	–	–	–	**60**	58	57	55	54	53	52	51	50
65%	–	60	59	57	56	54	53	51	52	50	49	48	47
60%	58	56	54	53	52	50	49	48	47	47	46	45	45
55%	53	51	50	49	47	46	45	45	44	43	42	41	41
50%	48	47	46	45	44	43	42	41	41	40	–	–	–
45%	43	42	41	40	40	–	–	–	–	–	–	–	–
40%	–	–	–	–	–	–	–	–	–	–	–	–	–

DESIRED MOISTURE LEVEL

MOISTURE CONTROL EXAMPLE:

To reduce the moisture level of the wet organic material to the desired 40 - 60% moisture level for composting, **we refer to the Moisture Control Ratio Chart. EXAMPLE: I**f your organic material is 70% moisture and you wish to get it to 60% moisture, you need to add 25% dry product by volume.

* dry hulking product with 20% moisture

* The actual percentage of bulking product needed can vary depending on density and climate conditions.

MOISTURE CONTROL

Table 4

APPROXIMATE MANURE VALUME BY MOISTURE AND WEIGHT

Manure Weight	Manure Weight	Manure Volumne	Estimated % of Moisture
1 cu.ft. = 20 lbs.	1 cu.yd. = 540 lbs.	1 Ton = 3.71 cu.yds.	6%
= 25 lbs.	= 675 lbs.	= 2.97 cu.yds.	16%
= 30 lbs.	= 810 lbs.	= 2.47 cu.yds.	26%
= 35 lbs.	= 945 lbs.	= 2.12 cu.yds.	36%
= 40 lbs.	= 1080 lbs.	= 1.86 cu.yds.	46%
= 45 lbs.	= 1215 lbs.	= 1.65 cu.yds.	56%
= 50 lbs.	= 1350 lbs.	= 1.49 cu.yds.	66%
= 55 lbs.	= 1485 lbs.	= 1.35 cu.yds.	76%
= 60 lbs.	= 1620 lbs.	= 1.24 cu.yds.	86%
= 65 lbs.	= 1755 lbs.	= 1.14 cu.yds.	96%

Table 5

APPROXIMATE GALLONS OF WATER NEEDED TO BRING DRY WASTE UP TO 40% MOISTURE

Manure Moisture Level	Gallons of Water Needed
10%	20 gal/cubic yard
20%	16 gal/cubic yard
30%	8 gal/cubic yard
40%	0

The Compost-A-Matic spraying system can apply the needed amount of water, when required, as it passed over the composting pit.

Table 6

DETERMINING MOISTURE LEVEL IN ORGANIC WASTE

Collect 1 lb. of organic waste	state	16 ounces
Place in microwave		
Cook 4 to 6 times	loss	4 ounces
(enough so last time in microwave,		
there are no changes in weight)	net weight	12 ounces

Sample is 25% moisture (4 ounces divided by 16 ounces = .25)

COMPOST-A-MATIC®

Automated Composting Systems

COMPOST-A-MATIC SPECIFICATIONS

Model Number	210M	310M	410M	510M	610M
Pit width	77.50”	116.90”	156.25”	195.63”	235.00”
Pid depth	39.37”	39.37”	39.37”	39.37”	39.37”
Machine width	112.01”	151.38”	190.75”	230.13”	269.50”
Machine height	57”	57”	57”	57”	57”
Machine weight	4410 lb.	5031 lb.	5652 lb.	6273 lb.	6894 lb.
Agitator motor	7.5 HP	10 HP	10 HP	15 HP	7.20 HP
Lift/Propel Motoer	Hydrostatic Above All In One	2 HP	2 HP	2 HP	2 HP
Power required at 480VAC	11.5 FLA	17.4 FLA	17.4 FLA	24.4 FLA	27.0 FLA
Service requirement at 480VAC	30A fused	30A fused	30A fused	40A fused	60A fused
Agitate speed (inches per minute)	18”	18”	18”	18”	18”
Return speed (feet per minute)	10’	10’	10’	10’	10’
Approximate material progression per operation	7’	7’	7’	7’	7’
Cubic yards of space available per day	5 cu.yds.	8 cu.yds.	11 cu.yds.	14 cu.yds.	16 cu.yds.

REMARKS: *The actual yards can vary depending on climate conditions, weather, and manure moisture content.*

All motors T.E.F.C. high efficiency 480 volts, 3 phase.
Approximate power consumption 15 KWH per cycle. *(based on 200’ pit length)*
Farmer Automatic of America research and development policy is one of continuous improvement.
We, therefore, reserve the right to amend specifications without notice.

Farmer Automatic
OF AMERICA, INC.
P.O. Box 39 • Register, GA 30452
912/681-2763 • Fax: 912/681-1096
www.farmerautomatic.com

Distributed by:

Automated Composting Systems

COMPOST-A-MATIC

In-vessel systems for organic waste processing

Compost-A-Matic. The To Turn Waste Into

The Compost-A-Matic from Farmer Automatic of America Inc. provides an alternative method of handling and processing manure and other organic waste into compost for use in lawn, landscape, gardening and plant growing applications, without the risk of chemically burning plants and vegetation.

Waste materials are thoroughly mixed within each pit while the finished compost is moved forward to one end on a daily basis.

How The Compost-A-Matic Process Works.

The Compost-A-Matic process eliminates methane gas and hydrogen sulfide odors while converting manure in a pathogen-free, weed seed-free organic product that will never revert to raw manure.

The end product is a stable organic material which has retained most of its nutrients and is no longer a breeding source for flies, beetles and other insects.

Compost–A–Matic in its raised position shows the structural steel arms with mixing paddles.

The Compost-A-Matic system incorporates fresh air into the waste pile by stirring the mixture while moving the material forward in the pit. The aerobic decomposition by micro-organisms converts the organic material to an oxidized, stable organic product. Aerobic composting generates thermophilic temperatures from 130° to 160° Fahrenheit. As a result, these temperatures provide an effective pathogen kill and desiccate weed seeds.

Compost-A-Matic's end product is more uniform in particle size and consists of a friable texture with a reduction in material volume and weight. Moreover, some ammonia nitrogen is volitized during the composting process.

Simple, Automatic Way Valuable Compost.

Compost-A-Matic Requires Minimum Maintenance, Provides Maximum Performance.

Compost–A–Matic's state–of–the–art control panel simplifies composting operations.

Hydraulic fluids propel the Compost-A-Matic in a forward and reverse motion while raising and lowering the composting paddles. The equipment utilizes time- proven hydraulic components coordinated in a compact package that assures a minimum of maintenance while providing superior performance.

