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Cost Methodology Report for Beef and Dairy Animal Feeding Operations

Final
Cost Methodology Report for Beef and Dairy Animal Feeding Operations

Engineering and Analysis Division
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1.0 INTRODUCTION

Section 301(d) of the Clean Water Act (CWA) directs EPA to periodically review and revise, if necessary, effluent limitations guidelines and standards promulgated under CWA Sections 301, 304, and 306. Animal feeding operations (AFOs) have been identified as a major source of nutrients impairing surface water and groundwater in the United States; therefore, EPA is reviewing and revising the existing effluent guidelines for AFOs.

For beef (including veal) and dairy (including heifer) animal feeding operations, EPA collected data on the amount of manure and wastewater produced, the pollution control and management practices in place, and current land-application practices at beef and dairy operations. Based on these data, EPA identified possible new regulatory requirements that may be imposed on concentrated animal feeding operations (CAFOs) through revision of the effluent guidelines and standards. These new requirements are grouped into seven possible regulatory options. This report describes the methodology used to estimate engineering compliance costs (in 1997 dollars) associated with installing and operating the various technologies and practices that make up the seven regulatory options considered for beef and dairy operations.

Section 1.1 describes the regulatory options costed for beef and dairy operations, Section 1.2 discusses the development of model farms used to determine compliance costs for each option, and Section 1.3 presents the overall organization of the report.

1.1 Regulatory Options

EPA developed the following eight regulatory options for beef and dairy operations:

- Option 1 - Nitrogen-Based Application;
- Option 2 - Phosphorus-Based Application;
- Option 3 - Phosphorus-Based Application + Groundwater;

- Option 4 - Phosphorus-Based Application + Groundwater + Surface Water;
- Option 5 - Phosphorus-Based Application + Drier Manure;
- Option 6 - Phosphorus-Based Application + Anaerobic Digestion;
- Option 7 - Phosphorus-Based Application + Timing Requirements; and
- Option 8 - Phosphorus-Based Application + Minimized Potential for Discharge.

Options 1 through 7 were evaluated for Best Available Technology (BAT) regulatory options, and Options 1 through 8 were evaluated for New Source Performance Standards (NSPS). Table 1-1 presents the technology requirements of each regulatory option.

To determine the cost of complying with each option, EPA developed a technology train that forms the basis of the cost estimate for each type of beef and dairy operation under the BAT and NSPS options. The waste management technologies that make up the train are based primarily on the animal type and the type of waste management practices in use; specifically, these assumptions are typical for those larger farms most likely to be regulated. Waste management practices determine the amount of manure waste and wastewater generated that are used to size and cost various technologies or practices required by the regulatory options. The waste management assumptions for each type of beef and dairy operation are summarized below; these assumptions are typical for the larger farms that are most likely to be regulated:

BAT Options

- Beef and stand-alone heifer feedlots house cattle on drylots. The manure that deposits in the drylot is periodically scraped and stockpiled on site or is transported to cropland on or off site. It is handled as a solid material. Runoff from the feedlot operation is collected and stored in a waste storage pond with capacity for the 25-year, 24-hour storm and 180 days storage. Runoff is treated in a sedimentation basin before going to the storage pond.

- Dairies with flush barns house the milking cows (both lactating and dry) in freestall barns that are flushed twice daily while the cows are being milked. The cows are milked in separate parlors that are flushed between milkings. Flush water is collected in a central collection system and

Table 1-1

Summary of Regulatory Options for Beef and Dairy Operations

Technology or Practice	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7	Option 8
Feedlot best management practices (BMPs), including stormwater diversions,	✓	✓	✓	✓	✓	✓	✓	✓
Mortality-handling requirements (e.g., rendering, composting)[1]	✓	✓	✓	✓	✓	✓	✓	✓
Nutrient management planning and recordkeeping (sample soils once every 3 years,	✓	✓	✓	✓	✓	✓	✓	✓
Land application limited to nitrogen-based agronomic application rates	✓							
Land application limited to phosphorus-based agronomic application rates where		✓	✓	✓	✓	✓	✓	✓
No manure application within 100 feet of any surface water, tile drain inlet, or	✓	✓	✓	✓	✓	✓	✓	✓
Groundwater requirements, including assessment of hydrologic link, monitoring			✓	✓				✓
Surface-water monitoring requirement, including 4 total grab samples upstream and downstream of both feedlot and land application areas, 12 times per year. One composite sample collected once per year at stockpile and surface impoundments. Samples are analyzed for nitrogen, phosphorus, and total suspended solids.				✓				
Drier manure technology basis (covered lagoons for veal, composting)[2]					✓			
Anaerobic digestion						✓		
Timing requirements for land application							✓	
Diminished Potential for Discharge (underpit storage for heifers and dairy cows; confinement barns for calves with covered storage; covered walkways and handling areas at dairy operations; 100-year, 24-hour storm capacity requirement at beef and stand-alone heifer operations, covered lagoon storage for veal.)								✓

[1]There are no additional compliance costs expected for beef and dairy operations related to mortality-handling requirements.
[2]Composting is included in Options 1 through 4 and Options 7 & 8 when expected to be the least costly method of handling manure.

transported to an on-site anaerobic lagoon, with capacity for the 25-year/ 24-hour storm and 180 days storage. The wastewater may undergo solids separation before going to the lagoon.

Immature animals (i.e., heifers and calves) are housed on drylots. The manure that deposits in the drylot is periodically scraped and stockpiled on site or is transported to cropland on or off site. It is handled as a solid material. Runoff from the drylot is routed to the lagoon.

- Dairies with scrape barns house the milking cows (both lactating and dry) in freestall barns that are scraped daily. The scraped manure is stored on site or is transported to cropland on or off site. The cows are milked in separate parlors that are hosed down between milkings. Parlor hose water is collected in a central collection system and transported to an on-site anaerobic lagoon with capacity for the 25-year, 24-hour storm and 180 days storage. Wastewater may undergo solids separation before going to the lagoon.

  Immature animals (i.e., heifers and calves) are housed on drylots. Their manure is handled as described under flush barns above.

- Veal operations house the veal calves in confinement barns that are flushed daily. The flush water is collected and stored in a central collection system, usually a lagoon or a pit under the barn, until it is transported to cropland on or off site. Storage lagoons are sized to hold 180-days storage.

NSPS Options

- Beef feedlots and stand-alone heifer operations house cattle on drylots. The manure that deposits in the drylot is periodically scraped and stockpiled on site or is transported to cropland on or off site. It is handled as a solid material. Runoff from the feedlot operation is collected and stored in a waste storage pond with capacity for the 100-year, 24-hour storm and 180 days storage. Runoff is treated in a sedimentation basin before going to the storage pond.

- Dairies house the milking cows (both lactating and dry) in freestall barns with slatted floors, which allow the manure to drop directly into an underpit storage area. The cows are milked twice daily in parlors that are hose-cleaned between milkings. Hose-down water is collected in a central collection system and transported to the confinement barn underpit storage area. The underpit area is sized for 180 days storage.

Heifers are also housed in freestall barns with 180-days of underpit storage. Calves are housed in confinement barns, in which the manure and bedding are scraped daily to an enclosed manure storage area adjacent to the barn. The calf manure storage area is also sized for 180 days.

Cattle walkways and handling areas are covered to divert precipitation from falling on the cattle areas and forming contaminated runoff.

- Veal operations house the veal calves in confinement barns that are flushed daily. The flush water is collected and stored in a central collection system, usually a lagoon or a pit under the barn, until it is transported to cropland on or off site. The lagoon is sized to hold 180-days storage. Lagoons are covered to prevent direct precipitation from entering the lagoon.

There are other, less prevalent waste management systems used than those listed here; however, the costs related to these systems are not significantly different for the purposes of this analysis. Section 4.0 describes the components of the waste management system that form the basis of the cost estimate for each type of animal operation.

1.2 Model Farms

For each regulatory option, EPA estimated the costs to install, operate, and maintain specific techniques and practices. EPA traditionally develops either *facility-specific* or *model facility* costs. Facility-specific compliance costs require detailed process information about many, if not all, facilities in the industry. These data typically include production, capacity, water use, wastewater generation, waste management operations (including design and cost data), monitoring data, geographic location, financial conditions, and any other industry-specific data that may be required for the analyses. EPA then uses each facility's information to determine how the potential regulatory options will impact that facility and to estimate the cost of installing new pollution controls.

When facility-specific data are not available, EPA develops model facilities to provide a reasonable representation of the industry. Model facilities are developed to reflect the different characteristics found in the industry, such as the size or capacity of an operation, type of operation, geographic location, mode of operation, and type of waste management operations. These models are based on data gathered during site visits, information provided by industry members and their associations, and other available information. EPA estimates the number of facilities that are represented by each model. Cost and financial impacts are estimated for each model facility, then industry-level costs are calculated by multiplying model facility costs by the number of facilities represented by each particular model. Given the amount and type of information that is available for the beef and dairy industry, EPA has chosen a model-facility approach to estimate compliance costs.

Model facilities, or model farms, are defined for beef feedlots, dairy operations, stand-alone heifer operations, and veal operations based on size and regional location. The development of each model farm, as well as the number of facilities by model farm, are described in more detail below. All model farms reflect medium or large-sized animal operations.

1.2.1 Dairy Operations

EPA developed two model farms to represent medium and large-sized dairy operations in the United States. The model farms are a complete flush dairy and a hose/scrape dairy. The parameters describing the dairy model farms are developed from information from the United States Department of Agriculture (USDA) National Agriculture Statistics Service (NASS), 1997 Agricultural Census data, data collected during site visits to dairy farms across the country, meetings with USDA extension agents, and meetings with the National Milk Producers Federation and Western United Dairymen. A description of the various components that make up the model farms is presented below, with the sources of the information used to develop that piece of the model farm.

Housing

To determine the type of housing used at the model farm, the type of animals on the farm must be considered. In addition to the mature dairy herd (including lactating, dry, and close-up cows), there are often other animals on site at the dairy operation, including calves, heifers, and bulls. The number of immature animals (i.e., calves and heifers) at the operation is proportional to the number of mature cows in the herd and depends on the farm’s management. For example, the operation may house virtually no immature animals on site and obtain their replacement heifers from off-site operations, or the operation could have close to a 1:1 ratio of immature animals to mature animals. The percent of immature animals on site varies depending on the size and location of the operation.

Typically, according to Census of Agriculture data, for dairies greater than 200 milking cows, the number of calves and heifers on site equals approximately 60% of the mature dairy (milking) cows (USDA, 1997). EPA assumes that there are an equal number of calves and heifers on site (30% each). Based on this information, a percentage of 30% of the mature cows is used to estimate the number of calves on site, and another 30% of the mature cows is used to estimate the number of heifers for the dairy model farm. The percentage of bulls is typically small (USDA, 1997). For this reason, it is assumed that their impact on the model farm waste management system is insignificant, and bulls are not considered in the dairy model farm.

The most common types of housing for mature cows include freestall barns, tie stalls/stanchions, pasture, drylots, freestall barns, and combinations of these (Stull, 1998). Based on site visits, most medium to large dairies (>200 mature dairy cattle) house their mature dairy cows in freestall barns; therefore, it is assumed that mature dairy cows are housed in freestall barns for the BAT and NSPS dairy model.

The most common types of calf and heifer housing are drylots, multiple animal pens, and pasture (USDA, 1996a). Based on site visits, most moderate to large facilities use drylots to house their heifers and calves; therefore, it is assumed that calves in hutches on drylots and heifers in groups on drylots are the housing for calves and heifers at dairy operations under all BAT scenarios and under NSPS Options 1 though 7. The size of the drylot for the model farm was calculated using animal space requirements suggested by Midwest Plan Service (MWPS, 1995).

Under the NSPS Option 8, the model farm is required to eliminate the potential for discharge; therefore, confinement barns are costed for heifer and calf housing to avoid contaminated runoff from drylots.

Waste Management Systems

Waste is generated in two main areas at dairy operations: the milking parlor and the housing areas. Waste from the milking parlor includes manure and wash water from cleaning the equipment and the parlor after each milking. Waste from the confinement barns includes bedding and manure for all barns, and wash water if the barns are flushed for cleaning. Waste generated from the drylots includes manure and runoff from any precipitation that falls on the drylot.

Based on site visits, most dairy operations transport their wastewater from the parlor and flush barns to a lagoon for storage and treatment. A solid-separator (either gravity or mechanical) is sometimes present before the lagoon to remove larger solids prior to the wastewater entering the lagoon. Solids are removed from the separator frequently to prevent buildup in the separator, and they are stockpiled on site. Solid waste scraped from a barn is typically stacked on the feedlot for storage for later use or transport. Solid waste on the drylot is often mounded on the drylot for the cows and is later moved for transport or land application. Wastewater in the lagoon is held in storage for later use, typically as fertilizer onsite on cropland either on or off-site. The waste management systems used for the BAT and NSPS Options 1 through 7 model dairy farm is shown in Figure 1-1.

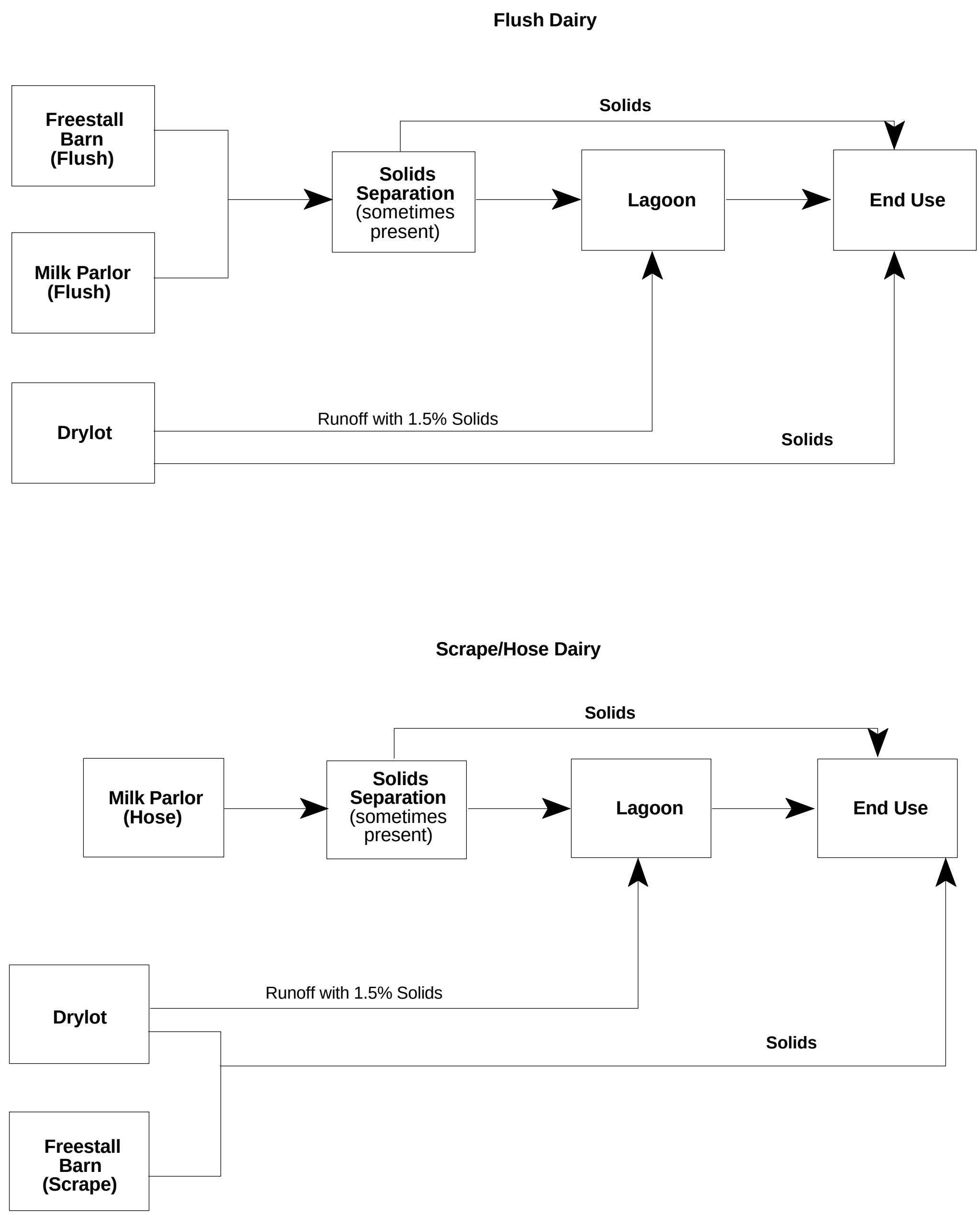


Figure 1-1. Dairy Waste Management Systems

Under the NSPS Option 8, the dairy waste management system is contained in three separate areas for each animal: the mature dairy cows and the heifers are housed in separate confinement barns with underpit manure storage. All manure and wastewater generated in the milking parlor is channeled to the mature cow manure storage pit. The manure pits provide storage for the waste until the waste is land applied or transported off site. The calves at this model farm are also housed in a confinement barn; however, the barn has a solid floor and the manure waste is scraped to a covered storage area, where it is stored until the waste is land applied or transported off site.

The amount of waste generated at a dairy depends on how the operation cleans the barn and parlor on a daily basis. Some dairy operations clean the parlor and barns by flushing the waste (a flush dairy); others use less water, hosing down the parlor and scraping the manure from the barns (a hose/scrape dairy). The number of facilities that operate as a flush dairy or a hose/scrape dairy is estimated from site visits. Both flush and hose/scrape dairy systems are modeled as part of the model facility, and then the results of each are weighted and combined to reflect the percentage of operations that are assumed to be flush verses hose/scrape.

Size Group

Size classes and average head were determined using 1997 Census of Agriculture data and 1993-1997 National Agricultural Statistics Service data. Size groups were determined based on these data, and were developed to correspond to current CAFO definitions. Published Census of Agriculture data provide data for operations having 200 - 499 milk cows and 500-999 milk cows. To form the basis of EPA’s 350 - 500 size group, EPA estimated that 70% of operations in the 200 - 499 size group fall in the 200 - 349 size group, and 30% fall into the 350 - 500 size group. Further, to form the basis of EPA’s 500 - 700 size group, EPA estimated that 60% of operations in the 500 - 999 Census of Agriculture size group fall in the 500-699 size range, and the remainder have 700-1000 milk cows. Data collected during site visits that indicate that dairies operate differently depending on their size and whether they are currently considered a

CAFO. For example, larger dairies tend to already have adequate lagoon storage, while moderate-sized dairies may have only a small amount of lagoon storage. Also, because dairies with greater than 700 mature dairy cows are already regulated under the current rule, it is assumed for the cost model that these facilities are already in compliance for many components of the proposed rule; therefore, three different size groups are used to model dairy operations with greater than 200 head (mature dairy cows). For further detail on the calculation of the size classes, see Eastern Research Group Memorandum *Facility Counts for Beef, Dairy, Veal, and Heifer Operations,* 2000) The size groups are presented in Table 1-2.

Table 1-2

Size Classes for Dairy Model Farms

Size Class	Number of Mature Dairy Cows	Average Number of Mature Dairy Cows
Medium1	200-350	235
Medium2	350-700	460
Large1	>700	1,419

REFERENCE: Eastern Research Group Memorandum *Facility Counts for Beef, Dairy, Veal, and Heifer Operations,* 2000

Region

Data from site visits indicate that dairies in varying regions of the country have different characteristics. These differences are primarily related to climate. For example, a dairy in the Pacific region receives a larger amount of rainfall annually than a dairy in the Central region; therefore, the Pacific dairy produces a higher amount of runoff to be contained and managed. Because operating characteristics may change between regions, dairies are modeled in five separate regions of the United States: Central, Mid-Atlantic, Midwest, Pacific, and South. The Economic Research Service of USDA has developed 10 regions of the country for use in grouping economic information. EPA originally planned to model costs using these 10 regions; however, the National Agricultural Statistics Service required EPA to combine the ERS regions to meet disclosure criteria for economic data. Therefore, the ten ERS regions were condensed into the five regions used in this model because of similarities in animal production and manure handling techniques. Table 1-3 presents the states that are contained within each region.

Table 1-3

Definition of Model Farm Regions

Region	States Included in Region
Central	AZ, CO, ID, MT, NM, NV, OK, TX, UT, WY
Mid-Atlantic	CT, DE, KY, MA, MD, ME, NC, NH, NJ, NY, PA, RI, TN, VA, VT, WV
Midwest	IA, IL, IN, KS, MI, MN, MO, ND, NE, OH, SD, WI
Pacific	AK, CA, HI, OR, WA
South	AL, AR, FL, GA, LA, MS, SC

Reference: Tetra Tech, 1999a.

In the Large1 dairy size group, more than 80% of dairy operations are located in the Central and Pacific regions. In the medium size groups, most operations are located in the Midwest and Mid-Atlantic regions. Table 1-4 presents the number of dairies in each region.

Table 1-4

Number of Dairy Operations by Region

	Region				
Size Class	**Central**	**Mid-Atlantic**	**Midwest**	**Pacific**	**South**
Medium1	593	870	943	722	253
Medium2	433	487	497	725	170
Large1	404	81	90	786	84

REFERENCE: Number of facilities were determined using 1997 Census of Agriculture data and 1993-1997 National Agricultural Statistics Service data. For further detail on the calculation of the size classes, see Eastern Research Group Memorandum *Facility Counts for Beef, Dairy, Veal, and Heifer Operations,* 2000)

EPA estimated the number of dairy operations by region using Census of Agriculture data by state. Using the data with the regional classifications, the number of operations per region were estimated for each EPA size group.

1.2.2 Beef Feedlots

EPA developed one model farm to represent medium and large beef feedlot operations in the United States. The parameters describing the beef model farm are developed from information from NASS, collected during site visits to beef feedlots across the country, meetings with USDA extension agents, and meetings with the National Cattlemen's Beef Association. The same model farm is used in all BAT and NSPS Options. A description of the various components that make up the model farm is presented below, with the sources of the information used to develop that piece of the model farm referenced.

Housing

The large majority of beef feedlot operations in the United States house the cattle on drylots (USDA, 1995b). There is a small number of smaller operations that use confinement barns at beef feedlots, but the vast majority use open lots and most new operations use open lots; therefore, drylots are used as the housing for the beef model farm. The size of the drylot is calculated using animal space requirements suggested by Midwest Plan Service (MWPS, 1995).

Waste Management System

Based on site visits, the drylot is the main area where waste is produced at beef operations. Waste from the drylot includes solid manure, which has dried on the drylot, and runoff, which is produced from precipitation that falls on the drylot and open feed areas.

Most beef operations in the United States divert runoff from the drylot to a storage pond (USDA, 1995b). A solids separator (typically an earthen basin) is sometimes present before the pond to remove solids from the waste stream prior to the runoff entering the pond. Solid waste from the drylot is often mounded on the drylot to provide topography for the cattle and is later moved from the drylot for transportation off site or land application on site (USDA, 1995b).

The beef model farm was developed following these typical characteristics of beef operations. Figure 1-2 presents the waste management system used as part of the beef model farm.

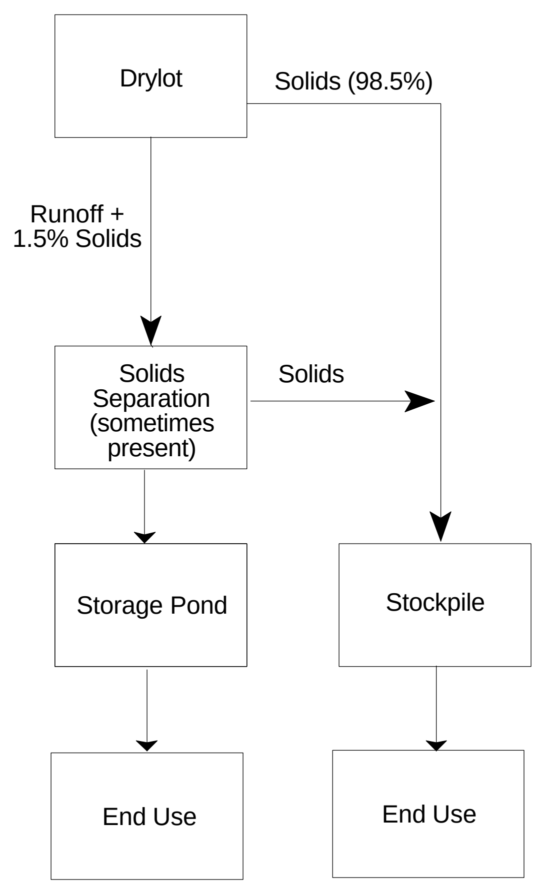


Figure 1-2. Beef and Heifer Waste Management System

Size Group

Size classes and average head were determined using 1997 Census of Agriculture data and 1993-1997 National Agricultural Statistics Service data. Size groups were determined based on these data and were developed to correspond to current CAFO definitions. Eight size groups were used to develop the data for EPA's four size groups. The census of Agriculture size groups are:

- 0 to 299 head
- 300 to 999 head
- 1,000 to 1,999 head
- 2,000 to 3,999 head
- 4,000 to 7,999 head
- 8,000 to 15,999 head
- 16,000 to 31,999 head
- and 32,000 head and greater.

To calculate the average head for EPA's 500-1000 size group, EPA estimated that 98% of feedlots with less than 300 head have a capacity less than 100 head, and 99% of all feedlots with less than 1,000 head have a capacity of less than 500 head. Data collected during site visits that indicate that beef feedlots operate differently depending on their size and whether they are currently considered a CAFO. For example, larger feedlots more frequently have solid separators prior to a holding pond compared to medium-sized feedlots. Additionally, feedlots with a capacity for more than 1,000 beef cattle are already regulated under the current rule; therefore, it is assumed that these large feedlots are already in compliance for many components of the proposed rule. To account for these differences, four different size groups were used to model beef operations with greater than 300 animal units. The size groups are presented in Table 1-5.

Table 1-5

Size Classes for Beef Model Farms

Size Class	Capacity of Feedlot (Number of Head)	Average Head
Medium1	300-500	600
Medium2	500-1000	1,088
Large1	1000-8000	2,628
Large2	> 8,000	43,805

REFERENCE: Eastern Research Group Memorandum *Facility Counts for Beef, Dairy, Veal, and Heifer Operations,* 2000

For beef feedlots, the average number of cattle sold per year is used to determine the capacity of the operation. The capacity of a feedlot is a combination of sales and the number of turnovers per year plus inventory. A feedlot may have anywhere from 1 to 3.5 turnovers of its herd per year. Most feedlots operate at 80 to 85% of their capacity, with an average of 1.5 to 2.5 turnovers per year. (USDA, 1999)

Region

Data from site visits to beef feedlots indicate that beef feedlots in varying regions of the country have different characteristics. These differences are primarily related to climate. For example, a beef feedlot in the Pacific region receives a larger amount of rainfall annually than a beef feedlot in the Central region; therefore the Pacific feedlot produces a larger volume of runoff to be contained and managed. Because operating characteristics may change between regions to accommodate these climatological differences, beef feedlots are modeled in five separate regions of the United States: Central, Mid-Atlantic, Midwest, Pacific, South, and Midwest. These regions are defined in Table 1-6.

Approximately 95% of large beef feedlots are located in the Central and Midwest regions (USDA, 1997). Almost 75% of medium feedlots are located in the Midwest region.

Table 1-6

Number of Beef Feedlots by Region

Size Class	Region				
	Central	Mid-Atlantic	Midwest	Pacific	South
Medium1	86	150	685	35	42
Medium2	130	35	810	19	7
Large1	332	25	1,236	55	6
Large2	182	0	217	22	0

REFERENCE: For further detail on the calculation of the size classes, see Eastern Research Group Memorandum *Facility Counts for Beef, Dairy, Veal, and Heifer Operations,* 2000)

EPA estimated the number of beef feedlots by region and size group using 1997 Census of Agriculture and National Agriculture Statistics Service data by state. Using these data with the regional classifications, the number of operations per region were estimated for each EPA size group.

1.2.3 Veal Operations

EPA developed one model farm to represent medium and large veal operations in the United States. The parameters describing the veal model farm are developed from information collected during site visits to veal operations in Indiana and discussions with the American Veal Association. A description of the various components that make up the model farm is presented below, with the sources of the information used to develop that piece of the model farm referenced.

Housing

Veal calves are generally grouped by age in environmentally controlled buildings. The majority of veal operations in the United States utilize individual stalls or pens with slotted floors, which allow for efficient removal of waste (Wilson, 1995). Because this type of housing is the predominant type of housing used in the veal producing industry, individual stalls in an environmentally controlled building is designated as the housing for the veal model farm.

Waste Management Systems

Based on site visits, the only significant source of waste at veal operations is from the veal confinement areas. Veal feces are very fluid; therefore, manure is typically handled in a liquid waste management system. Manure and waste that fall through the slotted floor are flushed regularly out of the barn. Flushing typically occurs twice daily. Most veal operations have a lagoon to receive and treat their wastewater from flushing, although some operations have a holding pit system in which the manure drops directly into the pit. The pit provides storage until the material can be land applied or transported off site. Wastewater in the lagoon is held in storage for later use as fertilizer off site.

The veal model farm used in this cost methodology is developed from these general characteristics. The animals are totally confined; therefore, the only source of wastewater is from flushing the manure and waste from the barns. The BAT and the NSPS veal model farms are identical. Figure 1-3 presents a diagram of the veal model farm waste management system.

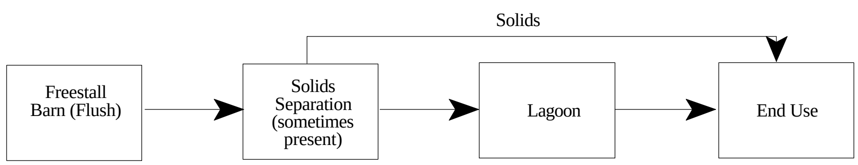


Figure 1-3. Veal Model Farm

Size Group

The veal industry standard operating procedures do not vary significantly based on the size of the operation, according to data collected during site visits and discussions with the American Veal Association (Crouch, 1999). Two size groups are used to model the industry to account for two theoretical regulatory thresholds, as presented in Table 1-7:

Table 1-7

Size Classes for Veal Model Farm

Size Class	Size Range	Average Head
Medium1	300-500	400
Medium2	>500	540

REFERENCE: Eastern Research Group Memorandum *Facility Counts for Beef, Dairy, Veal, and Heifer Operations,* 2000

For veal operations, the average number of calves on-site at a given time is used to determine the capacity of the operation. (ERG Memorandum, 2000)

Region

The American Veal Association indicates that veal producers are located predominantly in the Midwest and Central regions (Crouch, 1999); therefore, only these two regions are modeled as part of the veal model farm.

The number of veal operations modeled in the United States is provided in Table 1-8.

Table 1-8

Number of Veal Operations by Region

Size Class	Region				
	Central	**Mid-Atlantic**	**Midwest**	**Pacific**	**South**
Medium1	5	1	119	0	0
Medium2	3	1	81	0	0

REFERENCE: Number of operations were determined using 1997 Census of Agriculture data and 1993-1997 National Agricultural Statistics Service data. For further detail on the calculation of the size classes, see Eastern Research Group Memorandum *Facility Counts for Beef, Dairy, Veal, and Heifer Operations,* 2000)

1.2.4 Heifer Operations

EPA developed one model farm to describe medium and large stand-alone heifer operations (also called contract heifer farms) in the United States. The parameters describing the stand-alone heifer model farm are developed from meetings with the National Milk Producers Federation and discussions with the Professional Heifer Growers Association. The same model farm is used in all BAT and NSPS options. A description of the various components that make up the model farm is presented below, with the sources of the information used to develop that piece of the model farm.

Housing

Stand-alone heifer raising operations use two primary methods for housing the animals. One method is to raise the heifers on pasture, and the second method is to raise the heifers on confined drylots. Because this regulation only addresses confined operations, the heifer model facility accounts for animals housed on drylots.

Waste Management System

The drylot is the main area where waste is produced at heifer operations. Waste from the drylot includes solid manure, which has dried on the drylot, and runoff, which is produced from precipitation that falls on the drylot and feed areas.

Stand-alone heifer operations typically operate like beef feedlots (Cady, 2000). As such, it is assumed that runoff from the drylot is channeled to a storage pond. A solids separator (typically an earthen basin) is sometimes present before the pond. Solid waste from the drylot is mounded on the drylot, and is later moved for transportation off site or land application on site.

Size Group

There is very little information available on the number of heifer operations raising heifers in confinement. It is believed that most large heifer raising operations (greater than 1000 head) are confinement-based, while smaller operations are often pasture-based (Cady, 2000). The average size of heifer grower operations ranges from 50 head to 25,000 head and varies geographically. The average size of a heifer operation located west of the Mississippi River is 1,000 to 5,000 head, while the average size in the upper Midwest, Northeast, and South is 50 to 200 head. Nationally, the median size of a dairy heifer raising operation is approximately 200 head (Cady, 2000).

Because of the lack of information on the size distribution of confined heifer operations, EPA chose to use three size groups which are consistent with the beef model farm size groups, as presented in Table 1-9. The average head for each size group is calculated as the median of the size group range.

Table 1-9

Size Classes for Heifer Model Farm

Size Class	Size Range	Average Head
Medium1	300-500 animals	400
Medium2	500-1000 animals	750
Large1	>1000 animals	1,500

Region

There is very little information on the location of heifer grower operations in the United States; however, because they directly support the dairy industry, it is assumed that they are concentrated in areas where the dairy industry is moving toward specialization (Bocher, 1999). It is estimated that heifer grower operations are located in four areas of the country: 70% are managed in the west, 20% are managed in the south/southeast, 7% are managed in the northeast, and 3% are managed in the upper Midwest.

The number of operations modeled for the heifer model farms is presented as Table 1-10.

Table 1-10

Number of Heifer Operations by Region

Size Class	Region				
	Central	Mid-Atlantic	Midwest	Pacific	South
Medium1	25	0	200	25	0
Medium2	250	0	100	150	0
Large1	180	0	0	120	0

REFERENCE: Number of operations were estimated using Best Professional Judgement and discussions with Dr. Roger Cady (Cady, 2000). For further detail on the calculation of the size classes, see Eastern Research Group Memorandum *Facility Counts for Beef, Dairy, Veal, and Heifer Operations*, 2000)

1.3 Organization of Report

The following information is discussed in detail in this report:

- Section 2.0 presents the structure of the cost model;
- Section 3.0 discusses the cost model inputs;
- Section 4.0 discusses the technology cost modules, which comprise the regulatory options;
- Section 5.0 discusses weighting factors, which represent which portion of the industry currently has technologies or practices in place;
- Section 6.0 discusses the cost test performed on the cost model and total facility costs (category costs);
- Section 7.0 provides an example of total model farm costs calculated for one model farm and option; and
- Section 8.0 presents references used to develop the cost model.

2.0 COST MODEL STRUCTURE

To generate industry compliance cost estimates associated with each regulatory option for beef and dairy operations, EPA developed a computer-based cost model made up of several individual cost modules. The cost model is executed on a personal computer and consists of a collection of programs written in Visual Basic® and data tables created in Microsoft® Access 97. Figure 2-1 presents a flow chart of the cost model methodology. The cost model consists of several components, which can be grouped into four major categories:

- Input data;
- Technology cost modules;
- Frequency factors (including farm weighting factors); and
- Output data.

Each module calculates a specific piece of operational data (e.g., runoff) or develops a design and cost for a specific waste management system component (e.g., an anaerobic lagoon) based on model farm characteristics. Frequency factors are then applied to the component costs to weight the costs by the estimated percentage of operations that already have the component in place. Farm-weighting factors are applied to certain weighted component costs to further weight these costs by the percentage of operations that operate in different ways (e.g., flush versus hose dairies). These weighted farm costs are then summed for each regulatory option and model farm. Finally, a Transportation Cost Test evaluates several methods of transporting waste off site, identifies the least expensive scenario, and outputs final costs for each model farm and option. All costs are in 1997 dollars. The remainder of this section describes each of these components. Input Data inputs to the cost model include information on the model farms, runoff, wastewater generation, and manure generation, as described below: Model farm definitions - Animal type, EPA regulatory option, farm type, size class, average number of head, region, and number of operations that are represented by the model farm.

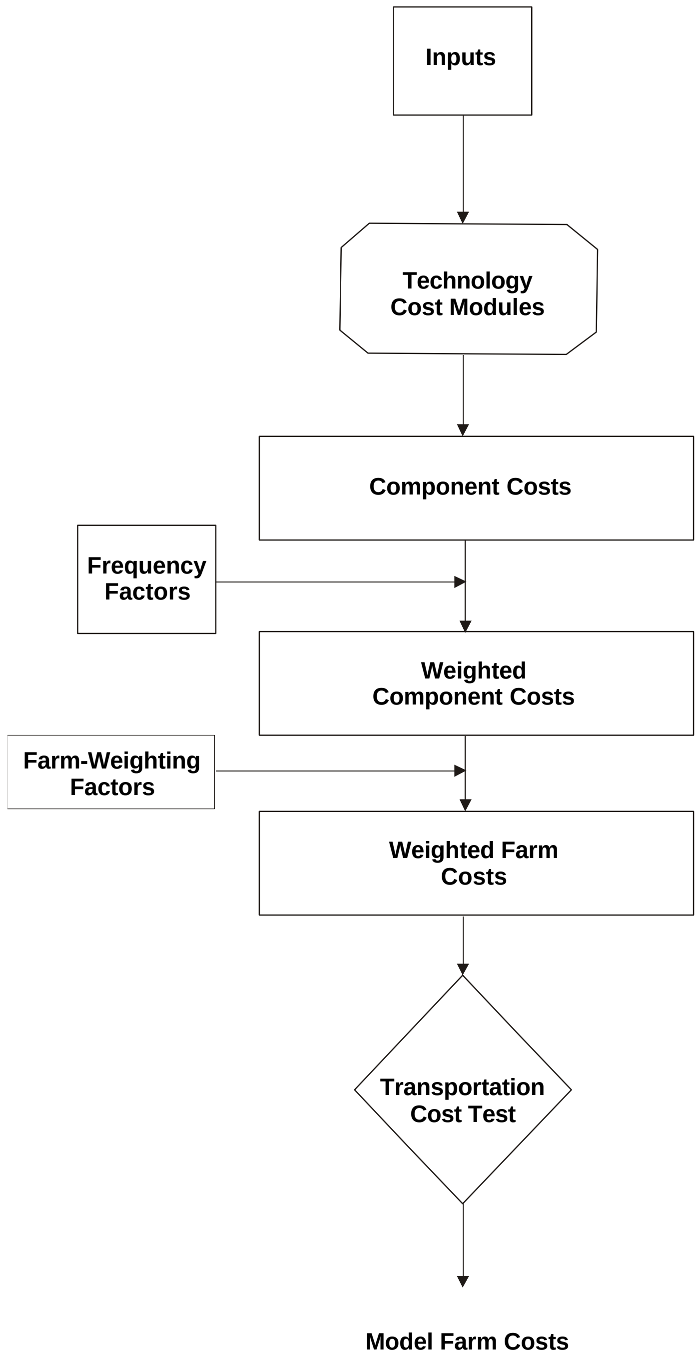


Figure 2-1. Flow Chart of General Cost Methodology

- Wastewater generation - Volume of milking parlor wastewater and barn wastewater generated.

- Manure generation - Amount and composition of manure generated at the operation.

- Runoff generation - Precipitation data (including average rainfall, evaporation, and 25-year, 24-hour rainfall amounts) by model farm type and region.

All of these data are fed to one input page, which contains all the design information required for the subsequent cost modules. Section 3.0 discusses inputs to the cost model in greater detail.

2.1 Technology Cost Modules

Each technology cost module calculates direct capital and annual costs for installing and implementing a particular technology or practice. In some cases, the modules calculate initial fixed costs that are not able to be amortized and operating and maintenance costs that only occur every three years. In the summary of costs this is referred to as a “3-year recurring cost”.

For each regulatory option, the cost model combines a series of modules. Tables 2-1 through 2-3 present the waste management technology components (for dairy operations, beef feedlots, and veal operations, respectively) that make up the basis for each option. Each module manipulates the input data tables to generate costs to implement the technologies under each regulatory option. Figure 2-2 presents the components of the technology cost modules, and Section 4.0 discusses each cost module in detail.

Each regulatory option includes at least one module from Pretreatment, Storage/Treatment, Pollution Prevention/Monitoring, and Waste Utilization/Transportation (see Figure 2-2). Microsoft© Access 97 queries are used to create a module-specific input page that selects only the input required to run the specific scenario of interest. For example, because

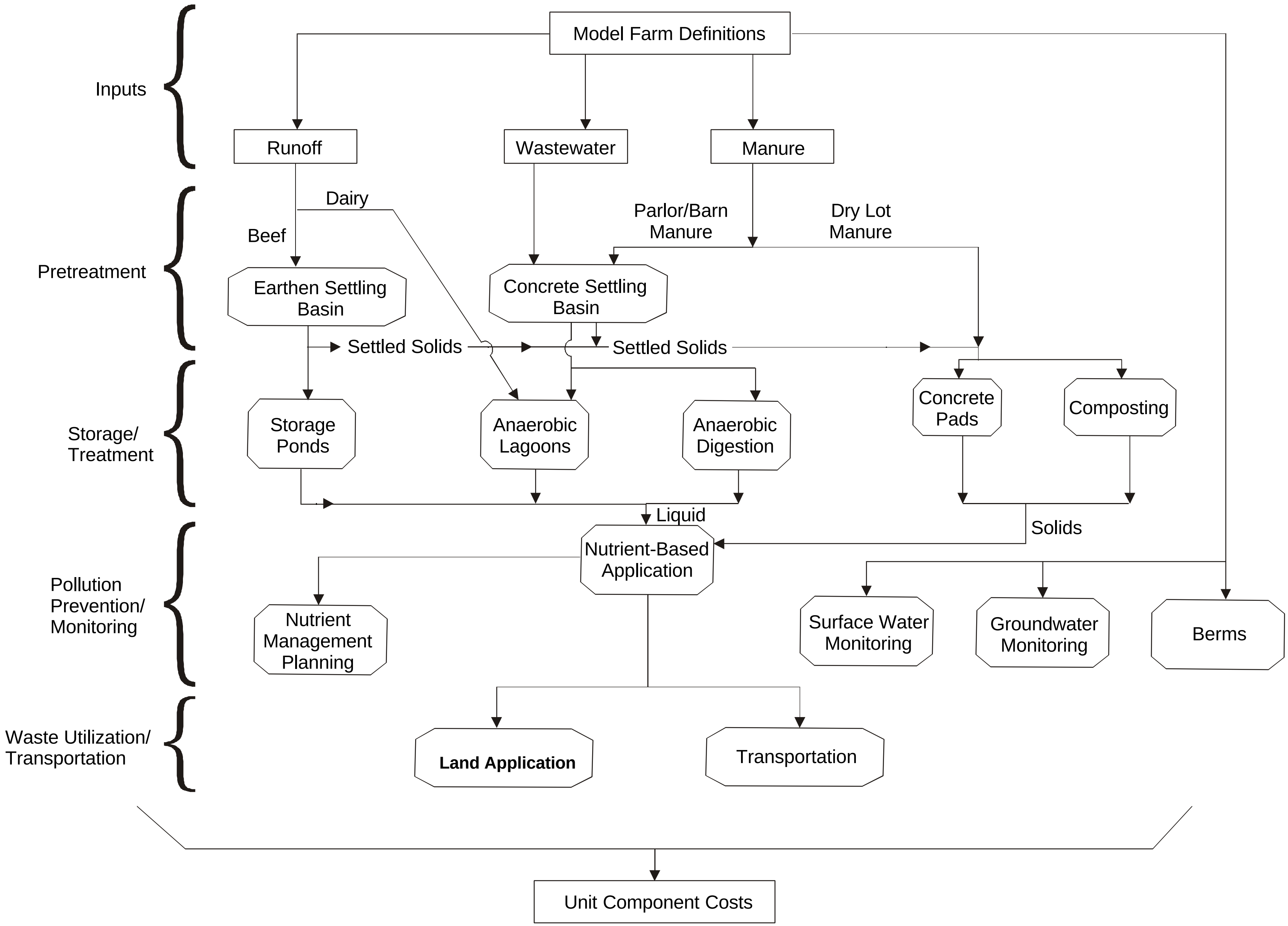


Figure 2-2. Components of Technology Cost Modules

Table 2-1

Waste Management Technologies for Dairy Operations by Regulatory Option

Technology or Practice	Technology Cost Module	Regulatory Option							
		1	2	3	4	5	6	7	8
Solids Separation	Concrete Basin	✓	✓	✓	✓	✓	✓	✓	
Anaerobic Treatment	Naturally-lined Lagoon	✓	✓			✓		✓	
	Lined Lagoon			✓	✓				
	Anaerobic Digester						✓		
	Additional Lagoon Capacity (for land application timing restrictions)							✓	
Liquids Storage	Underpit storage								✓
Runoff Controls	Berms	✓	✓	✓	✓	✓	✓	✓	✓
On-Site Manure Handling	Composting[1]					✓			
	Concrete Pad			✓	✓				
On-Site Land Application	Nutrient Management Planning	✓	✓	✓	✓	✓	✓	✓	✓
	Nutrient-Based Application	✓	✓	✓	✓	✓	✓	✓	✓
	On-Site Irrigation	✓	✓	✓	✓	✓	✓	✓	✓
Monitoring	Groundwater Protection			✓	✓				✓
	Surface Water Monitoring				✓				
Off-Site Transportation		✓	✓	✓	✓	✓	✓	✓	✓

[1]EPA evaluated composting for Options 1 through 4, 6, and 7, but determined that it was not the least costly method of handling manure.