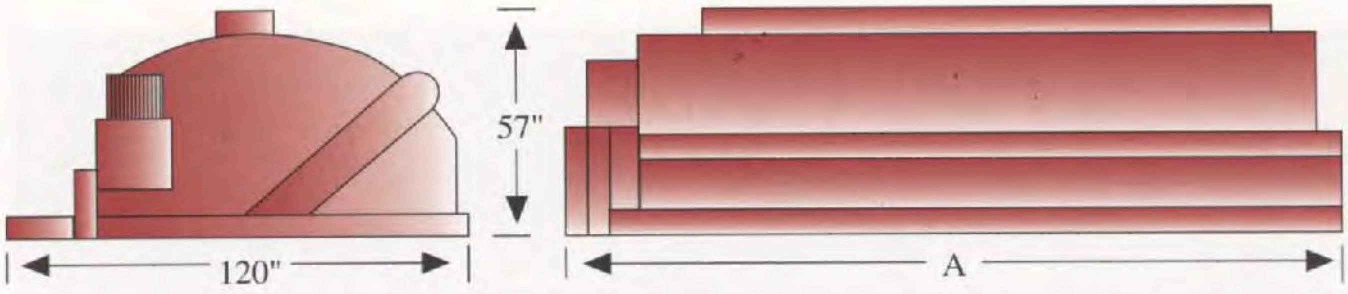
The control panel features a solid state programmable controller mounted in a NEMA 12 cabinet with IEC rated motor controls to assure years of reliable service. A convenient set of manual override controls also enables the operator to move the machine for convenient maintenance.

Compost–A–Matic stirs, mixes and moves all waste material forward.

The pit walls are constructed of 6" poured reinforced concrete. Footings should be below the frost-line. The floors are poured concrete, usually 3 or 4 inches thick. The floor of the pit is poured and leveled after the Compost-A-Matic is in place.

This enables the Compost-A-Matic's paddle tips to clear the floor. The pit and the equipment are protected from the outside environment with a frame or house construction covered with plastic or regular roofing.

The transfer trolley enables one in-vessel machine to service multiple pits.



COMPOST-A-MATIC SPECIFICATIONS

Model Number	210M	310M	410M	510M	610M
Cubic yards of space available per day	6 cu. yds.	9 cu. yds.	12 cu. yds.	15 cu. yds.	18 cu. yds.
Pit width	77.50"	116.90"	156.25"	195.63"	235.00"
Pit depth	39.37"	39.37"	39.37"	39.37"	39.37"
Machine width (A)	112.01"	151.38"	190.75"	230.13"	269.50"
Machine height	57"	57"	57"	57"	57"
Machine weight	4410lb.	5031lb.	5652lb.	6273lb.	6894lb.
Agitator motor	7.5 HP Hydrostatic	10HP	10HP	15HP	15HP
Lift/Propel Motor	Above all in one	2HP	2HP	2HP	2HP
Power required @ 480 V	11.5FLA	17.4FLA	17.4FLA	24.4FLA	24.4FLA
Service requirement @ 480 V	30A fused	30A fused	30A fused	40A fused	40A fused
Agitate speed (inches per minute)	18"	18"	18"	18"	18"
Return speed (feet per minute)	10'	10'	10'	10'	10'
Approximate material progression per operation	7'	7'	7'	7'	7'

NOTE: The actual yards can vary by +-15% depending on climactic conditions, weather, material moisture content. ● All motors T.E.F.C. high efficiency 480 volts 3 phase. ● Approximate power consumption 15 Kw per cycle. (Based on 200' pit length). ● Machine height, 57"; becomes 87" in the raised position.
Farmer Automatic of America research and development policy is one of continuous improvement. We, therefore, reserve the right to amend specifications without notice.

COMPOST-A-MATIC FEATURES AND BENEFITS

- Rugged Steel Construction
- Special Epoxy Bonded to Steel
- Quiet Running - Minimum Maintenance
- Eliminates Foul Odors
- Breaks Fly Breeding Cycle
- Cost Efficient Composting
- Automated Processing
- In-Vessel, Agitated Bed Design
- Automatic Moisture Application
- Proven Performance - Installations Throughout The World
- Engineered And Manufactured In The USA

Farmer Automatic
OF AMERICA, INC.
P.O. Box 39, Register, GA 30452
(912) 681-2763 FAX: (912) 681-1096

APPENDIX C-3
Equipment Information:
Gore Cover System

GORE cover
GORE™ COVER SYSTEM
NORTH AMERICA

THE PRINCIPLES OF COMPOSTING WITH THE GORE™ COVER SYSTEM

The GORE™ Cover System consists essentially of three components: aeration, control and the specially designed GORE™ Cover membrane laminate. Brought together in a perfect balance, the three components interact to produce a unique, economical and reliable composting system.

In order to provide oxygen – the essential basic requirement for aerobic microorganisms – medium pressure blowers are connected to in-floor aeration trenches under the windrow. The blowers supply air to the windrow and are controlled by means of data obtained from an oxygen sensor placed under the GORE™ Cover. A second sensor, also placed under the GORE™ Cover, collects temperature data required to document pile temperatures for regulatory purposes. Data from the oxygen and temperature sensors is fed into a computer, which controls the process accordingly.

Feedstocks that will be composted in the GORE™ Cover System are prepared as they would be to enter any other composting system. This includes setting the feedstock's initial moisture content, carbon-to-nitrogen ratio, particle size, porosity and pH. The prepared feedstock is then delivered to the desired windrow position and placed over the aeration trenches with a front-end loader.

After windrow formation is completed, the GORE™ Cover is pulled over the windrow automatically and secured to the ground.

To complete the preparation process, oxygen and temperature sensors are inserted through special sealable openings in the GORE™ Cover, and the system is turned over to automatic computer control.

For the next four weeks while the windrow undergoes high-rate composting, no additional handling of the material is necessary. The composting process continues naturally under the cover. Spent process air passing through the cover is free of conspicuous odors and microorganisms.

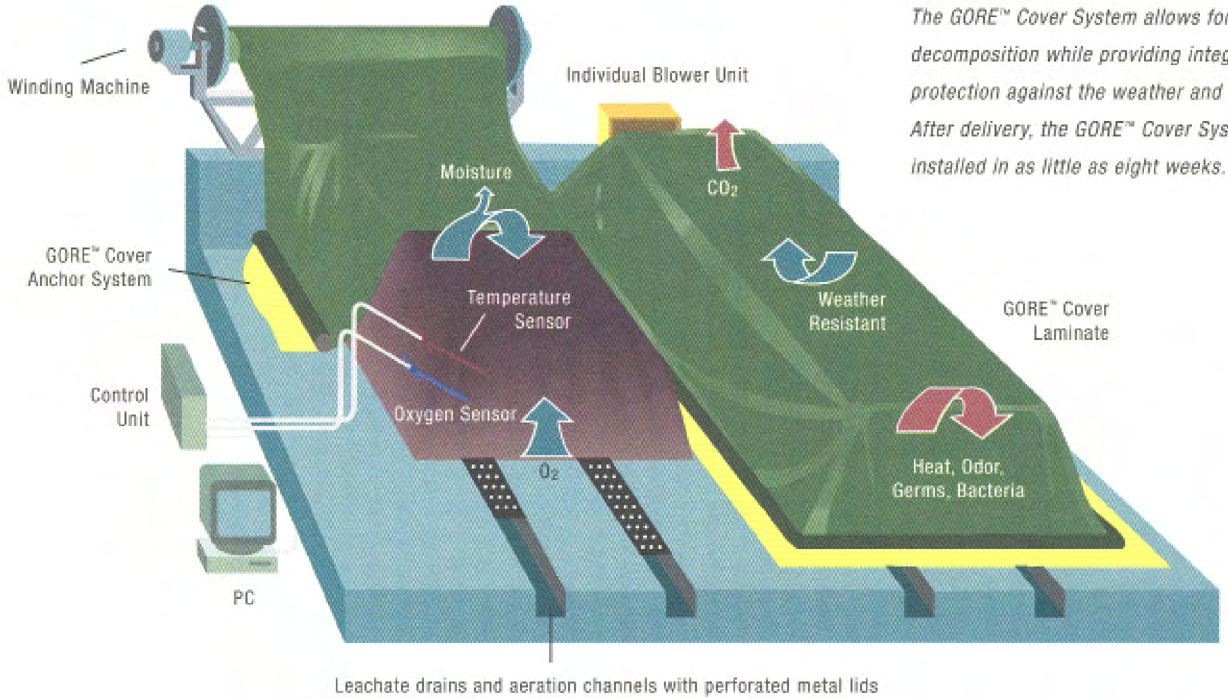
During the four weeks of composting, the microorganisms digest and alter the odor-causing compounds to a level where the cover can be removed without causing an odor problem.

At this stage, the sensors are removed from the cover, the system securing the cover to the ground is removed, and the cover is removed automatically. The windrow is then moved to a new position where it is rebuilt to restore the pile's porosity and to remix and further homogenize the material. Additional makeup water is added to the windrow as necessary while moving from one position to the next.

After rebuilding the windrow at its new location, the GORE™ Cover once again is pulled into position and secured to the ground. The sensors are replaced and the windrow is returned to computer control for an additional two weeks of maturation and odor management.

Finally, after the sixth week of composting, the sensors and cover are removed and the windrow is allowed to further stabilize with automatic or timed aeration for an additional two weeks prior to product screening.

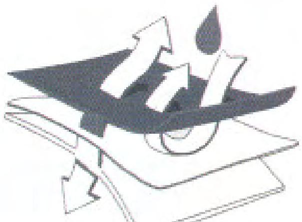
DIAGRAM OF THE GORE™ COVER SYSTEM TECHNOLOGY



The GORE™ Cover System allows for rapid organic decomposition while providing integrated protection against the weather and emissions. After delivery, the GORE™ Cover System can be installed in as little as eight weeks.

SEC TECHNOLOGIES, INC., YOUR EXCLUSIVE NORTH AMERICAN SALES REPRESENTATIVE OF THE **GORE™** COVER SYSTEM
774 D MEADOWLARK RD., LYNDEN, WA 98264 USA PH: 360.354.2250 FAX: 360.354.2251 WWW.GORECOVER.COM

GORE™ COVER SPECIFICS



The GORE™ Cover System is built around a specially developed membrane laminate. GORE™ Cover is made by W.L. Gore & Associates, GmbH, the German branch of W.L. Gore & Associates Inc., makers of world-renowned products such as GORE-TEX® and Wind Stopper.

GORE™ Cover consists of a GORE-TEX® membrane, developed specifically for the composting process, that is laminated between two highly robust layers of polyester. The membrane itself has a specific pore size designed to benefit the composting process. GORE™ Cover not only protects the composting material from the elements, it also allows spent process air to escape the pile at the same time.

The GORE™ Cover also serves to manage odors by providing a physical barrier that prevents gaseous compounds from leaving the windrow. In addition, a thin film of condensation forms on the inner surface of the cover during composting that captures other odor compounds and gaseous substances. These gases and odor compounds are partly dissolved in the condensed water film, which drops back into the composting material where the compounds are broken down by microorganisms.

The pore size of the membrane in the GORE™ Cover can be controlled to regulate the amount of water vapor that is allowed to leave the windrow.