Table 2-2

Waste Management Technologies for Beef Feedlots and Heifer Operations by Regulatory Option

Technology or Practice	Technology Cost Module	Regulatory Option							
		1	2	3	4	5	6	7	8
Solids Separation	Earthen Basin	✓	✓	✓	✓	✓	✓	✓	✓
Storage Pond	Naturally-lined Pond	✓	✓			✓	✓	✓	
	Lined Pond			✓	✓				✓
	Additional Pond Capacity (for land application timing restrictions)							✓	✓
	Peak Design Storm = 25-year, 24-hour Capacity	✓	✓	✓	✓	✓	✓	✓	
	Peak Design Storm = 100-year, 24-hour Capacity								✓
Runoff Controls	Berms	✓	✓	✓	✓	✓	✓	✓	✓
On-Site Manure Handling	Composting[1]					✓			
	Concrete Pad			✓	✓				
On-Site Land Application	Nutrient Management Planning	✓	✓	✓	✓	✓	✓	✓	✓
	Nutrient-Based Application	✓	✓	✓	✓	✓	✓	✓	✓
	On-Site Irrigation	✓	✓	✓	✓	✓	✓	✓	✓
Monitoring	Groundwater Protection			✓	✓				✓
	Surface Water Monitoring				✓				
Off-Site Transportation		✓	✓	✓	✓	✓	✓	✓	✓

Table 2-3

Waste Management Technologies for Veal Operations by Regulatory Option

Technology or Practice	Technology Cost Module	Regulatory Option							
		1	2	3	4	5	6	7	8
Solids Separation	Concrete Basin	✓	✓	✓	✓	✓	✓	✓	✓
Anaerobic Treatment	Naturally-lined Lagoon 180-day storage capacity	✓	✓			✓	✓	✓	
	Lined Lagoon 180-day storage capacity			✓	✓				✓
On-Site Land Application	Nutrient Management Planning	✓	✓	✓	✓	✓	✓	✓	✓
	Nutrient-Based Application	✓	✓	✓	✓	✓	✓	✓	✓
Monitoring	Groundwater Protection			✓	✓				✓
	Surface Water Monitoring				✓				
Off-Site Transportation		✓	✓	✓	✓	✓	✓	✓	✓

concrete pads are only required in groundwater-protection options, the input page for concrete pads only includes the input data for Options 3 and 4. No costs are calculated for components that are not included in the option.

Each module generates an intermediate output page, containing the capital, fixed, annual, and recurring costs associated with that module. The output page also includes input data so that it may be used as an input page to subsequent modules.

2.2 Frequency Factors

EPA determined the current frequency of existing waste management practices at beef feedlots, dairies, and veal operations to estimate the portion of the operations that would incur costs to comply with the new regulation. The frequency information is used to estimate compliance costs for specific model farms for the regulatory options being considered. The resulting weighted farm costs can be multiplied by the number of facilities represented by each model to estimate industry-wide costs.

Currently, no publicly available information is available that can be used with a high degree of confidence to determine what each frequency factor should be for each size class within a given region. EPA, therefore, estimates frequency factors based on the sources below. (Each source was considered along with its limitations.) See Appendix D for a discussion of the supplemental analyses performed by EPA to assess the validity of this modeling approach.

- EPA site visit information - This information is used to assess general practices of beef feedlots, dairies, and veal operations and how they vary between regions and size classes.

- Observations from industry experts - Experts on beef and dairy animal feeding operations were contacted to provide insight into operations and practices, especially where data are limited or not publicly available.

- USDA/NASS - The data currently available from NASS are used to determine the distribution of beef and dairy operations across the regions by size class.

- USDA/Animal Plant and Health Inspection Service (APHIS)/National Animal Health Monitoring System (NAHMS) - This source provides information on dairy practices, facility size, and waste system components sorted by size class and region. These data have limited use due to the small number of respondents in the size classes of interest.

- *State Compendium: Programs and Regulatory Activities Related to AFOs* - This summary of state regulatory programs is used to estimate frequency factors based on current waste-handling requirements that already apply to beef and dairy operations in various states and in specific size classes.

2.3 Output Data

The cost model generates weighted component costs using the frequency factors described in Section 2.3, and further weights these costs according to farm factors that indicate farm type (e.g., flush dairies versus hose dairies), nutrient application (nitrogen- or phosphorus-based application), and availability of crops on site (see section 4.14 for a detailed discussion). This further weighting is described in Section 5.0.

The weighted farm costs are then used in a “cost test,” described in Section 6.0, to select the least costly transportation option. There are four transportation options considered: hiring a contractor to haul manure; purchasing trucks to haul manure; composting to reduce the volume of waste before hiring a contract hauler; and composting before using purchased trucks. Total model farm costs are the sum of the weighted farm costs and the least costly transportation option.

The cost estimates generated contain the following types of costs:

- Capital costs - Costs for facility upgrades (e.g., construction projects);

- Fixed costs - One-time costs for items that cannot be amortized (e.g., training);

- Annual operating and maintenance (O&M) costs - Annually recurring costs, which may be positive or negative. A positive O&M costs indicates an annual cost to operate, and a negative O&M cost indicates a benefit to operate, due to cost offsets;

- Three-year recurring O&M costs - Operating and maintenance costs that only occur once every three years; and

- Annual fertilizer costs - Costs for additional commercial nitrogen fertilizer needed to supplement the nutrients available from manure application.

These costs provide the basis for evaluating the total annualized costs, cost effectiveness, and economic impact of the regulatory options proposed for the CAFOs industry. Appendix C presents these model farm cost outputs.

3.0 INPUT DATA

The cost model uses three main types of input data, in addition to the model farm information presented in Section 1.2, to calculate compliance costs for each model farm and regulatory option. These input modules are: wastewater generation, manure generation, and runoff.

3.1 Wastewater Generation

The cost model calculates the total amount of wastewater generated at dairies and veal operations and uses it as input for the design of storage and treatment technologies. Wastewater, as used in the cost model, includes water from flushing or hosing confinement barns and milking parlors at dairies and veal operations. (Runoff and precipitation are calculated separately in this model and are not included in the wastewater calculations.) Sections 3.1.1 through 3.1.4 describe the equations used to calculate the wastewater generated, and the different wastewater sources present at hose dairies, flush dairies, and veal operations. No wastewater is generated at beef operations because manure is handled as a solid.

3.1.1 Hose Dairies

The amount of wastewater generated at dairies includes wash water for equipment, milking parlor floors, and holding area floors. The cost model assumes wastewater is generated only in the milking parlor for hose dairies, because confinement barn waste is scraped without using flush water. Table 3-1 lists the sources of milking parlor wastewater by size class for dairies using hose systems.

Table 3-1

Milking Parlor Wastewater Generated at Dairies Using Hose Systems

Water Source	Units	Small Operations (< 200 Head)	Medium Operations (200-700 Head)	Large Operations (> 700 Head)
Bulk Tank-Manual[1]	gal/wash	40	35	30
Pipeline In Parlor[1]	gal/wash	75	100	125
Miscellaneous Equipment[1]	gal/day	30	30	30
Cow Preparation-Manual[2]	gal/wash-cow	0.5	0.375	0.25
Milkhouse Floor[2]	gal/day	20	15	10
Parlor and Holding Area Flush[2]	gal/milking	40	30	20

[1] Information taken from Midwest Plan Service - 7, Dairy Freestall Housing and Equipment, p78.
[2] Information taken from Midwest Plan Service - 18, Livestock Waste Facilities Handbook.

Based on site visits, dairies milk their cows either two or three times per day; therefore, the cost model assumes each cow is milked an average of 2.5 times per day, and the equipment is washed after each milking. The general parlor wastewater generation equation is thus:

$$\text{Parlor Wastewater (gal/day)} = \frac{\text{No. Washes}}{\text{Day}} * \left(\frac{\text{Bulk Tank Rinse}}{\text{Wash}} + \frac{\text{Pipeline Rinse}}{\text{Wash}}\right)$$

$$+ \text{Miscellaneous Equipment}$$

$$+ \frac{\text{No. Washes}}{\text{Day}} * \text{Cow Preparation} * \text{Number of Cows}$$

$$+ \text{Milkhouse Floor Wash}$$

$$+ \frac{\text{No. Milkings}}{\text{Day}} * \text{Parlor and Holding Area Flush}$$

After plugging in the values from Table 3-1, and assuming the number of washes and milkings equals 2.5, the total wastewater generated in the milking parlor for each size class is computed using the following equations:

< 200 Head	Parlor Wastewater (gal/day) = [2.5 washes/day × (40 + 75) gal/wash] + 30 gal/day + [0.5 gal/wash-cow × 2.5 washes/day × Number of Dairy Cattle] + 20 gal/day + [40 gal/milking × 2.5 milkings/day]
	Parlor Wastewater (gal/day) = 437.5 gal/day + (1.25 gal/cow-day × Number of Dairy Cattle)
200-700 Head	Parlor Wastewater (gal/day) = [2.5 washes/day × (35 + 100) gal/wash] + 30 gal/day + [0.375 gal/wash-cow × 2.5 washes/day × Number of Dairy Cattle] + 15 gal/day + [30 gal/milking × 2.5 milkings/day]
	Parlor Wastewater (gal/day) = 457.5 gal/day + (0.9375 gal/cow-day × Number of Dairy Cattle)
> 700 Head	Parlor Wastewater (gal/day) = [2.5 washes/day × (30 + 125) gal/wash] + 30 Gal/day + [0.25 gal/wash-cow × 2.5 washes/day × Number of Dairy Cattle] + 10 gal/day + [20 gal/milking × 2.5 milkings/day]
	Parlor Wastewater (gal/day) = 477.5 gal/day + (0.625 gal/cow-day × Number of Dairy Cattle)

Only the mature herd is used to calculate the wastewater use in the parlor because the wastewater use estimates are based on the number of animals passing through the parlor. Although the dairy model farm includes calves and heifers in addition to the milking herd on site, these animals are not counted in the milking herd count because they do not produce milk. To be conservative, all mature dairy cattle, both lactating and dry, are used to calculate parlor wastewater.

3.1.2 Flush Dairies

Dairies using flush systems generate larger quantities of water than dairies using hose systems. Table 3-2 lists the sources of wastewater by size class for dairies using flush systems.

Table 3-2

Milking Parlor Wastewater Generated at Dairies Using Flush Systems[1]

Water Source	Units	Small Operations (<200 Head)	Medium Operations (200-700 Head)	Large Operations (>700 Head)
Bulk Tank-Automatic	gal/wash	60	55	50
Pipeline In Parlor	gal/wash	75	100	125
Miscellaneous Equipment	gal/day	30	30	30
Cow Preparation-Automatic	gal/wash-cow	2	2	2
Milkhouse Floor	gal/day	20	15	10
Parlor and Holding Area Flush	gal/day-cow	40	32.5	25

[1]Information was taken from Midwest Plan Service- 18, Livestock Waste Facilities Handbook.

As with hose dairies, the cost model assumes each cow is milked 2.5 times per day, and the equipment is washed after each milking. The general parlor wastewater generation equation is thus:

$$\begin{aligned}
\text{Parlor Wastewater (gal/day)} \quad = \quad & \frac{\text{No. Washes}}{\text{Day}} * \left(\frac{\text{Bulk Tank Rinse}}{\text{Wash}} + \frac{\text{Pipeline Rinse}}{\text{Wash}}\right) \\
+ \quad & \text{Miscellaneous Equipment} \\
+ \quad & \frac{\text{No. Washes}}{\text{Day}} * \text{Cow Preparation} * \text{Number of Cows} \\
+ \quad & \text{Milkhouse Floor Wash} \\
+ \quad & \frac{\text{No. Milkings}}{\text{Day}} * \text{Parlor and Holding Area Flush}
\end{aligned}$$

After plugging in the values from Table 3-1, the total wastewater generated in the milking parlor for each size class is computed using the following equations:

< 200 Head Parlor Wastewater (gal/day) = [2.5 washes/day × (60 + 75) gal/wash] + 30 Gal/day + [2 gal/wash-cow × 2.5 washes/day × Number of Dairy Cattle] + 20 gal/day + [40 gal/day-cow × Number of Dairy Cattle]

Parlor Wastewater (gal/day) = 387.5 gal/day + (45 gal/cow-day × Number of Dairy Cattle)

200-700 Head Parlor Wastewater (gal/day) = [2.5 washes/day × (55 + 100) gal/wash] + 30 gal/day + [2 gal/wash-cow × 2.5 washes/day × Number of Dairy Cattle] + 15 gal/day + [32.5 gal/day-cow × Number of Dairy Cattle]

Parlor Wastewater (gal/day) = 432.5 gal/day + (37.5 gal/cow-day × Number of Dairy Cattle)

> 700 Head Parlor Wastewater (gal/day) = [2.5 washes/day × (50 + 125) gal/wash] + 30 gal/day + [2 gal/wash-cow × 2.5 washes/day × Number of Dairy Cattle] + 10 gal/day + [25 gal/day-cow × Number of Dairy Cattle]

Parlor Wastewater (gal/day) = 477.5 gal/day + (30 gal/cow-day × Number of Dairy Cattle)

Only the milking herd is used to calculate the wastewater use in the parlor because the wastewater use estimates are based on the number of animals passing through the parlor. Although the dairy model farm includes calves and heifers in addition to the milking herd on site, these animals are not counted in the milking herd count because they do not produce milk.

In addition to the milking parlor wastewater, water is used to flush the confinement barns. The amount of water required is estimated at 100 gal/day-cow (MWPS,1993). The amount of wastewater generated is calculated by the following equation:

Barn Wastewater (gal/day) = 100 gal/day-cow × Number of Dairy Cattle

Because only the milking herd is housed in the confinement barn for the flush dairy model farm, only the milking herd is counted in the number of dairy cattle.

3.1.3 Veal

Veal operations do not generate as much wastewater as dairies because there is no milk parlor wastewater. Wastewater is generated at veal operations from flushing confinement barns. It is estimated that the amount of water required is 100 gal/day-cow, the value provided for beef feeders (MWPS, 1993); therefore, the wastewater generated from veal operations is calculated from the following equation:

$$\text{Barn Wastewater (gal/day)} = 100 \text{ gal/day-calf} \times \text{Number of Veal Calves}$$

3.1.4 Total Wastewater Generation

The equations listed in Sections 3.1.1 through 3.1.3 require the average number of animals as input. Table 1-2 lists the average number of head for each model farm (USDA, 1997; for further discussion of the calculation of average head per model facility, see the ERG Memorandum *Facility Counts for Beef, Dairy, Veal and Heifer Operations,* 2000). The total wastewater generated is the sum of the wastewater generated from the confinement barn and milking parlor.

$$\text{Total Wastewater (gal/day)} = \text{Parlor Wastewater (gal/day)} + \text{Barn Wastewater (gal/day)}$$

Table 3-3 shows the wastewater generation by model farm.

Table 3-3

Wastewater Generation by Model Farm

Animal Type	Size Class	Average Head	Parlor Wastewater[1] (gal/day)	Barn Wastewater[1] (gal/day)	Total Wastewater (gal/day)
Dairy-Flush	Medium1	235	9,245	23,500	32,745
	Medium2	460	17,683	46,000	63,683
	Large1	1419	43,048	141,900	184,948
Dairy-Hose	Medium1	235	678	0	678
	Medium2	460	889	0	889
	Large1	1419	1,364	0	1,364
Veal	Medium1	400	0	40,000	40,000
	Medium2	540	0	54,000	54,000

[1]For the dairy model farm, only the mature herd is including in the calculation of wastewater generation. To be conservative all mature dairy cattle, both lactating and dry, are used to calculate parlor wastewater.

3.2 Manure Generation

The amount of manure generated at beef feedlots, dairies, and veal operations is also needed for the design of storage and treatment technologies. In addition to the volume generated, the location of manure generation and collection affects the size and type of different waste management components. The cost model calculates the amount of manure generated for each model farm. Sections 3.2.1 through 3.2.3 describe the estimates of manure generated at beef feedlots, dairies, and veal operations and the assumptions and equations used in the cost model.

3.2.1 Manure Estimates Per Animal

The cost model calculates the total amount of manure generated using manure characteristics and the total number of animals on the beef feedlots, dairies, and veal operations. Table 3-4 lists the assumptions used to approximate the manure generated. The moisture content can be used to calculate the total solids content or total water content of the manure. In practice, manure characteristics are variable; the values shown here reflect the best available data for national estimates.

Table 3-4

Manure Production and Characteristics

Animal Type	Animal Weight (lbs)[1]	Manure Production ((lb/day)/1,000-lb animal)	Manure Density (lb/ft^3)[1]	Manure Moisture (percent)
Beef Cattle	877	63[2]	62	88[3]
Mature Dairy Cattle	1350	83.5[2]	62	87[3]
Calves	350	65.8[2]	62	98[5]
Heifers	550	66[2]	62	87[5]
Veal Calves	275	65.8[2]	62	98[4]

[1]Information taken from the Beef and Dairy Industry Profile, 2000.
[2]Information taken from Lander, 1998.
[3]Information taken from NCSU, 1994.
[4]Information taken from ASAE, 1993.
[5]Assume that heifers are equal to dairy cows and calves are equal to veal calves.

3.2.2 Manure Placement

The amount of manure generated is distributed among the different areas of the operation. For beef feedlots, it is assumed that all manure is generated on the drylot. For dairies, it is assumed that 85% of the manure is generated in the confinement barn and 15% is generated in the milking parlor (USDA, 1992). For veal operations, it is assumed that all manure is generated in the confinement barn. These estimates are based on the amount of time dairy cattle typically spend in each facility.

3.2.3 Total Manure Generation

The cost model calculates the amount of manure generated in each area of the farm using the following equations. Information in Table 3-4 is used for manure generation information, and information in Table 1-2 is used to obtain the average number of head.

Beef Cattle, Calves, and Heifers

Manure = Average Head × Animal Weight (lbs) × Manure Production ((lb/day)/1,000-lb animal)

Mature Dairy Cattle

Milking Parlor Manure = 0.15 × Average Head × Animal Weight (lbs) × Manure Production ((lb/day/1,000-lb animal)

Barn Manure = 0.85 × Average Head × Animal Weight (lbs) × Manure Production ((lb/day/1,000-lb animal)

Veal Calves

Barn Manure = Average Head × Animal Weight (lbs) × Manure Production ((lb/day/1,000-lb animal)

Table 3-5 presents manure generation by model farm. Manure generation does not vary by region.

Table 3-5

Manure Generation by Model Farm

Animal Type	Size Class	Drylot Manure[1] (lbs/day)	Milking Parlor Manure (lbs/day)	Barn Manure (lbs/day)	Total Manure (lbs/day)
Beef	Medium1	33,151	NA	NA	33,151
	Medium2	60,113	NA	NA	60,113
	Large1	145,200	NA	NA	145,200
	Large2	2,420,270	NA	NA	2,420,270
Heifers	Medium1	14,520	NA	NA	14,520
	Medium2	27,225	NA	MA	27,225
	Large1	54,450	NA	NA	54,450
Dairy	Medium1	4,212	3,973	22,517	30,702
	Medium2	8,187	7,778	44,075	60,040
	Large1	25,275	23,994	135,963	185,232
Veal	Medium1	NA	NA	7,238	7,238
	Medium2	NA	NA	9,771	9,771

NA - Not applicable.
[1]For dairy farms, drylot manure includes calf and heifer waste.

3.3 Runoff

Runoff from drylots at beef, heifer, and dairy operations under Options 1 through 7 is added to the volume required for liquid storage at the operation. Runoff from the drylot becomes contaminated with manure solids and must be collected to prevent clean surface water from becoming contaminated. The cost model calculates the volume of runoff that must be accommodated in the storage facility. Runoff is the only liquid waste to be stored at beef feedlots. The cost model assumes calves and heifers at dairies are kept on drylots (under Options 1 through 7) while the mature dairy cattle are kept in confinement barns; therefore, the runoff from the calf and heifer drylot is included in the dairy wastewater for these options. Veal cattle are kept in confinement barns rather than drylots; therefore, it is assumed that contaminated runoff is negligible.

3.3.1 Precipitation Runoff Estimates

The annual precipitation for each region is calculated using monthly precipitation values from the National Climatic Data Center (NCDC, 1999). The monthly data are summed to obtain a yearly precipitation rate. Yearly rates were averaged by state and then by region. Annual evaporation is estimated from a map of mean annual lake evaporation (MWPS, 1997). The net annual precipitation is then calculated as the difference between annual precipitation and annual evaporation. The monthly rainfall is also used to determine the net rainfall for the wettest six months, which is used to size the lagoons and storage ponds. Rainfall depth for the 25-year, 24-hour design storm and the 100-year, 24-hour design storm is estimated from map contour lines (MWPS, 1997). The average net precipitation depth and the peak storm depth are used in the cost model to estimate total drylot runoff and direct precipitation to storage ponds and lagoons.

3.3.2 Drylot Area Estimates

The area of the drylot is used to determine the runoff. Only runoff from the drylot is considered to be contaminated with manure solids; therefore, it requires collection and storage. Table 3-6 presents the range of drylot area for each animal type.

Table 3-6

Drylot Area Required by Animal Type[1]

Animal Type	Area Required per Animal (ft^2)
Calves	150-300
Heifers	250-500
Beef Cattle	300-500

[1]Information taken from Midwest Plan Service - 6, Beef Housing and Equipment Handbook for unpaved lots with mounds.

The cost model assumes the area required for each animal type equals the average area of each range plus an additional 15% for storage and handling facilities and feed silage areas (George, 1999). The following equation is used to calculate total drylot area per animal:

$$\text{Drylot Area (ft}^2\text{/animal)} = \text{Average Area} + (0.15 \times \text{Average Area})$$

Table 3-7 lists the calculated drylot areas used in the cost model. The total drylot area for each model farm is calculated by multiplying the average area per animal type by the average number of head at the operation, as shown in Table 1-2.

Table 3-7

Drylot Area Required by Animal Type Used in the Cost Model

Animal Type	Area Required per Animal (ft^2)
Calves	259
Heifers	431
Beef Cattle	460

3.3.3 Total Runoff

The precipitation and area of the drylot are used to determine the total amount of runoff from the drylot. The cost model assumes 40% of the total precipitation over the storage period will run off a drylot that is 20% paved (Shuyler, 1999):

$$R = 0.4 \times P \times A$$

where:

where:	R	=	Runoff volume (ft^3)
	P	=	Precipitation for the wettest six months (ft)
	A	=	Drylot area (ft^2)

Table 3-8 shows the volumes for the six-month runoff by model farm and by region. The cost model uses these volumes to size settling basins, ponds, and lagoons.

Table 3-8

Six-Month Runoff Volumes

Animal Type	Size Class	Wettest Six-Month Runoff (ft^3) by Region				
		Central	Mid-Atlantic	Midwest	Pacific	South
Beef	Medium1	61,180	197,984	103,040	213,900	235,428
	Medium2	110,940	359,011	186,846	387,872	426,909
	Large1	267,970	867,170	451,320	936,880	1,031,170
	Large2	4,466,650	14,454,480	7,522,780	15,616,480	17,188,210
Stand-Alone Heifer Operations	Medium1	38,238	123,740	64,400	133,688	147,143
	Medium2	71,695	232,013	120,750	250,664	275,892
	Large1	143,391	464,025	241,500	501,328	551,784
Dairy (Heifers and Calves)	Medium1	10,783	34,895	18,161	37,700	41,494
	Medium2	21,107	68,304	35,549	73,796	81,223
	Large1	20,830	210,700	109,660	227,640	250,550

The cost model also calculates runoff volumes from the 25-year, 24-hour storm (for Options 1 through 7) and the 100-year, 24-hour storm (for Option 8). The volume of runoff for a single storm event is calculated using the equation below, which assumes the first half-inch of rain is absorbed by the drylot (MWPS, 1993):

$$R = (P - 0.5) / (12 \text{ in/ft}) \times A$$

where:

	R	=	Runoff volume (ft^3)
	P	=	Precipitation in)
	A	=	Drylot area (ft^2)

Table 3-9 shows the runoff volumes for a 25-year, 24-hour storm by model farm and by region, and Table 3-10 shows the runoff volumes for the 100-year, 24-hour storm by model farm. The cost model uses these volumes to size settling basins, ponds, and lagoons.

Table 3-9
25-year, 24-hour Runoff Values

Animal Type	Size Class	Runoff (ft^3) by Region				
		Central	Mid-Atlantic	Midwest	Pacific	South
Dairy (Heifers and Calves)	Medium1	14,188	19,863	18,242	38,511	30,403
	Medium2	27,773	38,882	35,780	75,383	59,513
	Large1	85,670	119,940	110,150	232,540	183,580
Heifers	Medium1	50,313	70,438	64,688	136,563	107,813
	Medium2	94,336	132,070	121,289	256,055	202,148
Beef	Medium1	80,500	112,700	103,500	218,500	172,500
	Medium2	145,973	204,363	187,680	396,213	312,800
	Large1	352,590	493,630	453,330	957,030	755,550
	Large2	5,877,170	8,228,040	7,556,360	15,952,320	12,593,938

Table 3-10
100-year, 24-hour Runoff Values

Animal	Size Group	Central	Mid-Atlantic	Midwest	Pacific	South
Dairy	Medium1	18,242	24,728	22,296	46,618	34,457
	Medium2	35,708	48,403	43,643	91,253	67,448
	Large1	110,150	149,314	134,628	281,494	208,061
Heifers	Medium1	64,688	87,687	79,063	165,313	122,188
	Medium2	121,289	164,414	148,242	309,961	229,102
	Large1	242,578	328,828	296,484	619,922	458,203
Beef	Medium1	103,500	140,300	126,500	264,500	195,500
	Medium2	187,680	254,411	229,387	479,627	354,507
	Large1	453,330	614,514	554,070	1,158,510	856,290
	Large2	7,556,363	10,243,069	9,235,554	19,310,704	14,273,129

4.0 COST MODULES

Cost modules calculate the direct capital and annual costs for installing, operating, and maintaining a particular technology or practice for a beef feedlot, stand-alone heifer operation., dairy operation, or veal operation. Each cost module determines an appropriate design of the system component based on the characteristics of the model farm and the specific regulatory option. Waste volumes generated in the wastewater, manure, and runoff input modules described in Section 3.0 are used to size equipment and properly estimate the direct capital costs for purchasing and installing equipment and annual operating and maintenance (O&M) costs.

Estimates of capital and annual cost components are based on information collected from vendors, literary references, EPA site visits, and/or estimates based on engineering judgment. The following subsections describe each technology cost module used as a basis for the regulatory options and specifically discuss the following:

- Description of the technology or practice;
- Prevalence of the technology or practice at animal feeding operations;
- Design;
- Costs; and
- Results for component costs for the technology or practice.

Appendix A of this report contains output tables of capital and annual costs (in 1997 dollars) for each cost module.

4.1 Earthen Settling Basins

Earthen settling basins are used at animal feeding operations to remove manure solids, soil, and other solid materials from wastewater prior to storage (e.g., a pond) or further treatment (e.g., a lagoon). In the cost model, earthen basins are used at beef feedlots and stand-alone heifer operations to collect runoff. Because high wastewater flows from flushing operations could cause erosion in the earthen basin, concrete settling basins, discussed in Section 4.2, are used at dairies and veal operations to collect barn and milking parlor wastewater. An earthen settling basin is costed for beef feedlots and stand-alone heifer operations for all regulatory options.

4.1.1 Technology Description

An earthen basin is a shallow basin that is designed for accumulation of solids. Earthen basins receive raw wastewater from beef feedlots. The basin allows solids to settle and liquids to drain. Generally, the basin is designed to handle a wastewater flow velocity less than 1.5 feet per second, which is sufficiently slow enough to allow solids to settle. Periodic removal of the accumulated solids is necessary; therefore, access to the earthen basin must be provided for a frontend loader or tractor. (The costs for periodic solids removal is included in the annual costs, which is presented as a percent of the total capital costs.) A properly designed settling basin is capable of removing approximately 50% of the solids from the effluent (MWPS, 1987).

4.1.2 Prevalence of the Technology in the Industry

All regulatory options assume an earthen basin is required for collection of runoff from beef feedlots and stand-alone heifer operations. It is assumed that dairies and veal operations have concrete basins instead of earthen basins due to the higher flow of water from the barn and parlor cleaning operations that enter the settling basin.

Not all beef feedlots and stand-alone heifer operations are expected to have in place a properly sized settling basin. Some of these operations have no settling basin in place. From site visits and NAHMS data, EPA estimated the percentage of operations that do not currently have properly sized earthen basins in place. Table 4-1 lists the percentage of beef feedlots and stand-alone heifer operations that would incur costs for earthen basins by size class and region.

Table 4-1

Percentage of Beef Feedlots and Stand-Alone Heifer Operations Incurring Earthen Basin Costs for All Regulatory Options

Animal Type	Size Class	Region				
		Central	Midwest	Mid-Atlantic	Pacific	South
Beef	Medium1	67%	67%	67%	67%	67%
	Medium2	67%	67%	67%	67%	67%
	Large1	60%	60%	60%	60%	60%
	Large2	60%	60%	60%	60%	60%
Heifers	Medium1	67%	67%	67%	67%	67%
	Medium2	67%	67%	67%	67%	67%
	Large1	60%	60%	60%	60%	60%

4.1.3 Design

Earthen basins are designed to capture runoff from the beef feedlot and are rectangular in shape. The four sides are sloped at a 4:1 (horizontal:vertical) ratio to prevent erosion and allow for front-end loader access to remove solids. Earthen basins are constructed of soils which have a significant clay content (usually at least 10%). Figure 4.1-1 shows side views of the basin.

The earthen basin is constructed by excavating part of the volume required and building embankments to construct the remaining basin volume. The variables in Figure 4.1-1 are defined as follows:

h_e = height of embankment
h = height (depth) of basin
w_e = width of embankment
w_b = width at bottom of basin
w_s = width at surface of basin
l_b = length at bottom of basin
l_s = length at surface of basin

Table 4-2 summarizes the default design criteria used in the cost model.

Table 4-2

Design Parameters for Earthen Basins

Parameter	Value
Total height (depth) required (h)	4 feet
Side slopes (horizonal:vertical) (s)	4:1
Bottom width (w_b)	12 feet
Width of embankment (w_e)	6 feet

Midwest Plan Service Structures and Environment Handbook, 1974

The remaining portion of this subsection describes the methods used to calculate the other basin dimensions listed on Figure 4.1.

Earthen Basin Influent and Effluent Flows

The design volume of the earthen basin is based on the peak runoff entering the basin, which is equal to the peak runoff from a 10-year/1-hour storm event for all regulatory options. Section 3.4 describes the details of the runoff calculation. In addition, it is assumed that runoff contains 1.5% solids (MWPS, 1993); therefore, the total amount of water and solids entering the earthen basin are calculated as follows:

Water Entering = (Peak) × (1 - 0.015)
Solids Entering = (Peak) × (0.015)

where: Peak = Peak runoff during 10-year/1-hour storm event

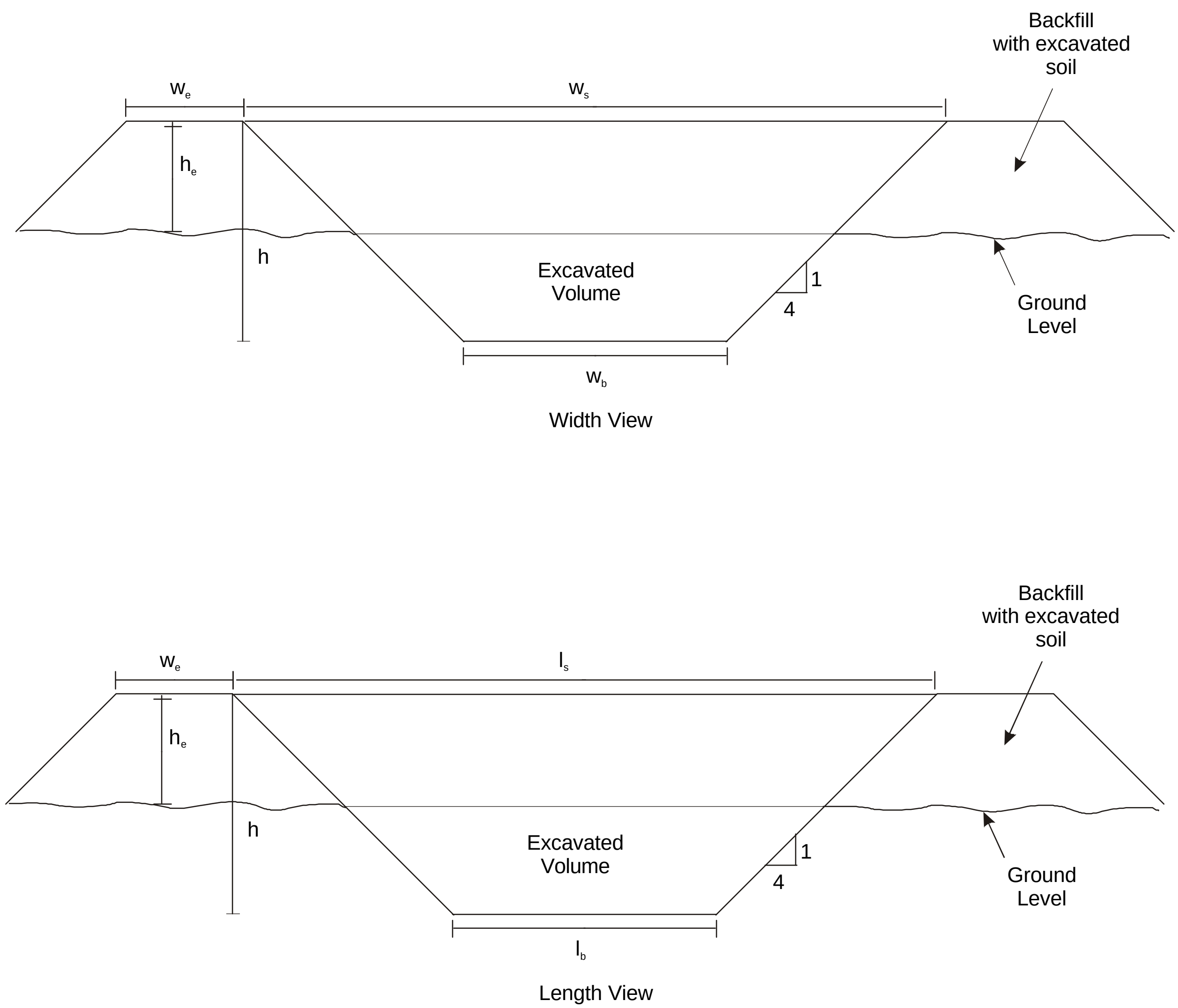


Figure 4-1. Cross-Section of an Earthen Basin

For the cost model calculations, it is assumed that earthen basins have a settling efficiency of 50%, and the moisture content of the settled solids is 80 percent (Fulhage and Pfost, 1995). Solids separators can have a solids separation efficiency between 35% (for mechanical separators) and 60% (gravity settling basins) (Fulhage and Phost, 1995); therefore, EPA estimated that most solids separators used in this industry are settling basins, and used a settling efficiency of 50%. The amount of water and solids in the settled solids and basin effluent are calculated from the following equations:

Settled Solids = Solids Entering × 0.5
Water in Settled Solids = Settled Solids × [0.8/(1- 0.8)]

Solids Exiting = Solids Entering - Settled Solids
Water Exiting = Water Entering - Water in Settled Solids

The above equations are used to calculate the amount of solids and water that leave the earthen basin and enter a storage pond (see Section 4.3); these calculations are not used in calculating the volume of the basin.

Earthen Basin Volume

The required volume of the basin is calculated from the following equation (MWPS, 1987):

$$\text{Volume}_{basin} = \text{Surface Area} \times h$$

where:

Surface Area = Peak/4
h = Basin depth (Table 4-2 value)

Solids from the basin are removed frequently to prevent significant accumulation, and therefore, accumulated solids are not included in the volume calculations. Table 4-3 presents a summary of the earthen basin design volumes calculated for all regulatory options by model farm.

Earthen Basin Dimensions

For the cost model calculations, it is assumed that the earthen basin has four sloped sides with a rectangular base. To determine the dimensions of the basin, the design volume of the basin is used with the design parameters shown in Table 4-2. The following equation is used to determine the length of the basin:

$$Volume_{basin} = ½\ h\ [A_1 + A_2 + (A_1\ A_2\ )^{0.5}]$$

$$Volume_{basin} = ½\ h\ [l_b\ W_b + l_s\ W_s + (l_bW_bl_sW_s)^{0.5}]$$

where:	A_1	=	Area of the bottom base	=	$l_b\ W_b$
	A_2	=	Area of the top (surface area)	=	$l_s\ W_s$

Earthen Basin Floor Surface Area

The surface area of the floor of the basin is calculated to determine the area for compaction. The surface area includes the bottom area plus the area of the four trapezoids that make up the sides of the basin. Figure 4-2 depicts the surfaces of the sloped sides.

The surface area of the sloped sides is calculated using the formula for the area of a trapezoid.

$$\text{Area of Side} = ½\ HS\ (a + b)$$

where:	HS	=	Height of the side (see equation below)
	a	=	Bottom width (1_b or w_b)
	b	=	Top width (1_s or w_s)

The height of the side is calculated using the Pythagorean Theorem,

$$HS = (h^2 + (4h)^2)^{0.5}$$

The total surface area of the basin is:

$$\text{Surface Area}_{basin} = l_b\, W_b + 2\,[0.5 \times HS\,(l_b + l_s)\,] + 2\,[0.5 \times HS\,(w_b + w_s)]$$

Earthen Basin Excavation and Embankment Volumes

Earthen basins are constructed by excavating a portion of the necessary volume and building embankments around the perimeter of the basin to make up the total design volume. The cost model performs an iteration to maximize the use of excavated material used in constructing the embankments that minimizes the costs for construction. The excavation volume is represented by the following equation:

$$Vol_{extracted} = 0.5\,(h - h_e)\,[l_b w_b + l_s w_s + (l_b w_b l_s w_s)^{0.5}]$$

The excavated soil is used to build the embankments. Because some settling of the soil will occur, it is assumed that an extra 5% of volume is required. The embankment volume is represented by the following equation:

$$Vol_{embankment} = 2\,[(1.05\,h_e w_e + s\,(1.05\,h_e)^2)\,(l_b + 2\,\,sh)] + 2\,[(1.05\,h_e w_e + (1.05\,s)^2\,h_e^{2})\,(w + 2sh)]$$

The dimensions of the basin which yield the desired volume are calculated by the cost model.

Table 4-3

Earthen Basin Volume by Model Farm for All Regulatory Options

Animal Type	Size Class	Earthen Basin Volume (ft^3) by Region				
		Central	Midwest	Mid-Atlantic	Pacific	South
Beef	Medium1	858	3,720	3,453	2,410	6,046
	Medium2	3,078	10,857	10,135	7,329	17,192
	Large1	8,077	26,815	25,131	18,315	42,157
	Large2	141,617	454,190	425,776	312,123	709,936
Heifer	Medium1	777	3,453	3,212	2,250	5,645
	Medium2	1,848	6,848	6,393	4,575	10,964
	Large1	4,121	14,145	13,236	9,601	22,351

NA - Not applicable. No regulatory options include this component for this model farm.

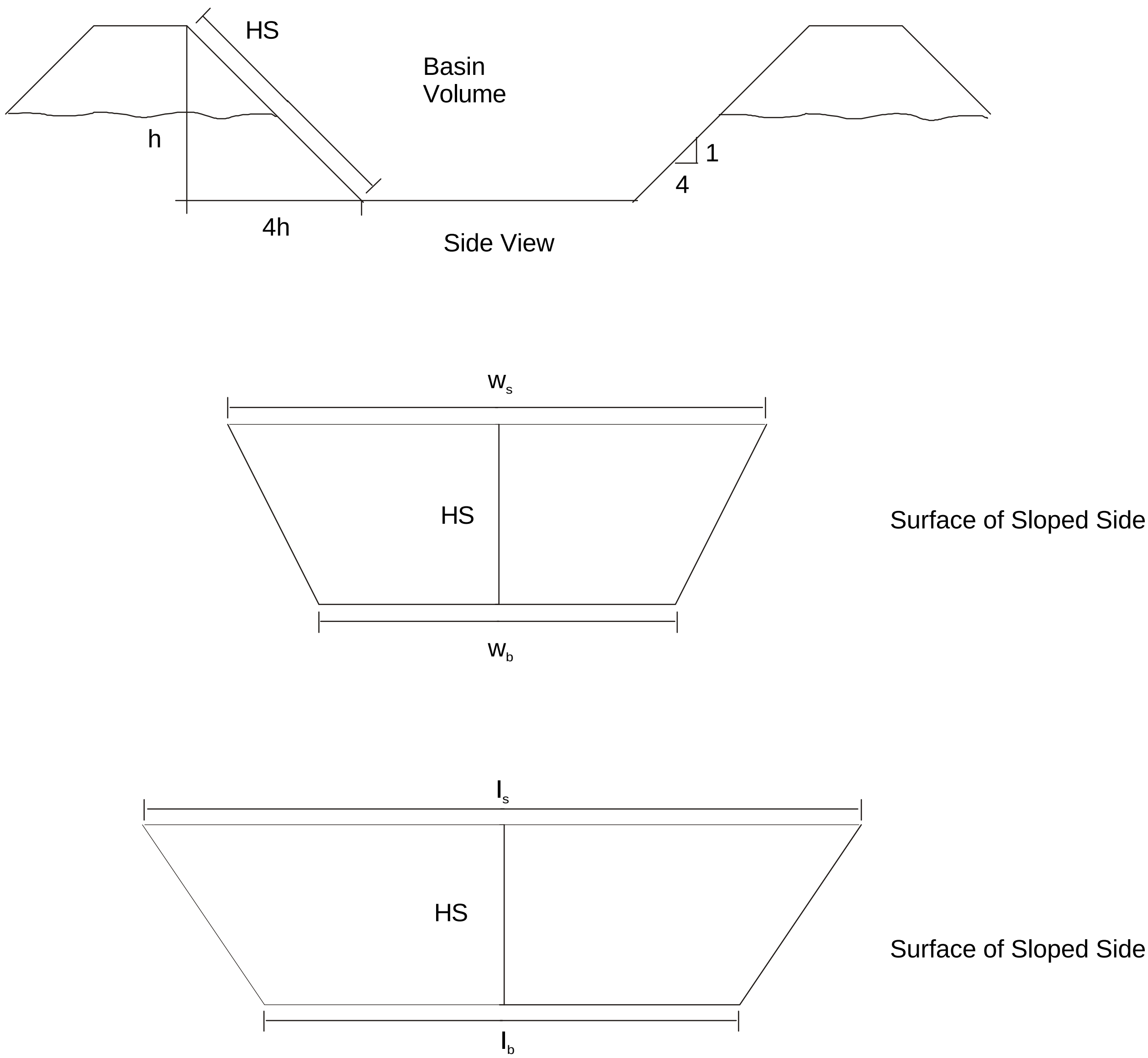


Figure 4-2. Sloped Sides of Earthen Basin

4.1.4 Costs

Capital costs for the construction and installation of the earthen basin consist of mobilization, excavation, and compaction. The unit costs for each of these elements are listed in Table 4-4.

The excavation cost is calculated from the following equation:

$$\text{Excavation Cost} = \text{Excavation Unit Costs } (\$/yd^3) \times \text{Volume}_{excavated}\ (ft^3) / (27\ ft^3/yd^3)$$

Table 4-4

Unit Costs for Earthen Basins

Unit	Cost (1997 dollars)	Source[1]
Backhoe mobilization	$204.82/event	Means 1999 (022 274 0020)
Excavating	$2.02/yd^3$	Means 1999 (022 238 0200)
Compaction	$0.41/yd^3$	Means 1996 (022 226 5720)

[1]Information taken from Means Construction Data. The numbers in parentheses refer to the division number and line number.

The total volume of soil that is compacted includes the surface area times a 1-foot compaction depth plus the entire volume of the embankment because it is compacted as placed.

$$\text{Volume}_{compacted}\ (ft^3) = [\text{Surface Area}_{basin}\ (ft^2) \times 1\ ft] + \text{Volume}_{embankment}\ (ft^3)$$

$$\text{Compaction Cost} = [\text{Compaction Unit Costs } (\$/yd^3) \times \text{Volume}_{compacted}\ (ft^3) / (27\ ft_3/yd_3)]$$

Total Capital Costs

The total capital cost for the earthen basin is calculated using the following equation:

$$\text{Capital Cost} = \text{Mobilization Cost} + \text{Excavation Cost} + \text{Compaction Cost}$$

Total Annual Costs

Based on best professional judgement, it is estimated that annual operating and maintenance costs are 5% of the total capital costs.

Annual Cost = 0.05 × (Capital Cost)

4.1.5 Results

The cost model results for constructing an earthen basin are presented in Appendix A, Table A-1.

4.2 Concrete Gravity Settling Basins

Concrete gravity settling basins, also called concrete sedimentation basins, are used at animal feeding operations to remove manure solids, soil, and other solid materials from wastewater prior to storage (e.g., a pond) or further treatment (e.g., a lagoon). In this cost model, concrete settling basins are used at dairies to collect barn and milking parlor wastewater because the higher wastewater flows could cause significant erosion in an earthen basin. A concrete gravity settling basin is costed for all dairies for all regulatory options.

4.2.1 Technology Description

The settling basin is a shallow basin or pond that is designed for accumulation of solids. The purpose of a settling basin is to slow wastewater flow sufficiently to allow solids to settle and liquids to drain. In general, reducing the flow velocity to less than 1.5 feet per second is sufficient to allow solids to settle. Access to the settling basin must be provided for periodic removal of solids. Solids separators can have a solids separation efficiency between 30% (for mechanical separators) and 60% (gravity settling basins)(Fulhage and Phost, 1995); therefore, EPA estimated that most solids separators used in this industry are settling basins, and used a settling efficiency of 50%.

Settling basins may be constructed from a variety of materials, including concrete. Concrete construction offers the advantage of added durability and stability of side slopes. Also, concrete construction facilitates the removal of solids with heavy equipment such as a front-end loader, which may drive onto a concrete settling basin floor. A concrete basin design is also advantageous in areas where soils are not suitable for earthen construction (e.g., areas where soils have a high sand content). Concrete basins are preferable to earthen basins to prevent erosion when high velocity wastewater flows are anticipated, such as at flush dairies.

4.2.2 Prevalence of the Technology in the Industry

Each regulatory option for dairies includes a concrete settling basin as part of the waste handling and treatment system. Solids separation is used at dairies to increase the storage volume available for wastewater in ponds and lagoons or to reduce the moisture content of the waste to make it more suitable for transport, disposal, composting, and other uses, such as bedding materials.

EPA expects that a percentage of dairies do not currently have a settling basin of this type installed and estimates this percentage for costing purposes. Estimates of the frequency of use of concrete settling basins at beef feedlots and dairies are made based on information obtained from site visits and NAHMS data. It is assumed that beef feedlots do not require concrete settling basins due the relatively low flow of wastewater which consists only of runoff from the feedlot. It is assumed that veal operations do not require concrete settling basins due to the low solids content of the waste. Table 4-5 lists the percentage of dairies that would incur costs for concrete basins by size class and region.

Table 4-5

Percentage of Dairy and Veal Operations Incurring Concrete Settling Basin Costs for All Regulatory Options

Animal Type	Size Class	Region				
		Central	Midwest	Mid-Atlantic	Pacific	South
Dairy	Medium1	80%	80%	80%	80%	80%
	Medium2	80%	80%	80%	80%	80%
	Large1	67%	67%	67%	67%	67%
Veal	Medium1	NA	NA	NA	NA	NA
	Medium2	NA	NA	NA	NA	NA

NA - Not applicable. No regulatory options include this component for this model farm.

4.2.3 Design

Wastes entering the concrete settling basin include manure from the mature dairy cattle, wastewater from the milk parlor, and flush water from the freestall barns. A settling basin is designed to handle peak wastewater flows (NRAES, 1989); for a dairy operation, the peak flows are assumed to occur during the flushing of one freestall barn. Settling basin size is dependent on the surface loading rate (i.e., the hydraulic load per unit of basin surface area) for agricultural wastewater; basin depth may be adjusted to allow for solids accumulation. It is assumed that wastewater flows to the settling basin via gravity.

The concrete settling basin design consists of a rectangular basin with a sloped ramp for front-end loader access (see Figure 4-3). The basin is 3 feet deep, allowing for 1 foot of solids accumulation. Rectangular concrete basins are typically designed with a 3:1 length-to-width ratio (NRAES, 1989). The sloped access ramp forms one side of the basin; however, additional length is required for the basin to have sufficient volume. The access ramp is sloped 1 inch fall per 1 foot run (MWPS, 1987). The concrete thickness is 6 inches (USDA, 1995c). The sub-base for the concrete floor and access ramp is prepared with 6 inches of compacted gravel fill

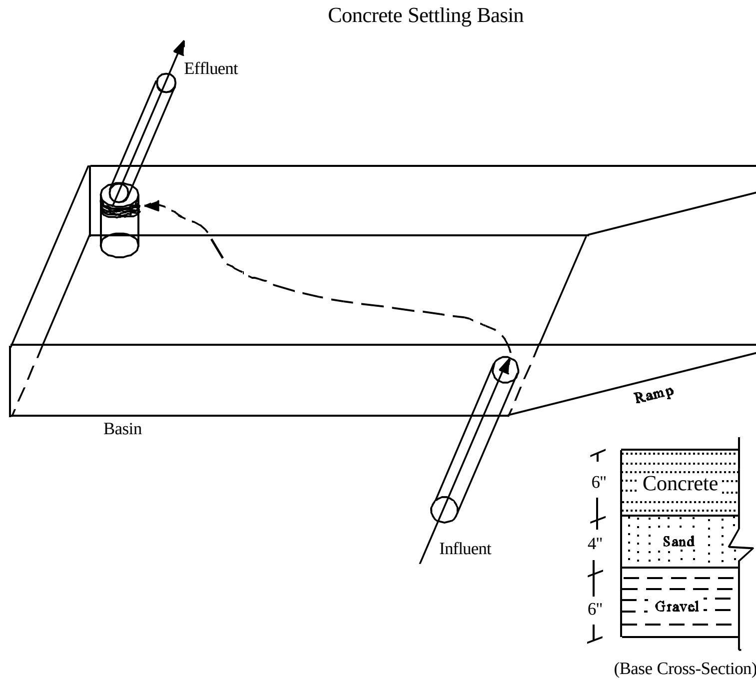


Figure 4-3. Concrete Settling Design

and 4 inches of graded sand fill. The concrete is shaped with wooden forms and reinforced with steel (#4 bars).

Concrete Basin Volume and Surface Area

The required area and volume of the basin are calculated from the Midwest Plan Service (MWPS, 1987) formulas below.

Surface Area = Peak/4
Volume = Surface Area × h

where:	h	=	Basin depth = 3 ft (Recommended depth is 2 feet plus depth required for solids storage. Depth of solids should not exceed 1.5 feet; therefore, assume 1 foot.) (Pfost and Fulhage, 1995).

Using the Pythagorean Theorem,

$$\text{Ramp Length} = (h^2 + run^2)^{1/2}$$

where:	Run	=	(h) (12 in/ft) (1 ft run/1 in fall)
	Surface Area of Ramp	=	(Ramp Length) (Basin Width)
	Volume Along Access Ramp	=	0.5 (Fall) (Run) (Basin Width)

Additional basin length is needed to account for the slope of ramp.

Length = 0.5 × Run of Ramp

$\text{Length}_{\text{settling basin}}$ (including access ramp) = Theoretical Length + Additional Length

$\text{Length}_{\text{settling basin}}$ (excluding access ramp) = Length of Basin - Run

Table 4-6 presents a summary of the concrete basin volumes calculated for flush and hose dairies by size group. Note that the basin design does not vary by region or regulatory option.

Table 4-6

Concrete Basin Volume by Model Farm for All Regulatory Options

Animal Type	Size Class	Concrete Basin Volume (ft^3)
Dairy - Flush	Medium1	7,069
	Medium2	13,837
	Large1	42,684
Dairy - Hose	Medium1	408
	Medium2	535
	Large1	821
Veal	Medium1	16,243
	Medium2	16,243

4.2.4 Costs

The capital costs for the construction and installation of the concrete settling basin include mobilization of the backhoe used for excavation, excavation of soil, compaction of the ground surface, hauling gravel and sand to the lot, purchasing the gravel and sand, grading the sand, the form work, reinforcement, and concrete for the walls, slab (including reinforcement), and finishing the slab. The unit costs for each of these components are presented in Table 4-7.

Table 4-7

Unit Costs for Concrete Settling Basin

Unit	Cost (1997 dollars)	Source[1]
Backhoe mobilization	$204.82/event	Means 1999 (022 274 0020)
Excavating	$2.02/yd^3$	Means 1999 (022 238 0200)
Hauling of material	$4.95/yd^3$	Means 1996 (022 266 0040)
Compaction	$0.41/yd^3$	Means 1996 (022 226 5720)
Gravel fill (6")	$9.56/yd^3$	Means 1998 (022 308 0100)
Sand fill	$48.55/yd^3$	Richardson 1996 (3-5 p1)
Grading sand	$1.73/ft^3$	Means 1999 (025 122 1100)
Wall form work	$4.90/ft^2$	Building news 1998 (03110.65)
Wall reinforcement bars	$0.45/ft	Richardson 1996 (3-5 p9)
Ready mix concrete	$63.70/yd^3$	Means 1998 (033 126 0200)
Slab on grade	$116.29/yd^3$	Means 1999 (033 130 4700)
Finishing slab (concrete)	$0.33/ft^2$	Means 1999 (033 454 0010)

[1] For Means Construction Data, the numbers in parentheses refer to the division number and line number.

The excavation cost is calculated from the following equations:

$$\text{Volume}_{\text{excavated}} = \text{Volume}_{\text{basin}} + \text{Volume}_{\text{ramp}} + \text{Volume}_{\text{subsurface}}$$

$$\text{Excavation Cost} = \text{Excavation Unit Costs } (\$/\text{yd}^3) \times \text{Volume}_{\text{exacavated}} \ (\text{ft}^3) / (27 \ \text{ft}^3/\text{yd}^3)$$

The total volume to be compacted includes the surface area of the basin and the ramp times a 1-foot compaction depth.

$$\text{Volume}_{\text{compacted}} = [\text{Surface Area}_{\text{basin}} \ (\text{ft}^2) + \text{Surface Area}_{\text{ramp}} \ (\text{ft}^2)] \ (1 \ \text{ft})$$

The total volume of gravel and sand needed is equal to the volume underneath the settling basin and the ramp.

$$\text{Volume}_{\text{gravel}} \ (\text{yd}^3) = [\text{Surface Area}_{\text{basin}} \ (\text{ft}^2) + \text{Surface Area Ramp } (\text{ft}^2)] \ (0.5 \ \text{ft}) \ (1 \ \text{yd}^3/27 \ \text{ft}^3)$$

$$\text{Volume}_{\text{sand}} \ (\text{yd}^3) = [\text{Surface Area}_{\text{basin}} \ (\text{ft}^2) + \text{Surface Area Ramp } (\text{ft}^2)] \ (0.33 \ \text{ft}) \ (1 \ \text{yd}^3/27 \ \text{ft}^3)$$

The volume of the material to be hauled includes the sand plus the gravel.

The concrete wall form work is calculated as follows:

$Area_{wall\ forms} = Area_{settling\ basin} + Area_{basin\ end} + Area_{ramp\ sides}$

Assuming that reinforcements are spaced every 12 inches along the length and width of the basin;. the total length of reinforcement is calculated as follows:

$Length_{reinforcement} = 2\ bars/ft \times [Surface\ Area_{basin} + Surface\ Area_{ramp}]$

The concrete volume for the walls and slab are calculated as follows:

$Volume_{concrete} = Area_{wall\ forms} \times Concrete\ Thickness$

$Volume_{concrete\ slab} = [Area_{floor} + Area_{ramp}] \times Concrete\ Depth$

The area of concrete to be finished is:

$Area_{concrete} = [Area_{floor} + Area_{ramp}]$

Total Capital Costs

The cost for construction of the concrete settling basin is calculated by summing the components above and multiplying them by the unit costs listed in Table 4-7. The total capital cost is:

Capital Cost = Mobilization + Excavation + Compaction + Hauling (sand and gravel) + Gravel Fill + Sand Fill + Grading Sand + Walls (form work, reinforcement, concrete) + Concrete Slab + Slab Finishing

Total Annual Costs

Based on best professional judgement, it is assumed that annual operating and maintenance costs are 5% of the total capital costs based on best professional judgment.

Annual Cost = 0.05 × (Capital Cost)

4.2.5 Results

The cost model results for constructing a concrete gravity settling basin are presented in Appendix A, Table A-2.

4.3 Ponds

Waste storage ponds are frequently used at animal feeding operations to contain wastewater and runoff from contaminated areas. Manure and runoff are routed to the storage pond where the mixture is held until it can be used for irrigation or can be transported elsewhere. Solids settle to the bottom of the pond as sludge, which is periodically removed and land applied on site or off site. The liquid can be applied to cropland as fertilizer/irrigation, used for dust control, reused as flush water for animal barns, or transported off site. Section 4.14 discusses the costs associated with transporting waste off site, including the solids and liquids. Ponds are included in all regulatory options for beef feedlots and stand-alone heifer operations.

4.3.1 Technology Description

Storage ponds provide a location for long term storage of water and are appropriate for the collection of runoff. Ponds are typically located at a lower elevation than the animal pens or barns; gravity is used to transport the waste to the pond, which minimizes labor. Although ponds are an effective means of storing waste, no treatment is provided. Because ponds are open to the air, odor can be a problem.

Although ponds are not designed for treatment, there is some reduction of nitrogen and phosphorus in the liquid effluent due to settling and volatilization. Influent phosphorus settles to the bottom of the pond and is removed with the sludge. Influent nitrogen is reduced through volatilization to ammonia. Pond effluent can be applied to cropland as fertilizer/irrigation, reused as flush water for the animal barns, or transported off site. The sludge can also be land applied as a fertilizer and soil amendment.

4.3.2 Prevalence of the Technology in the Industry

Storage ponds are appropriate for use at operations that collect runoff and do not collect process water or manure flush water. Typically, beef feedlots and stand-alone heifer operations operate in this manner and have storage ponds for runoff collection. All cost options for beef feedlots and stand-alone heifer operations include a storage pond. Dairies and veal operations typically operate lagoons to provide treatment for the barn and milking parlor flush water; therefore, storage ponds are not costed for these operations. Ponds (and lagoons) costed for Options 1 through 6 are designed with 180 days of storage. Option 7 requires compliance with land application timing restrictions; therefore, storage capacity varies by region. Under Options 3 and 4, storage ponds are required to have a liner to prevent seepage of wastewater into groundwater.

Not all beef feedlots and stand-alone heifer operations are expected to have a storage pond currently in place. EPA estimates (from site visits and NAHMS data) the percentage of beef feedlots and stand-alone heifer operations that require the installation of a pond. In addition, EPA estimates the number of feedlots that require a liner for Options 3 and 4 and the number of feedlots that require additional pond capacity under the Option 7 requirements. Sections 4.3.2.1 through 4.3.2.3 detail the frequency factors used for storage ponds.

Naturally-Lined Ponds

Ponds without a synthetic or clay liner are currently more prevalent at beef feedlots and stand-alone heifer operations than are lined ponds. For the model facilities, it is assumed that all large beef feedlots and stand-alone heifer operations have a naturally-lined storage pond in place. Table 4-8 presents the percentage of beef feedlots and stand-alone heifer operations that would incur costs to install a naturally-lined pond.

Table 4-8

Percentage of Beef Feedlot and Stand-Alone Heifer Operations Incurring Naturally-Lined Pond Costs for Options 1, 2, 5, 6, and 7

Animal Type	Size Class	Region				
		Central	Mid-Atlantic	Midwest	Pacific	South
Beef	Medium1	50%	50%	50%	50%	50%
	Medium2	50%	50%	50%	50%	50%
	Large1	0%	0%	0%	0%	0%
	Large2	0%	0%	0%	0%	0%
Heifers	Medium1	50%	50%	50%	50%	50%
	Medium2	50%	50%	50%	50%	50%
	Large1	0%	0%	0%	0%	0%

Lined Ponds

Options 3 and 4 require the implementation of groundwater protection measures. Groundwater may be protected by installing a synthetic or clay liner in the storage pond. Ponds lined with a synthetic or clay liner are not as prevalent at beef feedlots as naturally-lined ponds. The cost model assumes that all storage ponds currently in place are naturally-lined and a fraction of these operations will require a liner. The frequency factors for lined ponds represent the percentage of operations that would require a liner due to the geography of the site (e.g., sandy soil type or hydrologic links from ground water to surface water). Table 4-9 presents the percentage of beef feedlot and stand-alone heifer operations that would incur costs for installing a lined pond.

Table 4-9

Percentage of Beef Feedlot and Stand-Alone Heifer Operations Incurring Lined Pond Costs for Options 3 and 4[1]

Animal Type	Size Class	Region				
		Central	Mid-Atlantic	Midwest	Pacific	South
Beef	Medium1	13%	24%	27%	12%	22%
	Medium2	13%	24%	27%	12%	22%
	Large1	13%	24%	27%	12%	22%
	Large2	13%	24%	27%	12%	22%
Heifer	Medium1	13%	24%	27%	12%	22%
	Medium2	13%	24%	27%	12%	22%
	Large1	13%	24%	27%	12%	22%

[1] EPA, 1999

Naturally-lined ponds are also costed in Options 3 and 4. The number of beef feedlot and stand-alone heifer operations incurring a cost for naturally-lined ponds represent the operations that do not currently have ponds and are located in an area where the hydrogeologic conditions do not favor seepage from the pond to surrounding areas.

Option 7 Naturally-Lined Ponds

Under Option 7, the storage pond capacity is determined based on manure land application restrictions. These restrictions prohibit the application of manure on frozen, snow-covered, or saturated soils. EPA estimates the number of days of storage capacity that are required by region under this option, shown in Table 4-10 (for detailed information on the determination for the number of storage days, see ERG, Inc. *Methodology to Calculate Storage Capacity Requirements Under Option 7 and Existing Capacity*. 2000). Operations that do not have a pond are costed for this full capacity, or a minimum of 180 days storage. The percentage of beef feedlot and stand-alone heifer operations that incur the full naturally-lined pond cost are presented in Table 4-8.

EPA also estimates the capacity of existing ponds, based on state regulations (ERG, 2000c). Operations with existing ponds are costed for an additional pond to provide the necessary storage capacity, as shown in Table 4-10. The percentage of beef feedlots that require additional capacity are presented in Table 4-11.

Table 4-10

Pond Storage Capacities at Beef Feedlot and Stand-Alone Heifer Operations for Option 7

Region	Required Storage Capacity (days)	Existing Storage Capacity (days)	Additional Pond Capacity Costed (days)
Central	180	50	130
Mid-Atlantic	225	80	145
Midwest	225	190	35
Pacific	135	30	105
South	45	45	0

Reference: ERG, *Methodology to Calculate Storage Capacity Requirements Under Option 7 and Existing Capacity*. Memorandum to EPA. 2000)

Table 4-11

Percentage of Beef Feedlot and Stand-Alone Heifer Operations Incurring Costs for Additional Naturally-Lined Pond Capacity for Option 7

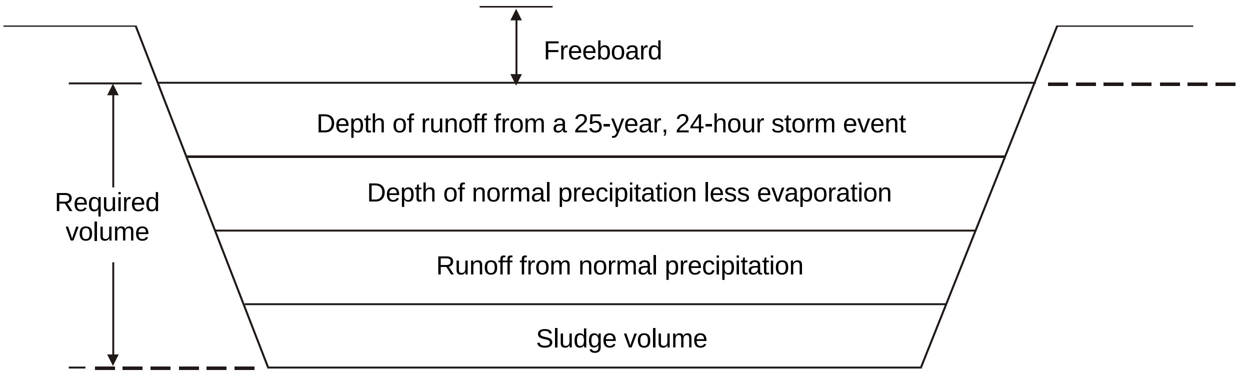
Animal Type	Size Class	Region				
		Central	Mid-Atlantic	Midwest	Pacific	South
Beef	Medium1	50%	50%	50%	50%	50%
	Medium2	50%	50%	50%	50%	50%
	Large1	100%	100%	100%	100%	100%
	Large2	100%	100%	100%	100%	100%
Heifer	Medium1	50%	50%	50%	50%	50%
	Medium2	50%	50%	50%	50%	50%
	large1	100%	100%	100%	100%	100%

4.3.3 Design

The cost model assumes only direct runoff or runoff that has gone through the settling basin enters the storage pond. Runoff will contain a portion of manure solids from the beef drylots. Ponds are typically constructed by excavating a pit and using the excavated soil to build embankments around the perimeter. An additional 5% is added to the required height of the embankments to allow for settling. The sides of the pond are sloped with a 1.5:1 or 3:1 (horizontal:vertical) ratio. Considerations are also made to avoid groundwater and soil contamination. Options 1, 2, and 5 through 7 assume the bottom and sides of the pond are constructed of soil that is at least 10% clay compacted with a sheepsfoot roller. Under Options 3 and 4, some facilities will require additional groundwater protection; therefore, a synthetic liner is included in the lagoon costs in addition to a compacted clay liner.

Storage ponds are designed using the following steps:

1) Determine the necessary pond volume. Storage ponds are designed to contain the following volumes (see Figure 4-4):



Source: Agricultural Waste Handbook

Figure 4-4. Cross-Section of a Storage Pond

- Sludge Volume: Volume of accumulated sludge between clean-outs (depends on the type and amount of animal waste);
- Runoff: The runoff from drylots for normal and peak precipitation;
- Net Precipitation: Annual precipitation minus the annual evaporation;
- Design Storm: The depth of the peak storm event; and
- Freeboard: A minimum of one foot of freeboard.

2) Determine the dimensions and configuration of the pond, depending on the regulatory option.

3) Determine the costs for constructing the pond, using the dimensions calculated in step 2.

Determination of Pond Volume

The pond volume is determined by the following equation:

Pond Volume = Sludge Volume + Runoff + Net Precipitation + Design Storm + Freeboard

The determination of each volume is discussed below.

Sludge Volume

The amount of sludge that accumulates between pond cleanouts varies based on the type and amount of animal waste. As manure decomposes in the pond, portions of the total solids do not decompose. A layer of sludge accumulates on the floor of the pond, which is proportional to the quantity of total solids that enter the pond. The sludge accumulation period is equal to the storage retention time of the pond. The rate of sludge accumulation is 0.0729 ft^3/lb (USDA, 1992).

$$\text{Sludge Volume} = 0.0729\ ft^3/lb \times \text{Runoff Solids (lb)}$$

Runoff

The amount of runoff entering the pond is determined from the average monthly precipitation amounts, using the wettest six-month consecutive period to calculate the average "wet" precipitation over the storage period. The amount of runoff is determined by adjusting the six-month wet precipitation to the required number of days of storage for the option. New ponds are costed under Options 1 through 6 for 180 days of storage. Option 7 storage requirements are presented in Table 4-10. In addition, the runoff contribution to the pond is reduced by the amount of water retained by the solids that settle out in the basin. The solids entering the earthen basin are 1.5% of the total runoff, while the solids entering the pond are 50% of the basin solids:

$$\text{Settled solids}_{\text{pond, influent}} = \text{Runoff} \times 0.015 \times 0.5$$

For the model calculations, it is assumed that settled solids have a moisture content of 80 percent; therefore, the runoff entering the pond is:

$$\text{Runoff}_{\text{pond, influent}} = [(\text{Runoff 6 mo./180 days}) \times \text{Required Storage Days}] - [\text{Settled Solids} \times 0.8/(1-0.8)]$$

The peak storm runoff is also included. Section 3.3 describes the details of the precipitation and runoff calculations.

Net Precipitation

The pond depth is increased to allow for direct net precipitation, calculated as the average precipitation minus the average evaporation over the storage period. The precipitation data are extracted from the National Oceanic and Atmospheric's National Climate Data Center web site (NCDC, 1999), and the evaporation data are extracted from Midwest Plan Service publications. The net precipitation contribution to the pond depth is equal to:

Net Precipitation = Average Precipitation - Average Evaporation

Design Storm

The depth of the peak storm event is added to the depth of the pond to account for direct precipitation. For Options 1 through 7, this peak storm event is the 25 year/24-hour storm. For Option 8, the peak storm event used is the 100 year/24-hour storm. Precipitation information for these storms was also extracted from the NCDC database.

Peak Precipitation =25-Year/24-Hour Precipitation or 100-year, 24-hour Precipitation

Freeboard

A minimum of one foot of freeboard is added to the depth.

Dimensions and Configuration of Pond

The pond is designed in the shape of an inverted frustum, containing the required volume. The depth of the pond is set as follows:

h = 10 feet + Net Precipitation + Freeboard (1 foot) + peak precipitation depth

The initial depth of the pond is set at 10 feet, based on discussions with industry consultants. The slope of the sides is set at 3 ft/ft. The width is solved by iteration, knowing the pond volume and the other variables in the equation. See Section 4.1.3 for the methodology in determining pond dimensions and configurations.

Pond Liners

For Options 3 and 4, ponds are designed with a liner for those operations located in areas requiring groundwater protection. The liner consists of clay soil with a synthetic liner cover. The dimensions of the liner are equal to the surface area of the floor and sides of the pond.

4.3.4 Costs

The construction of the storage pond includes a mobilization fee for the heavy machinery, excavation of the pond area, compaction of the ground and walls of the pond, and the construction of conveyances to direct runoff from the drylot area to the storage pond. Table 4-12 presents the unit costs used to calculate the capital and annual cost for constructing storage ponds.

Table 4-12

Unit Costs for Storage Pond

Unit	Cost (1997 dollars)	Source
Mobilization	\$205/event	Means 1999 (022 274 0020)[1]
Excavation	\$2.02/yd^3	Means 1999 (022 238 0200)[1]
Compaction	\$0.41/yd^3	Means 1996 (022 226 5720)[1]
Conveyance	\$7,644/event	ERG, 2000
Clay Liner	\$0.24/ft^2	George, 1999
Synthetic Liner	\$1.50/ft^2	Tetra Tech, 2000

[1] Information taken from Means Construction Data. The numbers in parentheses refer to division and line numbers.

The calculations for the costs associated with these items are shown below:

Excavation

To calculate the pond excavation costs, the volume of material that is excavated is first calculated, as described in Section 4.1.3. The excavated material is expected to be used to construct embankments around the pond, which will provide additional storage other than that volume which is excavated; therefore, the excavated volume is not equal to the pond volume; it is equal to the pond volume minus the storage that the embankments provide.

The excavation cost is calculated with the following equation:

$$\text{Excavation} = \$2.02/\text{yd}^3 \times \text{Volume}_{\text{excavated}}\ (\text{ft}^3) / (27\ \text{ft}^3/\text{yd}^3)$$

Compaction

To calculate compaction costs, the volume for compaction is calculated, as described in Section 4.1.3. The compaction cost is calculated with the following equation:

Compaction = \$0.41/yd^3 × Volume$_{compacted}$ (ft^3) / (27 ft^3/yd^3)

Liners

To calculate liner costs, the surface area of the basin floor and sidewalls is calculated, as described in Section 4.1.3. The liner cost includes both a clay and synthetic liner, and is calculated using the following equations:

Clay Liner = \$0.24/ft^2 × Surface Area

Synthetic Liner = \$1.50/ft^2 × Surface Area

Total Capital Costs

The total capital cost for construction of the naturally-lined storage pond is the following:

Capital Cost = Mobilization + Excavation + Compaction + Conveyance

The total capital cost for construction of the lined clay pond is the following:

Capital Cost = Mobilization + Excavation + Compaction + Conveyance + Clay Liner + Synthetic Liner

Total Annual Costs

Based on best professional judgement, annual operating and maintenance costs for both naturally-lined and lined storage ponds are estimated at 5% of the total capital costs.

Annual Cost = 0.05 × (Capital Cost)

4.3.5 Results

The cost model results for constructing a naturally-lined storage pond, a synthetically-lined storage pond, and additional ponds for extra capacity (Option 7) are presented in Appendix A, Tables A-3, A-4, and A-5, respectively.

4.4 Lagoons

Anaerobic lagoons are used at dairies and veal operations to collect process water and flush water, which contain manure waste. Anaerobic microbiological processes promote decomposition, thus providing treatment for wastes with high biochemical oxygen demand (BOD), such as animal waste. Manure, process water, and runoff are routed to the lagoon where the mixture undergoes treatment. New lagoons also provide storage capacity until the waste can be applied to cropland as fertilizer/irrigation or transported off site. Section 4.14 discusses the costs associated with transporting waste off-site, including solids and liquids. Lagoons are included in all regulatory options for dairies and veal operations, except Option 6 which replaces the lagoon with an anaerobic digester (see Section 4.6).

4.4.1 Technology Description

Anaerobic lagoons provide storage for animal wastes while decomposing and liquefying manure solids. Anaerobic processes degrade high BOD wastes into stable end products without the use of free oxygen. Nondegradable solids settle to the bottom as sludge, which is periodically removed. The liquid is applied to on-site cropland as fertilizer/irrigation, or it is transported off site. The sludge can also be land applied as a fertilizer and soil amendment. Anaerobic lagoons can handle high pollutant loading rates while minimizing manure odors. Properly managed lagoons have a musty odor.

Lagoons reduce the concentrations of both nitrogen and phosphorus in the liquid effluent. Phosphorus settles to the bottom of the lagoon and is removed with the lagoon sludge. Approximately 70 to 80% of the influent nitrogen is reduced through volatilization to ammonia.

Anaerobic lagoons offer several advantages over other methods of storage and treatment. Anaerobic lagoons can handle high loading rates and provide a large volume for long term storage of liquid wastes. Lagoons treat the manure by reducing nitrogen and phosphorus in the effluent. Lagoons allow manure to be handled as a liquid. Lagoons are typically located at a lower elevation than the animal barns; gravity is used to transport the waste to the lagoon, which minimizes labor.

4.4.2 Prevalence of the Practice in the Industry

Anaerobic lagoons are appropriate for use at operations that collect high BOD waste, such as milking parlor flush or hose water and flush barn water. Typically, dairies and veal operations operate in this manner and have lagoons for wastewater storage. The cost model assumes all dairies and veal operations require anaerobic lagoons and beef feedlot and stand-alone heifer operations require a storage pond. Lagoons costed for Options 1 through 6 are designed with 180 days of storage. Option 7 requires compliance with land application timing restrictions; therefore, storage capacity varies by region. Lagoons may also require a liner to prevent seepage of wastewater into groundwater.

Not all dairy operations are expected to have a lagoon currently in place. EPA estimates the percentage of dairies that would require the installation of a lagoon based on site visits and NAHMS data (USDA, 1995b, 1996a, 1996b). In addition, EPA estimates the number of dairies and veal operations that require a liner for Options 3 and 4 and the number of facilities that require additional lagoon capacity under Option 7. Based on site visits, EPA assumes all veal operations have sufficient storage, such as lagoons, currently in place. Sections 4.4.2.1 through 4.4.2.3 detail the frequency factors used for lagoons.

Naturally-Lined Lagoons

Naturally-lined lagoons are more prevalent at dairies and veal operations than synthetically-lined lagoons. For this cost model, it is estimated that all large dairies and veal operations have a naturally-lined lagoon in place. Table 4-13 presents the percentage of dairy and veal operations that would incur costs for installing a naturally-lined lagoon.

Table 4-13

Percentage of Dairies and Veal Operations Incurring Naturally-Lined Lagoon Costs for Options 1, 2, 5, 6, and 7

Animal Type	Size Class	Region				
		Central	Mid-Atlantic	Midwest	Pacific	South
Dairy	Medium1	10%	10%	10%	10%	10%
	Medium2	10%	10%	10%	10%	10%
	Large1	0%	0%	0%	0%	0%
Veal	Medium1	0%	0%	0%	0%	0%
	Medium2	0%	0%	0%	0%	0%

NA - Not applicable. No regulatory options include this component for this model farm.

Lined Lagoons

Options 3 and 4 require the implementation of groundwater protection measures. Groundwater can be protected by installing a synthetic or clay liner in the lagoon. Ponds lined with a synthetic or clay liner are not as prevalent in dairies or veal operations compared to naturally-lined ponds. The cost model assumes that all lagoons currently in place are naturally-lined and that a fraction of these operations will require additional lining protection. The frequency factors for synthetically-lined lagoons represent the percentage of operations that would require additional lining protection due to the geography of the site (e.g., sandy soil type or hydrologic links from groundwater to surface water). Table 4-14 presents the percentage of dairy and veal operations that would incur costs for installing a synthetically-lined lagoons.

Table 4-14

Percentage of Dairies and Veal Operations Incurring Lined Lagoon Costs for Options 3 and 4[1]

Animal Type	Size Class	Region				
		Central	Mid-Atlantic	Midwest	Pacific	South
Dairy	Medium1	13%	24%	27%	12%	22%
	Medium2	13%	24%	27%	12%	22%
	Large1	13%	24%	27%	12%	22%
Veal	Medium1	0%	0%	0%	0%	0%
	Medium2	0%	0%	0%	0%	0%

[1] EPA, 1999

Naturally-lined lagoons are also costed in Options 3 and 4. The number of operations incurring a cost for naturally-lined lagoons represent the operations which are located in an area where the soil has a sufficiently high clay content to act as an impermeable barrier. The percentage of dairy and veal operations incurring costs for naturally-lined lagoons in Options 3 and 4 is calculated by subtracting the frequency factor for synthetically-lined ponds (Table 4-13) from the frequency of naturally-lined ponds for Options 1, 2, 5, 6, and 7 (Table 4-14).

Option 7 Naturally-Lined Lagoons

Under Option 7, additional lagoon capacity is required due to manure application restrictions. These restrictions prohibit the application of manure on frozen, snow-covered, or saturated soils. EPA estimates the number of days of storage capacity that are required by region under this option (ERG, 2000c). These capacities are presented in Table 4-15. It is assumed that veal operations currently have sufficient storage capacity. Operations that do not have a lagoon are costed for this capacity, or a minimum of 180 days storage. The percentage of dairies that incur the full lagoon cost are presented in Table 4-13.

EPA also estimates the capacity of existing lagoons, based on state regulations ERG, 2000c). Operations with existing lagoons are costed for an additional lagoon to provide the necessary storage capacity as shown in Table 4-15. It is assumed that veal operations have sufficient capacity. The percentage of dairy and veal operations that require additional capacity are presented in Table 4-16.

Table 4-15

Lagoon Storage Capacities at Dairies for Option 7

Region	Required Storage	Existing Storage	Additional Pond
Central	180	60	120
Mid-Atlantic	225	30	195
Midwest	225	90	135
Pacific	135	30	105
South	45	30	15

Reference: ERG, *Methodology to Calculate Storage Capacity Requirements Under Option 7 and Existing Capacity.* Memorandum to EPA. 2000)

Table 4-16

Percentage of Dairies and Veal Operations Incurring Costs for Additional Naturally-Lined Lagoon Capacity for Option 7

Animal	Size Class	Region				
		Central	Midwest	Mid-Atlantic	Pacific	South
Dairy	Medium1	10%	10%	10%	10%	10%
	Medium2	10%	10%	10%	10%	10%
	Large1	100%	100%	100%	100%	100%
Veal	Medium1	0%	0%	0%	0%	0%
	Medium2	0%	0%	0%	0%	0%

4.4.3 Design

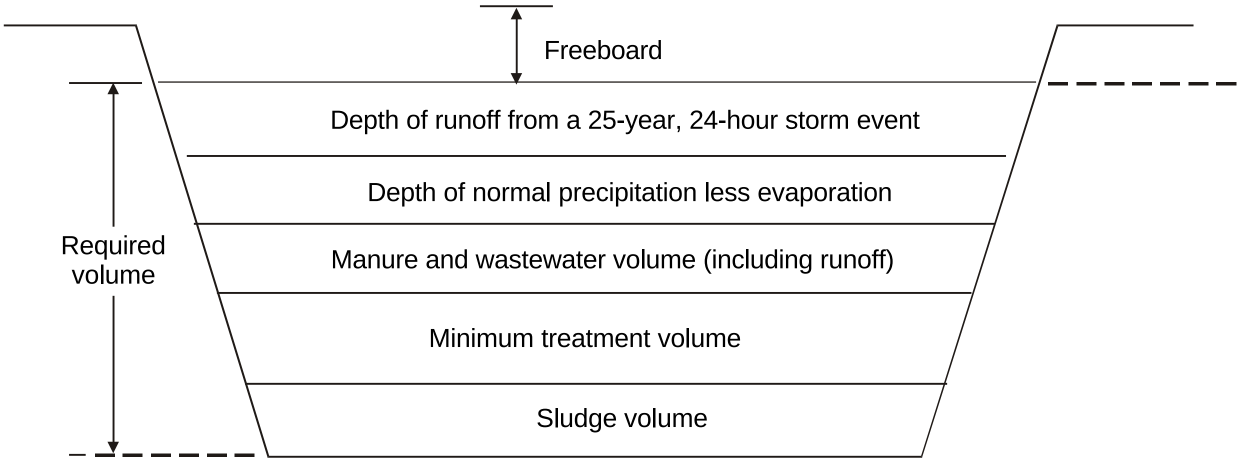
Anaerobic lagoons are designed based on volatile solids loading rates (VSLR). Volatile solids represent the amount of wastes that will decompose. Anaerobic lagoons are typically at least 6 to 10 feet in depth, although 8 to 20 foot depths are not unusual. Deeper lagoons require a smaller surface area, allow less area for volatilization, provide a more thorough mixing of lagoon contents by rising gas bubbles, and minimize odors. Lagoons are typically constructed by excavating a pit and building berms around the perimeter. The berms are constructed with an extra 5% in height to allow for settling. The sides of the lagoon are typically sloped with a 2:1 or 3:1 (horizontal:vertical) ratio.

Considerations are also made to avoid groundwater and soil contamination. Options 1, 2, 5, 6, and 7 assume the bottom and sides of the lagoon are constructed of soil that is at least 10% clay compacted with a sheepsfoot roller. Options 3 and 4 require additional groundwater protection; therefore, operations that are located in areas of high risk for groundwater contamination are costed for installation of a synthetic liner over a compacted clay liner.

Lagoons are designed for the cost model using the following steps:

1) Determine the necessary storage volume of the lagoon. Lagoons are designed to contain the following volumes (see Figure 4-5):

   - Sludge Volume:Volume of accumulated sludge between cleanouts (depends on the type and amount of animal waste);
   - Minimum Treatment Volume: Volume necessary to allow anaerobic decomposition to occur;
   - Manure and Wastewater: Milk parlor and flush barn wastewater and manure and runoff from drylots;
   - Net Precipitation: Annual precipitation minus the annual evaporation;
   - Design Storm: The depth of the peak storm event;
   - Freeboard: A minimum of one foot of freeboard; and
   - Runoff.



Source: Agricultural Waste Handbook

Figure 4-5. Cross-Section of an Anaerobic Lagoon

2) Determine the dimensions of the lagoon, given the required storage volume depending on the regulatory option.

3) Determine the costs for constructing the lagoon, using the dimensions calculated in step 2.

Determination of Lagoon Volume

The lagoon volume is determined by the following equation:

Pond Volume = Sludge Volume + Minimum Treatment Volume + Manure and Wastewater + Runoff + Net Precipitation + Design Storm + Freeboard

The determination of each volume is discussed below.

Sludge Volume

The amount of sludge that accumulates between lagoons cleanouts varies based on the type and amount of animal waste. As manure decomposes in the lagoon, portions of the total solids do not decompose. A layer of sludge accumulates on the floor of the lagoon, which is proportional to the quantity of total solids that enter the lagoon. The sludge accumulation period is equal to the storage retention time of the lagoon. The rate of sludge accumulation is 0.0729 ft^3/lb solids for dairy cattle (USDA, 1992).

$$\text{Sludge Volume } (ft^3) = 0.0729 \ ft^3/lb \times (\text{Separator Solids (lb)} + \text{Runoff Solids (lb)})$$

Minimum Treatment Volume (MTV)

The minimum treatment volume is based on the volatile solids loading rate (VSLR) which varies with temperature. The minimum treatment volume is calculated using the influent daily volatile solids loading from all sources, and a regional volatile solids loading rate per 1,000 cubic feet. The quantity of volatile solids (VS) entering the lagoon is calculated in the following equation:

$$\text{Separated VS Into Lagoon} = \text{Manure VS} - (\text{Manure VS} \times 0.50)$$

Therefore, the minimum treatment volume is calculated as follows:

$$\text{MTV} = \text{Daily Volatile Solids} \times 1000 \ / \ \text{VSLR}$$

The VSLR varies by region because the rate of solids decomposition in anaerobic lagoons is a function of temperature (USDA, 1992).

Manure and Wastewater Volume

Lagoons are designed to store manure and wastewater that is generated over a specific period of time, typically 90 to 365 days. Retention times used in the cost model are discussed above.

All of the manure and wastewater that is flushed or hosed from the dairy parlor or flush barn is washed to a concrete settling basin before it enters the lagoon (see Section 4.2). To calculate the influent to the lagoon over the storage period, the daily effluent from the separator is multiplied by the number of days of storage required. It is assumed that the barn flush water is recycled back to the barns from the lagoon; therefore, only one storage volume of barn flush water is added to the total influent over the whole storage period. It is assumed that the settling basin has a 50% solids removal efficiency, and the removed solids have a moisture content of 80 percent (based on best professional judgement). The following equations are used to calculate the influent to the lagoon:

Separator Water Into Lagoon = (Parlor Wash + Barn Wash + Manure Water) × Storage Days

Separator Water Out of Lagoon = Barn Wash × (Storage Days - 1)

Separator Water Into Lagoon for Storage =[(Parlor Wash + Barn Wash + Manure Water) × Storage Days] - (Barn Wash × (Storage Days - 1))

Separated Solids Into Lagoon = Manure Solids - (Manure Solids× 0.50)

Net Precipitation

The lagoon depth is increased to allow for the annual precipitation minus the annual evaporation. The precipitation data are extracted from the National Oceanic and Atmospheric Association's National Climate Data Center (NCDC) web site, and the evaporation data are extracted from Midwest Plan Service publications. The net precipitation contribution to the lagoon depth is equal to:

Net Precipitation = Six-Month Precipitation - Six-Month Evaporation

Design Storm

The depth of the peak storm event is added to the depth of the lagoon. This information is also extracted from the NCDC web site.

Peak Precipitation =25-year/24-hour Storm or 100-year, 24-hour Storm Precipitation

Freeboard

A minimum of one foot of freeboard is added to the depth.

Runoff

The amount of runoff entering the lagoon is determined by scaling the six-month wet precipitation to the required number of days of storage for the option. Options 1 through 6 assume 180 days of storage are necessary for new lagoons. Option 7 storage requirements are presented in Table 4-15. The peak storm runoff is also included in the storage requirements. Section 3.3 describes the details of the precipitation and runoff calculations.

The runoff solids make up 1.5 % of the total runoff from the drylot (MWPS, 1993).

$$\text{Runoff solids}_{\text{lagoon, influent}} = \text{Runoff} \times 0.015$$

Dimensions and Configuration of the Lagoon

The lagoon is designed in the shape of an inverted pyramid with a flat top, containing the required volume. The depth of the lagoon is set as follows:

$$h = 10 \text{ feet} + \text{Net Precipitation} + \text{Freeboard (1 foot)}$$

The slope of the sides (H) is set at 3 ft/ft. The width is solved by iteration, knowing the lagoon volume and the other variables in the equation. See Section 4.1.3 for the methodology on determining lagoon dimensions and configurations.

Lagoon Liners

For Options 3 and 4, lagoons are designed with a synthetic liner for those operations located in areas requiring groundwater protection. The costs assume that clay is brought on site in a truck (locally) and applied as a slurry to the lagoon basin. The liner system consists of clay soil with a synthetic line cover.

4.4.4 Costs

The construction of the storage lagoon includes a mobilization fee for the heavy machinery, excavation of the lagoon area, compaction of the ground and walls of the lagoon, and the construction of conveyances to direct runoff from the drylot area to the storage lagoon. Table 4-17 presents the unit costs used to calculate the capital and annual cost for constructing the storage lagoon.

Table 4-17

Unit Costs for Storage Lagoon

Unit	Cost (1997 dollars)	Source
Mobilization	\$205/event	Means 1999 (022 274 0020)[1]
Excavation	\$2.02/yd^3	Means 1999 (022 238 0200)[1]
Compaction	\$0.41/yd^3	Means 1996 (022 226 5720)[1]
Flush Wash Conveyance	\$11,025/system	ERG, 2000
Hose Wash Conveyance	\$7,644/system	ERG, 2000
Clay Liner (shipped & installed)	\$0.24/ft^2	George, 1999
Synthetic Liner (installed)	\$1.50/ft^2	Tetra Tech, 1999

[1]Information taken from Means Construction Data. The numbers in parentheses refer to division and line numbers.

The calculations for the cost associated with these items are shown below:

Excavation

To calculate the lagoon excavation costs, the volume of material that is excavated is first calculated, as described in Section 4.1.3. The excavated material is expected to be used to construct embankments around the lagoon, which will provide additional storage other than that volume which is excavated; therefore, the excavated volume is not equal to the lagoon volume. Instead, it is equal to the pond volume minus the storage that the embankments provide.