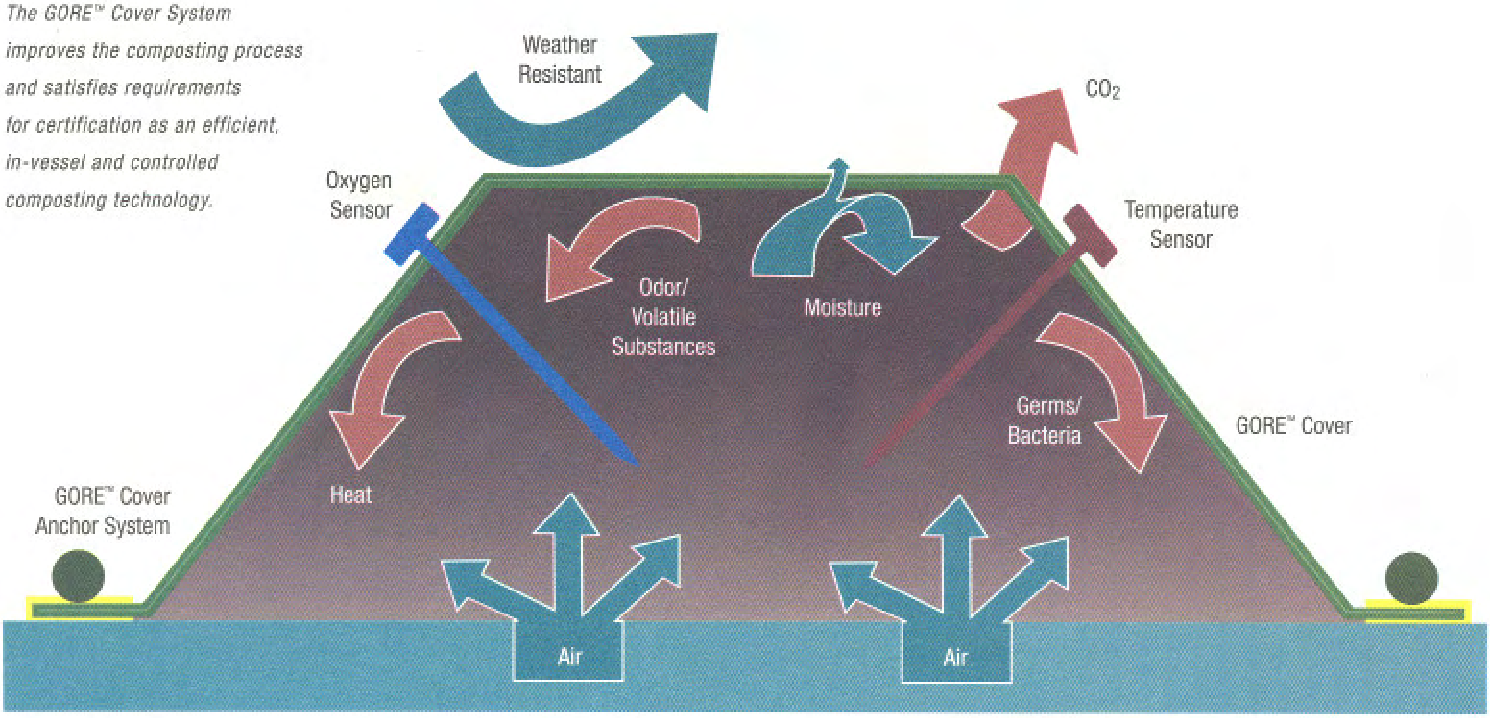
In arid climates, a smaller pore size is selected to conserve the moisture content of the composting material. This engineered pore size also is beneficial for another reason – the containment of microbes.

Numerous microbiological tests have shown that GORE™ Cover contains more than 99% of microbes in the composting system. This ensures that site workers and the surrounding community are protected from bioaerosol emissions.

GORE™ Cover also provides an insulating layer to the pile and an increased air pressure during aeration. This provides more uniform conditions in the system, which ensures even temperature distribution necessary to achieve Pathogen Reduction (PFRP) standards across the entire windrow, even during the winter months.

GORE™ COVER SYSTEM PRINCIPLES OF OPERATION – CROSS SECTION

The GORE™ Cover System improves the composting process and satisfies requirements for certification as an efficient, in-vessel and controlled composting technology.



APPENDIX C-4
Equipment Information: Mixer

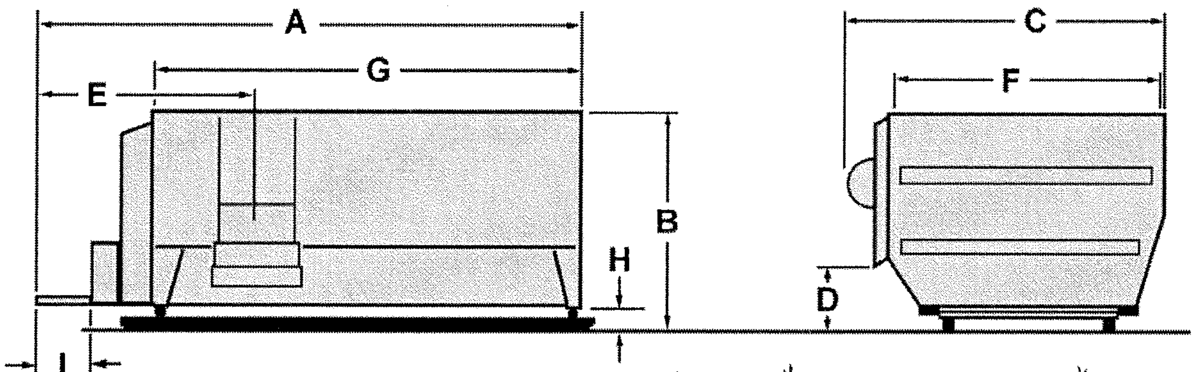
3100

Reel Auggie and Commercial Reel

Stationary TMR Mixers

KUHN KNIGHT

147 – 950 Cubic Feet



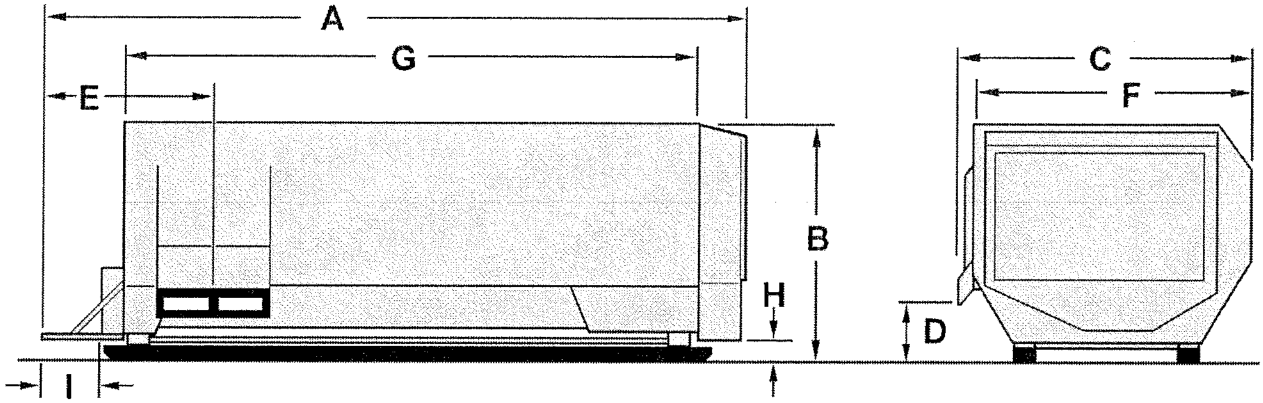
$14,500* (above 3125) $19,500* (above 3136)

MODEL - STATIONARY	3115	3120	3125	3130	3136	3142
DIMENSIONS (INCHES)						
A - Overall Length - with motor mount	113	159	160	184	181	205
B - Overall Height - with rails and scales	64	64	69	69	83	83
C - Overall Width - with magnet tray	87	95	97	97	105	105
D - Height of Discharge - with rails and scales	16 1/2	18	19	19	28	28
E - Motor Mount to Center of Discharge Door	50	65	66	66	60	60
F - Overall Width Top Opening	71	78	81 1/2	81 1/2	87	87
G - Overall Length Top Opening	82	120	120	144	132	156
H - Height Reduction - less rails and scales	7	7	6 1/2	6 1/2	10	10
I - Length Reduction - less motor mount	12	18	23	23	30	30
SPECIFICATIONS						
Unit Weight [1] - pounds	2850	4809	6489	7021	8480	8762
Mixing Capacity - cubic foot/bushels	147 / 118	216 / 174	250 / 200	300 / 240	360 / 288	420 / 340
Reel Diameter	52"	52"	60"	60"	68"	68"
Reel Drive Shaft Diameter	3"	3 1/2"	3 1/2"	3 1/2"	4"	4"
Reel Arms	4"	4	4	4	5	5
Reel Hopper Thickness	3/16"	3/16"	5/16"	5/16"	5/16"	5/16"
Reel Speed RPM	4.37	4.89	4.60	4.60	4.0	4.0
Lower Auger						
Flighting Diameter	16"	16"	18"	18"	20"	20"
Flighting Thickness - Sectional	3/8"	3/8"	3/8"	3/8"	1/2"	1/2"
Tube-Outside Diameter	4"	4"	5 9/16"	5 9/16"	5 9/16"	5 9/16"
Drive Shaft Diameter	2"	2 1/2"	2 1/2"	2 1/2"	3"	3"
Upper Auger						
Flighting Diameter	14"	14"	18"	18"	20"	20"
Flighting Thickness - Sectional or Helicoid	3/8" - H	3/8" - H	3/8" - H	3/8" - H	1/4" - S	1/4" - S
Tube-Outside Diameter	4"	4"	5 9/16"	5 9/16"	5 9/16"	5 9/16"
Drive Shaft Diameter	2"	2"	2 1/2"	2 1/2"	3"	3"
Auger Hopper Thickness	1/4"	1/4"	5/16"	5/16"	5/16"	5/16"
Side Sheets Thickness	10 ga.	10 ga.	10 ga.	10 ga.	10 ga.	10 ga.
End Sheets Thickness	10 ga.	10 ga.	3/16"	3/16"	3/16"	3/16"
Door Opening Size	20" x 16"	36" x 20"	36" x 20"	36" x 20"	36" x 20"	36" x 20"
Oil Bath	Front	Front	Front	Front	Rear	Rear
Roller Chain Drive	60-80-100	60H-80-100H	60H-80H-100H	60H-80H-100H	80-100-120	80-100-120
Electric Drive (HP) [2]	7 1/2-10	10	10	10-15	15-20	15-25

[1] Unit is equipped with most common options. [2] Horsepower requirements vary greatly with different materials. Consult operator's manual for proper motor sizing.

* Price without motor and does not include shipping ($2,000). Available used $4–$10,000.

WORLD-WIDE LEADER IN TMR MIXERS



MODEL - STATIONARY	3150	3160	3170	3195
DIMENSIONS (INCHES)				
A - Overall Length - with motor mount[1]	224	254	284	307
B - Overall Height - with rails and scales	84	84	84	95
C - Overall Width - with magnet tray	114	114	114	125
D - Height of Discharge - with rails and scales	26	26	26	23
E - Motor Mount to Center of Discharge Door	70	70	70	NA
F - Overall Width Top Opening	93	93	93	108
G - Overall Length Top Opening	168	198	228	216
H - Height Reduction - less rails and scales	$5^1/_2$	$5^1/_2$	$5^1/_2$	NA
I - Length Reduction - less motor mount	36	36	36	NA
SPECIFICATIONS				
Unit Weight [2] - pounds	11,788	13,599	17,295	20,500
Mixing Capacity - cubic foot/bushels	500 / 415	600 / 490	700 / 562	950 / 763
Reel Diameter	70	70	70	84
Reel Drive Shaft Diameter	5"	5"	5"	8" tube
Reel Arms	5	5	5	5
Reel Hopper Thickness	$^3/_8$"	$^3/_8$"	$^3/_8$"	$^3/_8$"
Reel Speed RPM	5.7	5.7	5.7	5.2
Lower Auger				
Flighting Diameter	24	24	24	28
Flighting Thickness [3] - Sectional	$^5/_8$"	$^5/_8$"	$^5/_8$"	$^5/_8$"
Tube-Outside Diameter	$6^5/_8$"	$6^5/_8$"	$8^5/_8$"	$8^5/_8$"
Drive Shaft Diameter	$3^1/_2$"	$3^1/_2$"	$3^1/_2$"	5"
Upper Auger				
Flighting Diameter	22	22	24	28
Flighting Thickness - Sectional	$^1/_2$"	$^1/_2$"	$^1/_2$"	$^1/_2$"
Tube-Outside Diameter	$6^5/_8$"	$6^5/_8$"	$8^5/_8$"	$8^5/_8$"
Drive Shaft Diameter	$3^1/_2$"	$3^1/_2$"	$3^1/_2$"	4"
Auger Hopper Thickness	$^3/_8$"	$^3/_8$"	$^3/_8$"	$^3/_8$"
Side Sheets Thickness	$^3/_{16}$"	$^3/_{16}$"	$^3/_{16}$"	$^1/_4$"
End Sheets Thickness	$^1/_4$"	$^1/_4$"	$^1/_4$"	$^1/_4$"
Door Opening Size	42" x 22"	42" x 22"	42" x 22"	48" x 26"
Roller Chain Drive	80-100-120-140	80-100-120-140	80-100-120-140	80-120-140-Double 140
Electric Drive (HP)[4]	50	60	70	100

[1] 3195 motor mounts on the floor and dimension includes motor, 18 in. driveline and gearbox.
[2] Unit is equipped with most common options.
[3] $^3/_4$" flighting at convergence is standard.
[4] HP requirement may vary with different materials. Consult operator's manual for proper motor sizing.

We reserve the right to change any equipment specifications, design, or materials without notice. These mixers are designed for mixing dairy and feedlot rations up to 30 lbs. per cubic foot. Contact factory for non-agricultural use or heavier materials.
US and foreign patents filed.

SAFETY FIRST

Always read and understand the Operator's Manual and all Safety Decals before using the equipment.

Visit your dealer or our Web site at www.kuhnknight.com for information on all Kuhn Knight products.