The excavation cost is calculated with the following equation:

$$\text{Excavation} = \$2.02/\text{yd}^3 \times \text{Volume}_{\text{excavated}}\ (\text{ft}^3) / (27\ \text{ft}^3/\text{yd}^3)$$

Compaction

To calculate compaction costs, the volume for compaction is calculated, as described in Section 4.1.3. The compaction cost is calculated using the following equation:

$$\text{Compaction} = \$0.41/\text{yd}_3 \times \text{Volume}_{\text{compacted}}\ (\text{ft}_3) / (27\ \text{ft}^3/\text{yd}^3)$$

Liners

To calculate liner costs, the surface area of the basin flow and sidewalls is calculated, as described in Section 4.1.3. The liner cost includes both clay and synthetic liners, and is calculated using the following equations:

$$\text{Clay Liner} = \$0.24/\text{ft}^2 \times \text{Surface Area}$$
$$\text{Synthetic Liner} = \$1.50/\text{ft}^2 \times \text{Surface Area}$$

Total Capital Costs

The total capital cost for construction of the naturally-lined storage lagoon is the following:

Capital Cost = Mobilization + Excavation + Compaction + Conveyance

The total capital cost for construction of the lined storage lagoon is the following:

Capital Cost = Mobilization + Excavation + Compaction + Conveyance + Clay Liner + Synthetic Liner

Total Annual Costs

Based on best professional judgement, annual operating and maintenance costs are estimated at 5% of the capital costs.

$$\text{Annual Cost} = 0.05 \times (\text{Capital Cost})$$

4.4.5 Results

The cost model results for constructing a naturally-lined lagoon, a synthetically-lined lagoon, and additional lagoons for extra capacity (Option 7) are presented in Appendix A, Tables A-6, A-7, and A-8, respectively.

4.5 Underpit Storage Barns and Confined Manure Storage for New Dairy Sources

Option 8, considered for new sources, requires "zero discharge with no overflow provision" for dairy operations. The technology basis for this option assumes all animals must be confined and all animal waste must be covered. Underpit storage barns are costed for housing mature dairy cows, and a complete barn and underpit storage system is costed for housing heifer cows on site at the dairy.

Calf barns may be used at animal feeding operations to confine the calves separate from the more mature animals. Barns with underpit storage are not practical for calves because of their smaller hoof size and bedding requirements; therefore, a barn with individual stalls is assumed for calf housing. Typically, the manure is moved out of the barn and stored outside the barn, where it is exposed to precipitation and will produce contaminated runoff. The NSPS regulatory option for dairies requires that there is no potential for discharge; therefore, to reduce the quantity of manure that is exposed to the environment, dairies under the NSPS option are costed for a calf barn with adjacent covered manure storage.

4.5.1 Technology Description

In an underpit storage system, a freestall barn contains a slatted floor, where the animals deposit waste. The waste is manipulated through the floor slats to the storage pit underneath by the hooves of the animals. The storage pit is designed to hold manure and wastewater for sufficient time to allow for land application or transportation of the waste. This method of manure management can eliminate the need for outdoor storage, such as a lagoon or pond. These outdoor storage facilities that are exposed to the elements have the potential to overflow under extreme precipitation events, such as the 25-year, 24-hour storm event.

Calf barns with covered storage are a pollution prevention measure. For this cost model it is assumed that calves are typically kept on open drylots. Precipitation falling on the drylot comes into contact with manure and then runs off the drylot. Completely confining the animals in a barn and then storing the scraped manure in adjacent covered manure storage reduces this potential for discharge by eliminating contaminated runoff from the calf drylot.

4.5.2 Prevalence of the Technology in the Industry

Estimates of the percentage of dairies that do not currently have underpit storage in place are based upon NAHMS, USDA data, and site visits. It is assumed that only 1 to 8 percent of operations currently have underpit storage systems in place (for additional detail, please see ERG, Inc. *Development of Frequency Factors Used in the Beef and Dairy Cost Methodology*, 2000). The Midwest and Mid-Atlantic region have the highest percentage of operations with underpit storage.

Table 4-18 presents an estimate of feedlot operations that will incur costs for installing underpit storage systems based on regional location.

Table 4-18

Dairy Operations Incurring Costs for Installation and Maintenance of Underpit Storage for NSPS Option 8

Animal Type	Size Class	Region				
		Central	Midwest	Mid-Atlantic	Pacific	South
Dairy	Medium1	95%	92%	92%	95%	99%
	Medium2	95%	92%	92%	95%	99%
	Large1	95%	92%	92%	95%	99%

Reference: USDA and NAHMS; for further detail see ERG, Inc. *Development of Frequency Factors Used in the Beef and Dairy Cost Methodology*, 2000

4.5.3 Design

At a dairy operation, there are two types of underpit storage barns designed (one for the mature cattle and one for the heifers) and one type of calf barn designed. Each of these barns are designed to hold waste generated over a six-month period.

Mature Dairy Cattle Barn with Underpit Storage

Under baseline conditions, it is assumed that a dairy operation will install freestall barn housing as part of building a new operation; therefore, no costs are included in the NSPS costs related to the construction of a new freestall barn. It is also assumed (under baseline conditions) that a dairy operation will install either a flush system or a scrape system to clean out waste from the barn; therefore, the NSPS costs include the cost for the underpit storage system **minus** the cost of the flush or scrape system. Additionally, NSPS costs include manure storage pit ventilation.

The NSPS freestall barn is designed with a slatted floor, where the cows work the manure into a storage pit underneath the barn. Because the manure is kept in the same building as the animals, and toxic gases will tend to move into the housing area, extra ventilation is required for this type of waste handling system. These gases are removed from the building by constructing an exhaust air duct from the pit to exhaust fans. The estimated requirements for ventilation in the manure pit are not more than the winter minimum ventilation rate for that animal. Higher volumes of air tend to dry the manure on the slots and clog the floor (Zulovich, 1993). The winter minimum ventilation rate for mature dairy cows is 50 cfm (MWPS, 1997).

Heifer Barns with Underpit Storage

Under baseline conditions, it is assumed that a dairy operation will house heifers on drylots; therefore, the complete cost for constructing a freestall barn as well as the underpit storage with ventilation is include in the NSPS costs.

The freestall barn contains a slatted floor, where the heifers work the manure into a storage pit underneath the barn. The size of the barn is determined using barn space requirements for a heifer per head. The space required per head is 21.9 ft^2 (Hilne, 1999).

Ventilation is required for the heifer manure pit, as discussed for the mature dairy cows. The winter minimum ventilation rate assumed for heifer cows is 25 cfm (MWPS, 1997).

Calf Barn with Manure Storage

The calf barn contains individual pens with a manure scrape system. The manure is scraped into an adjacent manure storage area, kept under a roof. The manure storage area is calculated from the number of calves and the amount of manure generated over a 180-day storage period, using the BAT cost methodology used to size concrete pads. The freestall space required for a calf is 14 ft^2 per head. The calf area plus the manure storage area was used to size the calf barn. It is assumed the dairy will use natural ventilation for the calf barn.

4.5.4 Costs

The costs for underpit storage consist of three elements: the manure pit, the ventilation for the manure pit, and the confinement barn.

Manure Pit Costs

Costs to construct and operate an underpit storage system as well as costs for flush and scrape operations are provided in Table 4-19. These costs are used to estimate the costs for underpit storage for heifers and dairies. The underpit storage system costed for the heifer barn is estimated at the full cost provided in Table 4-19, since it is assumed that heifers do not currently have a waste management system. The underpit storage system costed for dairies is offset by the cost for the type of waste management system that is typical for dairy operations, either a scrape system or a flush system.

Table 4-19

Unit Costs for Underpit Storage

Barn type	Capital Costs (Cost per 100 cows)		Annual Costs (Cost per 100 cows)	
	1995 Canadian Dollars[1]	1997 U.S. Dollars[2]	1995 Canadian Dollars[1]	1997 U.S. Dollars[2]
Fully Slatted Pit Under Barn	$127,000	$90,134	$11,700	$8,304
Scraper to Cross-Gutter & Gravity Flow to Earthen Storage	$83,400	$59,190	$7,500	$5,322
Flush System to Cross Gutter and Gravity Flow to Earthen Storage	$58,000	$41,164	$6,200	$4,400

[1]Data extracted from Animal Agriculture and the Environment: Nutrients, Pathogens, and Community Relations (NRAES-96).
[2]Conversion to U.S. dollars is 0.677 x Canadian Dollars (conversion from **http://www.bloomberg.com** on 08/23/00.) Conversion from 1995 U.S. dollars to 1997 U.S. Dollars from Means 1999.

Manure Pit Ventilation

The manure pit must be ventilated to ensure that toxic gases do not build up in the housing level of the barn. The estimated requirements for ventilation in the manure pit is equal to the winter minimum ventilation rate for barn housing for that animal (Zulovich, 1993). The cost for ventilation for six various sized fans was taken from Means, 1999 for chilled water air handling units. A polynomial regression was performed on these data to develop a relationship between fan capacity and costs. The resulting equation to calculate the capital costs is the following:

$$\text{Capital Cost} = 2.0 \times 10^{-06} * (\text{Flow Rate})^2 + 0.6641 * (\text{Flow Rate}) + 2{,}255$$

where: Flow Rate is in cubic feet per minute

Data Source: Means 1999 (157 125 1100-2100)

Costs are in 1999 dollars.

Table 4-20 presents the winter minimum ventilation rates and costs for dairy cows and heifer manure pits.

Table 4-20

Underpit Storage Ventilation

Animal	Winter Minimum Ventilation Rate (cfm)/head[1]	1999 U.S. Dollars/head	1997 U.S. Dollars/head[2]
Mature Dairy Cow	50	$2,288	$2,217
Heifer	25	$2,272	$2,202

[1]Midwest Plan Service, 1997

[2] Conversion from 1999 U.S. dollars to 1997 U.S. Dollars from Means 1999.

Confinement Barn Costs

Confinement barn costs are included in the dairy operation NSPS costs for the heifer and calf animals. Under baseline conditions, these animals are assumed to be confined on a drylot; therefore the full costs to construct that heifer and calf barns are included as part of the NSPS costs. Costs for a barn for mature dairy cattle are not included in the NSPS costs, since it is assumed that the facility will construct a barn under baseline conditions.

The costs to construct a freestall barn for mature dairy cows is estimated at $1,722 per head (NMPF, 2000). To convert this unit cost into the cost to construct a barn for heifers and calves, the estimated freestall barn dimensions per cow for a mature dairy cow, heifer, and calf are used to ratio the cost per head. Table 4-21 presents the dimensions recommended for barns for these animals.

Table 4-21

Freestall Dimension Requirements for Mature Dairy Cows, Heifers, and Calves

	Dimension			
Animal	**Width (ft)**	**Length (ft)**	**Area (ft^2)**	**Source**
Dairy cows	3.83	8.25	31.6	MWPS-7
Heifers	3.25	6.75	21.9	PDHGA Proceedings, 1999
Calves	2.25	4.08	9.2	PDHGA Proceedings, 1999

The cost to construct the heifer freestall barn is estimated using the following equation:

$$\text{Cost per Heifer (2000\$)} = \$1{,}722 * 21.9\ ft^2 / 31.6\ ft^2$$
$$= \$1{,}193$$

The cost to construct the calf freestall barn is composed of two parts: the living area and the manure storage area. The cost for the living area of the barn is calculated using the following equation:

$$\text{Cost per Calf (2000\$)} = \$1722 * 9.2\ ft^2 / 31.6\ ft^2 = \$501$$

The cost for the manure storage area is calculated by determining the required area of the manure storage area, and then using the unit barn cost ($1722/31.6 = 54.5 per square feet) to estimate the construction cost.

Excreted volume of manure per calf over the storage area:

$$\text{Weight of Manure per Calf} = \text{Rate} * \text{Average Weight} * \text{Storage Days}$$
$$= \frac{65.8\ lb}{\text{day-1000 lb}} * \frac{350\ lb}{\text{animal}} * 180\ \text{days}$$
$$= 4{,}145\ \text{lb per animal}$$

$$\text{Volume of Manure per Calf} = 4{,}145\ lbs / (62\ lb/ft^3)$$
$$= 67\ \text{cubic feet per animal}$$

Estimated volume of bedding per animal (weight and density of bedding was taken from the Agricultural Waste Management Field Handbook, USDA 1992):

$$\text{Weight of bedding per calf} = \frac{\text{Rate}}{\text{Day-1000lb}} * \text{Average Weight} * \text{Storage Days}$$

$$= \frac{2.7}{\text{Day-1000lb}} * \frac{350}{\text{animal}} * 180\ \text{days}$$

$$= 170.1\ \text{lb per animal}$$

$$\text{Volume of bedding per calf} = 170.1\ lb * 50\%\ \text{void space} / (6\ lb/ft^3)$$

$$= 14.2\ \text{cubic feet per animal}$$

Total calf manure and bedding storage requirement over the storage period:

$$\text{Total volume} = \text{manure volume} + \text{bedding volume}$$
$$= (67\ ft^3 + 14.2\ ft^3)\ \text{per animal}$$
$$= 81\ ft^3\ \text{per animal}$$

Assuming the maximum depth of the pile is 10 feet and the pile is parabolic in shape, the following equation provides the base diameter of the pile:

$$\text{Diameter} = \text{square root } \frac{8 * \text{volume}}{\text{PI} * \text{depth}}$$

$$= \text{square root } \frac{8 * 81}{3.14 * 10}$$

= 4.54 feet per animal

Assuming a square area, the area per animal required for manure storage is:

= 4.54 ft * 4.54 ft
= 20.6 square feet per animal

Using the estimated value for cost per square foot of $54.5/square feet, the estimated cost for the manure storage area is:

= 20.6 square feet * $54.5 per square feet
= $1,123 per calf (2000 $)

Total Capital Costs

The NSPS cost to construct an underpit storage system for a mature dairy cow confinement barn is equal to the difference between the cost to construct a new underpit storage system with associated ventilation and the cost to construct a flush or scrape manure removal system. The NSPS cost to construct an underpit storage system for heifers at a dairy operation is equal to the cost to construct the manure pit, (see Table 4-19), the cost of ventilation, and the cost for the confinement barn itself. The NSPS cost for a calf barn is equal to the cost of the barn and the cost for adjacent manure storage.

Mature Dairy Manure Pit (would-be flush system) = (Manure Pit - Flush System) + Ventilation
= $90,134/100 cows - $41,164/100 cows + $2,217/cow
= $2,707/cow

Mature Dairy Manure Pit (would-be scrape system) = (Manure Pit - Scrape System) + Ventilation
= $90,134/100 cows - $59,190/100 cows + $2,217/cow
= $2,526/cow

Heifer Manure Pit System = Manure Pit System + Ventilation + Barn
= $90,134/100 cows + $2,202/head + $1,193/head * 0.9689 (1997$/$2000$)

	=	$4,259/heifer
		(Combined with the assumption that there are 0.3 heifers per cow in this model):
	=	$4,259 * 0.3 per cow
	=	$1,278 per mature cow
Calf Barn and Adjacent Storage	=	Calf Barn + Manure Storage Area
	=	($501 + $1123 per calf) * 0.9689(1997$/2000)
	=	$1,573/calf
		(*(Combined with the assumption that there are 0.3 heifers per cow in this model)*:
	=	$1,573 * 0.3 per cow
	=	$472 per cow

Therefore, the total capital cost for the zero discharge dairy option is equal to:

Total Capital Cost (would-be flush system)	=	($2,707 + $1278 + $472) per cow
	=	$4,457 per cow
Total Capital Cost (would-be hose system)	=	($2,526 + $1278 + $472) per cow
	=	$4,276 per cow

Total Annual Costs

The annual NSPS cost for an underpit storage system for a mature dairy cow confinement barn is equal to the difference between the cost to operate a new underpit storage system with associated ventilation and the cost to operate a flush or scrape manure removal system. The NSPS cost to operate an underpit storage system for heifers at a dairy operation is equal to the cost to operate the manure pit, the cost for ventilation, and the cost to maintain the confinement barn itself. The estimated cost of maintaining and operating the calf barn is considered to be effectively the same as the cost for maintaining the drylot under the baseline condition; therefore, no annual costs are calculated for the calf barn.

Mature Dairy Manure Pit	=	(Manure Pit - Flush System) + Ventilation
(would-be flush system)	=	$8,304/100 cows - $4,400/100 cows +0.05 * $2,217/cow
	=	$238/cow

Mature Dairy Manure Pit	=	(Manure Pit - Scrape System) + Ventilation

(would-be scrape system)	=	$8,304/100 cows - $5,322/100 cows +0.05 * $2,217/cow
	=	$141/cow
Heifer Manure Pit System	=	Manure Pit System + Ventilation + Barn
	=	$8,304/100 cows + 0.05 * ($2,202/head + $1,193/head)
	=	$253/heifer
	(Combined with the assumption that there are 0.3 heifers per cow in this model):	
	=	$253 * 0.3 per cow
	=	$76 per cow

Therefore, the total annual cost for the zero discharge dairy option is equal to:

Total Annual Cost (would-be flush system)	=	($238 + $76) per cow
	=	$314 per cow
Total Annual Cost (would-be hose system)	=	($141 + $76) per cow
	=	$217 per cow

4.5.5 Results

The cost model results for constructing and maintaining the underpit storage systems and calf barns at dairies are presented in Appendix A, Table A-24.

4.6 <u>Berms</u>

Berms are used at beef feedlots and dairies to contain storm water runoff and process water that fall within the animal handling and feeding areas and to divert storm water that falls outside these areas. Because the handling and feeding areas contain manure, runoff from these areas needs to be contained and diverted to a waste management storage facility (e.g. a lagoon or a pond). Berms surrounding the handling and feeding area provide this containment by acting as a physical barrier between the containment area and adjacent “clean” land. Berms are costed for all beef feedlots and dairies for all regulatory options. Because veal operations are conducted indoors, berms are not costed for veal operations because they are assumed to be indoor operations.

4.6.1 Technology Description

Berms are earthen structures that channel clean runoff away from pollutant sources and divert runoff that falls within the area containing pollutant sources. Runoff that falls within the containment area may become contaminated from contact with animal, feed, and fecal matter deposited in the feedlot or handling area. This runoff is diverted by the berms to a waste management storage facility (e.g., a pond or lagoon).

4.6.2 Prevalence of the Technology in the Industry

Estimates of the percentage of beef feedlots and dairies that do not have berms currently in place were based upon best professional judgment by industry experts and regional data. Under all regulatory options, beef feedlots and dairies are required to contain any runoff collecting in potentially contaminated areas. It is assumed that all large operations have berms currently in place because runoff controls are required under the existing regulation. In addition, a small percentage of medium operations are estimated to have runoff diversions in place. The Midwest region is estimated to have a higher percentage of operations with runoff diversions because of specific regulatory language in that region.

Table 4-22 presents an estimate of feedlot operations that will incur costs to install berms based on regional location.

Table 4-22

Feedlots Operations Incurring Costs for Installation and Maintenance of Berms for All Regulatory Options

Animal Type	Size Class	Region				
		Central	Midwest	Mid-Atlantic	Pacific	South
Beef and Heifers	Medium1	90%	85%	90%	90%	90%
	Medium2	90%	85%	90%	90%	90%
	Large1	0%	0%	0%	0%	0%
	Large2	0%	0%	0%	0%	0%
Dairy	Medium1	90%	85%	90%	90%	90%
	Medium2	90%	85%	90%	90%	90%
	Large1	0%	0%	0%	0%	0%
Veal	Medium1	NA	NA	NA	NA	NA
	Medium2	NA	NA	NA	NA	NA

NA - Not applicable. No regulatory options include this component for this model farm.
Reference: ERG, 1999 site visits and ERG Memorandum, 2000

4.6.3 Design

The design of a berm system for a specific operation depends on the number of animals that are contained on a drylot. The feedlot area is dependent upon the number of animals contained on drylots at the facility.

The cost model assumes berms are constructed as a 3-foot high, 6-foot wide compacted soil mound that surrounds the feedlot and handling areas. Figure 4-6 depicts the cross-section of the berm assumed for this cost model.

The area of the cross-section of the berm is calculated using the following equation:

$$Area_{berm} = 2/3 \times b \times h$$

where:

b = Base width (6 feet)
h = Total height (3 feet)

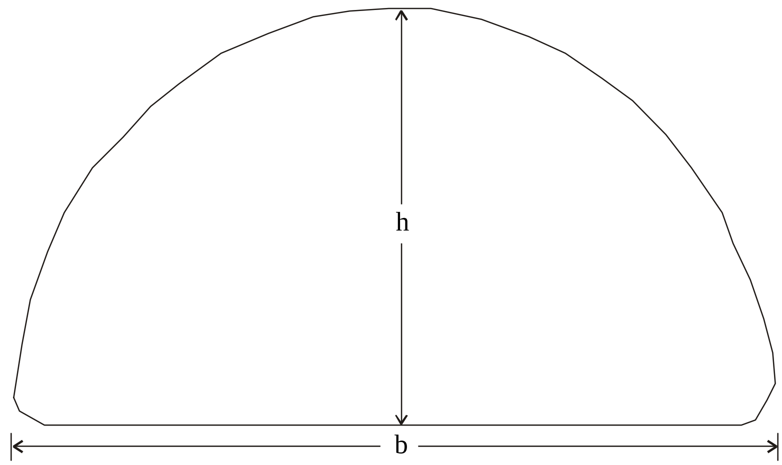


Figure 4-6. Cross-Section of Berm

The total length of the berm system varies according to the number of animals contained on drylots. The area required for each animal varies by animal type, because different sized animals require a different amount of space. Table 3-6 provides the recommended area per animal for a drylot, not including handling and storage areas. For this cost model, the average area per animal on a drylot is calculated using the ranges presented in Table 3-6, and adding 15% for handling areas. The actual drylot area per animal that is used in the cost model is provided in Table 4-23.

Table 4-23

Space Requirements Assumed for Animals Housed on Drylots[1]

Animal Type	Drylot Area (ft^2/animal)	Handling Area (ft^2/animal)	Total Area (ft^2/animal)
Beef cattle	400	60	460
Mature dairy cattle	400	60	460
Heifers	375	56	431
Calves	225	34	259

[1]REFERENCE: MWPS, 1993; George, 1999.

The total perimeter of the berm is calculated as follows:

$$L = 4 \times (Area_{feedlot} \times Head)^{0.5}$$

where:

where:	L	=	Total perimeter (length of four sides of a square area) (feet)
	$Area_{feedlot}$	=	Total area of drylot and handling areas per animal (ft^2) (Table 4-23 value)
	Head	=	Average Head (Table 1-2 value)

Table 4-24 presents a summary of the perimeter of the berm calculated for all model farms. Note that the berm design does not vary by region or regulatory option.

Table 4-24

Berm Perimeter by Model Farm for All Regulatory Options

Animal Type	Size Class	Berm Perimeter (ft)
Beef	Medium1	2,101
	Medium2	2,830
	Large1	4,398
	Large2	17,956
Heifers	Medium1	1,661
	Medium2	2,274
	Large1	3,216
Dairy (Heifers and Calves)	Medium1	882
	Medium2	1,234
	Large1	2,168
Veal	Medium1	NA
	Medium2	NA

NA - Not applicable. No regulatory options include this component for this model farm.

4.6.4 Costs

To construct the berm, the volume of material to construct the berm is excavated along the perimeter of the containment area. The excavated soil is mounded to form the berm and the soil is compacted. The following table presents unit costs for constructing the berm.

Table 4-25

Unit Costs for Constructing Berms

Unit	Cost (1997 Dollars)	Source[1]
Compaction	$\$0.41/yd^3$	Means 1996 (022 226 5600)
Excavation	$\$2.02/yd^3$	Means 1999 (022 238 0200)

[1]Information taken from Means Construction Data and Means Construction Data. The numbers in parentheses refer to the division number and line number. Different years were selected for the different components based on consultation with industry experts and best professional judgement.

The total volume of the berm is calculated using the following equation:

$$\text{Volume}_{\text{berm system}} = \text{Area}_{\text{berm}} \times L \times 1.25 \times 1.05$$

where:

$\text{Area}_{\text{berm}}$	=	Cross-sectional area of berm (square feet)
L	=	Total length of berm around containment area (feet)
1.25	=	Factor accounting for volumetric expansion on soil for cut/fill (George, 1999b)
1.05	=	Factor accounting for 5% settling after compaction

$$\text{Compaction Cost} = \frac{\$0.41/yd^3 \times \text{Volume}}{27\ ft^3/yd^3}$$

$$\text{Excavation Cost} = \frac{\$2.02/yd^3 \times \text{Volume}}{27\ ft^3/yd^3}$$

Total Capital Cost

The total capital cost, therefore, is \$2.43 per cubic yard of berm. To convert this cost to a cost per foot, the volume is divided by the berm area, taking into account the factors for expansion and settling as follows:

$$\text{Capital Cost} = \text{Cost/Linear Foot} = \frac{\$2.43/yd^3 \times 2/3 \times 6 \times 3 \times 1.25 \times 1.05}{27\ ft^3/yd^3} = \$1.41/ft$$

The cost of \$1.41 per linear foot of berm is the cost included in the cost model.

Total Annual Costs

Based on best professional judgement, the total annual cost for berm maintenance is estimated at 2% of the total capital costs.

$$\text{Annual Cost} = 0.02 \times (\text{Capital Cost})$$

4.6.5 Results

The cost model results for constructing and maintaining berms at beef feedlots and dairies are presented in Appendix A, Table A-9.

4.7 Anaerobic Digestion with Energy Recovery

Anaerobic digesters are sometimes used at animal feeding operations to biologically decompose manure while controlling odor and generating energy. Anaerobic digestion with energy recovery is used as the cost basis for Option 6. Under this option, only large dairies are costed for installation of a digester.

4.7.1 Technology Description

Anaerobic digestion is the decomposition of organic matter in the absence of oxygen and nitrates. Under these anaerobic conditions, the organic material is stabilized and is converted biologically to a range of end products including methane and carbon dioxide. Anaerobic treatment reduces BOD, odor, ammonia emissions, pathogens, and generates biogas (methane) that can be used as a fuel. The methane-rich gas produced during digestion may be collected as a source of energy to offset the cost of operating the digester. Liquid and sludge from the system are applied to on-site cropland as fertilizer/irrigation or are transported off site.

Anaerobic digesters are specially designed tanks or concrete basins that can anaerobically decompose volatile solids in the manure to produce biogas. Manure and/or process wastewater may be routed to these digesters for storage and treatment. Depending on the waste characteristics, one of the following main types of anaerobic digesters may be used:

- Plug flow;
- Complete mix; and
- Covered lagoon.

Plug flow digesters are applicable for wastes with high (>10%) solids content, while covered lagoons are appropriate for wastes with low (<2%) solids content. Complete mix digesters are used for wastes with a solids content between 2 and 10 percent. The plug flow and the complete mix digesters are applicable in virtually all climates as they use supplemental heat to ensure optimal temperature. Covered lagoons generally do not use supplemental heat and are most effectively used in warmer climates (USEPA, 1996b).

A plug flow digester is a constant volume, flow through long tank with a gas-tight expandable cover. Manure waste is added to the digester daily, slowly pushing the older manure plugs through the tank. Average manure retention times range from 15 to 20 days. The gas-tight cover maintains anaerobic conditions inside the tank and collects the biogas through attached pipes (USEPA, 1997c).

A complete mix digester is a heated, constant volume, mechanically-mixed tank with a gas-tight collection cover. Manure waste is preheated and added daily to the digester, where it is intermittently mixed to prevent formation of a crust and to keep solids in suspension. Average manure retention times range from 15 to 20 days. The gas-tight cover maintains anaerobic conditions inside the tank and collects the biogas through attached pipes. The heat generated by burning the collected biogas is used to heat the digester (USEPA, 1997b).

A covered lagoon digester is the simplest type of methane recovery system. This digester consists of two basins, one of which is topped with a gas-tight cover. This floating impermeable cover is typically made of high density polyethylene (HDPE) or polypropylene. The cover may be designed as a "bank-to-bank" cover, which spans the entire lagoon surface with a fabricated floating cover, or as a "modular" cover, in which the cover is comprised of smaller sections. Biogas collects under the cover and is recovered for use in generating electricity. The second basin is uncovered and is used to store effluent from the digester. Often, manure waste is treated through a solids separator prior to the covered lagoon digester to ensure the solids content is less than 2 percent (USEPA, 1996b).

Selection of the type of digester is dictated by the percent solids expected in the manure waste. For this cost model, dairies that operate flush cleaning systems are costed for the use of a covered lagoon system following a settling basin, while dairies that operate scrape systems are costed for the use of a complete mix digester following a settling basin. The design of the digester and methane recovery system is based on the AgSTAR FarmWare model (EPA, 1997a). The design and cost of the concrete settling basins are discussed in Section 4.2.

4.7.2 Prevalence of the Technology in the Industry

In the United States, as of 1998 there were about 94 digesters that were installed or were planned for working dairy, swine, and caged-layer poultry operations (Lusk, 1998). Of these 94 digesters, more than 60% of plug flow and complete mix digesters and 12% of the covered lagoon digesters have failed (Lusk, 1998). Many of these failures were of systems constructed prior to 1984; since that time, more simplified digester designs have been implemented which have greatly improved reliability. Very few dairy operations in the United States have operable digesters with energy recovery.

For purposes of costing Option 6, it is assumed that no large dairies currently operate a digester with energy recovery. As mentioned previously, digesters are not being costed for medium sized dairies or for beef feedlots and veal operations.

4.7.3 Design

Inputs to the FarmWare model are based on the model farm characteristics for a large dairy, as discussed in Section 3. The FarmWare model requires input data on the livestock type, number of animals, geographic location, method of manure collection, and the type of waste management system. Tables 4-26 summarizes the inputs used for both the covered lagoon and complete mix digesters. User-selected input values are noted with the letter "S" in brackets, [S]. Default input values that are selected are noted with an [S,d].

The representative region used for the large dairy is Tulare County, California. The farm has 1,419 cows, 426 heifers, and 426 calves in free stalls. The farm is evaluated with two types of waste management systems, as shown below in Table 4-26:

Table 4-26

FarmWare Input Table

Input Data	Type of Digester: Covered Lagoon Digester	Type of Digester: Complete Mix Digester
Climate Data		
County, State	Tulare, California [S]	
Rainfall	Determined by FarmWare [S,d]	
Recommended Minimum Lagoon HRT	42 days	
Recommended Maximum Lagoon Loading	10 lb VS/1,000 cu ft	
25-yr, 24-hr Storm	3.5 inches	
Annual Runoff Unpaved	23% of precipitation	
Annual Runoff Paved	50% of precipitation	
Annual Evaporation	55 inches	
Farm Type		
Farm Type	Dairy: Freestall [S]	
Farm Size (Farm Number)	1,419 milking cows [S] 426 heifers [S] 426 calves [S]	
Manure Collection Method	Flush parlor/ Flush freestall barn [S]	Flush parlor/ Scrape freestall barn [S]
Waste Treatment System	Methane recovery lagoon [S]	
Pretreatment	Settling basin [S]	N/A

[S] = User selected input
[d] = default input

Based on the input data provided, FarmWare calculates the influent and effluent waste to and from the digester and the specific design and operating parameters. With the herd size given as 1,419 milking cows, 426 heifers, and 426 calves, the FarmWare model calculates a total manure generation of about 185,000 lb/day. With an average VS production of 8.5 lb/day per 1,000 pounds of animal, the FarmWare program estimates a total VS production of nearly 20,000 lb/day. The model also generates the design specification for each system as shown in Table 4-27:

Table 4-27

FarmWare Design Information

Design Information	Type of Digester	
	Covered Lagoon Digester	Complete Mix Digester
Waste Characteristics		
Amount of Influent Manure (lb)	1,656,696	239,325
Rainfall (lb)	14,883	NA
Amount Digested (lb)	23,642	76,285
Effluent (lb)	1,647,937	163,040
Design Parameters		
Hydraulic Retention Time (days)	42	20
Depth (ft)	20	20
Dimension (ft)	284 × 284	73.8 diameter
Freeboard (ft)	1	1
Slope (hor/ver)	2	NA
Total Volume	1,200,218	85,664

NA- Not applicable.

4.7.4 Costs

FarmWare calculates the cost to construct the digester, with or without energy recovery equipment. Option 6 costs were calculated including the cost for energy recovery equipment, as well as an additional 15% of the capital costs estimated by FarmWare to account for contingency items.

The biogas that is collected during the digestion process may be used to produce electricity and propane. FarmWare allows the user to assign a unit value for electricity to estimate the amount of cost savings the farm would receive by recovering biogas for energy use. For Option 6 costs, a national average unit price for electricity of 7.4 cents per kilowatt hour (kWh) is used (USDOE, 1998).

The model also allows the user to assign a dollar value for benefits such as odor and pathogen reduction. For the Option 6 costs, no dollar value is assigned for these benefits.

Covered Lagoon System

For this cost model, it is assumed that the cows spend 4 hours per day in the milking parlor and 20 hours per day in the barn, and the heifers and calves spend 24 hrs/day in drylots. The milking parlor and the barn use a flush system for manure removal, and the wastewater is sent to a covered anaerobic lagoon through a settling basin. The manure from the feed apron and the drylots is scraped and applied to cropland.

The total lagoon digester volume is calculated to be about 1,200,000 cubic feet. With a lagoon depth of 20 feet, the linear surface dimensions are estimated to be 284 feet by 284 feet, representing a total area of about 80,656 square feet that requires an industrial fabric cover, such as HDPE. Table 4-26 presents the design information for the covered lagoon digester, as determined by the FarmWare model.

The capital cost of a primary digester lagoon with cover is $110,000 and the engine generator is $80,000. Other engineering costs total $25,000. The total capital cost is $215,000. Annual costs include the FarmWare estimated operating savings, water costs for dilution water, and an estimated 15% of the total capital costs. The net annual operating cost is estimated to be ($52,779) per year (i.e., a net savings). This annual operating cost does not reflect additional potential decreases in transportation costs, due to the reduction in solids a digester causes. (Transportation costs are considered in section 4.14 of this report).

Complete Mix Digester System

For this cost model, it is assumed that the cows spend 4 hours per day in the milking parlor which uses a flush system for manure removal and 20 hours per day in the freestall barn, and the heifers and calves spend 24 hrs/day in drylots. The wastewater from the milking parlor goes through a mix tank before going to the complete mix digester. The manure in the freestall barn and the drylots is scraped and field applied.

The total digester volume is calculated to be about 86,000 cubic feet. With a digester depth of 20 feet, the diameter is estimated to be 74 feet, with a total area of 4,300 square feet. Table 4-26 presents the design information for the complete mix digester, as determined by the FarmWare model.

The capital costs for the complete mix digester is $128,000, the mix tank is $26,000, and the engine generator is $198,000. Other engineering costs total $25,000. The total capital cost is $377,447. Annual costs include the FarmWare estimated operating savings, water costs for dilution water, and an estimated 15% of the total capital costs. This annual operating cost does not reflect potential decreases in transportation costs, due to the reduction in solids a digester causes. (Transportation costs are considered in section 4.14 of this report.) The net annual operating cost is estimated to be -$92,209 per year (i.e., a net savings).

4.7.5 Results

The cost model results for constructing anaerobic digesters with methane recovery at large dairies are presented in Appendix A, Table A-10.

4.8 <u>Concrete Pads</u>

Animal feeding operations sometimes use pads made of concrete or other similarly impervious material to provide a temporary storage surface for solid and semi-solid wastes that would otherwise be stockpiled directly on the feedlot. These wastes include solids separated from the waste stream in a solids separator and manure scraped from drylots and housing facilities.

4.8.1 Description of Concrete Pads

The pads provide a centralized location for the operation to accumulate excess manure for later use (e.g. bedding, land application, or transportation off site). A centralized location for stockpiling the waste also allows the operation to better control stormwater runoff (and potential associated pollutants). Rainwater that comes into contact with the waste is collected on the concrete pad and is directed to a pond or lagoon, thereby preventing it from being released on the feedlot. Additionally, the pad provides an impermeable base to minimize or prohibit seepage of rainfall leaching through the waste and infiltrating the soil underneath the waste.

The pad serves as a pollution prevention measure. The waste is not treated once it is on the concrete pad; however, through the regular handling of the waste, the nitrogen loadings in the waste will decrease due to volatilization, and both nitrogen and phosphorus may run off the pile into ponds or lagoons after storm events. Pathogen content, metals, growth hormones, and antibiotics loadings are not expected to decrease significantly on the concrete pad.

4.8.2 Prevalence of the Practice in the Industry

Based on observations during site visits, only a small number of beef feedlots, dairies, and veal operations have concrete pads, and that number varies by region and not by animal type or size group. Table 4-28 presents the estimate of facilities that do not currently have concrete pads in place for storage of manure solids.

Table 4-28

Percentage of Beef Feedlot, Stand-Alone Heifer Operations, Dairies, and Veal Operations Incurring Concrete Pad Costs for All Regulatory Options[1]

Animal Type	Size	Region				
		Central	Midwest	Mid-Atlantic	Pacific	South
Beef and Heifers	Medium1	13%	27%	24%	12%	22%
	Medium2	13%	27%	24%	12%	22%
	Large1	13%	27%	24%	12%	22%
	Large2	13%	27%	24%	12%	22%
Dairy	Medium1	13%	27%	24%	12%	22%
	Medium2	13%	27%	24%	12%	22%
	Large1	13%	27%	24%	12%	22%
Veal	Medium1	13%	27%	24%	12%	22%
	Medium2	13%	27%	24%	12%	22%

[1] EPA, 1999

Concrete pads are included in Options 3 and 4 for the protection of groundwater. The frequencies shown in Table 4-28 reflect the percentage of operations that are located in areas that would require groundwater protection. The model assumes that very few operations have impermeable pads in place, and all facilities in groundwater protection areas are costed for a concrete pad.

4.8.3 Design

The design for the concrete pad varies according to the type of waste stored on the pad. For dairies that flush the manure, the waste targeted for the concrete pad includes the settled solids from the settling basin, including flushed manure from mature dairy cows in the milking parlor and flush barns. The concrete pad design has two walls to assist in containing the waste, and the maximum height of the manure pile is 4 feet due to the semi-liquid state of the waste. Bucking walls are 3.5 foot walls used to help contain semi-liquid manure on the concrete pad.

For dairies that hose and scrape the manure, the wastes targeted for the concrete pad are the settled solids from the settling basin and the scraped manure from the barn, including bedding. The concrete pad design has two bucking walls, and the maximum height of the manure pile is 4 feet due to the semi-liquid state of the waste.

For beef feedlot and stand-alone heifer operations, the waste targeted for the concrete pad is the scraped manure from the drylots, including bedding. The concrete pad design has no bucking walls, and the maximum height of the manure pile is 15 feet, because the manure is dryer and can be stacked more easily.

Concrete pads are 6 inches thick, and contain reinforced concrete to support the weight of a loading truck. The concrete pad is underlain by 6 inches of gravel and 4 inches of sand. Additionally, the sides of the concrete pad are sloped, which will divert stormwater runoff from the pile to the on-site waste management system, such as a lagoon or a pond. Bucking walls are 8-inches thick and 3 feet to 4 feet tall, and made with reinforced concrete. Figure 4-7 presents the detail of these specifications (MWPS, 1998; USDA, 1995c).

The design of the concrete pad is primarily based on the volume of waste that is costed for storage. First, the dimensions of the waste pile are calculated, assuming that the pile is in the shape of a paraboloid (see Figure 4.7). Then, using the waste pile dimensions, pad dimensions are calculated.

Dimensions of the Waste

To estimate the volume of waste the pad must store over the storage period, the following parameters are needed: the storage period, the volume of waste, the volume of bedding in the waste, the moisture content of the waste, and the unit weight of the waste.

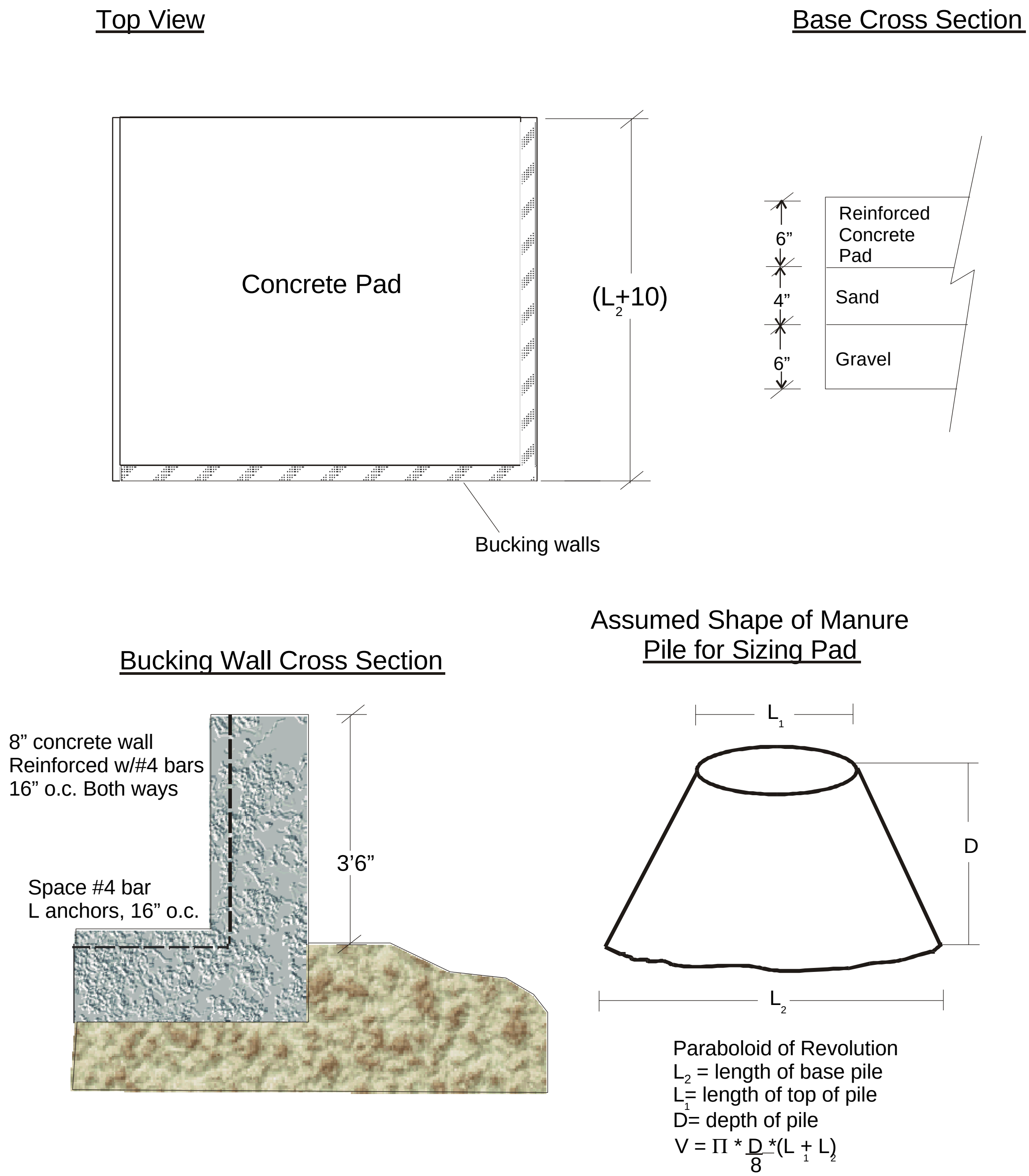


Figure 4-7. Concrete Pad Design

Beef Feedlots and Stand-Alone Heifer Operations

For beef feedlots and stand-alone heifer operations, the model assumes that all cattle are kept on drylots. These lots are periodically scraped, and the manure is removed to the stockpile. Some of the manure solids are lost in the runoff from the feedlot (runoff contains 1.5% solids (MWPS, 1993) before the waste is stockpiled. For Options 3 and 4, which require groundwater protection, drylot wastes are stockpiled on a pad. Because beef waste on the drylot is fairly dry, the maximum stacking height assumed for the stockpile is 15 feet. The model assumes that the necessary waste storage period for beef waste is 90 days.

Manure scraped from drylots includes bedding. Bedding is assumed to have a unit weight of 6 lb/ft (USDA, 1992). For this cost model, it is assumed that 2.7 pounds of bedding are used per 1,000-lb animal per day. The volume of bedding collected from the drylot is calculated by the following equation:

$$\text{Bedding} = \text{Average Head} \times \frac{2.7\text{ lb bedding}}{1{,}000\text{-lb animal}} \times \text{Animal Weight} \times \frac{ft^3}{6\text{ lb}} \times 0.50$$

where: Average Head = Table 1-2 value
Animal Weight = Table 3-4 value
0.50 = The void ratio of the bedding

The maximum volume of beef feedlot waste stored on the concrete pad is calculated as follows:

$$\text{Volume}_{\text{to pad}} = \text{Drylot Manure} \times 90\text{ days} / (62\text{ lb/ft}^3) + \text{Bedding} * 90\text{ days} - \text{Runoff Solids}$$

where: Runoff Solids = 0.015 × 90-day Runoff (see Section 3.4.3)

Hose Dairies

For hose dairies, the model assumes that the milking cows are kept in confinement barns 85% of the day and in the milking parlor 15% of the day (USDA, 1992). Manure deposited in the milking parlor is hosed down and sent to a concrete gravity settling basin (see Section 4.2). For Options 3 and 4, which require groundwater protection for some operations, the separated solids are stockpiled. The settling efficiency of the basin is estimated to be 50% (i.e., the settling basin removes 50% of the solids from the waste). The moisture content of excreted dairy manure is 87.2 percent (Lander,et.al, 1998). Settled solids are assumed to enter the stockpile at 65% moisture (NCSU, 1993). Manure deposited in the confinement barns is scraped along with the bedding and also stockpiled on the pad. Waste from heifers and calves is deposited and remains on a drylot. Because dairy waste from the settling basin is fairly wet, the maximum stacking height assumed for the stockpile is 4 feet. The model assumes that the necessary waste storage period for dairy waste is 180 days.