YOUR KUHN KNIGHT DEALER

Kuhn Knight, Inc.
Corporate Headquarters – 1501 West Seventh Avenue
Brodhead, WI 53520 – Phone: (608) 897-2131 – Fax: (608) 897-2561
www.kuhnknight.com – info@kuhnknight.com

KUHN KNIGHT

<u>APPENDIX C-5</u>
Equipment Information: Screen

PRIMUS

Mobile trommel screening machine

KOMPTECH®
FARWICK®

Technology for a better environment

This machine has outstan
ratio in i

PRI
mobile trommel sc

Compost

Bark mulch

Old wood

MSW (municipal solide wate)

nding price/performance its class

MUS

creening machine

Best in its class
through superior technology

The PRIMUS is an appropriate name for this model. The combination of high screening performance and economy makes it the best in its class. The powerful screen drive and reliable screen cleaning system deserves the mark of excellence.

The PRIMUS proves its versatile talent when supplied with a Core trommel (Version B) with interchangeable screening segments. Simply change the segments - and the PRIMUS is ready for screening either fine compost, bark mulch or brick rubble.

Screening trommel
(Version A)

With a diameter of 1.45 m and a length of 4 m the one piece screening trommel of the PRIMUS has an effective screening area of 16 m2. The screening trommels are available with perforations from 8 - 80 mm (square or round).

A robust hydraulic motor, transmitting the drive power by means of a strong roller chain, drives the trommel.

For changing the standard trommel, the large lateral door is folded down and the trommel lifted from the machine with a front-end loader or similar lifting equipment.

Core trommel[1)]
(Version B)

Especially when used in several operations, the use of interchangeable screening segments made of high wear-resistant spring steel is advantageous, since different mesh sizes can be carried along with the screening machine. The segments are available in mesh sizes 3 x 9 mm to 80 x 80 mm and mounted onto the Core trommel via sprung steel cables.

For changing the segments, fold open the sidewall to obtain free access to the segments on the trommel. The clamping device is unlocked, the screen segment changed and clamped in position again. The segment change for the entire screening trommel takes only about 30 - 40 minutes and can be performed by one person.

* Optinal configuration

- **Square or round holes over a length of 4 m for optimum screening results**

- **Reliable positive power transmission of the trommel drive by way of a roller chain is important especially with heavy material**
- **Low wear due to large drive sprocke contact**

- **The screening trommel is supported by heavy-duty load support wheels**
- **Whether standard screening trommel or core trommel with screening segments - the screening performance of the PRIMUS is always highly efficient and of a high standard**
- **With interchangeable screening segments, no second or third screening trommel needs to be transported when used in different operations**
- **Segment change simple and easy, possible by one person**

➜ The use of a screening trommel with the dirt deflection bars* and the round perforation is unique for screening MSW-material

➜ 3 m² filling capacity for continuous operation

➜ No overfilling of the screening trommel possible - hopper belt conveyor is automatically switched off during overloading

➜ Optimum adaptation to individual operating situations through variable speed control of hopper belt conveyor and screening trommel*

➜ The discharge belt conveyors can be quickly changed from transport to working position

* Optinal configuration

Decisive features

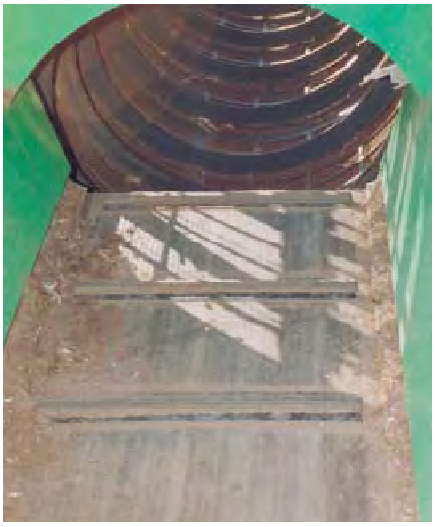
The PRIMUS possesses the equipment required for professional operation even in the standard version. Based on this, the screening machine can be exactly matched to the desired application by means of additional equipment.

Hopper

No bridge formation through steep hopper sidewalls.

The sturdy hopper discharge belt conveyor is of cassette design and fitted with transverse cleats with a mechanical trakking alignment. The support rollers of the conveyor belt are equipped with buffer rings to prevent aggressive objects damaging the belt.

Hopper conveyor feed and trommel speed* can be variably adjusted. The hopper belt conveyor is switched off automatically if the screen trommel is overloaded.



Discharge belt conveyors

The discharge belt conveyors can be pivoted from transport to working position with a manual winch.

Conveyor speed is variably adjustable*.

The oversize conveyor is equipped with bolt-on T-cleats and can be lowered down to horizontal position.

Magnet rollers for both discharge belt conveyors and an extension for the fines conveyor are available options.

Chassis

The PRIMUS is designed as an 80 km/h central axle trailer including ABS. The technical equipment corresponds to the StVZO (regulations governing the registrations of vehicles on the road). The manually operated front support allows disconnection from the towing machine and safe parking.

In addition to this, the front supports can also be used to easily adjust the inclination of the screening trommel.

Drive unit

A water-cooled four-cylinder Perkins diesel engine with 34 kW ensures reliable drive even in difficult and dusty operating conditions.

Coarse material separator*

A heavy hydraulic folding-type grid can be mounted over the loading hopper as a coarse material separator (optional Equipment).

Dirt deflection bars*

The screening trommel with dirt deflection bars is designed for use in the screening of MSW-material.

The dirt deflection bars are metal webs attached to the edge of the screen perforation, which effectively prevent clogging of the screening area, in this way guaranteeing continuously high screening performance.

KOMPTECH-FARWICK sets its trust in quality

Quality is essential today. However, our objective at KOMPTECH-FARWICK is to continuously work on improving the quality level. We extend the term of quality not only to the quality of the machine but also to the interaction with our customers. We aim at setting standards with our advice for the correct machine, operator training and perfect service with spare part security.

Quality and production

High-quality machines are produced in our production facility under the cleanest working conditions. In the highly modern painting plant, all frame and body components pass through a careful pre-treatment and painting process.

Maintenance

The lateral doors of the PRIMUS can be easily folded open manually to provide free access to the units and conveyor installations.

All belt conveyors are of the cassette design. Maintenance and repair operations on the conveyors can therefore be performed easily and quickly.

The use of a central lubrication system* reduces daily maintenance activities to a minimum.

Service

Buyers of quality machines are entitled to expect perfect service for it has to be ensured that a competent service technician is available in emergencies in the shortest space of time.

Safety

Safety to KOMPTECH-FARWICK is more than a key word. An extensive and clearly designed and easily legible operating manual provides the customer with all information required for the safe operation of the machines.

* Optinal configuration

➔ Quality assurance from design, to production and delivery is a matter of course at KOMPTECH-FARWICK

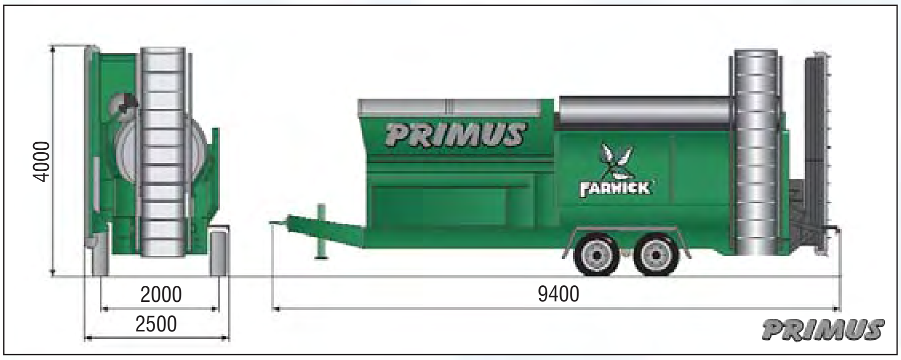
➔ Simple maintenance - fold-up side panels and all conveyor facilities are freely accessible

➔ An experienced service team is available within a short space of time

➔ Necessary spare parts can be easily ordered by fax or e-mail. The customer will then be supplied via express service from the central spare parts store.

➔ "With the CE declaration of conformity we guarantee that our machines comply with the stringent EU machine guideline."

Technical data



Machine dimensions:	Standard machine
Transport position	
Overall length	9.400 mm
Overall height	4.000 mm
Overall width	2.500 mm
Working position	
Overall length	11.660 mm
Overall height	2.975 mm
Overall width	4.780 mm
Filling hopper:	
Capacity	3 m^3
Filling height	2.640 mm
Filling width	2.900 mm
Filling depth	1.340 mm
Width of conveyor	1.000 mm
Screening trommel:	
Length	4.000 mm
Diameter	1.450 mm
Screening area	16 m^2
Material thickness	6/8/10 mm
Hole sizes	3-80 mm
Cleaning brush diameter	500 mm

Discharge conveyors:	
Conveyor length (fines and oversize)	3.400 mm
Conveyor width	700 mm
Discharge height (oversize)	2.300 mm
Discharge heights (fines)	2.080 mm
Drive unit:	
Perkins industrial diesel engine	
Power	34 kW
Cylinders	4 Stk.
Tank volume	80 l
Permissible gross weight	8.000 kg
Standard paint work	green RAL 6029

Optional equipment:

Tailings conveyor extension, coarse material grid separator, magnet roller, hydraulic connection at the rear, central lubrication system or central lubrication bars, slip-on shoe for the pulling eye for repositioning the machine, special paint finish, etc.

A-8130 Frohnleiten, Kühau 37
Tel.: (++43) 3126 / 505 - 0
Fax: (++43) 3126 / 505 - 505
E-mail: info@komptech.com

KOMPTECH® FARWICK®
Machines for a better environment

D-59302 Oelde, Beckumer Strasse 51
Tel.:(++49)2522/93 45 - 0
Fax:(++49)2522/93 45 - 45
E-mail: info@farwick.de

www.komptech-farwick.com

E02/01

4/7/04

Norton ENVIRONMENTAL EQUIPMENT

Exclusive N. American Distributor For:
KOMPTECH FARWICK
Technology for a better environment

Mobile, Diesel powered unit:
$180,000

Farwick PRIMUS Trommel Screen Specifications

SPECIFICATIONS

Transport Position			
	Total length	30.8 ft.	
	Total height	13 ft.	
	Total width	8.2 ft.	
Working Position			
	Total length	38 ft.	
	Total height	9.70 ft.	
	Total width	15.7 - 19.3 ft.	
Input Hopper			
	Capacity	4 yd^3	
	Input height	8.6 ft.	
	Input width	9.5 ft.	
	Input depth	4.30 ft.	
	Belt width	39 in.	
	Mesh size for coarse grid	9" x 17"	
Screening Drum			
	Length	13 ft.	
	Diameter	5 ft.	
	Drum surface	196 ft^2	
	Screening surface	172 ft^2	
	Material thickness	1/4" - 3/4"	
	Mesh size	1/4" - 3"	
	Diameter cleaning brush	20"	
Discharge Belts		*Fines*	*Overs*
	Transport length	11 ft.	11 ft.
	Transport width	2.3 ft.	2.3 ft.
	Discharge height:	6.8 - 9.0 ft.	7.5 ft.
Engine			
Perkins	kins industrial diesel motor		
	er	45 HP	
	Cylinder	4	
	Tank volume	21 Gallons	
Total Weight		20,944 lbs.	
Standard color		Green RAL 6029	
Trailer		Trailer is single axle-central-trailer up to 50 mph with ABS.	

4/7/04

Norton ENVIRONMENTAL EQUIPMENT

Exclusive N. American Distributor For:

KOMPTECH FARWICK

Technology for a better environment

MODEL SPECIFICATIONS

Changeable Drum Farwick PRIMUS Trommel Screen

Price Without screening drum

Changeable Drums for Farwick PRIMUS Trommel Screen

Perforation Square x Wall Thickness

3/8" x 1/4"

1/2" x 1/4"

3/4" x 1/4"

1" - 3" x 1/4"

Additional price for screening drum with wall thickness 3/8 in.

Additional price for screening drum with wall thickness 1/2 in.

Other perforations on request

OPTIONAL EQUIPMENT AVAILABLE

Special Color
Standard color is Green, all PMS colors available

Remote Control
Controls various functions via 7 channel remote control

Variable Speed Belt
Variable belt speed, either for oversized or fine

4/7/04

Norton
ENVIRONMENTAL EQUIPMENT

Exclusive N. American Distributor For:

KOMPTECH FARWICK

Technology for a better environment

Belt extension

Laterally for fine fraction

Discharge length	15 ft.
Dropping height	10.5 ft.