The maximum volume of hose dairy waste stored on the concrete pad is calculated as follows:

$$\text{Volume}_{\text{to pad}} = \text{Barn Manure} \times (180 \text{ days} / (62 \text{ lb ft}^3) + \text{Bedding} * 180 \text{ days} + \text{Separated Solids}$$

where: Separated Solids = Milking Parlor Manure × 180 days / (62 lb/ft^3) × (1-0872) / (1-0.65) × Efficiency
Efficiency = 0.50

Flush Dairies

For flush dairies, the model assumes that the milking cows are kept in confinement barns 85% of the day and in the milking parlor 15% of the day (USDA, 1992). Manure deposited in the confinement barns and the milking parlor is flushed to a concrete gravity settling basin (see Section 4.2) (Because of the configuration of the flush alleys, no bedding is assumed to be flushed with the manure.) For Options 3 and 4, which require groundwater protection for some operations, the separated solids are stockpiled on a concrete pad. The model uses a settling efficiency of 50% (i.e., the settling basin removes 50% of the solids from the waste). The moisture content of excreted dairy manure is 87.2 percent. Settled solids are assumed to enter the stockpile at 65% moisture. Waste from heifers and calves on drylots is not moved to the stockpile. Because dairy waste from the settling basin is fairly wet, the maximum stacking height assumed for the stockpile is 4 feet.   The model uses a 180-day storage period for dairy waste is 180 days.

The maximum volume of flush dairy waste stored on the concrete pad is calculated as follows:

$Volume_{to\ pad}$= Separated solids

where: Separated Solids = (Barn Manure + Milking Parlor Manure) × 180 days / (62 lb/ft^3) × (1-0.872) / (1-0.65) × Efficiency

Shape of the Stockpile

The shape of the stockpile is assumed to be parabolic, as shown in Figure 4.7. Using the volume calculated for each animal and farm type and the assumed maximum depth, the shape of the stockpile at maximum concrete pad capacity is calculated as shown in the following equation:

$$Volume_{to\ pad}\ \frac{\Pi \times D}{8} \times (L_1^2 + L_2^2)$$

Assume $L_1 = 0.5 \times L_2$

$$L_2 = \sqrt{\frac{8 \times Volume_{to\ pad}}{1.25 \times \Pi \times D}}$$

As shown in Figure 4.7-1, L_2 is the bottom diameter of the pile. Assuming the concrete pad is square, its minimum dimensions are $L_2 \times L_2$.

Dimensions of Concrete Pad

To account for walking and moving equipment around the pile, 10 feet are added to the minimum dimensions; therefore, the concrete pad dimensions are determined using the following equation;

$$\text{Area} = (L_2 + 10) \times (L_2 + 10)$$

The perimeter of the area is then:

$$\text{Perimeter} = (L_2 + 10) \times 2 + (L_2 + 10) \times 2$$

The walls for the pad run the length of two sides of the pad. The walls are 3 feet 6 inches high and 8 inches thick, built with concrete reinforced with #4 bars, 16 inches o.c. both ways. Figure 4.7-1 presents a cross-section of the bucking wall design. The equation for calculating the volume of concrete needed to construct the bucking walls is:

$$\text{Wall Volume} = 2 \times ((L_2 + 10) \times 3.5 \times 8 / 12)$$

4.8.4 Costs

The following unit costs are used to calculate the capital and annual costs for constructing the concrete pad:

Table 4-29

Unit Costs for Concrete Pad

Unit	Cost (1997 dollars)	Source[1]
Compaction	$\$0.41/yd^3$	Means 1996 (022 226 5720)
Gravel Fill	$\$9.56/yd^2$	Means 1998 (022 308 0100)
Sand Fill	$\$48.55/yd^3$	Richardson 1996, (3-5 p1)
6" Concrete Pad	$\$116.29/yd^3$	Means 1999 (033 130 4700)
Concrete Finishing	$\$0.33/ft^2$	Means 1998 (033 454 0010)
Concrete Bucking Walls	$\$300.41/yd^3$	Means 1999 (033 130 6200)
Sand Grading	$\$1.73/ft^3$	Means 1999 (025 122 1100)
Hauling Gravel and Sand	$\$4.95/yd^3$	Means 1998 (022 266 0040)

[1]For information taken from Means, the numbers in parentheses refer to the division number and line number.

Concrete Pad Costs

The costs for the concrete pad include the compaction of the ground surface, hauling gravel and sand to the lot, purchasing the gravel and sand, grading the sand, constructing the 6-inch pad, and finishing the concrete on the 6-inch pad. These calculations are shown below:

$$\text{Compaction (to 12 inches)} = \$0.41/yd^3 \times \frac{\text{Pad Area } (ft^2) \times 1 \text{ ft}}{27\ ft^3/yd^3}$$

$$\text{Hauling Cost for Sand and Gravel} = \frac{(\text{Gravel volume} + \text{Sand volume})}{27\ ft^3/yd^3} \times \$4.95/yd^3$$

$$\text{Volume of Gravel for 6-inch Layer} = \frac{\text{Pad Area } (ft^2) \times 6 \text{ in}}{12 \text{ in/ft}}$$

$$\text{Volume of Sand for 4-inch Layer} = \frac{\text{Pad Area } (ft^2) \times 4\text{-inch}}{12 \text{ inches/ft}}$$

$$\text{Gravel Cost} = \text{Gravel } (ft^3)/ft \times \$9.56/yd^2/0.5\ ft^2 \times 1\ yd^2/9\ ft^2$$

$$\text{Sand Cost} = \text{Sand } (ft^3) \times \$48.55/yd^3 \times 1\ yd^3/27\ ft^3$$

$$\text{Grading Sand} = \text{Sand } (ft^3) \times \$1.73/ft^3$$

$$\text{Six Inch Pad} = \text{Pad Area } (ft^2) \times \$116.29/yd^3 \times 0.5\ ft/yd^3 \times 1\ yd^3/27\ ft^3$$

Concrete Finishing = Pad Area(ft^2) × \$0.33/ft^2

Bucking Wall Costs

The cost for bucking walls is the volume of the bucking walls multiplied by the cost per cubic yard. (This cost is only added for dairies.)

Walls Cost = Wall Volume (ft^3) × \$300.41/yd^3 × 1 yd^3/27 ft^3

Total Capital Costs

The cost for construction of the concrete pad (and walls, if applicable) is calculated using the following equation:

Capital Cost = Compaction + Hauling + Gravel + Sand + Grading Sand + 6-inch Pad + Concrete Finishing + Bucking Walls

Total Annual Costs

Based on best professional judgement, annual costs are estimated at 2% of the total capital costs based on best professional judgment.

Annual Cost = 0.02 × Capital Cost

4.8.5 Results

The cost model results for constructing a concrete pad are presented in Appendix A, Table A-11.

4.9 Groundwater Wells/Protection

Storing or treating animal waste at or below the ground surface has the potential to contaminate groundwater. Groundwater wells may be used at animal feeding operations to monitor groundwater contamination. Groundwater well installation and associated monitoring is costed for all model farms under Options 3 and 4 where there is a hydrologic link between groundwater and surface water.

4.9.1 Technology Description

Manure and waste that infiltrates into the soil, and is not taken up by crops, may contaminate underlying aquifers with nutrients, bacteria, viruses, hormones, and salts. Irrigation of manure may also contaminate aquifers with salt and high levels of total dissolved solids. Groundwater wells can be installed to monitor for these pollutants.

Geologic conditions, as well as the elevation and shape of the water table, vary based on region. A hydrogeologic site investigation should occur prior to well installation to determine site conditions and to determine the number and location of samples as well as the sampling depth. See Section 4.12 for more information on establishing a hydrologic link between groundwater and surface water.

4.9.2 Prevalence of the Technology in the Industry

Groundwater protection, including the installation of monitoring wells, is included in Options 3 and 4. Only a portion of beef feedlot and stand-alone heifer operations, dairies, and veal operations are expected to be located in areas where there is a hydrologic link of groundwater to surface water. The percentage of operations that need groundwater monitoring is based on soil and landscape site factors that indicate a potential of groundwater contamination (USEPA, 1999). Table 4-30 presents an estimate of operations that will incur groundwater monitoring costs based on regional location. It is assumed that no operations have groundwater programs in place; therefore all operations located in these areas are costed for the installation of wells.

Table 4-30

Percentage of Beef Feedlots and Stand-Alone Heifer Operations, Dairies, and Veal Operations Incurring Groundwater Monitoring Costs for Options 3 and 4[1]

Animal Type	Size Class	Region				
		Central	Midwest	Mid-Atlantic	Pacific	South
Beef and Heifers	Medium1	13%	27%	24%	12%	22%
	Medium2	13%	27%	24%	12%	22%
	Large1	13%	27%	24%	12%	22%
	Large2	13%	27%	24%	12%	22%
Dairy	Medium1	13%	27%	24%	12%	22%
	Medium2	13%	27%	24%	12%	22%
	Large1	13%	27%	24%	12%	22%
Veal	Medium1	13%	27%	24%	12%	22%
	Medium2	13%	27%	24%	12%	22%

[1] EPA, 1999

4.9.3 Design and Costs

The design for the groundwater wells does not vary according to animal type or size of facility. Wells will be installed only by facilities where a hydrologic link has been established (see Section 4.12). Each facility determined to have a hydrologic link will install four 50-foot groundwater monitoring wells, one up-gradient and three down-gradient from the manure storage facility, as shown in Figure 4-8.

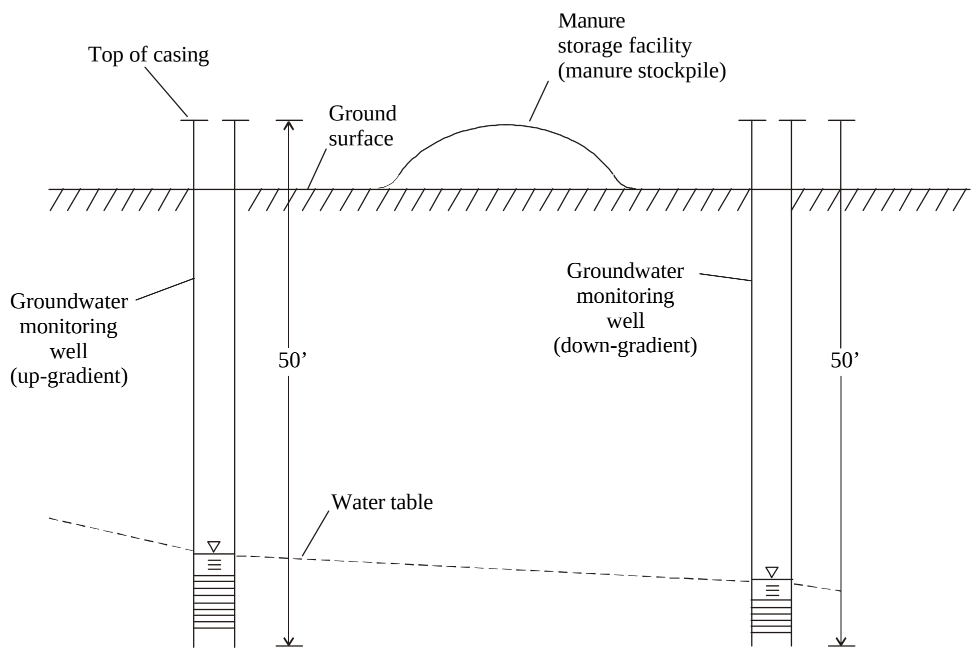


Figure 4-8. Schematic of Groundwater Monitoring Wells

Total Capital Costs

Capital costs for well installation include well drilling at $21 per foot, well casing at $2 per foot for the upper 30 feet, well screening of the lower 20 feet at $3 per foot, and gravel for the entire 50 feet at $1 per foot. A protective casing for each well head is valued at $120. A bailer, which samples water from the well, costs $35 and can be used to test all the wells on the farm. Groundwater well installation data are compiled from two sources (Schultes, 1999; USEPA, 1998).

To determine baseline concentrations, an initial groundwater sample is required for each well in the first year after installation to determine baseline concentrations ($85 per well, including 1 hour of labor at $10 per hour and $75 for laboratory analyses of the water sample for total coliform, fecal coliform, nitrate-N, ammonia-N, chloride, and total dissolved solids). Subsequent groundwater monitoring costs are incurred as annual costs (two samples per well per year), with two samples per well taken in the first year in addition to the initial samples.

Capital Cost	=	4 Wells × [Well Drilling + Well Casing + Well Screening + Gravel + Well Head Protection] + Bailer + Initial Sampling
	=	4 Wells×[($21/ft × 50 ft) + ($2/ft × 30 ft) + ($3/ft × 20 ft) + ($1/ft × 50 ft) + $120] + $35 + (2 samples × $85/sample x 4 wells)
	=	$6,075

Total Annual Costs

Groundwater monitoring operational and maintenance (O&M) costs are estimated at 2% of capital costs. Additional annual costs include two samples per year for each well, with 1 hour of labor required for each sample at $10 per hour and $75 per sample for laboratory analyses (REFERENCE); therefore, the total annual cost for groundwater monitoring is $801.50.

Annual Cost	=	Sampling + O&M + Labor
	=	[4 wells × ($75/sample × 2 samples)] + (0.02 × Capital Cost) + (1 hr/sample × 4 Wells × 2 samples/well × $10/hr)
	=	$801.50

4.9.4 Results

The cost model results for installing groundwater monitoring wells are $6,075 for capital costs and $801.50 for annual costs for each model facility, regardless of animal type or region, as shown in Appendix A, Table A-12.

4.10 Composting

Composting is used at animal feeding operations to biologically stabilize and dry waste for use as a fertilizer or soil amendment. Composting reduces the weight and moisture content of manure, which can lower transportation costs. Composting is evaluated as a method of handling animal waste on site for all regulatory options.

4.10.1 Technology Description

Composting is an aerobic process in which microorganisms decompose organic matter into heat, water, carbon dioxide, and a more stable form of organic matter (compost). Composting results in a relatively uniform, dry, odorless end product that can be used as a soil amendment. The initial volume, weight, and particle size of raw materials is reduced during the composting process. The elevated temperatures in the interior of properly operated compost piles kill weed seeds, pathogens, and fly larvae.

Because composting is an aerobic process, a continuous supply of oxygen must be available for the microorganisms to break down the organic matter. Aeration can be accomplished either by natural convection and diffusion or forced aeration. Aeration reduces the chance of the pile becoming anaerobic. Anaerobic decomposition is slower and produces compounds with strong odors. Aerating the pile also helps to remove excess heat and trapped gases from the composting pile.

Composting time and efficiency are affected by the amount of oxygen, the energy source (carbon) and amount of nutrients (nitrogen) in the raw materials, the moisture content, and the particle size and porosity of the materials. The proper balance of carbon, nitrogen, and moisture should be present in the initial compost mix. Moisture levels should be in the range of 40 to 65 percent. Water is necessary to support biological activity; however, if the moisture content is too high, water displaces air in the pore spaces and the pile can become anaerobic. Moisture content gradually decreases during the composting period. The carbon to nitrogen ratio (C:N) should be between 20:1 and 40:1. If the C:N ratio is too low, the carbon is used before all the nitrogen is stabilized and the excess nitrogen can volatilize as ammonia and cause odor problems. If the ratio is too high, the composting process slows as nitrogen becomes the limiting nutrient. Manure typically needs to be mixed with drier, carbonaceous material to obtain the desired moisture and C:N levels.

The length of time required for composting depends on the materials used, the composting management practices, and the desired compost characteristics. Compost is judged to be complete by characteristics related to its use and handling such as C:N ratio, oxygen demand, temperature, and odor. A curing period of about one month follows composting. Resistant compounds, organic acids, and large particles are further decomposed during the curing period.

4.10.2 Prevalence of the Technology in the Industry

The frequency of occurrence of composting operations at beef feedlots and dairies is not known. Although many operations stockpile manure, a true composting operation is rare. For all regulatory options, the cost model compares the cost of composting waste to traditional storage and transportation options. For Options 1 through 4, and 6 through 7, the cost model selects composting if it is the lowest cost option. In Option 5, composting is costed for all beef feedlots and dairies.

4.10.3 Design

Windrow composting systems are designed for use at beef feedlots and dairies. Manure and other raw materials are formed into windrows and periodically turned. The size and shape of the windrow depends on the type of turning equipment used by the site. The cost model assumes that sites use a tractor attachment for turning made by Valoraction, Incorporated (NRAES, 1992) (see Figure 4-9). This type of windrow turner is capable of turning windrows 10 feet wide by 4.2 feet tall. Windrow composting requires less labor and equipment than other types of composting and allows greater flexibility with respect to location and composting amendments.

Beef feedlots are capable of composting the manure collected from the drylots. Because dairies use flush and hose systems, dairy waste is too wet for composting; however, the manure from calves and heifers kept on drylots at dairies can be composted. Separated solids from sedimentation basins can also be added to the compost pile.

Volume of Manure

The composting cost module calculates the volume of waste transferred to the compost pile from drylots and from settling basins.

Drylots

For this model, it is assumed that all beef cattle and dairy calves and heifers are kept on drylots. Waste from confined barns where mature dairy cattle are housed is typically too wet for effective composting. Manure from drylots is periodically scraped and moved to the compost pile. The amount of manure generated (as-excreted) is calculated using the information and equations in Section 3.2. The volume of manure collected from the drylot is less than the as-excreted volume because the manure moisture content decreases on the drylot. Because the volume of solids in the as-excreted manure is the same as in the collected manure, the volume of manure collected from the drylot can be calculated using a mass balance on solids by the following equation:

$$\text{Volume Solids}_{collected} = \text{Volume Solids}_{excreted}$$

$$\text{Volume Solids} = \text{Total Volume} * (1 - \text{Moisture})$$

$$\text{Volume}_{collected}\ (1 - \text{Moisture}_{collected}) = \text{Volume}_{excreted}\ (1 - \text{Moisture}_{excreted})$$

$$\text{Volume}_{collected} = [\text{Volume}_{excreted}\ (1 - \text{Moisture}_{excreted})] / (1 - \text{Moisture}_{collected})$$

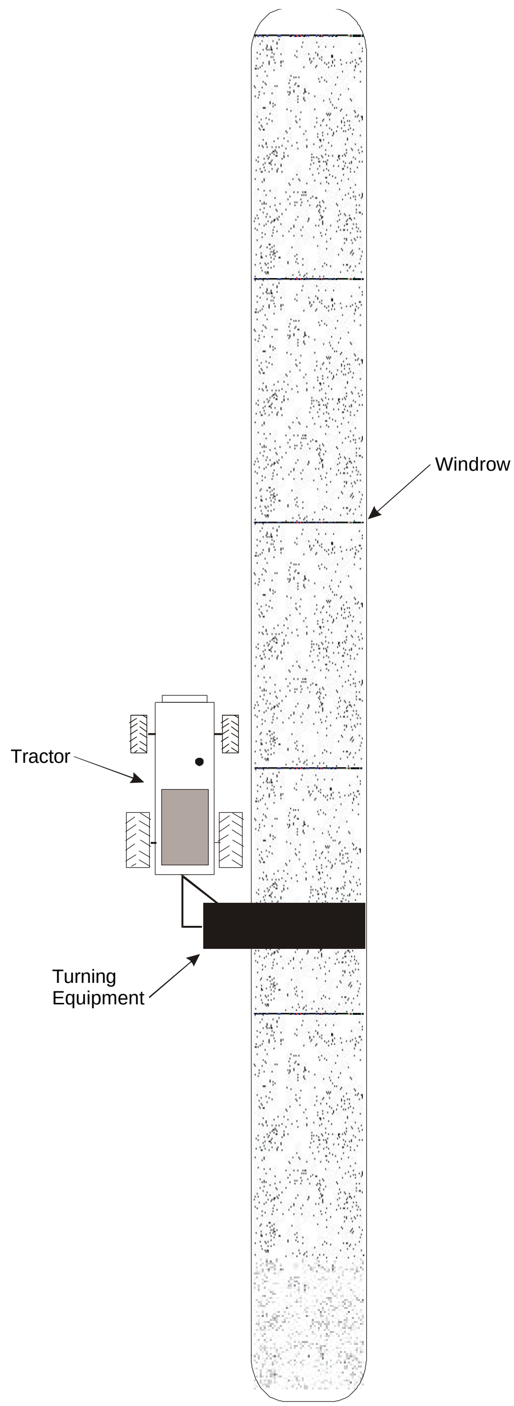


Figure 4-9. Windrow Composting

It is estimated that manure collected from the drylot has a moisture content of 35.4% (Sweeten, et al., 1995). The values of the parameters used to compute the volume of manure are contained in the manure reference table and cost run information in the cost model.

Some of the manure solids that accumulate on drylots are lost in the runoff from the feedlot before the waste is composted; therefore, the solids lost in runoff are subtracted from the total volume of manure. The amount of solids lost in runoff is estimated at 1.5% of the total drylot runoff (MWPS, 1985).

Separated Solids

Option 5 requires the addition of separated solids from the settling basin to the compost pile. Because wastes from dairy flush barns have a high moisture content, they are generally not composted; however, the settled solids from sedimentation basins can be added to the compost pile. Therefore, a fraction of the manure from mature dairy cattle barns is added to the compost pile after some drying has occurred. For beef feedlots, only runoff enters the sedimentation basins, therefore, a fraction of the solids entering the basin as runoff is added to the compost pile.

For dairies, the amount of separated solids is calculated by computing the amount of manure generated and multiplying by the settling efficiency of 50% (see Section 4.1). For beef feedlots, the additional volume added to the compost pile from the settling basin is the annual solids in runoff multiplied by the settling efficiency.

Volume Reduction

One of the major benefits of composting is waste volume reduction, which can reduce transportation costs. Finished compost is estimated to contain 30.8% moisture (Sweeten et.al., 1995). This moisture content is used in the following equation to determine the weight of finished compost:

$$\text{Final Weight} = \text{Initial Weight} \times (1\text{- Initial Moisture}) / (1\text{- Final Moisture})$$

Compost Recipe

As stated in Section 4.9.1, manure must be mixed with composting amendments to obtain the proper C:N ratio and moisture content. The cost model assumes wheat straw is used as the composting amendment. Wheat straw has a moisture content of 10% and a C:N ratio of 130. Manure collected from drylots has a moisture content of 35.4 percent. The carbon content is calculated from the volatile solids composition of manure. It is estimated that manure has a volatile solids composition of 564.6 lb/ton (Sweeten, et al. 1995). The carbon content is calculated using the following equation:

$$\text{Carbon}_{\text{manure}} = \text{Volatile Solids}_{\text{manure}} / 1.8$$

$$= 564.6/1.8 = 314$$

(USDA, 1992)

The nitrogen content of manure is estimated to be 25.71 lb/ton (Sweeten, et al. 1995). The carbon and nitrogen contents are converted to a percent basis. The C:N ratio of the manure is calculated using the percent composition and the volume of manure. Wheat straw and water are added to the compost mix until the C:N ratio is between 25:1 and 40:1 and the moisture content is between 40 and 65 percent. The cost model simulates this method in the composting cost module, performing an iteration to determine the proper mix of manure, wheat straw, and water.

4.10.4 Costs

Capital costs for composting includes turning equipment and thermometers to monitor the pile temperature. Annual costs include the labor to turn the pile and any required composting amendment (in this case, wheat straw). Table 4-31 presents the 1997 unit costs for these items.

Table 4-31

Unit Costs for Composting

Unit	Cost (1997)	Source
Windrow turning equipment (Valoraction 510 rotary drum turner tractor attachment)	$8,914	On-Farm Composting Handbook, NRAES-54
Thermometers	$242.27 (for set of two)	Omega Engineering
Turning labor	$2.69/ton	On-Farm Composting Handbook, NRAES-54
Wheat straw	$72.68/ton	Case's Agworld.com

Total Capital Costs

The following equation is used to calculate the composting capital cost:

Capital Cost = Windrow Turning Equipment + Thermometers

= $8,914 + $242.27

The total capital costs for composting is $9,156.27.

Total Annual Costs

The volume of wheat straw required is used to determine the cost of the composting amendments. The total volume of the compost pile is used to calculate the labor costs for turning. The following equation is used to calculate the composting annual cost (Sweeten et al, 1995):

$$\text{Annual Cost} = (\$2.69/\text{ton} \times \text{Volume}_{\text{collected}}) + (\$72.68/\text{ton} \times \text{Volume}_{\text{wheat straw}})$$
$$+ (\$1.75/100\text{cf} \times \text{Volume}_{\text{water}}) - (\$1.70 \times \text{Selling Weight}/2000)$$

There is some reduction in manure solids expected as a result of composting; however, with the addition of the carbon amendments, the weight of compost to be transported or land applied is not significantly different than that manure which is not composted. These differences are calculated in the cost model, however, and they are considered in calculating transportation costs, described in Section 4.14.

4.10.5 Results

The cost model results for composting at each model farm are presented in Appendix A, Table A-13.

4.11 Surface Water Monitoring

Option 4 requires animal feeding operations to monitor nearby water bodies for contaminants.

4.11.1 Practice Description

Surface water monitoring is used to evaluate the nutrient loading of waterways near animal feeding operations. The primary purpose of this monitoring is to determine the effectiveness of implemented technologies and practices at preventing contamination of surface water. Possible sources of excess loading include uncontained runoff and lagoon overflow during peak storm events.

The best time to monitor the effectiveness of runoff control systems is immediately following storm events; therefore, sampling events are not scheduled in advance. Animal feeding operations are costed for sampling water bodies going through or adjacent to feeding operations immediately following storm events, up to 12 times per year.

4.11.2 Prevalence of the Practice in the Industry

It is assumed that beef feedlots, dairies, and veal operations do not have surface water monitoring programs in place, therefore, the cost model assigns the cost of surface water monitoring to every operation evaluated under Option 4. Note that Option 4 is the only option in the cost model that includes surface water monitoring.

4.11.3 Design

The design for surface water monitoring is based on the sampling program and includes monitoring at the surface impoundment (pond or lagoon) and the stockpile. The requirements of the sampling program are:

- Twelve sampling events per year at surface water bodies;
- One sampling event per year at the lagoon or pond and at the stockpile;
- Four grab samples and one quality assurance (QA) sample per sampling event (Table 4-32 shows the total number of samples over a one-year period);
- Sampling will coincide with rain events in excess of 0.5 inches precipitation; and
- Analysis of each sample for nutrients (nitrite, nitrate, total Kjeldahl nitrogen, total phosphorus) and total suspended solids (TSS).

An alternative analysis considered ambient monitoring for metals (zinc, arsenic, copper), BOD_5, and biological organisms (fecal coliforms, enterococcus, salmonella, and escherichia coli). Due to high costs and limited holding times for BOD and pathogen samples, these parameters were not costed for Option 4. EPA believes the uncertainty of precipitation events prevents the CAFO owner from being prepared to rapidly sample; therefore, accurate sample collection and shipping would be very difficult for these additional constituents.

Table 4-32

Number of Samples

Number of sampling events per year	12
Number of samples per sampling event (4 grab + 1 QA)	5
Total annual samples	60

4.11.4 Costs

Initial cost estimates, shown in Table 4-33, include training, coolers, and reusable sampling equipment. Annual costs, shown in Table 4-34, include sterile containers and sampling supplies for each sampling event, labor costs associated with sampling, sample overnight shipment, and lab processing fees.

Table 4-33

Capital Costs for Surface Water Sampling

Description	Unit Cost	Capital Cost
Training (8 hr)	$10/hr	$80
Course fee	$40	$40
Misc. other costs (15% of labor)	--	$12
Coolers (2)	$30/cooler	$60
Sampling equipment (pipet, etc.)	$200	$200
	Total Capital Cost	**$392**

Table 4-34

Annual Costs for Surface Water Sampling

Description	Unit Cost	Annual Cost
250-mL bottles (2 per sample)	$2/bottle	$240
500-mL bottles (1 per sample)	$2.70/bottle	$162
Overnight shipping (30-lb cooler)	$60/sampling event	$720
Misc. supplies and transportation	$30	$30
Laboratory costs	$79/sample	$4,740
Sample collection (2 hrs/sampling event)	$10/hr	$240
QA & recordkeeping (1 hr/sampling event)	$10/hr	$120
	Total Annual Cost	**$6,252**

REFERENCE: Tetra Tech 1999a

4.11.5 Results

The cost model results for the surface water monitoring option do not vary between animal type, region, or size group. The capital cost for surface water monitoring is $392, and the annual cost is $6,252, as shown in Appendix A, Table A-14.

4.12 <u>Nutrient-Based Land Application</u>

Cattle manure is a valuable source of plant nutrients and organic matter and is commonly applied to the land for use as a fertilizer and soil conditioner. Applying too much manure to the land, however, can harm crop growth, contaminate soil, cause surface and groundwater pollution, and waste nutrients. The regulatory options evaluated require facilities to limit the application of manure nitrogen (for all Option 1 facilities and for some Option 2 - 8 facilities) or manure phosphorus (for some Option 2-8 facilities) to a rate based on the agronomic requirements of the crops. Depending on the amount of manure generated at beef feedlots, dairies, and veal operations, the amount of land available for manure application, the specific crops that are grown, and the expected crop yields, operations may or may not have sufficient land on site to apply all of their manure.

4.12.1 Practice Description

Land application of manure should be planned to ensure that the proper amounts of all nutrients are applied in a way that minimizes risks to water quality and public health. This can be accomplished by developing and implementing a permit nutrient plan (PNP), described in Section 4.12. As part of the PNP, operations calculate and use manure application rates that are sufficient to meet, but not exceed, the nutrient needs of agronomic crops. Under Option 1, the manure application rates are based on the nitrogen requirements of the crops, and under Options 2-7, the manure application rates are based on the phosphorus requirements of the crops in areas with high soil phosphorus levels and on the nitrogen requirements of the crops everywhere else. (See Section 4.12 for a discussion of the breakout of nitrogen- versus phosphorus-based application.) Crops need more nitrogen than phosphorus; however, animal manure tends to have a low nitrogen-to-phosphorus ratio. This means that applying manure at a crop's agronomic requirement for nitrogen results in applying more phosphorus than is needed by the crop. Conversely, applying manure at a crop's agronomic requirement for phosphorus results in a need for supplemental application of commercial nitrogen fertilizer.

Accurate estimates of the amount of manure available for land application and the composition of that manure are essential for developing appropriate manure application rates. The amount of manure generated at an operation is directly linked to the number of animals maintained at the operation; however, because the composition of manure changes as it ages, the amount collected and applied to the land is often much less than the amount of manure generated by the animals. Applying cattle manure to the land at agronomic application rates also requires a good perspective of appropriate crop rotations (e.g., the growing of a sequence of crops to optimize yield, crop quality, and maintaining or improving soil productivity), expected crop yields, and crop nutrient requirements. An appropriate application rate can be calculated using the nutrient availability of the manure and the crop requirement for the nutrient having the highest priority (nitrogen or phosphorus).

Restricting manure application to an agronomic application rate for nitrogen and phosphorus will reduce nutrient runoff and leaching. This restriction, however, will result in the need to transport excess manure nutrients off site for many facilities (described in Section 4.14). Because most crops do not need as much phosphorus as nitrogen, an agronomic phosphorus-based application scenario will result in the purchasing and application of commercial nitrogen fertilizer. Conversely, an agronomic phosphorus-based application scenario will result in a reduction in purchased commercial phosphorus fertilizer.

4.12.2 Prevalence of the Practice in the Industry

Fewer operations have sufficient land to apply their manure at agronomic phosphorus rates than agronomic nitrogen rates. To estimate the number of operations that incur transport costs due to insufficient on-site land, EPA used data from USDA for three categories of facilities:

Category 1: Facilities with sufficient land to land-apply all of their generated manure at appropriate agronomic rates. No manure is transported off site.

Category 2: Facilities without sufficient land to land-apply all of their generated manure at appropriate agronomic rates. The excess manure after agronomic application is transported off site.

Category 3: Facilities without any available land for manure application. All of the manure is transported off site regardless of the regulatory options considered by EPA.

Based on site visit observations, it appears that most veal operations have sufficient land to agronomically apply all of their manure; therefore, EPA assumes that all veal operations are in Category 1 for all regulatory options.

EPA's estimate of the number of Category 1, 2, and 3 beef and dairy operations is developed from a 1999 USDA analysis (Kellogg, 2000). In this analysis, USDA used 1997 Census of Agriculture data to estimate the manure production at livestock facilities. As part of this analysis, USDA estimated the number of confined livestock operations that produce more manure nutrients than they can land-apply on their available cropland and pasture lands at agronomic rates for nitrogen and phosphorus (i.e., Category 2 facilities) and the number of confined livestock operations that do not have any available cropland or pastureland (i.e., Category 3 facilities). Applying the percentage of these facilities estimated by USDA to the total number of beef and dairy livestock operations (shown in Table 1-4), EPA estimates the number of Category 1, 2, and 3 facilities for nitrogen-based application and for phosphorus-based application. The estimate of Category 1, 2, and 3 facilities by animal type and size class is presented in Table 4-36.

Table 4-36

Percentage of Category 1, 2, and 3 Facilities

Animal Type	Size Class	Category 1	Category 2	Category 3
Nitrogen-Based Agronomic Application				
Beef	Medium1	84%	9%	7%
	Medium2	84%	9%	7%
	Large1	68%	21%	11%
	Large2	8%	53%	39%
Dairy and Heifer Operations	Medium1	50%	36%	14%
	Medium2	50%	36%	14%
	Large1	27%	51%	22%
Veal	Medium1	100%	0%	0%
	Medium2	100%	0%	0%
Phosphorus-Based Agronomic Application				
Beef	Medium1	62%	31%	7%
	Medium2	62%	31%	7%
	Large1	22%	67%	11%
	Large2	1%	60%	39%
Dairy and Heifer Operations	Medium1	25%	61%	14%
	Medium2	25%	61%	14%
	Large1	10%	68%	22%
Veal	Medium1	100%	0%	0%
	Medium2	100%	0%	0%

Under Option 1, all facilities are expected to apply manure on a nitrogen basis; therefore, the percentage of facilities in each category is equal to the nitrogen-based application percentages shown in Table 4-36. Under Options 2 through 8, some operations are expected to apply manure on a nitrogen basis, while others are expected to apply manure on a phosphorus basis. Section 4.12 describes the nitrogen- and phosphorus-based management in more detail.

In addition, all Category 1 and 2 beef and dairy operations that implement phosphorus-based applications will be required to purchase and apply commercial nitrogen fertilizer for Options 2 through 8. Commercial fertilizer is required because manure applied on a phosphorus basis will not meet the crops' nutrient requirements for nitrogen. Because it is assumed that Category 3 operations do not have any cropland, these operations do not require commercial fertilizer.

4.12.3 Methodology

The cost model performs a number of calculations to determine for each model farm the acreage that is available to land-apply manure and the amount of manure requiring off-site transportation. These acreage calculations are performed for both nitrogen-based and phosphorus-based application scenarios. The model performs the following steps:

1. The model calculates the acreage for Category 1 facilities using agronomic application rates as inputs. (No manure is transported off site.)

2. The model calculates the acreage for Category 2 facilities using the average excess nutrients per operation as an input. The excess nutrients are converted to equivalent weight of manure, and this weight is transported off site.

3. The model calculates the amount of manure generated at Category 3 operations using the manure generation information as inputs. All manure at Category 3 operations is transported off site.

After calculating the amount of manure requiring transportation, the cost model calculates the amount and cost of commercial nitrogen fertilizer required at Category 1 and 2 operations under a phosphorus-based application scenario.

Estimation of Available Cropland Acreage

Data on the amount of land available to facilities for land application of manure are limited; therefore, the following assumptions are used in the cost model:

- By definition, Category 1 operations are defined as having a sufficient amount of land; therefore, EPA assumed that, at a minimum, the available land equaled the amount of land required to agronomically land-apply all of the manure generated at the operation on either a nitrogen- or a phosphorus-basis.

- Category 2 operations have the same amount of land as the Category 1 operations minus the acreage required to agronomically land-apply the excess manure nutrients. The amount of excess manure nutrients at Category 2 operations is obtained from the 1999 USDA analysis of manure production.

- Category 3 operations have no available land. The following subsections detail the calculation of agronomic application rates and category acreages for the model farms.

Agronomic Application Rates

Agronomic application rates are calculated using crop yields, crop uptakes, and crop utilization factors. Representative crops were identified for each model farm by contacting USDA state cooperative extension services. These crops vary by region and animal type. Because veal operations are located predominantly in the Midwest, EPA developed only one set of crop assumptions for veal that reflect the Midwest region. Crop nutrient requirements are calculated by multiplying the expected crop yields (obtained from state cooperative extension services or Census of Agriculture data) by the crop uptake (Lander, 1998) for both nitrogen and phosphorus.

$$\text{Crop Nitrogen Requirements (lb/acre)} = \text{Crop Yield (tons/acre)} \times \text{Crop Uptake (lb/ton)}_{\text{nitrogen}}$$

$$\text{Crop Phosphorus Requirements (lb/acre)} = \text{Crop Yield (tons/acre)} \times \text{Crop Uptake (lb/ton)}_{\text{phosphorus}}$$

Table 4-37 presents the representative crops, crop yields, crop uptakes, and crop nutrient (nitrogen and phosphorus) requirements for all animal types by region. Crops are not expected to vary significantly based on the size of the animal operation.

Table 4-37

Crop Information

Animal Type	Region	Crops	CropYield (tons/acre)	Crop Uptake		Crop Requirement (lb/ton)	
				Nitrogen	Phosphorus	Nitrogen	Phosphorus
Beef	Central	Corn-silage Hay	20 3	7.1 25.6	1.1 4.5	142 77	21 13
	Mid-Atlantic	Corn-silage Alfalfa	27 6	7.1 0	1.1 4.7	191 0	28 28
	Midwest	Corn-silage Alfalfa	20 6	7.1 0	1.1 4.7	142 0	21 28
	Pacific	Corn-silage Alfalfa Winter wheat	24 8 18	7.1 0 0.03	1.1 4.7 0.01	170 0 0.5	25 38 0.1
	South	Corn-silage Hay Rye	17 2 3	7.1 19.8 0.03	1.1 15.3 0.01	121 40 0.1	18 31 0.02
Dairy/ Heifer	Central	Corn-silage Hay	20 3	7.1 25.6	1.1 4.5	142 77	21 13
	Mid-Atlantic	Corn-silage Hay	17 2	7.1 19.8	1.15 15.3	121 40	18 31
	Midwest	Corn-silage Hay	17 2	7.1 19.8	1.1 15.3	121 40	18 31
	Pacific	Corn-silage Alfalfa Winter wheat	24 8 18	7.1 0 0.03	1.1 4.7 0.01	170 0 1	25 38 0.1
	South	Corn-silage Hay Rye	17 2 3	7.1 19.8 0.03	1.1 15.3 0.01	121 40 0.1	18 31 0.02
Veal	All (based on Midwest)	Corn-silage (50% of crop) Soybeans (50% of crop) Winter wheat (100% of crop)	138 (bu/acre) 42 (bu/acre) 46 (bu/acre)	0.8 (lb/bu) 3.6 (lb/bu) 1.0 (lb/bu)	0.2 (lb/bu) 0.4 (lb/bu) 0.2 (lb/bu)	110 150 47	21 15 9

When more than one crop is grown on the land, the total crop nutrient requirement for that land is equal to the sum of the individual crop nutrient requirements.

The cost model estimates that 70% of the nitrogen and 100% of the phosphorus in cattle manure that is applied to the land is available for crop uptake and utilization over time (Lander, 1998); therefore, the agronomic application rate is calculated as the total crop nutrient requirement divided by the appropriate utilization factor.

Nitrogen-Based Manure Application Rate (lb/acre) = Total Crop Nitrogen Requirements (lb/acre)/70%

Phosphorus-Based Manure Application Rate (lb/acre) = Total Crop Phosphorus Requirements (lb/acre)/100%

These agronomic application rates for nitrogen- and phosphorus-based application scenarios are used as inputs to the cost model. Table 4-38 presents the total crop nutrient (nitrogen and phosphorus) requirements and manure application rates (nitrogen and phosphorus) for all animal types by region.

Table 4-38

Total Crop Nutrient Requirements and Manure Application Rates

Animal Type	Region	Total Crop Requirements (lb/acre)		Manure Application Rate (lb/acre)	
		Nitrogen	Phosphorus	N-Based	P-Based
Beef	Central	219	34	312	34
	Mid-Atlantic	191	57	274	57
	Midwest	142	49	203	49
	Pacific	171	63	244	63
	South	160	49	229	49
Dairy	Central	219	34	312	34
	Mid-Atlantic	160	49	229	49
	Midwest	160	49	229	49
	Pacific	171	63	244	63
	South	160	49	229	49
Veal	All	102	27	146	27

Category 1 Acreage

Category 1 acreages are calculated using the agronomic application rates, number of animals, manure generation estimates, nutrient content of the manure, and manure recoverability factors:

$$\text{Category 1 Acreage} = \frac{\text{Animal Units (AUs)} \times \text{Manure Generation (tons/AU)} \times \text{Nutrient Content (lbs/ton manure)} \times \text{Recoverability Factor}}{\text{Agronomic application rate (lb/acre)}}$$

EPA defines recoverability factors as the percentage of manure, based on solids content, that would be practical to recover. Recoverability factors are developed for each region using USDA state-specific recoverability factors, and are based on the assumption that the decrease in nutrient values per ton of manure mirrors the reduction in solids content of the recoverable manure (Lander, 1998).

Category 2 Acreage

Category 2 acreages are calculated using Category 1 acreages, the estimate of excess manure from USDA's analysis, and acres required to land-apply excess manure:

Average Excess Nutrients (lbs/yr) =	Excess Nutrients (lbs/yr)/Number of Category 2 Facilities
Excess Acreage =	Average Excess Nutrients (lbs/yr)/Agronomic Application Rate (lb/acre)
Category 2 Acreage =	Category 1 Acreage − Excess Acreage

Table 4-39 presents Category 1 and 2 acreages by animal type, size group, and region.

Category 3 Acreage

Category 3 acreages, by definition, are zero.

Amount of Manure Requiring Off-Site Transportation

The amount of manure transported off site varies by animal type, region, category, and composting use:

Category 1 Manure Transported Off Site (tons) =	0
Category 2 Manure Transported Off Site (tons) =	Excess Nutrients (lbs)/Nutrient Content of Manure (lbs/ton)
Category 3 Manure Transported Off Site (tons) =	Total Manure Generated (tons)

Table 4-39

Category 1 and 2 Acreages

Animal Type	Size Class	Region	Category 1 Acreages		Category 2 Acreages	
			N-Based	P-Based	N-Based	P-Based
Beef	Medium1	Central	49	292	44	265
		Mid-Atlantic	52	165	47	148
		Midwest	71	189	63	170
		Pacific	65	163	58	148
		South	63	192	56	173
	Medium2	Central	134	794	104	658
		Mid-Atlantic	142	448	107	365
		Midwest	192	514	145	419
		Pacific	176	444	137	370
		South	170	523	128	426
	Large1	Central	325	1918	154	1094
		Mid-Atlantic	344	1081	149	581
		Midwest	464	1243	201	667
		Pacific	426	1073	207	623
		South	411	1264	178	679
	Large2	Central	5,413	31,974	3,438	20,234
		Mid-Atlantic	5,734	18,027	3,480	10,892
		Midwest	7,741	20,713	4,697	12,516
		Pacific	7,098	17,881	4,570	11,470
		South	6,851	21,077	4,157	12,735
Heifer	Medium1	Central	23	128	18	90
		Mid-Atlantic	28	80	20	53
		Midwest	31	88	23	61
		Pacific	31	71	23	51
		South	24	69	16	42

Table 4-39 (Continued)

Animal Type	Size Class	Region	Category 1 Acreages		Category 2 Acreages	
			N-Based	P-Based	N-Based	P-Based
Heifer	Medium2	Central	44	240	38	202
		Mid-Atlantic	52	150	45	123
		Midwest	58	164	50	137
		Pacific	57	134	50	113
		South	45	129	37	102
	Large1	Central	87	479	82	441
		Mid-Atlantic	105	300	97	273
		Midwest	115	328	107	301
		Pacific	115	268	107	247
		South	91	258	83	232
Dairy	Medium1	Central	55	200	42	163
		Mid-Atlantic	71	133	53	107
		Midwest	78	146	60	120
		Pacific	66	102	50	82
		South	61	115	43	89
	Medium2	Central	108	391	36	138
		Mid-Atlantic	139	260	39	81
		Midwest	152	285	53	106
		Pacific	130	200	37	62
		South	120	224	20	45
	Large1	Central	335	1,206	82	236
		Mid-Atlantic	427	802	82	112
		Midwest	468	879	123	189
		Pacific	401	616	77	86
		South	369	692	24	3
Veal	Medium1	All	100	100	-	-
	Medium2	All	100	100	-	-

Once the amount of manure requiring off-site transportation is calculated, the model determines how much of the manure is solid versus liquid using manure generation rates and percent solid content of the manure as generated and as aged. These calculations vary by animal type (i.e., beef, dairy, calf, heifer) and operating systems (i.e., flush versus hose systems at dairies). Total available solid manure is calculated by summing the solid portion of the manure excreted from the animals that does not enter a separator as well as the solids obtained from the solid separator. Total available liquid waste is calculated by summing the amount of liquid in the lagoons or ponds.

$$\text{Available Solids}_{\text{manure}}\ (\text{lb/yr}) = \frac{\text{Animal Units (AU)} \times \text{Manure Generation Rate (lb/AU/yr)} \times \%\ \text{Solid Content}_{\text{generated manure}}}{\%\ \text{Solid Content}_{\text{aged manure}}}$$

$$\text{Available Solids}_{\text{separator}}\ (\text{lb/yr}) = \frac{\text{Solids from Solid Separator (lb/yr)} \times \%\ \text{Solid Content}_{\text{separated solids}}}{\%\ \text{Solid Content}_{\text{aged manure}}}$$

$$\text{Total Available Solids (lb/yr)} = \text{Available Solids}_{\text{manure}}\ (\text{lb/yr}) + \text{Available Solids}_{\text{separator}}\ (\text{lb/yr})$$

$$\text{Total Available Liquid (lb/yr)} = (\text{Pond Liquid (ft}^3\text{/yr)} + \text{Lagoon Liquid (ft}^3\text{/yr)}) \times \text{Density (lb/ft}^3\text{)}$$

After calculating the total available solids and liquid waste for Category 2 operations, the model compares the amount of total available solids to the manure being transported off site (excess manure). If the total available solids is greater than the amount of excess manure, only solid waste is transported off site. If the total available solids is less than the amount of excess manure, solid and liquid waste are transported off site. The equations below demonstrate the algorithm used in the cost model to determine how much solid and/or liquid waste is generated:

Transportation of Solid Waste Only: Total Available Solids $\geq$ Excess Manure
Amount of Solid Waste Transported = Excess Manure

Transportation of Solid and Liquid Waste: Total Available Solids < Excess Manure
Amount of Solid Waste Transported = Total Available Solids
Amount of Liquid Waste Transported = Excess Manure − Total Available Solids

All solid and liquid waste generated at Category 3 operations is transported off site; however, there is no additional cost for this transportation, as EPA has assumed that these operations are already removing their manure because they have no cropland available. Transportation costs for Category 1 and 2 operations are discussed in Section 4.14.

4.12.4 Costs

In a phosphorus-based application scenario, the amount of manure applied to the land does not supply enough nitrogen to the crops; therefore, additional nitrogen will be applied in the form of commercial fertilizer. No capital costs are calculated because EPA assumes operations already own appropriate equipment. Annual costs are equal to the cost to purchase commercial nitrogen fertilizer.

The amount of commercial nitrogen fertilizer required at Category 1 and 2 operations under a phosphorus-based application scenario depends on the crop acreage and the nutrient content of the manure. The amount of nitrogen required by the crops is calculated from the crop type and the acreage. Then, the amount of nitrogen that would be incidentally applied in the manure under a phosphorus-based application scenario is calculated. The difference between these two quantities equals the amount of commercial nitrogen fertilizer that needs to be purchased.

$$\text{Fertilizer}_{\text{nitrogen}}\ (\text{lbs}) = \text{Acreage} \times (\text{Nitrogen-Based Manure Application Rate (lb/acre)} - \text{Phosphorus-Based Manure Application Rate (lb/acre)})$$

Using average United States commercial fertilizer prices paid by farmers in 1997 for ammonium nitrate and urea, EPA estimates that the cost of commercial nitrogen fertilizer is $0.12/lb (Fertilizer Institute, 2000).

$$\text{Annual costs} = \$0.12 \times \text{Nitrogen Deficit}_{\text{phosphorus-based scenario}}$$

4.12.5 Results

The cost model results for the purchase of commercial nitrogen fertilizer are presented in Appendix A, Table A-17.

4.13 Nutrient Management Planning

Nutrient management planning is a process for preventing excess application of manure nutrients on cropland and thereby minimizing the release of nutrients to groundwater and surface water. Manure nutrients are applied to the land in the form of solid manure and lagoon and pond effluent. Excess application is prevented by developing and abiding by appropriate manure application rates that are designed to add only the nutrients required by the planned crops at the expected yields. These rates may be based on nitrogen levels (N-based application), phosphorus levels (P-based application), or other nutrients. Nutrient management may also minimize releases of nutrients by specifying the timing and location of manure application.

4.13.1 Practice Description

Nutrient management planning is a site-specific activity that varies depending on the conditions at each operation. A Permit Nutrient Plan (PNP) is developed by a certified nutrient management specialist and implemented by trained and certified personnel. Each plan includes the following components:

- Name and address of the operation owner and manager;
- Description of the operation including operation type, facility map, facility capacity, number of animals produced or housed annually, and amount of manure produced;
- An analysis of manure and cropland soil to determine the nutrient content of manure to be land-applied and the existing cropland soil nutrient content;

- Calculation and documentation of the manure application rates that are applicable to a specific site;

- An assessment of the entire feedlot and cropland areas to assess groundwater links to surface water (this activity includes an evaluation of soil leaching and permeability index);

- Assessment of manure storage and handling practices and identification of best management practices, including the installation of a lagoon depth marker, to protect surface water and groundwater;

- Other site-specific management activities such as the cessation of crop production in setback areas of a water body (e.g., stream, lake, etc.);

- Requirements for the calibration of manure spreaders; and

- Recordkeeping requirements (including manure, land application, manure transfer, and crop records).

Implementation of the PNP serves as a pollution prevention measure and reduces the nutrients released to surface water and groundwater.

4.13.2 Nitrogen-based vs. Phosphorus-based Management

Nitrogen-based (N-based) management has been practiced and advocated by farm advisers for many years; however, the rapid growth and intensification of crop and animal farming in many areas has created regional and local imbalances in phosphorus inputs and outputs. The imbalances are caused by the high phosphorus content of animal manure. By applying manure on a nitrogen basis, farmers are significantly over applying the amount of phosphorus needed by the crop. On average, only 30% of the phosphorus in fertilizer and feed input to farming systems is output in the form of crop and animal produce. The remaining 70% of phosphorus either builds up in the soil, or is lost via runoff and erosion. The potential for phosphorus surplus increases when farming systems change from cropping to intensive animal production. Phosphorus accumulation on farms has built up soil phosphorus levels that often exceed crop needs. Today, there are serious concerns that agricultural runoff (surface and subsurface) and erosion from high phosphorus soils may be major contributing factors to surface water eutrophication. This phosphorus loss can lead to significant off-site economic impacts, which in some cases occur many miles from the sources of phosphorus (Sharpley et. al.,1999)

EPA uses information from a USDA survey of agricultural soils analyzed by state soil test laboratories in 1997. This information identifies those states with <25%, 25%-50%, and >50% of samples testing “high” or greater than “high” for phosphorus. This “high” rating is state-specific and may range from 50 to 150 ppm. EPA assumes that a percentage of feedlot facilities in each state require P-based manure management vs. N-based manure management using the soil test data results. EPA’s assumptions are shown in Table 4-40

Table 4-40

Percent Operations Requiring P-based vs. N-based Manure Management

Percentage of Samples Testing “High” or Above For Phosphorus (by State)	Percentage of Operations Likely to Require P-Based Manure Management	Percentage of Operations Likely to Require N-Based Manure Management
>50%	60	40
25-50%	40	60
<25%	0	100

Sharpley et al., 1999.

EPA used USDA Census of Agriculture and NASS data to determine the number of facilities of each model farm in every state in the United States. Then, the percentages in Table 4-40 were used to calculate the number of facilities that are likely to require N-based agronomic application rates verses P-based agronomic application notes for each model farm and each state. The state data were used to calculate the total number of facilities in each region that require N-based application verses P-based application. The results of these calculations provides the percentage of operations that require N-based verses P-based application in each region, for each model farm. (For additional detail on these calculations, see ERG, 2000g.) The results are presented in Table 4-41.

Table 4-41

Percentage of Operations by Nutrient Application Type for Options 2 through 8

Animal Type	Size Class	Region	P-based	N-based
Beef	Medium1 and Medium 2	Central	37%	63%
		Mid-Atlantic	29%	71%
		Midwest	12%	88%
		Pacific	60%	40%
		South	51%	49%
	Large1 and Large2	Central	48%	52%
		Mid-Atlantic	34%	66%
		Midwest	7%	93%
		Pacific	60%	40%
		South	36%	64%
Heifers	Medium1 and Medium 2	Central	45%	55%
		Mid-Atlantic	47%	53%
		Midwest	42%	58%
		Pacific	60%	40%
		South	25%	75%
	Large 1	Central	31%	69%
		Mid-Atlantic	53%	47%
		Midwest	39%	61%
		Pacific	60%	40%
		South	43%	57%
Dairy	Medium1 and Medium 2	Central	45%	55%
		Mid-Atlantic	47%	53%
		Midwest	42%	58%
		Pacific	60%	40%
		South	25%	75%
	Large1	Central	31%	69%
		Mid-Atlantic	53%	47%
		Midwest	39%	61%
		Pacific	60%	40%
		South	43%	57%
Veal	All	Central	45%	55%
		Mid-Atlantic	47%	53%
		Midwest	42%	58%
		Pacific	-	-
		South	-	-

4.13.3 Prevalence of the Practice in the Industry

While some of the components of a PNP may currently be in place or practiced at animal feeding operations, EPA has assumed that 100% of the facilities impacted by this practice need to develop a site-specific PNP under all regulatory options.

4.13.4 Design and Costs

The components of a PNP are discussed above and include:

- Nutrient management training and certification;
- Manure sampling;
- Soil sampling;
- Assessment of crop field/groundwater links to surface water;
- Lagoon depth marker with periodic inspections;
- Identification of setback areas;
- Development of the PNP report (including calculation of application rates);
- Manure spreader calibration; and
- Recordkeeping and reporting.

The costs for developing and implementing these PNP components are estimated using the assumptions and equations outlined below.

Nutrient Management Training and Certification

The costs for training and certification of personnel to implement the PNP includes a course fee, labor for missed work, and miscellaneous other direct costs. EPA assumes that the training and certification are conducted once for the owner/operator of the farm and every three years for the employee that actually applies the waste to the field. A fee of $25 for a 4-hour course offered by state land grant universities is estimated based on certification testing costs from various state extension services. The cost model assumes that an additional 4 hours of studying are required, and the time missed from work to attend the course and study are compensated at a rate of $20 per hour for the owner/operator and $10 per hour for the employee (Tetra Tech, 2000a). EPA estimates that miscellaneous other direct costs, such as travel to attend the course, are 15% of the cost of labor for missed work. The initial cost for training and certification does not vary with the size or type of facility (i.e., the cost is the same for each model facility). The labor cost is calculated as follows:

Course Cost	=	$25
Labor Cost	=	Course + Studying
	=	4 hr + 4 hr
	=	8 hr × $/hr
Miscellaneous Costs	=	0.15 x (8 hr x $/hr)

The owner/operator is expected to take this class once; therefore, the cost is an initial cost that will not recur, and can be considered a capital cost. This cost is:

Capital Cost	=	$25 + 8 hr x $20/hr + 0.15 x (8 hr x $20/hr)
	=	$209

The farm worker is also expected to take this class only once. However, field workers and laborers are assumed to have a turnover of every three years, and a new worker would need to be trained as a replacement. Therefore, this cost is a recurring three year cost:

3-Year cost	=	$25 + 8 hr x $10/hr + 0.15 x (8 hr x $10/hr)
	=	$117

Manure Sampling

EPA assumes that manure sampling and analysis are conducted each application season, and the only initial cost is the construction of a bailer to sample liquid/slurry lagoon or storage pond waste. The bailer is assumed to cost $30 (Tetra Tech, 2000a) and can be constructed with PVC pipe and a cork on the end attached to a string to obtain a sample through the entire lagoon or pond. EPA assumes that the equipment required to collect solid samples (e.g., scoops and pails) is currently owned by the facility.

Capital/Initial Costs = $30

Collection time is estimated to take one hour per sample. The sample collection labor rate is $10 per hour, and the cost per sample is assumed to be $40 (Tetra Tech, 2000a). Though EPA only requires one sample annually, EPA assumed that manure is sampled once before each application period and that all model farms have at least two crops requiring manure application each year. Therefore, EPA assumes that a total of four samples per operation are collected (two dry samples from stockpiled solids and two aqueous samples from a lagoon or storage pond). The annual costs do not vary by model farm and are calculated as follows:

Annual Costs	=	Collection + Analyses
Collection	=	(Number of Samples) × (Time for Collection) × (Hourly Wage)
	=	4 Samples × 1 hr/Sample × $10/hr
	=	$40
Analyses	=	(Number of Samples) × (Cost/sample)
	=	4 Samples × $40/Sample
	=	$160
Annual Costs	=	$40 + $160
	=	$200

Soil Sampling

EPA assumes that soil sampling occurs once every three years per operation. Two sets of costs are developed for each model farm for soil analysis: N-based costs and P-based costs. These costs are based on the collection of one soil sample for every 50 acres of cropland.

Soil sampling costs include the purchase of a soil auger and annual costs to collect and analyze soil samples. EPA assumes an auger cost of $25, a collection time of 1 hour per sample, an hourly wage of $10, and an analysis cost of $10 per sample. The cost for soil sample collection and analysis is calculated as follows:

Capital/Initial Cost	=	$25
Cost for Sample Collection =		(No. of Samples Collected) × (1 hr/Sample) × ($10/hr)
No. of Samples Collected	=	Available Acres/(50 Acres/Sample)
Cost for Sample Analysis	=	(No. of Samples Collected) × ($10/Sample)
Annual Costs	=	0.4 × Available Cropland Acres (See Section 4.11 for available acreage calculations.)

(Tetra Tech, 2000)

Assessment of Crop Field/Groundwater Links to Surface Water

Because the assessment of crop field and groundwater links to surface water requires professional expertise, EPA estimates a $55-per-hour pay rate for this activity. Assessment activities include a limited review of local geohydrology, topography, proximity to surface waters, and current animal waste management practices. EPA estimates that the assessment activities would require 2 days of work at the operation, 2 days of office work, and 2 days to compile the data into a final report. In addition, EPA assumes that a farmhand spends 8 hours assisting in the assessment. EPA estimated that miscellaneous expenses, including travel time, photocopying, purchasing, maps, and report generation are 15% of total costs. This one-time assessment does not vary with the size or type of operation; therefore, the cost is the same for each model farm. The one-time labor cost does not vary by model farm and is calculated as follows:

Professional Labor Cost = (Time at Operation + Time in Office + Final Report Time) × Labor Wage
= [(2 Days × 8 hr/day) + (2 Days × 8 hr/day) + (2 Days × 8 hr/day)] × $55/hr
= 48 hrs × $55/hr
= $2,640

Farmhand Labor Cost = (Time Assisting) × Labor Wage
= (1 Days × 8 hr/day) × $10/hr
= 8 hrs × $10/hr
= $80

The miscellaneous expenses are 0.15 × $2,720 = $408; therefore, the total cost for assessment of cropfield/groundwater links to surface water is $2,720 + $408 = $3,128 per model farm.

Lagoon Depth Marker with Periodic Inspections

Adequate manure storage capacity is critical for successful nutrient management planning. A permanent lagoon or pond depth marker helps to determine if sufficient capacity exists at any given time. A lagoon or pond depth marker can be constructed by using PVC pipe, fittings, and cement. The pipe must be long enough to reach the bottom of the lagoon and extend above the freeboard, and will be incrementally marked to measure water level. EPA assumed a cost of $30 to build and install lagoon/pond depth markers.

Capital/Initial Cost = $30 + Labor

Periodic visual inspections are performed to ensure that sufficient capacity exists at the lagoons and ponds. The annual labor cost of visual inspection does not vary by model farm, and is calculated as follows:

Annual Cost = 15 minutes/week x 52 weeks/year x $10/hr x 1 hr/60 minutes
= $130 per year

Setback Costs

Runoff control for fields used for manure application can be achieved by creating setback areas along the fields adjacent to streams, tile drain inlets, and sinkholes. EPA assumes there would be a cost to an operation if setback areas were required around a stream. EPA assesses a cost to the operation for that land that is taken out of crop production.

To determine the setback area, the ratio of stream length to land area is calculated based on national estimates of land area (3.0 million square miles of land in the contiguous United States (ESRI, 1998) and stream miles (3.5 million miles of steams (Tetra Tech, 2000a). This ratio is converted to miles per acre (0.00144 mile of stream per acre of land). The amount of setback land needed is then calculated by multiplying the average acres of cropland for each model farm by the ratio of stream miles per acre of land. (See Section 4.11 for information on cropland acreages.) EPA assumes that the farm is square and that the stream runs through the middle of the farm. The width of the setback area (on both sides of the stream) is estimated to be 100 feet based on information collected from a total of 914 filter strip projects in 28 states with an average cost of $106.62/acre (1999 dollars; USEPA, 1993). The net loss of tillable land for establishment of a setback is estimated at 3.5% of the cropland (0.00144 mile of stream/acre × 5,280 feet/mile × 200 ft^2 of buffer/ft of stream length divided by 43,560 ft^2/acre). Thus, the cost for the setback was estimated at $3.22/acre of total cropland. (Tetra Tech, 2000a.)

Development of the Nutrient Management Plan

EPA assumes that developing and updating a nutrient management plan occurs every 3 years. The costs to develop and implement the plan vary by size and type of operation. EPA estimates that it costs $5 per available acres to develop the PNP.

PNP Cost = $5 × Available Acres (Tetra Tech, 2000a)

Available acres for each model farm is determined by the Land Program described in Section 4.11.

Manure Spreader Calibration

EPA assumes one-time costs for manure spreading of $500 for the purchase of two scales.

Capital/Initial Cost = $500

Annual costs include two calibrations each for two spreaders per operation (one dry spreader and one liquid/slurry spreader). EPA assumes that operations spread both liquid and solid manure. EPA also assumes it takes 2 hours per calibration at $10 per hour. The costs associated with manure spreader calibration do not vary with the size or type of operations, and the costs are the same for each model farm. The annual costs are calculated as follows:

$$\begin{aligned}\text{Annual Costs} &= (\text{No. of Calibrations}) \times (\text{Time per Calibration}) \times (\text{Hourly Wage})\\ &= 4 \text{ Calibrations} \times 2 \text{ hrs/Calibration} \times \$10/\text{hr}\\ &= \$80\end{aligned}$$

Recordkeeping and Reporting

Monthly recordkeeping and reporting requirements include recording animal inventories, manure generation, field application of manure (amount, method, location, incorporation), manure and soil analysis, visual inspections, manure spreader calibration worksheets, and manure application worksheets. EPA assumes that 3 hours per month are required to perform field operations, 3 hours per month are required to prepare the monthly write-up, and one 8-hour day is required to prepare an annual report on animal inventories, manure generation, and overall manure application to the farm. EPA estimates that miscellaneous other direct costs are 10% of the labor cost, which is assumed to be $10/hour. EPA assumed that the annual cost for recordkeeping and reporting does not vary significantly with the size or type of operation. The total labor cost per year is calculated as follows:

$$\begin{aligned}\text{Labor Costs} &= (\text{Field Observations} + \text{Monthly Write-up} + \text{Annual Report}) \times \text{Labor Wage}\\ &= [(3 \text{ hr/mo} \times 12 \text{ mo/yr}) + (3 \text{ hr/mo} \times 12 \text{ mo/yr}) + (8 \text{ hr})] \times \$10/\text{hr}\\ &= 80 \text{ hr/yr} \times \$10/\text{hr}\\ &= \$800/\text{yr}\end{aligned}$$

The miscellaneous expenses are 0.10 × \$800 = \$80; therefore, the total cost for recordkeeping and reporting is \$800 + \$80 = \$880 per model facility.

4.13.5 Results

The cost model results for N-based and P-based PNP implementation are presented in Appendix A, Tables A-15 and A-16, respectively.

4.14 <u>Center Pivot Irrigation</u>

Center pivots are a method of precisely irrigating virtually any type of crop over large areas of land. This technology is more expensive than other methods of irrigation, and therefore, costs included for center pivot irrigation are conservative as land application costs. A center pivot can effectively distribute liquid animal waste and supply nutrients to cropland at agronomic rates since there a high level of control available. The center pivot design is flexible and can be adapted to a wide range of site and wastewater characteristics. Center pivots are also advantageous because they can distribute the wastewater quickly, uniformly, and with minimal soil compaction. In a center pivot, an electrically driven lateral assembly extends from a center point where the water is delivered, and the lateral circles around this point, spraying water. A center pivot irrigation system is costed for all operations with cropland under all regulatory options.

4.14.1 Technology Description

A center pivot generally uses 100 to more than 150 pounds of pressure per square inch (psi) to operate, which requires a 30- to 75-horsepower motor. The center pivot system is constructed mainly of aluminum or galvanized steel and consists of the following main components:

Pivot: The central point of the system around which the lateral assembly rotates. The pivot is positioned on a concrete anchor and contains various controls for operating the system, including timing and flow rate. Wastewater from a lagoon, pond, or other storage structure is pumped to the pivot as the initial step in applying the waste to the land.

Lateral: A pipe and sprinklers that distribute the wastewater across the site as it moves around the pivot, typically 6 to 10 feet above the ground surface. The lateral extends out from the pivot and may consist of one or more spans depending on the site characteristics. A typical span may be from 80 to 250 feet long, whereas the entire lateral may be as long as 2,600 feet.

Tower: A structure located at the end point of each span that provides support for the pipe. Each tower is on wheels and is propelled by either an electrically driven motor, a hydraulic drive wheel, or liquid pressure, which makes it possible for the entire lateral to move slowly around the pivot.

A schematic of a center pivot irrigation system is provided in Figure 4-10.

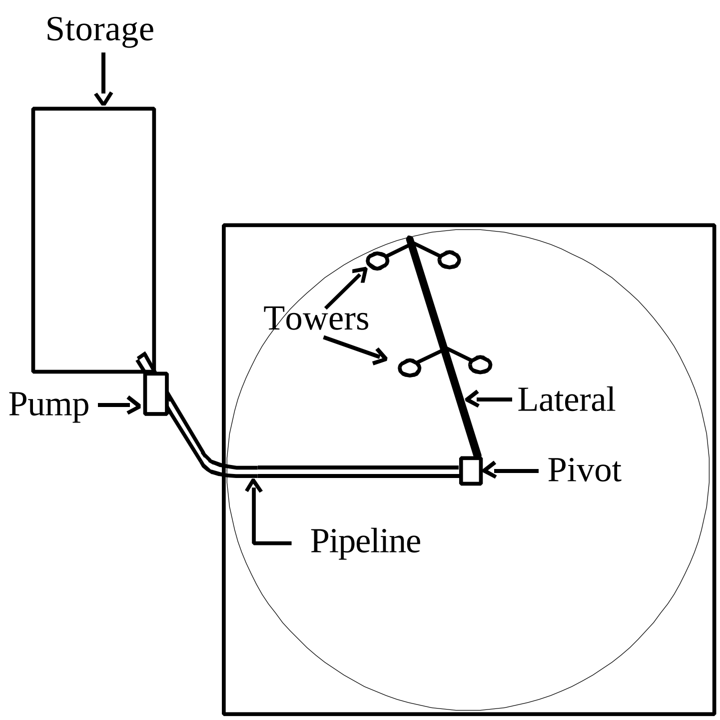


Figure 4-10. Schematic of Center Pivot Irrigation System

4.14.2 Prevalence of the Technology in the Industry

All regulatory options are based on the installation of irrigation equipment at beef and dairy operations that land-apply waste on site (i.e., Category 1 and 2 facilities). ERG developed frequency factors for center pivot irrigation based on the frequency factors for an unlined pond or lagoon. ERG assumed that if a facility has an unlined pond or lagoon on site, the facility would also already have some method of land application equipment to land apply the wastewater from this lagoon. The frequency factors do not vary by region. A center pivot irrigation system is costed for operations that do not currently have irrigation equipment. Because center pivot irrigation is typically more expensive than other methods of land application, the costs incurred for a model farm for land application are conservative. Veal operations are not costed for center pivot irrigation because they are assumed to have sufficient storage capacity and therefore the necessary irrigation equipment. Estimates of facilities that do not currently have center pivot irrigation systems are summarized in Table 4-42.

Table 4-42

Percentage of Facilities Incurring Center Pivot Irrigation Costs for All Regulatory Options

Animal Type	Size Class	Region				
		Central	Mid-Atlantic	Midwest	Pacific	South
Heifers	Medium1	5%	50%	50%	50%	50%
	Medium2	50%	50%	50%	50%	50%
	Large1	0%	0%	0%	0%	0%
Beef	Medium1	5%	50%	50%	50%	50%
	Medium2	50%	50%	50%	50%	50%
	Large1	0%	0%	0%	0%	0%
	Large2	0%	0%	0%	0%	0%
Dairy	Medium1	10%	10%	10%	10%	10%
	Medium2	10%	10%	10%	10%	10%
	Large1	0%	0%	0%	0%	0%

4.14.3 Design

The center pivot is designed specifically for each operation, based on wastewater volume and characteristics, as well as site characteristics such as soil type, parcel geometry, and slope. The soil type (i.e., its permeability and infiltration rate) affects the selection of the water spraying pattern. The soil composition (e.g., porous, tightly packed) affects tire size selection as to whether it allows good traction and flotation. Overall site geometry dictates the location and layout of the pivots, the length of the laterals, and the length and number of spans and towers. Center pivots can be designed for sites with slopes up to approximately 15%, although this depends on the type of crop cover and methods used to alleviate runoff. The costs developed in Section 4.13.4 assume a regular-shaped parcel (square), a water requirement of 7 gallons per minute per acre, and 1,000 operating hours per year.

4.14.4 Costs

Costs for a center pivot irrigation system are based largely on total acres irrigated; this is the only variable used to determine costs. Annual and capital costs for center pivots were derived from cost curves created from data available at a vendor web site (*http://www.Zimmatic.com*). Irrigated acres of 61, 122, and 488, which are listed on the website, are plotted on the x-axis and costs (capital and annual) are plotted on the y-axis. Capital costs include the pivot, lateral, towers, pumps, piping, generator and power units, and erection. Annual costs include power consumption and routine maintenance of mechanical parts. The costs for each of these points are shown in Table 4-43.

Table 4-43

Data Points for Center Pivot Irrigation Cost Curves

Irrigated acres	Capital Costs	Annual Costs
61	$58,741	$3,453
122	$64,130	$5,616
488	$122,414	$11,559

Total Capital Costs

A polynomial curve with a regression coefficient of 1 is drawn through the capital cost points. The resulting curve is used to estimate costs for the various acreages in the cost model. The equation is:

$$y = 0.166x^2 + 57.958x + 54588$$

where: y = Capital Cost
x = Irrigated Acreage

Total Annual Costs

A logarithmic curve with a regression coefficient of 0.9947 is drawn through the annual cost points. The resulting curve is used to estimate costs for various acreages in the cost model. The equation is:

$$y = 3954 \ln(x) - 13033$$

where: y = Annual Cost
x = Irrigated Acreage

4.14.5 Results

The cost model results for implementing center pivot irrigation at beef feedlots and dairies are presented in Appendix A, Table A-13.

4.15 <u>Transportation</u>

Animal feeding operations use different methods of transportation to remove excess manure waste and wastewater from the feedlot operation. The costs associated with transporting excess waste off site are calculated using two methods: contract hauling waste or purchasing transportation equipment. For all regulatory options, both methods of transportation are evaluated. The least expensive method for each model farm and regulatory option is chosen as the basis of the costs.

4.15.1 Technology Description

Many animal feeding operations use manure waste and wastewater on site as fertilizer or irrigation water on cropland; however, nutrient management plans (discussed in Section 4.12) require that facilities apply only the amount of nutrients agronomically required by the crop. When a facility generates more nutrients in their manure waste and wastewater than can be used for on-site application, they must transport the remaining manure waste and wastewater off site.

The amount of excess waste that requires transport is dependent on the nutrient basis used for land application. Option 1 requires that animal waste be applied on a nitrogen basis to cropland, and Options 2 through 8 require application on a phosphorus basis. In general, the amount of waste transported off site increases under a phosphorus-based application option. The methodology used to determine the amount of excess waste at beef feedlots and dairies is discussed in Section 4.11.

Manure is transported as either a solid or liquid material. The cost model assumes that solid waste is transported before liquid waste because it is less expensive to haul solid waste. This assumption means that operations apply liquid manure (i.e., lagoon and pond effluents) to cropland on site before solid waste.

Contract Hauling

One method evaluated for the transport of manure waste off site is contract hauling. In this method, the operation hires an outside firm to transport the excess waste. This method is advantageous to facilities that do not have the necessary capacity to store excess waste on site or the cropland acreage to agronomically apply the material. In addition, this method is useful for operations that do not generate enough excess waste to warrant purchasing their own waste transportation trucks. Contract haulers can also transport waste from multiple operations.

Purchase Equipment

Another method evaluated for the transport of manure waste off site is to purchase transportation equipment. In this method, the operation owner is responsible for purchasing the necessary trucks to haul the waste to an off-site location. Depending on the type of waste transported, a solid waste truck, a liquid tanker truck, or both types of trucks are required. In addition, the owner is responsible for determining a suitable location to transport the waste, as well as all costs associated with loading and unloading the trucks, driving the trucks to the off-site location, and maintaining the trucks.

4.15.2 Prevalence of Practice in the Industry

Beef feedlots and dairies are divided into three categories, as discussed in Section 4.11. Category 1 operations have sufficient cropland to agronomically apply all of their generated waste on site. Category 2 operations do not have sufficient cropland and may only agronomically apply a portion of their generated waste. Category 3 operations have no cropland and must already transport all of their waste off site.

The number of operations in each category depends on the nutrient application requirements, because more land is required for nitrogen-based application than for phosphorus based application. Therefore, a given facility may have adequate land to apply all of their waste under Option 1 (the N-based scenario) and would therefore be a Category 1 facility; however, under Options 2 though 8 (P-based scenarios) the same facility may only have enough land to apply a portion of their waste, causing the facility to fall into Category 2.

In determining costs associated with transportation, costs for each category under both an N-based and P-based application option are calculated. Category 1 and 3 operations will not incur any new transportation costs due to any of the regulatory options. Category 2 operations, however, do incur costs to transport excess manure off site under all regulatory options.

In addition, some operations are located in states that already require them to apply manure to cropland on an agronomic nitrogen basis; therefore, these operations will not incur additional transportation costs under Option 1. Table 4-44 presents the percentage of Category 2 operations in each region and size group that incur transportation costs for Option 1. Category 2 operations that are required to apply at phosphorus-based agronomic rates incur transportation costs for Options 2 through 8.

Table 4-44

Percentage of Category 2 Operations Incurring Option 1 Transportation Costs

		Region				
Animal	Size	Central	Mid-Atlantic	Midwest	Pacific	South
Beef	Medium1	100%	100%	100%	100%	100%
	Medium2	100%	79%	100%	100%	100%
	Large1	15%	20%	9%	100%	100%
	Large2	15%	20%	9%	100%	100%
Heifers	Medium1	100%	83%	100%	100%	100%
	Medium2	100%	83%	100%	100%	100%
	Large1	47%	69%	31%	100%	50%
Dairy	Medium1	100%	83%	100%	100%	100%
	Medium2	100%	83%	100%	100%	100%
	Large1	47%	69%	31%	100%	50%
Veal	Medium1	0%	0%	0%	0%	0%
	Medium2	0%	0%	0%	0%	0%

4.15.3 Design and Costs of Contract Hauling

In determining costs for the contract hauling option, three major factors are considered:

1) Amount of waste transported;
2) Type of waste transported (semi-solid or liquid); and
3) Location of the operation.

Additional factors that relate to these three major factors include:

- Hauling distance;
- Weight of the waste;
- Rate charged to haul waste ($/ton-mile); and
- Percentage of operations in each region and category that incur transport costs.

Using these factors, the cost model uses the following three steps to determine costs for a model farm:

1) Determine constants, based on region, animal type, and waste type;
2) Determine the weight of the transported waste, accounting for water losses during storage or composting; and
3) Determine the annual waste transportation costs.

Each of these steps is explained in detail below.

1) Determine constants, based on region, animal type, and waste type

Constants used in this evaluation include the hauling distance, the moisture content of stockpiled manure, the moisture content of composted manure, and the hauling rate ($/ton-mile).

Hauling Distance

Because Category 1 and 3 operations do not require additional hauling under the regulatory options, their haul distance is set to zero. The one-way hauling distance for a Category 2 operation, depends on the region in which it is located. The one-way hauling distance considers the size of the county, whether the county has a potential for excess manure nutrients, and the proximity of other counties that have a nutrient excess. (For more details, see *Revised Transportation Distances for Category 2 and 3 Type Operations*. Tetra Tech, 2000.) In determining counties with nutrient excess, all major animal types were counted. (Analysis based on Kellogg, 2000.) Table 4-45 presents the Category 2 hauling distances by region.

Table 4-45

Hauling Distances for Transportation

Region	One-Way Hauling Distance (miles) for Category 2	
	N-Basis	**P-Basis**
Central	11.0	16.5
Mid-Atlantic	5.5	30.5
Midwest	6.5	10.0
Pacific	12.5	21.5
South	6.0	14.5

REFERENCE: For detailed information on the calculation of one-way hauling distances, see *Revised Transportation Distances for Category 2 and 3 Type Operations.* Tetra Tech, 2000.

Moisture Content of Waste

Based on available information, it is estimated that the moisture content of stockpiled manure is assumed to be 35.4% and the moisture content of composted manure is assumed to be at 30.8% (Sweeten, et.al., 1995).

Hauling Rate

Based on information obtained from various contract haulers, the \$/ton-mile rate for liquid and solids wastes for Category 2 operations is estimated and presented in Table 4-46.

Table 4-46

Rates for Contract Hauling for Category 2 Operations

Type of Waste	N-Based Application	P-Based Application
Solid (\$/ton-mile)	0.24	0.15
Liquid (\$/ton-mile)	0.53	0.10

REFERENCE: For additional detail on the calculation of contract hauling rates, see *Methodology to Calculate Contract Hauling Rates for Beef and Dairy Cost Model. Eastern Research Group, Inc. 2000.*

2) Determine the weight of the transported waste.

The methods used to calculate the amount of waste that is transported off site are described in Section 4.11.3.2.

3) Determine the annual cost of transporting the waste each year.

The annual cost of hiring a contractor to haul the waste is based on the amount of waste (in either semi-solid or liquid form), the distance traveled, and the haul rate. The following equation incorporates both the solid and liquid annual hauling costs:

$$\text{Annual Cost} = (\text{Weight of Solids} \times \text{Solid Hauling Rate} \times \text{Hauling Distance}_{\text{Round-trip}}) + (\text{Weight of Liquids} \times \text{Liquid Hauling Rate} \times \text{Hauling Distance}_{\text{Round-trip}})$$

There are no capital costs associated with contract hauling.

4.15.4 Design and Cost of Purchase Equipment Transportation Option

In determining costs for the purchase truck transportation option, three major factors are considered:

1. Amount of transported waste;
2. Type of waste transported (semi-solid or liquid); and
3. The location of the operation.

Additional factors that relate to these three major factors include:
- Hauling distance;
- Number of hauling trips required per year;
- The waste volume;
- Average speed of the truck;
- Cost of fuel;
- Cost of maintenance;
- Cost of purchasing the truck;
- Cost for labor for the truck driver; and
- Percentage of facilities in each region and category that incur transport costs under the proposed regulatory options.

Using these factors, the cost model completes the following six steps to determine costs for a model farm:

1. Determine constants, based on region, animal type, and waste type;
2. Determine the weight of the waste transported, accounting for water losses during storage or composting;
3. Determine the number of trucks and number of trips required to haul all of the waste each year;
4. Determine the number of hours required to transport waste each year;
5. Determine the purchase cost for the trucks required to transport the waste; and
6. Determine the annual cost to transport the waste.

Each of these steps is explained in detail below.

1) Determine constants, based on region, animal type, and waste type

Constants used in this evaluation include the hauling distance, the average speed of the truck, the moisture content of stockpiled manure, the moisture content of composted manure, the hours spent hauling per day, the loading and unloading time, the fuel rate, the maintenance rate, the hourly hauling rate, the volume of waste the truck can haul, and the purchase price of the truck.

Hauling Distance

The one-way hauling distance for an operation depends on the region in which it is located and what category operation is being evaluated. For each region, the average distance the waste must be hauled varies according to regional factors. These distances are presented in Table 4-47.

Average Speed

The average speed of the truck is estimated to be 35 miles per hour (USEPA, 1996a).

Moisture Content of Waste

Based on available information, it is estimated that the moisture content of stockpiled manure is 35.4 percent, and the moisture content of composted manure is 30.8% (Sweeten, et.al., 1995.)

Working Schedule

For this cost model it is estimated that one laborer requires 25 minutes to load and unload the truck and hauls waste for 7 hours per day (USEPA, 1996a).

Fuel Rate

The diesel fuel is estimated to cost $1.35 per gallon. (Jewell, 1997)

Maintenance Rate

The estimated maintenance rates for liquid and solid waste trucks are $0.63 per hauling mile and $0.50 per hauling mile respectively (Jewell, 1997; USEPA, 1996b)

Labor Rate

The rate used in this model for the laborer to load, unload, and haul the waste is $10 per hour.

Capacity and Prices of Trucks

The size of the solid waste trucks vary, depending on the amount of waste that is hauled. The standard sizes and purchase prices for solid waste trucks used in the cost model are:

7-cubic-yard truck = $91,728
10-cubic-yard truck = $137,593
15-cubic-yard truck = $183,457
25-cubic-yard truck = $241,054

(Merle Kelly Ford, 1999)

The size of the liquid waste trucks also varies, depending on the amount of waste that is hauled. The standard sizes and purchase prices for liquid waste trucks used in the cost model are:

1,600-gallon truck = $84,262
2,500-gallon truck = $113,061
4,000-gallon truck = $140,792
(Klein Products of Kansas, 1999)

2) Determine the weight of the waste transported.

The methods used to calculate the amount of waste transported are described in Section 4.11.3.2.

3) Determine the number of trips required to haul all of the waste per year

To determine the number of trips per year required to haul all of the waste, the following calculations are performed. First, the size of the truck is determined. Then, the maximum possible number of trips per year is calculated, given the hauling schedule and the number of days the truck is available for transport per year. A test is then performed to see if the truck size selected is large enough to transport all of the waste requiring transport within the time frame calculated as the maximum number of trips per year. If the truck is not large enough, then the cost model assumes that multiple trucks are purchased, and recalculates the equations based on the larger capacity.

The equation for the maximum number of trips per year is:

$$\text{Maximum trips/yr} = \frac{(\text{Haul Schedule} \times \text{Haul Days})}{(\text{Truck Loading Time} + \text{Truck Unloading Time} + \text{Truck Haul Time})}$$

The capacity of the truck is determined through an iterative process that substitutes the size of the truck (10 CY, 15 CY, and 25 CY) and the number of trucks (1 or 2) into the following equation until the number of trips per year is greater than the maximum number of trips per year:

$$\text{Number of trips/yr} = \frac{\text{Solid Waste}_{\text{(as Collected)}}}{(\text{Number of Trucks} \times \text{Capacity of Truck})}$$

The equation for the actual number of trips per year is the following:

$$\text{Actual trips/yr} = \frac{\text{Solid Waste}_{\text{(as collected)}}}{(\text{Number of Trucks} \times \text{Capacity of Truck})}$$

Note: The number of trucks is rounded up to the nearest whole number.

4) Determine the number of hours required to transport waste each year

The number of hours required to transport all of the waste each year is based on the hauling time, the loading and unloading time, and the actual number of hauling trips per year, as shown below:

$$\text{Transport Hours} = (\text{Truck Loading Time} + \text{Truck Unloading Time} + \text{Truck Haul Time}) \times \text{Number of Trips}$$

5) Determine the purchase cost of the trucks required to transport the waste

The purchase cost of the truck(s) depends on the number of trucks needed and the cost for that size of truck, as shown below:

$$\text{Purchase Cost} = \text{Number of Trucks} \times \text{Cost of Truck}$$

6) Determine the annual cost to transport the waste

The annual operating and maintenance cost for owning and operating the trucks is based on the fuel spent, the maintenance rate per mile driven, and the labor costs. This is calculated for both the liquid waste transport and the solid waste transport. The equation for the annual cost is the following:

Annual Cost = (Maintenance Rate × Hauling Distance $_{\text{Round-trip}}$ × Number of Trips + Transport Hours × Labor Rate + Hauling Distance $_{\text{Round-trip}}$ × Number of Trips / Fuel Rate) × Number of Trucks

4.15.5 Results

The cost model results for contract hauling manure waste when applying on a nitrogen or a phosphorus basis are presented in Appendix A, Tables A-20 and A-21, respectively. The cost model results for purchasing equipment to transport manure waste off site when applying on a nitrogen or a phosphorus basis are presented in Appendix A, Tables A-22 and A-23, respectively.

5.0 FARM-WEIGHTING FACTORS

This section discusses three types of farm-weighting factors that are applied to the weighted component costs to generate weighted farm costs. The weighting factors are based on the farm operation: farm type, manure application basis, and category. These farm-weighting factors reflect the number of operations within a model farm for each type of operation.

5.1 Farm Type Factor

For all dairy model farms, two types of dairy operations are costed: a flush dairy and a hose dairy. There are six cost modules that generate different costs depending on whether the dairy operates as a flush or hose operation. These modules are: concrete gravity settling basin, lagoons, anaerobic digesters, concrete pads, center pivot irrigation, and transportation. As described in Section 4.0, these component costs are computed separately for both flush and hose dairies and adjusted based on frequency factors that indicate the use of the component in the industry as a whole. Then, these results are weighted by the "farm-type factor." This factor reflects the number of operations within a model farm that operate as flush versus hose dairies.

For beef and veal operations, only one type of operation is costed; therefore, the farm-type factor for each of these model farms is 100 percent.

Table 5-1 presents the farm-type factors used in the cost model for each model farm. These factors are based on data collected by EPA during site visits at operations across the United States and from communications with industry experts.

5.2 Manure Application Basis Factor

Under all regulatory options considered, all operations are required to implement nitrogen-based agronomic application rates when applying animal waste or wastewater.

Table 5-1

Farm-Type Weighting Factors by Model Farm

Animal Type	Size Class	Region	Flush Frequency	Hose Frequency	Beef/Veal/Heifer Frequency
Beef/Veal/Heifer	Medium1	Central	NA	NA	100%
		Mid-Atlantic	NA	NA	100%
		Midwest	NA	NA	100%
		Pacific	NA	NA	100%
		South	NA	NA	100%
	Medium2	Central	NA	NA	100%
		Mid-Atlantic	NA	NA	100%
		Midwest	NA	NA	100%
		Pacific	NA	NA	100%
		South	NA	NA	100%
	Large1	Central	NA	NA	100%
		Mid-Atlantic	NA	NA	100%
		Midwest	NA	NA	100%
		Pacific	NA	NA	100%
		South	NA	NA	100%
	Large2	Central	NA	NA	100%
		Mid-Atlantic	NA	NA	100%
		Midwest	NA	NA	100%
		Pacific	NA	NA	100%
		South	NA	NA	100%
Dairy	Medium1	Central	50%	50%	NA
		Mid-Atlantic	25%	75%	NA
		Midwest	25%	75%	NA
		Pacific	50%	50%	NA
		South	50%	50%	NA
	Medium2	Central	50%	50%	NA
		Mid-Atlantic	25%	75%	NA
		Midwest	25%	75%	NA
		Pacific	50%	50%	NA
		South	50%	50%	NA
	Large1	Central	75%	25%	NA
		Mid-Atlantic	50%	50%	NA
		Midwest	50%	50%	NA
		Pacific	75%	25%	NA
		South	75%	25%	NA

NA - Not applicable.

Under Options 2 through 8, however, operations that are located in areas with certain site conditions (e.g., phosphorus-saturated soils) are required to follow more stringent phosphorus-based agronomic application rates.

There are four cost modules that generate different costs dependent on whether the facility uses nitrogen- or phosphorus-based agronomic application rates. These modules are nutrient management planning, nutrient-based manure application, center pivot irrigation, and transportation. As described in Section 4.0, these component costs are computed separately for both nitrogen- and phosphorus-based application and adjusted based on frequency factors that indicate the use of the component in the industry. Then, these results are weighted by the "nutrient-based application factor." This factor reflects the number of operations within a model farm that require nitrogen-based application rates versus phosphorus-based application rates.

For Option 1, all operations are costed for nitrogen-based application. Table 5-2 presents the nutrient-based application factors used in the cost model for Options 2 though 7. Section 4.12 describes the development of these factors.