Magnetic head pulley (per belt)

Permanent magnet on either discharge belt with chute

Grizzley

Rock grizzley on top of input hopper, operation via remote control

Attachment for Loader

Drawbar to move the machines with the wheel loader

Central lubrication rails

Greasing lines run to a manual central greasing points

Brush Scrapers

Scraper for the round brush

Additional Oil Cooler

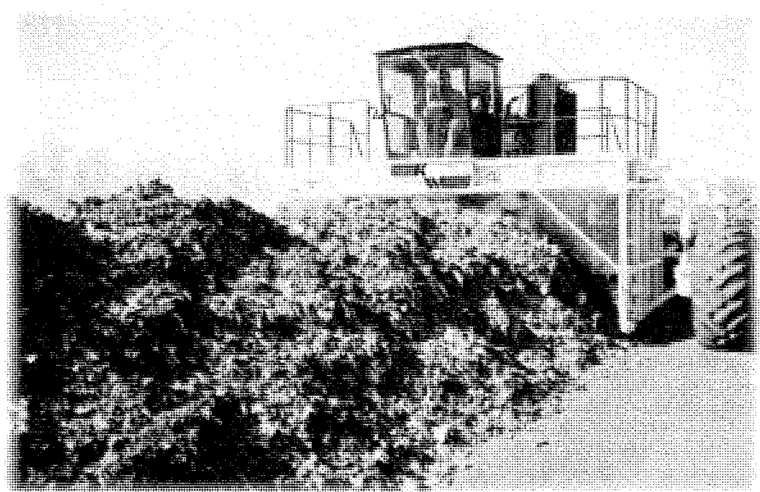
Oil cooler for high temperature climates

APPENDIX C-6
Equipment Information:
Windrow Turner

COMPOST EQUIPMENT

"King of the Windrow"

COMPOST TURNERS



KW windrow compost turners are utilized in many types of operations including, but not limited to, MS Solid Waste), animal and poultry manures, agricultural residues, sewage sludge (biosolids) and leaves a Agricultural wastes including bedding, slaughter house waste, sugar cane, cotton and rice wastes.

Resource Recovery has sold compost turning machines since 1977 and KW since 1981. Turners are fou States and elsewhere in the world.

Although six standard models are manufactured many are modified in various ways to fit a customer's s Options are listed elsewhere in our website.

A major investment may be made in the hydraulic drum drive and the cost increases as engine horsepow However, an alternative with many advantages is the belt driven (clutch engaged) drum which is very o private owners and by those in foreign countries.

Capacity of the turner is primarily determined by the horsepower of the engine and not tunnel size. One economical and valued options is to raise engine horsepower.

For additional information and specifications on **KW** compost turners e-mail us at *rrskw@kci.net*.

Specifications of KW Compost Turners

King of the Windrows (KW) self-propelled windrow straddler type turners have been manufactured sinc KW model types range in standard tunnel sizes from 5 feet by 10 feet to 8 feet by 20 feet with engines f KW turners are often customized to meet the needs of individual customers having unique conditions.

Model	Tunnel Size	Engine H.P.	Capacity (Tons/Hour)	
KW 408	4' x 8'	100	400	
KW 510	5' x 10'	230	1000	
KW 512	5' x 12'	230	1000	New $185,000
KW 614	6' x 14'	300	2000	Used $70-$100,000
KW 616	6' x 16'	400	2500	
KW 718	7' x 18'	440	3000	
KW 818	8' x 18'	550	3500	

KW Options/Modifications/Special Designs include

- Hydraulic or belt driven (clutch engaged)
- Various tire sizes - front and rear
- Rear wheel drive
- Fire suppression system
- Automatic reversible radiator fan
- Vandal protection system
- Various tunnel sizes
- Full tracks
- Spray systems
- Various engines - model and h.p.
- Easily transport options

Used Turners For Sale

KW windrow straddler compost machines can be leased for use in research and full scale projects.

2000 KW 718

- CAT 3406 (460 h.p.) engine, rebuilt with zero hours. One year warranty.
- Tunnel is 7 ft. x 18 ft. with all new lining, front and rear flaps.

· Hydraulically driven drum, variable speed drum

· Completely refurbished with new hydraulic pumps and hoses

· New McLaughlin Body Co. (John Deere) cab.

· New paint

· 28L x 26 front tires, 16.5L x 16.1 rear tires

· KW new style drum with 550 hours. Drum motors are original.

Note: This turner was set on fire (an act of sabotage), and had 550 hours on it at that time. We have completely refurbished it.

1990 KW 616

· CAT 3306 engine (300 h.p.) rebuilt in 2004, 300 hours

· Tunnel is 6 ft. x 16 ft.

· Belt driven drum, clutch engaged drum

· 23.1 x 26 front tires, 16.5 x 16.1 rear tires

· Equipped with dual water tanks

1997 KW 614 LP (Low Profile)

· Less than 2000 hours on CAT 3306 (300 h.p.) engine

· KW new style drum

· 18.4 x 26 front tires, 16.5 x 16.1 rear tires

· New drum drive belts

1991 KW 61

· CAT 3306 (300 h.p) engine with 900 hours, refurbished

· Belt driven, clutch engaged drum

· 28L x 26 front tires, 16.5 x 16.1 rear tires

· This turner caught on fire. New components include cab, radiator, hydraulic pumps and hoses, etc.

1991 KW 614

· CAT 3306 (300 h.p.) engine w/ 100 hours on rebuilt engine

· Rebuilt clutch, hydraulic pumps and motors, and wheel hubs.

· Belt driven drum

· 28L x 26 front tires, 16.5 x 16.1 rear tires

· Excellent condition

1990 KW 614 (90/98) · CAT 3306 (300 h.p.) engine new in 1988, presently with 800 hours

· Belt driven, clutch engaged drum

· 28L x 26 front tires, 16.5 x 16.1 rear tires

· Completely refurbished.

This machine was stripped of engine, hydraulic components and other parts because of a bankruptcy proceeding.

Only original 1990 parts were frame, cab, radiator, drum and wheels when we purchased it.

1988 KW 614 · CAT 3306 (300 h.p.) engine with 1400 hours

· Belt driven, clutch engaged drum

· Refurbished drum and new bearings installed

· New drum drive belts

· 23.1 x 26 front tires, 16.5 x 16.1 rear tires

NOTE: All turners equipped with McLaughlin Body Co, (John Deere) cab with dimensions of deluxe operator seat, heater, air conditioning, windshield wiper, cab lights and tilt steerin

All KW's equipped with automatic load control.

All KW's can be lifted up one foot for initial pass.

All KW 614's have 6' x 14' tunnel.

Contact RRS-N regarding the sale or lease of new or used equipment.

Web Site Traffic Report

Resource Recovery Systems of Nebraska, Inc.
511 Pawnee Drive ~ Sterling, CO 80751-8698
Ph: 970-522-0663 ~ Fax: 970-522-3387
E-mail: rrskw@kci.net

Wright-Pierce

Civil and Environmental Engineering Services