5.3 Category Factor

As described in Section 4.11, all operations fall into one of three categories depending on the amount of on-site cropland available for manure application. Category 1 operations have sufficient land to apply on site all manure waste and wastewater generated. Category 2 operations do not have sufficient land to apply on site all manure waste and wastewater generated. Category 3 operations have zero cropland available for on-site application and irrigation. Category acreages and the number of operations that fall into each category are calculated based on the type of nutrient-based application that is required.

Table 5-2

Nutrient-Based Weighting Factors for Options 2 through 8

Animal Type	Size Class	Region	Nitrogen Weighting	Phosphorus
Beef	Medium1	Central	63%	37%
		Mid-Atlantic	71%	29%
		Midwest	88%	12%
		Pacific	40%	60%
		South	49%	51%
	Medium2	Central	63%	37%
		Mid-Atlantic	71%	29%
		Midwest	88%	12%
		Pacific	40%	60%
		South	49%	51%
	Large1	Central	52%	48%
		Midwest	93%	7%
		Mid-Atlantic	66%	34%
		Pacific	40%	60%
		South	64%	36%
	Large2	Central	52%	48%
		Mid-Atlantic	66%	34%
		Midwest	93%	7%
		Pacific	40%	60%
		South	64%	36%
Dairy/Heifer	Medium1	Central	55%	45%
		Mid-Atlantic	53%	47%
		Midwest	58%	42%
		Pacific	40%	60%
		South	75%	25%
	Medium2	Central	55%	45%
		Mid-Atlantic	53%	47%
		Midwest	58%	42%
		Pacific	40%	60%
		South	75%	25%
	Large1	Central	69%	31%
		Mid-Atlantic	47%	53%
		Midwest	61%	39%
		Pacific	40%	60%
		South	57%	43%
Veal	Medium2	Central	55%	45%
		Mid-Atlantic	53%	47%
		Midwest	58%	42%
		Pacific	40%	60%
		South	75%	25%

Note: Option 1 assumes that all operations apply on a nitrogen-basis; therefore, the nitrogen weighting factor is 100% and the phosphorus weighting factor is zero. The above table applies to Options 2 through 8.

There are four cost modules that generate costs based on the amount of on-site cropland that is available: nutrient management planning, nutrient-based manure application, on-site irrigation, and transportation. As described in Section 4.0, these component costs are computed separately for each category (and whether nitrogen- or phosphorus-based application is required). Then, these results are weighted by the "category factor." This factor reflects the number of operations within a model farm that fall into each category based on whether nitrogen-based or phosphorus-based application rates are required.

Table 5-3 presents the category factors used in the cost model. Option 1 uses only nitrogen-based factors, while Options 2 though 7 use a combination of both nitrogen- and phosphorus-based factors. Section 4.11 describes the development of these factors.

Table 5-3

Category Weighting Factors

Animal Type	Size Class	Nitrogen-Based Application			Phosphorus-Based Application		
		Category 1	Category 2	Category 3	Category 1	Category 2	Category 3
Beef/Heifer	Medium1	84%	9%	7%	62%	31%	7%
	Medium2	84%	9%	7%	62%	31%	7%
	Large1	68%	21%	11%	22%	67%	11%
	Large2	8%	53%	39%	1%	60%	39%
Dairy	Medium1	50%	36%	14%	25%	61%	14%
	Medium2	50%	36%	14%	25%	61%	14%
	Large1	27%	51%	22%	10%	68%	22%
Veal	Medium1	100%	0%	0%	100%	0%	0%
	Medium2	100%	0%	0%	100%	0%	0%

6.0 TRANSPORTATION COST TEST

When evaluating costs to transport waste off site, purchasing a truck to transport waste and hiring a contractor to haul waste are two scenarios considered for the model beef feedlot or dairy. Because the weight and volume of the manure directly impact the transportation costs, each scenario is also considered with composting the waste prior to hauling and without composting. This section discusses the test used to determine which scenario is least costly for each model farm.

6.1 Purpose of the Cost Test

When animal feeding operations are unable to apply all of their waste on site at the appropriate agronomic rate, the waste is transported off site to a location where the waste is applied at the agronomic rate. EPA considered two methods of off-site transport: 1) hiring a contractor to haul the waste; or 2) purchasing a truck to move the waste without third-party assistance (see Section 4.14). In addition, animal feeding operations can choose to compost their waste before hauling to reduce the weight and volume of the waste and to improve the quality of the end product (see Section 4.9). It is assumed that operations will choose the transportation and composting pair that is least expensive. To determine which method a beef feedlot, dairy, or veal operation will choose, a cost test is performed that compares the costs annualized over 10 years.

For each model farm that transports waste off site under Options 1 through 4, and 6 through 8, it is assumed that the operation uses one of four transportation scenarios:

1. Composting with contract haul;
2. Composting with purchase truck;
3. No composting with contract haul; and
4. No composting with purchase truck.

For Option 5, only transportation scenarios with composting are considered.

6.2 Cost Test Methodology

The transportation scenario that is costed for each operation is the scenario that is the least costly when annualized over 10 years. To determine this, each transportation scenario is costed separately. The cost for each transportation scenario is then added to the weighted farm costs to create four possible model farm costs, with capital costs and annual costs. Each of these is annualized, using the following equation:

$$A(n) = P \times I \times (1 + I)^n / [(1 + I)^n - 1] + A$$

where:			
	A(n)	=	Annualized cost over n years
	P	=	Capital cost
	I	=	Interest rate
	n	=	Number of years
	A	=	Annual cost

The least expensive annualized cost of the four transportation scenarios is selected as the preferred scenario. Appendix B presents the transportation scenario selected for each model farm for each option.

7.0 MODEL FARM COSTS

The total model farm costs are calculated using the weighted component costs, the weighted farm costs, and the results of the cost test. This section presents an example of this calculation for the following model farm for Option 2:

- Animal type = Dairy;
- Size class = Large1; and
- Regional location = Central.

The costs presented in this example represent the expected costs for this model farm as of the Summer 2000 cost analysis. Appendix C presents the model farm costs (in 1997 dollars) for each regulatory option.

7.1 Calculation of Unit Component Costs

The first step in the cost calculation is the generation of costs for each component included in the regulatory option. Table 7-1 presents component costs that do not vary by nutrient application basis (i.e., nitrogen- versus phosphorus-based application). The costs are presented for both flush and hose dairies for this model farm and option. Table 7-2 presents component costs that do vary by nutrient application basis. Finally, Table 7-3 presents the component costs for the four transportation scenarios considered for both flush and hose dairies.

Table 7-1

Component Costs for Option 2
Dairy, Large1, Central

Component	Flush Dairy		Hose Dairy	
	Capital	Annual	Capital	Annual
Concrete Basin	$129,802	$2,596	$5,563	$111
Berms	$3,057	$61	$3,057	$61
Composting	$9,157	$7,939	$9,157	$7,939
Lagoon	$178,526	$8,926	$97,701	$4,885

Table 7-2

Component Costs for Option 2 That Vary by Nutrient Application Basis
Dairy, Large1, Central

Component	Type of Cost	Nitrogen-Based Application			Phosphorus-Based Application		
		Category 1	Category 2	Category 3	Category 1	Category 2	Category 3
Nutrient Management Planning	Fixed	$1,980	$1,006	$690	$5,333	$1,599	$690
	Annual	$2,040	$1,474	$1,290	$3,991	$1,819	$1,290
	3-year Recurring	$3,034	$1,184	$600	$9,341	$2,301	$600
Manure Application	Capital	$92,633	$60,457	$0	$365,922	$77,512	$0
	Annual	$9,956	$4,391	$0	$15,021	$8,571	$0
Commercial Fertilizer Application	Capital	$0	$0	$0	$0	$0	$0
	Annual	$0	$0	$0	$41,216	$8,049	$0

Table 7-3

Transportation Costs for Option 2 Dairy, Large1, Central Category 2 Operations[1]

Farm Type	Transportation Scenario	Nitrogen-Based Application		Phosphorus-Based Application	
		Capital	Annual	Capital	Annual
Flush Dairy	Purchase Truck	$373,312	$32,440	$373,312	$49,058
	Contract Haul	$0	$100,997	$0	$32,106
	Purchase Truck (composted manure)	$373,312	$32,363	$373,312	$48,955
	Contract Haul (composted manure)	$0	$100,957	$0	$32,069
Hose Dairy	Purchase Truck	$373,312	$28,093	$373,312	$43,017
	Contract Haul	$0	$77,074	$0	$26,878
	Purchase Truck (composted manure)	$373,312	$27,787	$373,312	$42,606
	Contract Haul (composted manure)	$0	$76,878	$0	$26,694

[1]Category 1 operations do not incur transportation costs because they have sufficient land to apply all waste on site, and Category 3 operations do not incur transportation costs because they are already assumed to transfer all waste off site.

7.2 Calculation of Weighted Costs

The component costs are then weighted to reflect the percentage of operations that already have some components in place. The following equation is used to weight the component costs:

$$Cost_{weighted} = Cost_{component} \times (1 - \text{Frequency Factor})$$

where:
- $Cost_{weighted}$ = Weighted component cost
- $Cost_{component}$ = Component cost (from Table 7-1)
- Frequency Factor = Percentage of operations that have component in place

Table 7-4 presents the weighted component costs for components that do not vary by nutrient application basis. The two components that vary by nutrient application basis (nutrient management planning and commercial fertilizer application) have a frequency factor of zero, meaning that no operations have the components in place; therefore, the weighted component costs are equal to the unweighted component costs presented in Table 7-2. Table 7-5 presents weighted component costs for each of the four transportation scenarios for both flush and hose dairies.

Table 7-4

Weighted Component Costs for Option 2
Dairy, Large1, Central

Component	Frequency Factor	Flush Dairy		Hose Dairy	
		Capital	Annual	Capital	Annual
Concrete Basin	33%	$86,967	$1,739	$3,727	$74
Berms	100%	$0	$0	$0	$0
Composting	0%	$9,157	$7,939	$9,157	$7,939
Lagoon	100%	$0	$0	$0	$0

Table 7-5

Weighted Transportation Costs for Option 2
Dairy, Large1, Central
Category 2 Operations[1]

Farm Type	Transportation Scenario	N-Based Frequency Factor[2]	Nitrogen-Based Application		Phosphorus-Based Application	
			Capital	Annual	Capital	Annual
Flush Dairy	Purchase Truck	53%	$175,457	$15,247	$175,457	$23,057
	Contract Haul	53%	$0	$53,806	$0	$89,543
	Purchase Truck (composted manure)	53%	$175,457	$15,211	$175,457	$23,009
	Contract Haul (composted manure)	53%	$0	$53,780	$0	$89,505
Hose Dairy	Purchase Truck	53%	$175,457	$13,014	$175,457	$19,954
	Contract Haul	53%	$0	$40,174	$0	$69,095
	Purchase Truck (composted manure)	53%	$175,457	$12,846	$175,457	$19,729
	Contract Haul (composted manure)	53%	$0	$40,037	$0	$68,890

[1]Category 1 operations do not incur transportation costs because they have sufficient land to apply all waste on site, and Category 3 operations do not incur transportation costs because they are already assumed to transfer all waste off site.
[2] No frequency factor is applied to P-based application scenarios because it is assumed that no facilities currently apply their waste on a P-basis.

7.3 Calculation of Weighted Farm Costs

Some weighted component costs vary depending on the type of farm operation and the type of application basis. The first farm-weighting factor applied adjusts the dairy weighted component costs for the percentage of operations that are flush dairies or hose dairies. The farm-type weighting factor applied is based on the regional location of the farm and does not vary by component. The following equations are used to weight the dairy component costs:

$$Cost_{weighted,\ flush} = Cost_{weighted} \times (\text{Farm-Type Weighting Factor}_{flush})$$
$$Cost_{weighted,\ hose} = Cost_{weighted} \times (\text{Farm-Type Weighting Factor}_{hose})$$

where:

where:	$Cost_{weighted}$	=	Weighted component cost
	Farm-Type Weighting $Factor_{flush}$	=	Percentage of operations that are flush dairies
	Farm-Type Weighting $Factor_{hose}$	=	Percentage of operations that are hose dairies

For the example model farm, EPA estimates that 75% of the operations are flush dairies and 25% of the operations are hose dairies.

The second farm-weighting factor applied adjusts the weighted component costs for the type of nutrient-based application used. Because all operations are required to land-apply using a nitrogen-based application rate under Option 1, the weighted farm costs are equal to the weighted component costs. For Options 2 though 8, the number of operations that require phosphorus-based application are estimated, as described in Section 4.12. To calculate costs weighted by application method, the component costs must be proportioned between the number of nitrogen-based operations and phosphorus-based operations. The following equation calculates the weighted cost for Category 1 operations.

$$\text{Weighted Category 1 Cost} = \frac{[(\text{Cat 1 Facs(N)} * \text{Cat1(N)Cost}) + (\text{Cat 1 Facs(P)} * \text{Cat1(P)Cost})]}{[\text{Cat 1 Facs(N)} + \text{Cat 1 Facs(P)}]}$$

where:	Cat 1 Facs (N)	=	Number of Category 1 operations that apply on nitrogen basis
	Cat 1(N) Cost	=	Weighted unit component cost, Category 1, nitrogen-based application
	Cat 1 Facs (P)	=	Number of Category 1 operations that apply on phosphorus basis
	Cat 1(P) Cost	=	Weighted unit component cost, Category 1, phosphorus-based application

Table 7-6 presents the weighted farm costs for the example model, including the selected least-cost transportation scenario.

Table 7-6

Weighted Farm Costs for Option 2[1]
Dairy, Large1, Central

Component	Category 1		Category 2		Category 3	
	Capital	Annual	Capital	Annual	Capital	Annual
Concrete Basin	$66,157	$1,323	$66,157	$1,323	$66,157	$1,323
Berms	$0	$0	$0	$0	$0	$0
Composting[2]	$9,157	$7,939	$9,157	$7,939	$9,157	$7,939
Lagoon	$0	$0	$0	$0	$0	$0
Nutrient Management Planning[3]	$1,068	$950	$1,600	$1,989	$304	$568
Commercial Fertilizer Application	$0	$5,880	$0	$3,015	$0	$0
Selected Transportation Scenario						
Purchase Truck	$0	$0	$0	$64,844	$0	$0

[1]Costs are weighted by farm type (hose versus flush) and by application basis (nitrogen versus phosphorus).
[2]Composting costs were not selected as part of the model farm costs.
[3]Nutrient management planning capital costs are fixed costs; 3-year recurring costs are also incurred, but are not shown in this table.

7.4 <u>Final Model Farm Costs</u>

The weighted farm costs are summed and annualized for each of the transportation scenarios, and the least costly scenario is selected. Table 7-7 presents the weighted farm costs selected for the model farm. These costs are summed to generate the final model farm capital, fixed, annual, and 3-year recurring costs by category. Commercial fertilizer costs are listed as a separate cost item in the model farm result tables presented in Appendix C.

Table 7-7

Model Farm Costs by Category
Dairy, Large1, Central

Component	Capital	Annual	Fixed	3-Year Recurring
Category 1				
Lagoon	$0	$0	$0	$0
Berms	$0	$0	$0	$0
Concrete Basin	$66,157	$1,323	$0	$0
Nutrient Management Planning	$0	$950	$1,068	$1,753
Selected Transportation Scenario: Contract Haul	$0	$0	$0	$0
Total Model Farm Costs	$66,157	$2,273	$1,068	$1,753
Commercial Fertilizer Application	$0	$4,122	$0	$0
Category 2				
Lagoon	$0	$0	$0	$0
Berms	$0	$0	$0	$0
Concrete Basin	$66,157	$1,323	$0	$0
Nutrient Management Planning	$0	$1,989	$1,600	$2,169
Selected Transportation Scenario: Purchase Truck	$0	$43,719	$0	$0
Total Model Farm Costs	$66,157	$47,031	$1,600	$2,169
Commercial Fertilizer Application	$0	$5,473	$0	$0
Category 3				
Lagoon	$0	$0	$0	$0
Berms	$0	$0	$0	$0
Concrete Basin	$66,157	$1,323	$0	$0
Nutrient Management Planning	$0	$568	$304	$264
Selected Transportation Scenario: Purchase Truck	$0	$0	$0	$0
Total Model Farm Costs	$66,157	$1,891	$304	$264
Commercial Fertilizer Application	$0	$0	$0	$0

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Appendix A

UNIT COMPONENT COSTS

Table A-1

Facility Costs for the Installation and Maintenance of Earthen Settling Basins

Animal	SizeClass	FarmType	Region	Capital	Annual
Beef	Large1	Beef	Central	1,449	72
Beef	Large1	Beef	MidAtlantic	4,107	205
Beef	Large1	Beef	South	6,284	314
Beef	Large1	Beef	Pacific	2,901	145
Beef	Large1	Beef	MidWest	3,868	193
Beef	Large2	Beef	Central	20,397	1,020
Beef	Large2	Beef	MidAtlantic	64,748	3,237
Beef	Large2	Beef	South	101,037	5,052
Beef	Large2	Beef	Pacific	44,590	2,230
Beef	Large2	Beef	MidWest	60,717	3,036
Beef	Medium2	Beef	Central	739	37
Beef	Medium2	Beef	MidAtlantic	1,843	92
Beef	Medium2	Beef	South	2,742	137
Beef	Medium2	Beef	Pacific	1,342	67
Beef	Medium2	Beef	MidWest	1,741	87
Heifers	Medium2	Heifers	Central	565	28
Heifers	Medium2	Heifers	MidAtlantic	1,274	64
Heifers	Medium2	Heifers	South	1,858	93
Heifers	Medium2	Heifers	Pacific	952	48
Heifers	Medium2	Heifers	MidWest	1,210	60
Heifers	Large1	Heifers	Central	887	44
Heifers	Large1	Heifers	MidAtlantic	2,309	115
Heifers	Large1	Heifers	South	3,474	174
Heifers	Large1	Heifers	Pacific	1,665	83
Heifers	Large1	Heifers	MidWest	2,181	109
Beef	Medium1	Beef	Central	515	26
Beef	Medium1	Beef	MidAtlantic	1,122	56
Beef	Medium1	Beef	South	1,619	81
Beef	Medium1	Beef	Pacific	845	42
Beef	Medium1	Beef	MidWest	1,069	53
Heifers	Medium1	Heifers	Central	413	21
Heifers	Medium1	Heifers	MidAtlantic	792	40
Heifers	Medium1	Heifers	South	1,103	55
Heifers	Medium1	Heifers	Pacific	622	31
Heifers	Medium1	Heifers	MidWest	758	38

Table A-2

Facility Costs for the Installation and Maintenance of Concrete Settling Basins

Animal	Size Class	Farm Type	Region	Capital Costs	Annual Costs
Dairy	Large1	Flush	Central	129,802	2,596
Dairy	Large1	Flush	MidAtlantic	129,802	2,596
Dairy	Large1	Flush	South	129,802	2,596
Dairy	Large1	Flush	Pacific	129,802	2,596
Dairy	Large1	Flush	MidWest	129,802	2,596
Dairy	Large1	Hose	Central	5,563	111
Dairy	Large1	Hose	MidAtlantic	5,563	111
Dairy	Large1	Hose	South	5,563	111
Dairy	Large1	Hose	Pacific	5,563	111
Dairy	Large1	Hose	MidWest	5,563	111
Dairy	Medium2	Flush	Central	48,098	962
Dairy	Medium2	Flush	MidAtlantic	48,098	962
Dairy	Medium2	Flush	South	48,098	962
Dairy	Medium2	Flush	Pacific	48,098	962
Dairy	Medium2	Flush	MidWest	48,098	962
Dairy	Medium2	Hose	Central	4,214	84
Dairy	Medium2	Hose	MidAtlantic	4,214	84
Dairy	Medium2	Hose	South	4,214	84
Dairy	Medium2	Hose	Pacific	4,214	84
Dairy	Medium2	Hose	MidWest	4,214	84
Veal	Medium2	Flush	Central	55,192	1,104
Veal	Medium2	Flush	MidAtlantic	55,192	1,104
Veal	Medium2	Flush	South	55,192	1,104
Veal	Medium2	Flush	Pacific	55,192	1,104
Veal	Medium2	Flush	MidWest	55,192	1,104
Dairy	Medium1	Flush	Central	27,457	549
Dairy	Medium1	Flush	MidAtlantic	27,457	549
Dairy	Medium1	Flush	South	27,457	549
Dairy	Medium1	Flush	Pacific	27,457	549
Dairy	Medium1	Flush	MidWest	27,457	549
Dairy	Medium1	Hose	Central	3,560	71
Dairy	Medium1	Hose	MidAtlantic	3,560	71

Table A-2 (Continued)

Animal	Size Class	Farm Type	Region	Capital Costs	Annual Costs
Dairy	Medium1	Hose	South	3,560	71
Dairy	Medium1	Hose	Pacific	3,560	71
Dairy	Medium1	Hose	MidWest	3,560	71
Veal	Medium1	Flush	Central	42,711	854
Veal	Medium1	Flush	MidAtlantic	42,711	854
Veal	Medium1	Flush	South	42,711	854
Veal	Medium1	Flush	Pacific	42,711	854
Veal	Medium1	Flush	MidWest	42,711	854

Table A-3

Facility Costs for the Installation and Maintenance of Naturally-Lined Storage Ponds

Animal	Size Class	Farm Type	Region	Capital Costs	Annual Costs
Beef	Large1	Beef	Central	11,156	558
Beef	Large1	Beef	MidAtlantic	29,126	1,456
Beef	Large1	Beef	South	32,741	1,637
Beef	Large1	Beef	Pacific	33,178	1,659
Beef	Large1	Beef	MidWest	17,459	873
Beef	Large2	Beef	Central	64,717	3,236
Beef	Large2	Beef	MidAtlantic	174,057	8,703
Beef	Large2	Beef	South	191,663	9,583
Beef	Large2	Beef	Pacific	195,723	9,786
Beef	Large2	Beef	MidWest	104,311	5,216
Beef	Medium2	Beef	Central	6,829	341
Beef	Medium2	Beef	MidAtlantic	16,880	844
Beef	Medium2	Beef	South	18,897	945
Beef	Medium2	Beef	Pacific	19,106	955
Beef	Medium2	Beef	MidWest	10,289	514
Heifers	Medium2	Heifers	Central	13,047	652
Heifers	Medium2	Heifers	MidAtlantic	20,863	1,043
Heifers	Medium2	Heifers	South	22,353	1,118
Heifers	Medium2	Heifers	Pacific	22,509	1,125
Heifers	Medium2	Heifers	MidWest	15,769	788
Heifers	Large1	Heifers	Central	7,874	394
Heifers	Large1	Heifers	MidAtlantic	19,927	996
Heifers	Large1	Heifers	South	22,258	1,113
Heifers	Large1	Heifers	Pacific	22,220	1,111
Heifers	Large1	Heifers	MidWest	12,036	602
beef	Medium1	Beef	Central	12,662	633
beef	Medium1	Beef	MidAtlantic	19,626	981
beef	Medium1	Beef	South	20,920	1,046
beef	Medium1	Beef	Pacific	21,170	1,059
beef	Medium1	Beef	MidWest	15,084	754
Heifers	Medium1	Heifers	Central	11,680	584

Table A-3 (Continued)

Animal	Size Class	Farm Type	Region	Capital Costs	Annual Costs
Heifers	Medium1	Heifers	MidAtlantic	17,013	851
Heifers	Medium1	Heifers	South	17,948	897
Heifers	Medium1	Heifers	Pacific	18,158	908
Heifers	Medium1	Heifers	MidWest	13,562	678

Table A-4

Facility Costs for the Installation and Maintenance of Lined Storage Ponds

Animal	Region	Size Class	Farm Type	Capital Costs	Annual Costs
Beef	Central	Large1	Beef	163,854	8,193
Beef	MidAtlantic	Large1	Beef	357,619	17,881
Beef	South	Large1	Beef	398,420	19,921
Beef	Pacific	Large1	Beef	388,521	19,426
Beef	MidWest	Large1	Beef	231,650	11,583
Beef	Central	Large2	Beef	985,160	49,258
Beef	MidAtlantic	Large2	Beef	2,660,936	133,047
Beef	South	Large2	Beef	3,068,854	153,443
Beef	Pacific	Large2	Beef	2,888,413	144,421
Beef	MidWest	Large2	Beef	1,531,647	76,582
Beef	Central	Large1	Beef	108,549	5,427
Beef	MidAtlantic	Large1	Beef	218,378	10,919
Beef	South	Large1	Beef	240,376	12,019
Beef	Pacific	Large1	Beef	237,247	11,862
Beef	MidWest	Large1	Beef	147,775	7,389
Heifers	Central	Large1	Heifers	90,789	4,539
Heifers	MidAtlantic	Large1	Heifers	176,263	8,813
Heifers	South	Large1	Heifers	192,512	9,626
Heifers	Pacific	Large1	Heifers	190,959	9,548
Heifers	MidWest	Large1	Heifers	121,923	6,096
Heifers	Central	Large1	Heifers	121,543	6,077
Heifers	MidAtlantic	Large1	Heifers	250,679	12,534
Heifers	South	Large1	Heifers	276,077	13,804
Heifers	Pacific	Large1	Heifers	271,600	13,580
Heifers	MidWest	Large1	Heifers	167,614	8,381
Beef	Central	Medium1	Beef	85,876	4,294
Beef	MidAtlantic	Medium1	Beef	163,431	8,172
Beef	South	Medium1	Beef	177,780	8,889
Beef	Pacific	Medium1	Beef	177,579	8,879
Beef	MidWest	Medium1	Beef	114,107	5,705
Heifers	Central	Medium1	Heifers	73,092	3,655
Heifers	MidAtlantic	Medium1	Heifers	133,304	6,665
Heifers	South	Medium1	Heifers	143,887	7,194
Heifers	Pacific	Medium1	Heifers	144,460	7,223
Heifers	MidWest	Medium1	Heifers	95,417	4,771

Table A-5

Facility Costs for Installation and Maintenance of Storage Ponds Under Timing Restriction Option (7)

Animal	Size Class	Farm Type	Region	Capital Costs	Annual Costs
Beef	Large1	Beef	Central	9,535	477
Beef	Large1	Beef	MidAtlantic	25,031	1,252
Beef	Large1	Beef	South	-	-
Beef	Large1	Beef	Pacific	22,081	1,104
Beef	Large1	Beef	MidWest	6,613	331
Beef	Large2	Beef	Central	54,441	2,722
Beef	Large2	Beef	MidAtlantic	147,507	7,375
Beef	Large2	Beef	South	-	-
Beef	Large2	Beef	Pacific	131,017	6,551
Beef	Large2	Beef	MidWest	35,415	1,771
Beef	Medium2	Beef	Central	5,905	295
Beef	Medium2	Beef	MidAtlantic	14,414	721
Beef	Medium2	Beef	South	-	-
Beef	Medium2	Beef	Pacific	13,037	652
Beef	Medium2	Beef	MidWest	4,406	220
Heifers	Medium2	Heifers	Central	12,276	614
Heifers	Medium2	Heifers	MidAtlantic	21,628	1,081
Heifers	Medium2	Heifers	South	11,504	575
Heifers	Medium2	Heifers	Pacific	17,868	893
Heifers	Medium2	Heifers	MidWest	14,631	732
Heifers	Large1	Heifers	Central	6,444	322
Heifers	Large1	Heifers	MidAtlantic	21,179	1,059
Heifers	Large1	Heifers	South	5,105	255
Heifers	Large1	Heifers	Pacific	15,075	754
Heifers	Large1	Heifers	MidWest	10,082	504
Beef	Medium1	Beef	Central	12,058	603
Beef	Medium1	Beef	MidAtlantic	17,966	898
Beef	Medium1	Beef	South	-	-
Beef	Medium1	Beef	Pacific	17,029	851
Beef	Medium1	Beef	MidWest	11,114	556
Heifers	Medium1	Heifers	Central	11,150	558
Heifers	Medium1	Heifers	MidAtlantic	17,527	876
Heifers	Medium1	Heifers	South	10,752	538
Heifers	Medium1	Heifers	Pacific	15,011	751
Heifers	Medium1	Heifers	MidWest	12,747	637

Table A-6

Facility Costs for the Installation and Operation of Naturally-Lined Lagoons

Animal	Size Class	Farm Type	Region	Capital Costs	Annual Costs
Dairy	Large1	Flush	Central	178,526	8,926
Dairy	Large1	Flush	MidAtlantic	243,680	12,184
Dairy	Large1	Flush	South	230,354	11,518
Dairy	Large1	Flush	Pacific	246,279	12,314
Dairy	Large1	Flush	MidWest	214,675	10,734
Dairy	Large1	Hose	Central	97,701	4,885
Dairy	Large1	Hose	MidAtlantic	162,570	8,128
Dairy	Large1	Hose	South	148,663	7,433
Dairy	Large1	Hose	Pacific	162,674	8,134
Dairy	Large1	Hose	MidWest	135,937	6,797
Dairy	Medium2	Flush	Central	81,821	4,091
Dairy	Medium2	Flush	MidAtlantic	105,344	5,267
Dairy	Medium2	Flush	South	101,789	5,089
Dairy	Medium2	Flush	Pacific	107,001	5,350
Dairy	Medium2	Flush	MidWest	94,564	4,728
Dairy	Medium2	Hose	Central	39,987	1,999
Dairy	Medium2	Hose	MidAtlantic	63,592	3,180
Dairy	Medium2	Hose	South	59,049	2,952
Dairy	Medium2	Hose	Pacific	63,863	3,193
Dairy	Medium2	Hose	MidWest	53,495	2,675
Dairy	Medium1	Flush	Central	53,779	2,689
Dairy	Medium1	Flush	MidAtlantic	66,833	3,342
Dairy	Medium1	Flush	South	65,255	3,263
Dairy	Medium1	Flush	Pacific	68,715	3,436
Dairy	Medium1	Flush	MidWest	60,273	3,014
Dairy	Medium1	Hose	Central	26,261	1,313
Dairy	Medium1	Hose	MidAtlantic	39,324	1,966
Dairy	Medium1	Hose	South	37,349	1,867
Dairy	Medium1	Hose	Pacific	40,114	2,006
Dairy	Medium1	Hose	MidWest	33,590	1,679

Table A-7

Facility Costs for Installation and Operation of Synthetically-Lined Lagoons

Animal	Size Class	Farm Type	Region	Capital Costs	Annual Costs
Dairy	Large1	Flush	Central	1,138,237	56,912
Dairy	Large1	Flush	MidAtlantic	1,265,246	63,262
Dairy	Large1	Flush	South	1,240,824	62,041
Dairy	Large1	Flush	Pacific	1,292,016	64,601
Dairy	Large1	Flush	MidWest	1,231,811	61,591
Dairy	Large1	Hose	Central	568,738	28,437
Dairy	Large1	Hose	MidAtlantic	700,696	35,035
Dairy	Large1	Hose	South	625,611	31,281
Dairy	Large1	Hose	Pacific	702,280	35,114
Dairy	Large1	Hose	MidWest	690,558	34,528
Dairy	Medium2	Flush	Central	600,007	30,000
Dairy	Medium2	Flush	MidAtlantic	669,878	33,494
Dairy	Medium2	Flush	South	671,111	33,556
Dairy	Medium2	Flush	Pacific	692,829	34,641
Dairy	Medium2	Flush	MidWest	640,565	32,028
Dairy	Medium2	Hose	Central	273,988	13,699
Dairy	Medium2	Hose	MidAtlantic	343,060	17,153
Dairy	Medium2	Hose	South	326,421	16,321
Dairy	Medium2	Hose	Pacific	356,636	17,832
Dairy	Medium2	Hose	MidWest	327,399	16,370
Dairy	Medium1	Flush	Central	419,505	20,975
Dairy	Medium1	Flush	MidAtlantic	468,805	23,440
Dairy	Medium1	Flush	South	476,732	23,837
Dairy	Medium1	Flush	Pacific	490,340	24,517
Dairy	Medium1	Flush	MidWest	444,591	22,230
Dairy	Medium1	Hose	Central	192,006	9,600
Dairy	Medium1	Hose	MidAtlantic	240,710	12,036
Dairy	Medium1	Hose	South	237,946	11,897
Dairy	Medium1	Hose	Pacific	255,757	12,788
Dairy	Medium1	Hose	MidWest	223,837	11,192

Table A-8

Facility Costs for Installation and Operation of Lagoons Under Timing Restriction Option (Option 7)

Animal	Size Class	Farm Type	Region	Capital Costs	Annual Costs
Dairy	Large1	Flush	Central	218,448	10,922
Dairy	Large1	Flush	MidAtlantic	338,146	16,907
Dairy	Large1	Flush	South	104,693	5,235
Dairy	Large1	Flush	Pacific	233,980	11,699
Dairy	Large1	Flush	MidWest	258,523	12,926
Dairy	Large1	Hose	Central	100,546	5,027
Dairy	Large1	Hose	MidAtlantic	146,116	7,306
Dairy	Large1	Hose	South	84,957	4,248
Dairy	Large1	Hose	Pacific	125,094	6,255
Dairy	Large1	Hose	MidWest	129,289	6,464
Dairy	Medium2	Flush	Central	98,241	4,912
Dairy	Medium2	Flush	MidAtlantic	149,433	7,472
Dairy	Medium2	Flush	South	48,578	2,429
Dairy	Medium2	Flush	Pacific	106,450	5,322
Dairy	Medium2	Flush	MidWest	112,856	5,643
Dairy	Medium2	Hose	Central	42,583	2,129
Dairy	Medium2	Hose	MidAtlantic	61,634	3,082
Dairy	Medium2	Hose	South	36,879	1,844
Dairy	Medium2	Hose	Pacific	54,117	2,706
Dairy	Medium2	Hose	MidWest	52,799	2,640
Dairy	Medium1	Flush	Central	63,626	3,181
Dairy	Medium1	Flush	MidAtlantic	95,831	4,792
Dairy	Medium1	Flush	South	34,229	1,711
Dairy	Medium1	Flush	Pacific	69,950	3,498
Dairy	Medium1	Flush	MidWest	72,614	3,631
Dairy	Medium1	Hose	Central	28,462	1,423
Dairy	Medium1	Hose	MidAtlantic	40,618	2,031
Dairy	Medium1	Hose	South	25,159	1,258
Dairy	Medium1	Hose	Pacific	35,908	1,795
Dairy	Medium1	Hose	MidWest	34,272	1,714

Table A-9

Facility Costs for Installation and Maintenance of Berms for Runoff Control

Animal	Size Class	Farm Type	Region	Capital Costs	Annual Costs
Beef	Large1	Beef	Central	6,201	124
Beef	Large1	Beef	MidAtlantic	6,201	124
Beef	Large1	Beef	South	6,201	124
Beef	Large1	Beef	Pacific	6,201	124
Beef	Large1	Beef	MidWest	6,201	124
Beef	Large2	Beef	Central	25,317	506
Beef	Large2	Beef	MidAtlantic	25,317	506
Beef	Large2	Beef	South	25,317	506
Beef	Large2	Beef	Pacific	25,317	506
Beef	Large2	Beef	MidWest	25,317	506
Dairy	Large1	Flush	Central	3,057	61
Dairy	Large1	Hose	Central	3,057	61
Dairy	Large1	Flush	MidAtlantic	3,057	61
Dairy	Large1	Hose	MidAtlantic	3,057	61
Dairy	Large1	Hose	South	3,057	61
Dairy	Large1	Flush	South	3,057	61
Dairy	Large1	Flush	Pacific	3,057	61
Dairy	Large1	Hose	Pacific	3,057	61
Dairy	Large1	Hose	MidWest	3,057	61
Dairy	Large1	Flush	MidWest	3,057	61
Beef	Medium2	Beef	Central	3,990	80
Beef	Medium2	Beef	MidAtlantic	3,990	80
Beef	Medium2	Beef	South	3,990	80
Beef	Medium2	Beef	Pacific	3,990	80
Beef	Medium2	Beef	MidWest	3,990	80
Dairy	Medium2	Flush	Central	1,740	35
Dairy	Medium2	Hose	Central	1,740	35
Dairy	Medium2	Flush	MidAtlantic	1,740	35
Dairy	Medium2	Hose	MidAtlantic	1,740	35
Dairy	Medium2	Hose	South	1,740	35
Dairy	Medium2	Flush	South	1,740	35
Dairy	Medium2	Flush	Pacific	1,740	35

Table A-9 (Continued)

Animal	Size Class	Farm Type	Region	Capital Costs	Annual Costs
Dairy	Medium2	Hose	Pacific	1,740	35
Dairy	Medium2	Hose	MidWest	1,740	35
Dairy	Medium2	Flush	MidWest	1,740	35
Heifers	Medium2	Heifers	Central	1,740	35
Heifers	Medium2	Heifers	MidAtlantic	1,740	35
Heifers	Medium2	Heifers	South	1,740	35
Heifers	Medium2	Heifers	Pacific	1,740	35
Heifers	Medium2	Heifers	MidWest	1,740	35
Heifers	Large1	Heifers	Central	1,740	35
Heifers	Large1	Heifers	MidAtlantic	1,740	35
Heifers	Large1	Heifers	South	1,740	35
Heifers	Large1	Heifers	Pacific	1,740	35
Heifers	Large1	Heifers	MidWest	1,740	35
Beef	Medium1	Beef	Central	2,963	59
Beef	Medium1	Beef	MidAtlantic	2,963	59
Beef	Medium1	Beef	South	2,963	59
Beef	Medium1	Beef	Pacific	2,963	59
Beef	Medium1	Beef	MidWest	2,963	59
Dairy	Medium1	Flush	Central	1,244	25
Dairy	Medium1	Hose	Central	1,244	25
Dairy	Medium1	Flush	MidAtlantic	1,244	25
Dairy	Medium1	Hose	MidAtlantic	1,244	25
Dairy	Medium1	Flush	South	1,244	25
Dairy	Medium1	Hose	South	1,244	25
Dairy	Medium1	Hose	Pacific	1,244	25
Dairy	Medium1	Flush	Pacific	1,244	25
Dairy	Medium1	Hose	MidWest	1,244	25
Dairy	Medium1	Flush	MidWest	1,244	25
Heifers	Medium1	Heifers	Central	1,244	25
Heifers	Medium1	Heifers	MidAtlantic	1,244	25
Heifers	Medium1	Heifers	South	1,244	25
Heifers	Medium1	Heifers	Pacific	1,244	25
Heifers	Medium1	Heifers	MidWest	1,244	25

Table A-10

Facility Costs for the Installation and Operation of Anaerobic Digestion with Methane Recovery

Animal	Region	Size Class	Farm Type	Capital	O&M
Dairy	MidWest	Large1	Hose	377,447	(64,434)
Dairy	Pacific	Large1	Hose	377,447	(64,434)
Dairy	Central	Large1	Hose	377,447	(64,434)
Dairy	South	Large1	Hose	377,447	(64,434)
Dairy	MidAtlantic	Large1	Hose	377,447	(64,434)
Dairy	Central	Large1	Flush	214,353	(52,779)
Dairy	MidAtlantic	Large1	Flush	214,353	(52,779)
Dairy	MidWest	Large1	Flush	214,353	(52,779)
Dairy	Pacific	Large1	Flush	214,353	(52,779)
Dairy	South	Large1	Flush	214,353	(52,779)

Table A-11

Facility Costs for Installation and Maintenance of Concrete Pads

Animal	Size Class	Farm Type	Region	Capital Costs	Annual Costs
Beef	Large1	Beef	Central	188,492	3,770
Beef	Large1	Beef	MidAtlantic	185,344	3,707
Beef	Large1	Beef	South	184,482	3,690
Beef	Large1	Beef	Pacific	184,978	3,700
Beef	Large1	Beef	MidWest	187,529	3,751
Beef	Large2	Beef	Central	2,904,786	58,096
Beef	Large2	Beef	MidAtlantic	2,854,341	57,087
Beef	Large2	Beef	South	2,840,533	56,811
Beef	Large2	Beef	Pacific	2,848,472	56,969
Beef	Large2	Beef	MidWest	2,889,352	57,787
Dairy	Large1	Flush	Central	92,996	1,860
Dairy	Large1	Flush	MidAtlantic	92,996	1,860
Dairy	Large1	Flush	South	92,996	1,860
Dairy	Large1	Flush	Pacific	92,996	1,860
Dairy	Large1	Flush	MidWest	92,996	1,860
Dairy	Large1	Hose	Central	42,336	847
Dairy	Large1	Hose	MidAtlantic	42,336	847
Dairy	Large1	Hose	South	42,336	847
Dairy	Large1	Hose	Pacific	42,336	847
Dairy	Large1	Hose	MidWest	42,336	847
Beef	Medium2	Beef	Central	82,506	1,650
Beef	Medium2	Beef	MidAtlantic	81,165	1,623
Beef	Medium2	Beef	South	80,798	1,616
Beef	Medium2	Beef	Pacific	81,009	1,620
Beef	Medium2	Beef	MidWest	82,096	1,642
Dairy	Medium2	Flush	Central	34,996	700
Dairy	Medium2	Flush	MidAtlantic	34,996	700
Dairy	Medium2	Flush	South	34,996	700
Dairy	Medium2	Flush	Pacific	34,996	700
Dairy	Medium2	Flush	MidWest	34,996	700
Dairy	Medium2	Hose	Central	16,935	339
Dairy	Medium2	Hose	MidAtlantic	16,935	339

Table A-11 (Continued)

Animal	Size Class	Farm Type	Region	Capital Costs	Annual Costs
Dairy	Medium2	Hose	South	16,935	339
Dairy	Medium2	Hose	Pacific	16,935	339
Dairy	Medium2	Hose	MidWest	16,935	339
Veal	Medium2	Flush	Central	2,689	54
Veal	Medium2	Flush	MidAtlantic	2,689	54
Veal	Medium2	Flush	South	2,689	54
Veal	Medium2	Flush	Pacific	2,689	54
Veal	Medium2	Flush	MidWest	2,689	54
Heifers	Medium2	Heifers	Central	601	12
Heifers	Medium2	Heifers	MidAtlantic	699	14
Heifers	Medium2	Heifers	South	720	14
Heifers	Medium2	Heifers	Pacific	708	14
Heifers	Medium2	Heifers	MidWest	637	13
Heifers	Large1	Heifers	Central	651	13
Heifers	Large1	Heifers	MidAtlantic	797	16
Heifers	Large1	Heifers	South	828	17
Heifers	Large1	Heifers	Pacific	811	16
Heifers	Large1	Heifers	MidWest	704	14
Beef	Medium1	Beef	Central	47,961	959
Beef	Medium1	Beef	MidAtlantic	47,202	944
Beef	Medium1	Beef	South	46,994	940
Beef	Medium1	Beef	Pacific	47,114	942
Beef	Medium1	Beef	MidWest	47,729	955
Dairy	Medium1	Flush	Central	20,257	405
Dairy	Medium1	Flush	MidAtlantic	20,257	405
Dairy	Medium1	Flush	South	20,257	405
Dairy	Medium1	Flush	Pacific	20,257	405
Dairy	Medium1	Flush	MidWest	20,257	405
Dairy	Medium1	Hose	Central	10,255	205
Dairy	Medium1	Hose	MidAtlantic	10,255	205
Dairy	Medium1	Hose	South	10,255	205
Dairy	Medium1	Hose	Pacific	10,255	205
Dairy	Medium1	Hose	MidWest	10,255	205
Heifers	Medium1	Heifers	Central	570	11

Table A-11 (Continued)

Animal	Size Class	Farm Type	Region	Capital Costs	Annual Costs
Heifers	Medium1	Heifers	MidAtlantic	639	13
Heifers	Medium1	Heifers	South	653	13
Heifers	Medium1	Heifers	Pacific	645	13
Heifers	Medium1	Heifers	MidWest	595	12
Veal	Medium1	Flush	Central	2,276	46
Veal	Medium1	Flush	MidAtlantic	2,276	46
Veal	Medium1	Flush	South	2,276	46
Veal	Medium1	Flush	Pacific	2,276	46
Veal	Medium1	Flush	MidWest	2,276	46

Table A-12

Facility Costs for Installation and Operation of Groundwater Monitoring

Animal	Size Class	Farm Type	Region	Capital Costs	Annual Costs
Beef	Large1	Beef	Central	6,075	802
Beef	Large1	Beef	MidAtlantic	6,075	802
Beef	Large1	Beef	MidWest	6,075	802
Beef	Large1	Beef	Pacific	6,075	802
Beef	Large1	Beef	South	6,075	802
Beef	Large2	Beef	Central	6,075	802
Beef	Large2	Beef	MidAtlantic	6,075	802
Beef	Large2	Beef	MidWest	6,075	802
Beef	Large2	Beef	Pacific	6,075	802
Beef	Large2	Beef	South	6,075	802
Beef	Medium2	Beef	Central	6,075	802
Beef	Medium2	Beef	MidAtlantic	6,075	802
Beef	Medium2	Beef	MidWest	6,075	802
Beef	Medium2	Beef	Pacific	6,075	802
Beef	Medium2	Beef	South	6,075	802
Beef	Medium1	Beef	Central	6,075	802
Beef	Medium1	Beef	MidAtlantic	6,075	802
Beef	Medium1	Beef	MidWest	6,075	802
Beef	Medium1	Beef	Pacific	6,075	802
Beef	Medium1	Beef	South	6,075	802
Dairy	Large1	Flush	Central	6,075	802
Dairy	Large1	Hose	Central	6,075	802
Dairy	Large1	Flush	MidAtlantic	6,075	802
Dairy	Large1	Hose	MidAtlantic	6,075	802
Dairy	Large1	Flush	MidWest	6,075	802
Dairy	Large1	Hose	MidWest	6,075	802
Dairy	Large1	Flush	Pacific	6,075	802
Dairy	Large1	Hose	Pacific	6,075	802
Dairy	Large1	Flush	South	6,075	802
Dairy	Large1	Hose	South	6,075	802
Dairy	Medium2	Flush	Central	6,075	802
Dairy	Medium2	Hose	Central	6,075	802

Table A-12 (Continued)

Animal	Size Class	Farm Type	Region	Capital Costs	Annual Costs
Dairy	Medium2	Flush	MidAtlantic	6,075	802
Dairy	Medium2	Hose	MidAtlantic	6,075	802
Dairy	Medium2	Flush	MidWest	6,075	802
Dairy	Medium2	Hose	MidWest	6,075	802
Dairy	Medium2	Flush	Pacific	6,075	802
Dairy	Medium2	Hose	Pacific	6,075	802
Dairy	Medium2	Flush	South	6,075	802
Dairy	Medium2	Hose	South	6,075	802
Dairy	Medium1	Flush	Central	6,075	802
Dairy	Medium1	Hose	Central	6,075	802
Dairy	Medium1	Flush	MidAtlantic	6,075	802
Dairy	Medium1	Hose	MidAtlantic	6,075	802
Dairy	Medium1	Flush	MidWest	6,075	802
Dairy	Medium1	Hose	MidWest	6,075	802
Dairy	Medium1	Flush	Pacific	6,075	802
Dairy	Medium1	Hose	Pacific	6,075	802
Dairy	Medium1	Flush	South	6,075	802
Dairy	Medium1	Hose	South	6,075	802
Heifers	Large1	Heifers	Central	6,075	802
Heifers	Large1	Heifers	MidAtlantic	6,075	802
Heifers	Large1	Heifers	MidWest	6,075	802
Heifers	Large1	Heifers	Pacific	6,075	802
Heifers	Large1	Heifers	South	6,075	802
Heifers	Medium2	Heifers	Central	6,075	802
Heifers	Medium2	Heifers	MidAtlantic	6,075	802
Heifers	Medium2	Heifers	MidWest	6,075	802
Heifers	Medium2	Heifers	Pacific	6,075	802
Heifers	Medium2	Heifers	South	6,075	802
Heifers	Medium1	Heifers	Central	6,075	802
Heifers	Medium1	Heifers	MidAtlantic	6,075	802
Heifers	Medium1	Heifers	MidWest	6,075	802
Heifers	Medium1	Heifers	Pacific	6,075	802
Heifers	Medium1	Heifers	South	6,075	802
Veal	Medium2	Flush	Central	6,075	802
Veal	Medium2	Flush	MidAtlantic	6,075	802

Table A-12 (Continued)

Animal	Size Class	Farm Type	Region	Capital Costs	Annual Costs
Veal	Medium2	Flush	MidWest	6,075	802
Veal	Medium2	Flush	Pacific	6,075	802
Veal	Medium2	Flush	South	6,075	802
Veal	Medium1	Flush	Central	6,075	802
Veal	Medium1	Flush	MidAtlantic	6,075	802
Veal	Medium1	Flush	MidWest	6,075	802
Veal	Medium1	Flush	Pacific	6,075	802
Veal	Medium1	Flush	South	6,075	802

Table A-13

Facility Costs for Implementing and Performing Composting

Animal	Size Class	Region	Farm Type	Capital Costs	Annual Costs
Beef	Large2	Central	Beef	9,157	1,614,871
Beef	Large2	MidAtlantic	Beef	9,157	1,401,589
Beef	Large2	South	Beef	9,157	1,400,238
Beef	Large2	Pacific	Beef	9,157	1,402,053
Beef	Large2	MidWest	Beef	9,157	1,438,485
Beef	Large1	Central	Beef	9,157	96,884
Beef	Large1	MidAtlantic	Beef	9,157	84,086
Beef	Large1	South	Beef	9,157	84,005
Beef	Large1	Pacific	Beef	9,157	84,114
Beef	Large1	MidWest	Beef	9,157	86,312
Beef	Medium2	Central	Beef	9,157	40,125
Beef	Medium2	MidAtlantic	Beef	9,157	34,812
Beef	Medium2	South	Beef	9,157	34,778
Beef	Medium2	Pacific	Beef	9,157	34,823
Beef	Medium2	MidWest	Beef	9,157	35,741
Beef	Medium1	Central	Beef	9,157	22,135
Beef	Medium1	MidAtlantic	Beef	9,157	19,198
Beef	Medium1	South	Beef	9,157	19,179
Beef	Medium1	Pacific	Beef	9,157	19,204
Beef	Medium1	MidWest	Beef	9,157	19,720
Dairy	Large1	Central	Flush	9,157	7,939
Dairy	Large1	MidAtlantic	Flush	9,157	4,223
Dairy	Large1	South	Flush	9,157	1,548
Dairy	Large1	Pacific	Flush	9,157	2,849
Dairy	Large1	MidWest	Flush	9,157	7,140
Dairy	Large1	Central	Hose	9,157	7,939
Dairy	Large1	MidAtlantic	Hose	9,157	4,223
Dairy	Large1	South	Hose	9,157	1,548
Dairy	Large1	Pacific	Hose	9,157	2,849
Dairy	Large1	MidWest	Hose	9,157	7,140
Dairy	Medium2	Central	Flush	9,157	2,584
Dairy	Medium2	MidAtlantic	Flush	9,157	1,377

Table A-13 (Continued)

Animal	Size Class	Region	Farm Type	Capital Costs	Annual Costs
Dairy	Medium2	South	Flush	9,157	504
Dairy	Medium2	Pacific	Flush	9,157	931
Dairy	Medium2	MidWest	Flush	9,157	2,324
Dairy	Medium2	Central	Hose	9,157	2,584
Dairy	Medium2	MidAtlantic	Hose	9,157	1,377
Dairy	Medium2	South	Hose	9,157	504
Dairy	Medium2	Pacific	Hose	9,157	931
Dairy	Medium2	MidWest	Hose	9,157	2,324
Dairy	Medium1	Central	Flush	9,157	1,320
Dairy	Medium1	MidAtlantic	Flush	9,157	707
Dairy	Medium1	South	Flush	9,157	261
Dairy	Medium1	Pacific	Flush	9,157	484
Dairy	Medium1	MidWest	Flush	9,157	1,190
Dairy	Medium1	Central	Hose	9,157	1,320
Dairy	Medium1	MidAtlantic	Hose	9,157	707
Dairy	Medium1	South	Hose	9,157	261
Dairy	Medium1	Pacific	Hose	9,157	484
Dairy	Medium1	MidWest	Hose	9,157	1,190
Heifers	Large1	Central	Heifers	9,157	485
Heifers	Large1	MidAtlantic	Heifers	9,157	485
Heifers	Large1	South	Heifers	9,157	485
Heifers	Large1	Pacific	Heifers	9,157	485
Heifers	Large1	MidWest	Heifers	9,157	485
Heifers	Medium2	Central	Heifers	9,157	559
Heifers	Medium2	MidAtlantic	Heifers	9,157	559
Heifers	Medium2	South	Heifers	9,157	559
Heifers	Medium2	Pacific	Heifers	9,157	559
Heifers	Medium2	MidWest	Heifers	9,157	559
Heifers	Medium1	Central	Heifers	9,157	298
Heifers	Medium1	MidAtlantic	Heifers	9,157	298
Heifers	Medium1	South	Heifers	9,157	298
Heifers	Medium1	Pacific	Heifers	9,157	298
Heifers	Medium1	MidWest	Heifers	9,157	298

Table A-14

Facility Costs for the Implementation and Execution of Surface Water Monitoring

Animal	Size Class	Farm Type	Region	Capital Costs	Annual Costs
Beef	Large1	Beef	Central	392	6,252
Beef	Large1	Beef	MidAtlantic	392	6,252
Beef	Large1	Beef	MidWest	392	6,252
Beef	Large1	Beef	Pacific	392	6,252
Beef	Large1	Beef	South	392	6,252
Beef	Large2	Beef	Central	392	6,252
Beef	Large2	Beef	MidAtlantic	392	6,252
Beef	Large2	Beef	MidWest	392	6,252
Beef	Large2	Beef	Pacific	392	6,252
Beef	Large2	Beef	South	392	6,252
Beef	Medium2	Beef	Central	392	6,252
Beef	Medium2	Beef	MidAtlantic	392	6,252
Beef	Medium2	Beef	MidWest	392	6,252
Beef	Medium2	Beef	Pacific	392	6,252
Beef	Medium2	Beef	South	392	6,252
Beef	Medium1	Beef	Central	392	6,252
Beef	Medium1	Beef	MidAtlantic	392	6,252
Beef	Medium1	Beef	MidWest	392	6,252
Beef	Medium1	Beef	Pacific	392	6,252
Beef	Medium1	Beef	South	392	6,252
Dairy	Large1	Flush	Central	392	6,252
Dairy	Large1	Hose	Central	392	6,252
Dairy	Large1	Flush	MidAtlantic	392	6,252
Dairy	Large1	Hose	MidAtlantic	392	6,252
Dairy	Large1	Flush	MidWest	392	6,252
Dairy	Large1	Hose	MidWest	392	6,252
Dairy	Large1	Flush	Pacific	392	6,252
Dairy	Large1	Hose	Pacific	392	6,252
Dairy	Large1	Flush	South	392	6,252
Dairy	Large1	Hose	South	392	6,252
Dairy	Medium2	Flush	Central	392	6,252

Table A-14 (Continued)

Animal	Size Class	Farm Type	Region	Capital Costs	Annual Costs
Dairy	Medium2	Hose	Central	392	6,252
Dairy	Medium2	Flush	MidAtlantic	392	6,252
Dairy	Medium2	Hose	MidAtlantic	392	6,252
Dairy	Medium2	Flush	MidWest	392	6,252
Dairy	Medium2	Hose	MidWest	392	6,252
Dairy	Medium2	Flush	Pacific	392	6,252
Dairy	Medium2	Hose	Pacific	392	6,252
Dairy	Medium2	Flush	South	392	6,252
Dairy	Medium2	Hose	South	392	6,252
Dairy	Medium1	Flush	Central	392	6,252
Dairy	Medium1	Hose	Central	392	6,252
Dairy	Medium1	Flush	MidAtlantic	392	6,252
Dairy	Medium1	Hose	MidAtlantic	392	6,252
Dairy	Medium1	Flush	MidWest	392	6,252
Dairy	Medium1	Hose	MidWest	392	6,252
Dairy	Medium1	Flush	Pacific	392	6,252
Dairy	Medium1	Hose	Pacific	392	6,252
Dairy	Medium1	Flush	South	392	6,252
Dairy	Medium1	Hose	South	392	6,252
Heifers	Large1	Heifers	Central	392	6,252
Heifers	Large1	Heifers	MidAtlantic	392	6,252
Heifers	Large1	Heifers	MidWest	392	6,252
Heifers	Large1	Heifers	Pacific	392	6,252
Heifers	Large1	Heifers	South	392	6,252
Heifers	Medium2	Heifers	Central	392	6,252
Heifers	Medium2	Heifers	MidAtlantic	392	6,252
Heifers	Medium2	Heifers	MidWest	392	6,252
Heifers	Medium2	Heifers	Pacific	392	6,252
Heifers	Medium2	Heifers	South	392	6,252
Heifers	Medium1	Heifers	Central	392	6,252
Heifers	Medium1	Heifers	MidAtlantic	392	6,252
Heifers	Medium1	Heifers	MidWest	392	6,252
Heifers	Medium1	Heifers	Pacific	392	6,252
Heifers	Medium1	Heifers	South	392	6,252
Veal	Medium2	Flush	Central	392	6,252

Table A-14 (Continued)

Animal	Size Class	Farm Type	Region	Capital Costs	Annual Costs
Veal	Medium2	Flush	MidAtlantic	392	6,252
Veal	Medium2	Flush	MidWest	392	6,252
Veal	Medium2	Flush	Pacific	392	392
Veal	Medium2	Flush	South	392	6,252
Veal	Medium1	Flush	Central	392	6,252
Veal	Medium1	Flush	MidAtlantic	392	6,252
Veal	Medium1	Flush	MidWest	392	6,252
Veal	Medium1	Flush	Pacific	392	6,252
Veal	Medium1	Flush	South	392	6,252

Table A-15

Facility Costs for Implementation of Nutrient Management Planning
N-Based Application

Animal	SizeClass	FarmType	Region	Category1Costs			Category2Costs			Category3Costs		
				Capital	Annual	Recurring	Capital	Annual	Recurring	Capital	Annual	Recurring
Beef	Large1	Beef	Pacific	2,330	2,244	3,685	1,487	1,754	2,091	690	1,290	600
Beef	Large1	Beef	MidAtlantic	2,014	2,061	3,100	1,264	1,624	1,671	690	1,290	600
Beef	Large1	Beef	South	2,272	2,211	3,567	1,375	1,689	1,881	690	1,290	600
Beef	Large1	Beef	MidWest	2,476	2,329	3,961	1,464	1,740	2,060	690	1,290	600
Beef	Large1	Beef	Central	1,941	2,018	2,962	1,283	1,635	1,717	690	1,290	600
Beef	Large2	Beef	MidAtlantic	22,767	14,134	42,133	14,089	9,085	25,809	690	1,290	600
Beef	Large2	Beef	MidWest	30,494	18,630	56,680	18,774	11,811	34,627	690	1,290	600
Beef	Large2	Beef	South	27,068	16,636	50,234	16,695	10,602	30,712	690	1,290	600
Beef	Large2	Beef	Central	21,531	13,415	39,812	13,927	8,991	25,512	690	1,290	600
Beef	Large2	Beef	Pacific	28,019	17,190	52,032	18,285	11,527	33,710	690	1,290	600
Beef	Medium1	Beef	MidAtlantic	994	1,467	1,169	971	1,454	1,118	690	1,290	600
Beef	Medium1	Beef	MidWest	1,098	1,527	1,369	1,067	1,510	1,307	690	1,290	600
Beef	Medium1	Beef	Central	975	1,456	1,143	956	1,445	1,097	690	1,290	600
Beef	Medium1	Beef	South	1,052	1,501	1,286	1,025	1,485	1,230	690	1,290	600
Beef	Medium1	Beef	Pacific	1,063	1,507	1,302	1,040	1,494	1,251	690	1,290	600
Beef	Medium2	Beef	MidWest	1,429	1,720	1,994	1,248	1,615	1,650	690	1,290	600
Beef	Medium2	Beef	South	1,345	1,671	1,820	1,183	1,577	1,522	690	1,290	600
Beef	Medium2	Beef	Pacific	1,368	1,684	1,871	1,217	1,597	1,589	690	1,290	600
Beef	Medium2	Beef	Central	1,206	1,590	1,573	1,090	1,523	1,358	690	1,290	600
Beef	Medium2	Beef	MidAtlantic	1,237	1,608	1,635	1,102	1,530	1,374	690	1,290	600

Table A-15 (Continued)

Animal	SizeClass	FarmType	Region	Category1Costs			Category2Costs			Category3Costs		
				Capital	Annual	Recurring	Capital	Annual	Recurring	Capital	Annual	Recurring
Dairy	Large1	Flush	Pacific	2,234	2,188	3,495	986	1,462	1,158	690	1,290	600
Dairy	Large1	Flush	MidAtlantic	2,334	2,246	3,690	1,006	1,474	1,184	690	1,290	600
Dairy	Large1	Flush	Central	1,980	2,040	3,034	1,006	1,474	1,184	690	1,290	600
Dairy	Large1	Flush	MidWest	2,492	2,338	3,982	1,164	1,566	1,497	690	1,290	600
Dairy	Large1	Flush	South	2,111	2,117	3,270	782	1,344	764	690	1,290	600
Dairy	Medium1	Flush	Central	902	1,413	1,005	852	1,384	897	690	1,290	600
Dairy	Medium1	Flush	MidAtlantic	963	1,449	1,107	894	1,409	974	690	1,290	600
Dairy	Medium1	Flush	South	925	1,427	1,036	856	1,386	903	690	1,290	600
Dairy	Medium1	Flush	Pacific	944	1,438	1,082	883	1,402	959	690	1,290	600
Dairy	Medium1	Flush	MidWest	990	1,465	1,164	921	1,424	1,031	690	1,290	600
Dairy	Medium2	Flush	Pacific	1,191	1,581	1,533	832	1,373	871	690	1,290	600
Dairy	Medium2	Flush	Central	1,106	1,532	1,379	829	1,371	866	690	1,290	600
Dairy	Medium2	Flush	MidWest	1,275	1,630	1,707	894	1,409	974	690	1,290	600
Dairy	Medium2	Flush	South	1,152	1,559	1,461	767	1,335	744	690	1,290	600
Dairy	Medium2	Flush	MidAtlantic	1,225	1,601	1,599	840	1,377	882	690	1,290	600
Dairy	Large1	Hose	Pacific	2,234	2,188	3,495	986	1,462	1,158	690	1,290	600
Dairy	Large1	Hose	Central	1,980	2,040	3,034	1,006	1,474	1,184	690	1,290	600
Dairy	Large1	Hose	MidWest	2,492	2,338	3,982	1,164	1,566	1,497	690	1,290	600
Dairy	Large1	Hose	MidAtlantic	2,334	2,246	3,690	1,006	1,474	1,184	690	1,290	600
Dairy	Large1	Hose	South	2,111	2,117	3,270	782	1,344	764	690	1,290	600
Dairy	Medium1	Hose	South	925	1,427	1,036	856	1,386	903	690	1,290	600
Dairy	Medium1	Hose	MidAtlantic	963	1,449	1,107	894	1,409	974	690	1,290	600
Dairy	Medium1	Hose	Central	902	1,413	1,005	852	1,384	897	690	1,290	600
Dairy	Medium1	Hose	MidWest	990	1,465	1,164	921	1,424	1,031	690	1,290	600
Dairy	Medium1	Hose	Pacific	944	1,438	1,082	883	1,402	959	690	1,290	600

Table A-15 (Continued)

Animal	SizeClass	FarmType	Region	Category1Costs			Category2Costs			Category3Costs		
				Capital	Annual	Recurring	Capital	Annual	Recurring	Capital	Annual	Recurring
Dairy	Medium2	Hose	Pacific	1,191	1,581	1,533	832	1,373	871	690	1,290	600
Dairy	Medium2	Hose	Central	1,106	1,532	1,379	829	1,371	866	690	1,290	600
Dairy	Medium2	Hose	MidAtlantic	1,225	1,601	1,599	840	1,377	882	690	1,290	600
Dairy	Medium2	Hose	MidWest	1,275	1,630	1,707	894	1,409	974	690	1,290	600
Dairy	Medium2	Hose	South	1,152	1,559	1,461	767	1,335	744	690	1,290	600
Heifers	Large1	Heifers	MidWest	1,133	1,548	1,435	1,102	1,530	1,374	690	1,290	600
Heifers	Large1	Heifers	Pacific	1,133	1,548	1,435	1,102	1,530	1,374	690	1,290	600
Heifers	Large1	Heifers	MidAtlantic	1,094	1,525	1,363	1,063	1,507	1,302	690	1,290	600
Heifers	Large1	Heifers	South	1,040	1,494	1,251	1,010	1,476	1,190	690	1,290	600
Heifers	Large1	Heifers	Central	1,025	1,485	1,230	1,006	1,474	1,184	690	1,290	600
Heifers	Medium1	Heifers	MidAtlantic	798	1,353	805	767	1,335	744	690	1,290	600
Heifers	Medium1	Heifers	Central	779	1,342	759	759	1,330	733	690	1,290	600
Heifers	Medium1	Heifers	MidWest	809	1,359	820	779	1,342	759	690	1,290	600
Heifers	Medium1	Heifers	South	782	1,344	764	752	1,326	723	690	1,290	600
Heifers	Medium1	Heifers	Pacific	809	1,359	820	779	1,342	759	690	1,290	600
Heifers	Medium2	Heifers	Central	859	1,389	908	836	1,375	877	690	1,290	600
Heifers	Medium2	Heifers	MidAtlantic	890	1,406	969	863	1,391	933	690	1,290	600
Heifers	Medium2	Heifers	South	863	1,391	933	832	1,373	871	690	1,290	600
Heifers	Medium2	Heifers	MidWest	913	1,420	1,020	883	1,402	959	690	1,290	600
Heifers	Medium2	Heifers	Pacific	909	1,418	1,015	883	1,402	959	690	1,290	600
Veal	Medium1	Flush	South	1,075	1,514	1,318	690	1,290	600	690	1,290	600
Veal	Medium1	Flush	Pacific	1,075	1,514	1,318	690	1,290	600	690	1,290	600
Veal	Medium1	Flush	Central	1,075	1,514	1,318	690	1,290	600	690	1,290	600
Veal	Medium1	Flush	MidAtlantic	1,075	1,514	1,318	690	1,290	600	690	1,290	600
Veal	Medium1	Flush	MidWest	1,075	1,514	1,318	690	1,290	600	690	1,290	600

Table A-15 (Continued)

Animal	SizeClass	FarmType	Region	Category1Costs			Category2Costs			Category3Costs		
				Capital	Annual	Recurring	Capital	Annual	Recurring	Capital	Annual	Recurring
Veal	Medium2	Flush	South	1,075	1,514	1,318	690	1,290	600	690	1,290	600
Veal	Medium2	Flush	Pacific	1,075	1,514	1,318	690	1,290	600	690	1,290	600
Veal	Medium2	Flush	MidWest	1,075	1,514	1,318	690	1,290	600	690	1,290	600
Veal	Medium2	Flush	MidAtlantic	1,075	1,514	1,318	690	1,290	600	690	1,290	600
Veal	Medium2	Flush	Central	1,075	1,514	1,318	690	1,290	600	690	1,290	600

Table A-16

Facility Costs for Implementation forNutrient Management Planning
P-Based Application

Animal	Size Class	Farm Type	Region	Category 1 Costs			Category 2 Costs			Category 3 Costs		
				Capital	Annual	Recurring	Capital	Annual	Recurring	Capital	Annual	Recurring
Beef	Large1	Beef	Pacific	4,821	3,694	8,373	3,089	2,686	5,104	690	1,290	600
Beef	Large1	Beef	MidAtlantic	4,852	3,711	8,434	2,927	2,591	4,807	690	1,290	600
Beef	Large1	Beef	South	5,557	4,121	9,761	3,304	2,811	5,514	690	1,290	600
Beef	Large1	Beef	MidWest	5,476	4,074	9,613	3,258	2,784	5,432	690	1,290	600
Beef	Large1	Beef	Central	8,075	5,586	14,486	4,902	3,741	8,521	690	1,290	600
Beef	Large2	Beef	MidAtlantic	70,098	41,670	131,210	42,626	25,688	79,506	690	1,290	600
Beef	Large2	Beef	MidWest	80,439	47,687	150,670	48,879	29,326	91,270	690	1,290	600
Beef	Large2	Beef	South	81,841	48,502	153,293	49,722	29,816	92,864	690	1,290	600
Beef	Large2	Beef	Central	123,796	72,912	232,245	78,595	46,614	147,191	690	1,290	600
Beef	Large2	Beef	Pacific	69,535	41,343	130,154	44,852	26,983	83,697	690	1,290	600
Beef	Medium1	Beef	MidAtlantic	1,641	1,843	2,378	1,576	1,805	2,270	690	1,290	600
Beef	Medium1	Beef	MidWest	1,783	1,926	2,650	1,710	1,884	2,511	690	1,290	600
Beef	Medium1	Beef	Central	2,376	2,271	3,767	2,272	2,211	3,567	690	1,290	600
Beef	Medium1	Beef	South	1,803	1,937	2,696	1,726	1,893	2,552	690	1,290	600
Beef	Medium1	Beef	Pacific	1,633	1,839	2,368	1,576	1,805	2,270	690	1,290	600
Beef	Medium2	Beef	MidWest	2,669	2,441	4,320	2,303	2,229	3,628	690	1,290	600
Beef	Medium2	Beef	South	2,704	2,462	4,387	2,330	2,244	3,685	690	1,290	600
Beef	Medium2	Beef	Pacific	2,399	2,285	3,818	2,115	2,119	3,275	690	1,290	600
Beef	Medium2	Beef	Central	3,747	3,069	6,349	3,223	2,764	5,365	690	1,290	600
Beef	Medium2	Beef	MidAtlantic	2,415	2,294	3,838	2,095	2,108	3,249	690	1,290	600

Table A-16 (Continued)

Animal	Size Class	Farm Type	Region	Category 1 Costs			Category 2 Costs			Category 3 Costs		
				Capital	Annual	Recurring	Capital	Annual	Recurring	Capital	Annual	Recurring
Dairy	Large1	Flush	Pacific	3,062	2,670	5,068	1,021	1,483	1,225	690	1,290	600
Dairy	Large1	Flush	MidAtlantic	3,778	3,086	6,410	1,121	1,541	1,400	690	1,290	600
Dairy	Large1	Flush	Central	5,333	3,991	9,341	1,599	1,819	2,301	690	1,290	600
Dairy	Large1	Flush	MidWest	4,074	3,259	6,969	1,418	1,713	1,958	690	1,290	600
Dairy	Large1	Flush	South	3,354	2,840	5,621	702	1,297	616	690	1,290	600
Dairy	Medium1	Flush	Central	1,460	1,738	2,055	1,318	1,655	1,784	690	1,290	600
Dairy	Medium1	Flush	MidAtlantic	1,202	1,588	1,568	1,102	1,530	1,374	690	1,290	600
Dairy	Medium1	Flush	South	1,133	1,548	1,435	1,033	1,489	1,241	690	1,290	600
Dairy	Medium1	Flush	Pacific	1,083	1,518	1,328	1,006	1,474	1,184	690	1,290	600
Dairy	Medium1	Flush	MidWest	1,252	1,617	1,656	1,152	1,559	1,461	690	1,290	600
Dairy	Medium2	Flush	Pacific	1,460	1,738	2,055	929	1,429	1,041	690	1,290	600
Dairy	Medium2	Flush	Central	2,195	2,166	3,423	1,221	1,599	1,594	690	1,290	600
Dairy	Medium2	Flush	MidWest	1,787	1,928	2,655	1,098	1,527	1,369	690	1,290	600
Dairy	Medium2	Flush	South	1,552	1,792	2,219	863	1,391	933	690	1,290	600
Dairy	Medium2	Flush	MidAtlantic	1,691	1,872	2,486	1,002	1,471	1,179	690	1,290	600
Dairy	Large1	Hose	Pacific	3,062	2,670	5,068	1,021	1,483	1,225	690	1,290	600
Dairy	Large1	Hose	Central	5,333	3,991	9,341	1,599	1,819	2,301	690	1,290	600
Dairy	Large1	Hose	MidWest	4,074	3,259	6,969	1,418	1,713	1,958	690	1,290	600
Dairy	Large1	Hose	MidAtlantic	3,778	3,086	6,410	1,121	1,541	1,400	690	1,290	600
Dairy	Large1	Hose	South	3,354	2,840	5,621	702	1,297	616	690	1,290	600
Dairy	Medium1	Hose	South	1,133	1,548	1,435	1,033	1,489	1,241	690	1,290	600
Dairy	Medium1	Hose	MidAtlantic	1,202	1,588	1,568	1,102	1,530	1,374	690	1,290	600
Dairy	Medium1	Hose	Central	1,460	1,738	2,055	1,318	1,655	1,784	690	1,290	600
Dairy	Medium1	Hose	MidWest	1,252	1,617	1,656	1,152	1,559	1,461	690	1,290	600
Dairy	Medium1	Hose	Pacific	1,083	1,518	1,328	1,006	1,474	1,184	690	1,290	600

Table A-16 (Continued)

Animal	Size Class	Farm Type	Region	Category 1 Costs			Category 2 Costs			Category 3 Costs		
				Capital	Annual	Recurring	Capital	Annual	Recurring	Capital	Annual	Recurring
Dairy	Medium2	Hose	Pacific	1,460	1,738	2,055	929	1,429	1,041	690	1,290	600
Dairy	Medium2	Hose	Central	2,195	2,166	3,423	1,221	1,599	1,594	690	1,290	600
Dairy	Medium2	Hose	MidAtlantic	1,691	1,872	2,486	1,002	1,471	1,179	690	1,290	600
Dairy	Medium2	Hose	MidWest	1,787	1,928	2,655	1,098	1,527	1,369	690	1,290	600
Dairy	Medium2	Hose	South	1,552	1,792	2,219	863	1,391	933	690	1,290	600
Heifers	Large1	Heifers	MidWest	1,953	2,025	2,977	1,849	1,964	2,778	690	1,290	600
Heifers	Large1	Heifers	Pacific	1,722	1,890	2,547	1,641	1,843	2,378	690	1,290	600
Heifers	Large1	Heifers	MidAtlantic	1,845	1,962	2,773	1,741	1,902	2,573	690	1,290	600
Heifers	Large1	Heifers	South	1,683	1,868	2,475	1,583	1,810	2,281	690	1,290	600
Heifers	Large1	Heifers	Central	2,534	2,363	4,059	2,388	2,278	3,802	690	1,290	600
Heifers	Medium1	Heifers	MidAtlantic	998	1,469	1,174	894	1,409	974	690	1,290	600
Heifers	Medium1	Heifers	Central	1,183	1,577	1,522	1,037	1,492	1,246	690	1,290	600
Heifers	Medium1	Heifers	MidWest	1,029	1,487	1,235	925	1,427	1,036	690	1,290	600
Heifers	Medium1	Heifers	South	956	1,445	1,097	852	1,384	897	690	1,290	600
Heifers	Medium1	Heifers	Pacific	963	1,449	1,107	886	1,404	964	690	1,290	600
Heifers	Medium2	Heifers	Central	1,614	1,828	2,342	1,468	1,742	2,065	690	1,290	600
Heifers	Medium2	Heifers	MidAtlantic	1,268	1,626	1,676	1,164	1,566	1,497	690	1,290	600
Heifers	Medium2	Heifers	South	1,187	1,579	1,528	1,083	1,518	1,328	690	1,290	600
Heifers	Medium2	Heifers	MidWest	1,321	1,657	1,789	1,217	1,597	1,589	690	1,290	600
Heifers	Medium2	Heifers	Pacific	1,206	1,590	1,573	1,125	1,543	1,425	690	1,290	600
Veal	Medium1	Flush	South	1,075	1,514	1,318	690	1,290	600	690	1,290	600
Veal	Medium1	Flush	Pacific	1,075	1,514	1,318	690	1,290	600	690	1,290	600
Veal	Medium1	Flush	Central	1,075	1,514	1,318	690	1,290	600	690	1,290	600
Veal	Medium1	Flush	MidAtlantic	1,075	1,514	1,318	690	1,290	600	690	1,290	600
Veal	Medium1	Flush	MidWest	1,075	1,514	1,318	690	1,290	600	690	1,290	600

Table A-16 (Continued)

Animal	Size Class	Farm Type	Region	Category 1 Costs			Category 2 Costs			Category 3 Costs		
				Capital	Annual	Recurring	Capital	Annual	Recurring	Capital	Annual	Recurring
Veal	Medium2	Flush	South	1,075	1,514	1,318	690	1,290	600	690	1,290	600
Veal	Medium2	Flush	Pacific	1,075	1,514	1,318	690	1,290	600	690	1,290	600
Veal	Medium2	Flush	MidWest	1,075	1,514	1,318	690	1,290	600	690	1,290	600
Veal	Medium2	Flush	MidAtlantic	1,075	1,514	1,318	690	1,290	600	690	1,290	600
Veal	Medium2	Flush	Central	1,075	1,514	1,318	690	1,290	600	690	1,290	600

Table A-17

Facility Cost for Purchase of Commercial Nitrogen Fertilizer for P-based Application Options

Animal	Size Class	Farm Type	Region	Category 1 Annual Cost	Category 2 Annual Cost
Beef	Large1	Beef	Central	65,557	37,388
Beef	Large1	Beef	MidAtlantic	28,840	15,482
Beef	Large1	Beef	South	28,060	15,064
Beef	Large1	Beef	Pacific	23,854	13,845
Beef	Large1	Beef	MidWest	23,424	12,575
Beef	Large2	Beef	Central	1,092,738	691,519
Beef	Large2	Beef	MidAtlantic	480,715	290,458
Beef	Large2	Beef	South	467,728	282,611
Beef	Large2	Beef	Pacific	397,614	255,057
Beef	Large2	Beef	MidWest	390,444	235,914
Beef	Medium1	Beef	Central	14,967	14,036
Beef	Medium1	Beef	MidAtlantic	6,584	6,143
Beef	Medium1	Beef	South	6,406	5,977
Beef	Medium1	Beef	Pacific	5,446	5,115
Beef	Medium1	Beef	MidWest	5,348	4,989
Beef	Medium2	Beef	Central	27,141	22,473
Beef	Medium2	Beef	MidAtlantic	11,940	9,726
Beef	Medium2	Beef	South	11,617	9,463
Beef	Medium2	Beef	Pacific	9,876	8,217
Beef	Medium2	Beef	MidWest	9,698	7,900
Dairy	Large1	Flush	Central	41,216	8,049
Dairy	Large1	Flush	MidAtlantic	17,794	2,494
Dairy	Large1	Flush	South	15,359	57
Dairy	Large1	Flush	Pacific	13,697	1,920
Dairy	Large1	Flush	MidWest	19,500	4,201
Dairy	Medium1	Flush	Central	6,826	5,581
Dairy	Medium1	Flush	MidAtlantic	2,947	2,373
Dairy	Medium1	Flush	South	2,544	1,970
Dairy	Medium1	Flush	Pacific	2,268	1,826
Dairy	Medium1	Flush	MidWest	3,229	2,655
Dairy	Medium2	Flush	Central	13,361	4,731

Table A-17 (Continued)

Animal	Size Class	Farm Type	Region	Category 1 Annual Cost	Category 2 Annual Cost
Dairy	Medium2	Flush	MidAtlantic	5,768	1,787
Dairy	Medium2	Flush	South	4,979	997
Dairy	Medium2	Flush	Pacific	4,440	1,376
Dairy	Medium2	Flush	MidWest	6,321	2,340
Dairy	Large1	Hose	Central	41,216	8,049
Dairy	Large1	Hose	MidAtlantic	17,794	2,494
Dairy	Large1	Hose	South	15,359	57
Dairy	Large1	Hose	Pacific	13,697	1,920
Dairy	Large1	Hose	MidWest	19,500	4,201
Dairy	Medium1	Hose	Central	6,826	5,581
Dairy	Medium1	Hose	MidAtlantic	2,947	2,373
Dairy	Medium1	Hose	South	2,544	1,970
Dairy	Medium1	Hose	Pacific	2,268	1,826
Dairy	Medium1	Hose	MidWest	3,229	2,655
Dairy	Medium2	Hose	Central	13,361	4,731
Dairy	Medium2	Hose	MidAtlantic	5,768	1,787
Dairy	Medium2	Hose	South	4,979	997
Dairy	Medium2	Hose	Pacific	4,440	1,376
Dairy	Medium2	Hose	MidWest	6,321	2,340
Heifers	Large1	Heifers	Central	16,376	15,084
Heifers	Large1	Heifers	MidAtlantic	6,644	6,048
Heifers	Large1	Heifers	South	5,735	5,139
Heifers	Large1	Heifers	Pacific	5,959	5,500
Heifers	Large1	Heifers	MidWest	7,281	6,685
Heifers	Medium1	Heifers	Central	4,367	3,075
Heifers	Medium1	Heifers	MidAtlantic	1,772	1,176
Heifers	Medium1	Heifers	South	1,529	933
Heifers	Medium1	Heifers	Pacific	1,589	1,130
Heifers	Medium1	Heifers	MidWest	1,942	1,346
Heifers	Medium2	Heifers	Central	8,188	6,896
Heifers	Medium2	Heifers	MidAtlantic	3,322	2,726
Heifers	Medium2	Heifers	South	2,867	2,271
Heifers	Medium2	Heifers	Pacific	2,979	2,520
Heifers	Medium2	Heifers	MidWest	3,641	3,045

Table A-17 (Continued)

Animal	Size Class	Farm Type	Region	Category 1 Annual Cost	Category 2 Annual Cost
Veal	Medium1	Flush	Central	4,440	-
Veal	Medium1	Flush	MidAtlantic	4,440	-
Veal	Medium1	Flush	South	4,440	-
Veal	Medium1	Flush	Pacific	4,440	-
Veal	Medium1	Flush	MidWest	4,440	-
Veal	Medium2	Flush	Central	1,772	-
Veal	Medium2	Flush	MidAtlantic	1,772	-
Veal	Medium2	Flush	South	1,772	-
Veal	Medium2	Flush	Pacific	1,772	-
Veal	Medium2	Flush	MidWest	1,772	-

Table A-18

Facility Costs for Installation and Operation of Center Pivot Irrigation
N-Based Application

Animal	SizeClass	FarmType	Region	Category 1 Costs		Category 2 Costs	
				Capital	Annual	Capital	Annual
Beef	Large1	Beef	Central	90,958	9,836	67,450	6,883
Beef	Large1	Beef	MidAtlantic	94,169	10,061	66,909	6,753
Beef	Large1	Beef	South	106,450	10,765	70,164	7,456
Beef	Large1	Beef	Pacific	109,403	10,906	73,698	8,053
Beef	Large1	Beef	MidWest	117,220	11,244	72,944	7,936
Beef	Large2	Beef	Central	5,232,209	20,958	2,215,942	19,163
Beef	Large2	Beef	MidAtlantic	5,844,793	21,186	2,266,608	19,211
Beef	Large2	Beef	South	8,243,068	21,889	3,164,107	19,914
Beef	Large2	Beef	Pacific	8,829,320	22,029	3,786,350	20,288
Beef	Large2	Beef	MidWest	10,450,472	22,372	3,989,077	20,397
Beef	Medium1	Beef	Central	59,786	3,985	59,377	3,709
Beef	Medium1	Beef	MidAtlantic	60,203	4,244	59,704	3,931
Beef	Medium1	Beef	South	61,503	4,931	60,887	4,625
Beef	Medium1	Beef	Pacific	61,772	5,055	61,237	4,803
Beef	Medium1	Beef	MidWest	62,597	5,406	61,862	5,096
Beef	Medium2	Beef	Central	65,335	6,333	62,411	5,331
Beef	Medium2	Beef	MidAtlantic	66,165	6,562	62,690	5,443
Beef	Medium2	Beef	South	69,238	7,274	64,726	6,152
Beef	Medium2	Beef	Pacific	69,931	7,411	65,644	6,421
Beef	Medium2	Beef	MidWest	71,835	7,755	66,482	6,645
Dairy	Large1	Hose	Central	92,633	9,956	60,457	4,391
Dairy	Large1	Hose	MidAtlantic	109,603	10,916	60,457	4,391
Dairy	Large1	Hose	South	98,577	10,338	56,476	415
Dairy	Large1	Hose	Pacific	104,522	10,667	60,035	4,142
Dairy	Large1	Hose	MidWest	118,070	11,278	64,228	5,994
Dairy	Medium1	Hose	Central	58,278	2,812	57,315	1,746
Dairy	Medium1	Hose	MidAtlantic	59,540	3,822	58,126	2,666
Dairy	Medium1	Hose	South	58,741	3,221	57,387	1,839
Dairy	Medium1	Hose	Pacific	59,136	3,533	57,901	2,435
Dairy	Medium1	Hose	MidWest	60,119	4,193	58,663	3,156

Table A-18 (Continued)

Animal	SizeClass	FarmType	Region	Category 1 Costs		Category 2 Costs	
				Capital	Annual	Capital	Annual
Dairy	Medium2	Hose	Central	62,784	5,480	56,890	1,136
Dairy	Medium2	Hose	MidAtlantic	65,851	6,478	57,101	1,453
Dairy	Medium2	Hose	South	63,933	5,897	56,476	415
Dairy	Medium2	Hose	Pacific	64,928	6,213	56,960	1,245
Dairy	Medium2	Hose	MidWest	67,233	6,831	58,126	2,666
Heifers	Large1	Heifers	Central	60,887	4,625	60,457	4,391
Heifers	Large1	Heifers	MidAtlantic	62,504	5,369	61,772	5,055
Heifers	Large1	Heifers	South	61,237	4,803	60,542	4,439
Heifers	Large1	Heifers	Pacific	63,449	5,728	62,690	5,443
Heifers	Large1	Heifers	MidWest	63,449	5,728	62,690	5,443
Heifers	Medium1	Heifers	Central	56,476	415	56,476	415
Heifers	Medium1	Heifers	MidAtlantic	56,476	415	56,476	415
Heifers	Medium1	Heifers	South	56,476	415	56,476	415
Heifers	Medium1	Heifers	Pacific	56,544	545	56,476	415
Heifers	Medium1	Heifers	MidWest	56,544	545	56,476	415
Heifers	Medium2	Heifers	Central	57,460	1,930	57,030	1,350
Heifers	Medium2	Heifers	MidAtlantic	58,051	2,590	57,532	2,019
Heifers	Medium2	Heifers	South	57,532	2,019	56,960	1,245
Heifers	Medium2	Heifers	Pacific	58,431	2,953	57,901	2,435
Heifers	Medium2	Heifers	MidWest	58,508	3,022	57,901	2,435

TableA-19

FacilityCostsforInstallationandOperationofCenterPivotIrrigation
P-BasedApplication

				Category 1 Costs		Category 2 Costs	
Animal	SizeClass	FarmType	Region	Capital	Annual	Capital	Annual
Beef	Large1	Beef	Central	776,420	16,855	316,669	14,635
Beef	Large1	Beef	MidAtlantic	311,222	14,588	144,297	12,133
Beef	Large1	Beef	South	393,064	15,207	170,474	12,750
Beef	Large1	Beef	Pacific	307,898	14,559	155,125	12,409
Beef	Large1	Beef	MidWest	383,108	15,140	167,098	12,679
Beef	Large2	Beef	Central	171,615,632	27,981	69,190,160	26,171
Beef	Large2	Beef	MidAtlantic	55,044,868	25,715	20,379,386	23,723
Beef	Large2	Beef	South	75,020,000	26,333	27,714,600	24,341
Beef	Large2	Beef	Pacific	54,166,140	25,683	22,558,476	23,927
Beef	Large2	Beef	MidWest	72,473,784	26,264	26,783,932	24,272
Beef	Medium1	Beef	Central	111,820	11,016	106,450	10,765
Beef	Medium1	Beef	MidAtlantic	79,031	8,751	76,700	8,469
Beef	Medium1	Beef	South	85,202	9,372	82,191	9,088
Beef	Medium1	Beef	Pacific	78,752	8,719	76,700	8,469
Beef	Medium1	Beef	MidWest	84,437	9,303	81,604	9,029
Beef	Medium2	Beef	Central	205,259	13,368	164,596	12,625
Beef	Medium2	Beef	MidAtlantic	113,870	11,105	97,858	10,295
Beef	Medium2	Beef	South	130,306	11,717	109,403	10,906
Beef	Medium2	Beef	Pacific	113,046	11,070	98,758	10,349
Beef	Medium2	Beef	MidWest	128,235	11,649	108,016	10,841
Dairy	Large1	Hose	Central	365,922	15,021	77,512	8,571
Dairy	Large1	Hose	MidAtlantic	207,842	13,408	63,162	5,624
Dairy	Large1	Hose	South	174,186	12,825	56,476	415
Dairy	Large1	Hose	Pacific	153,280	12,365	60,800	4,579
Dairy	Large1	Hose	MidWest	233,791	13,770	71,472	7,693
Dairy	Medium1	Hose	Central	72,820	7,917	68,446	7,108
Dairy	Medium1	Hose	MidAtlantic	65,233	6,303	62,690	5,443
Dairy	Medium1	Hose	South	63,449	5,728	61,061	4,715
Dairy	Medium1	Hose	Pacific	62,227	5,254	60,457	4,391
Dairy	Medium1	Hose	MidWest	66,588	6,672	63,933	5,897

Table A-19 (Continued)

				Category 1 Costs		Category 2 Costs	
Animal	**SizeClass**	**FarmType**	**Region**	**Capital**	**Annual**	**Capital**	**Annual**
Dairy	Medium2	Hose	Central	102,628	10,567	65,748	6,449
Dairy	Medium2	Hose	MidAtlantic	80,879	8,954	60,372	4,343
Dairy	Medium2	Hose	South	75,900	8,365	57,532	2,019
Dairy	Medium2	Hose	Pacific	72,820	7,917	58,820	3,286
Dairy	Medium2	Hose	MidWest	84,589	9,317	62,597	5,406
Heifers	Large1	Heifers	Central	120,437	11,370	112,431	11,043
Heifers	Large1	Heifers	MidAtlantic	86,915	9,520	82,782	9,147
Heifers	Large1	Heifers	South	80,591	8,923	76,969	8,503
Heifers	Large1	Heifers	Pacific	82,044	9,074	79,031	8,751
Heifers	Large1	Heifers	MidWest	91,457	9,873	87,073	9,533
Heifers	Medium1	Heifers	Central	64,726	6,152	61,149	4,759
Heifers	Medium1	Heifers	MidAtlantic	60,287	4,294	58,126	2,666
Heifers	Medium1	Heifers	South	59,377	3,709	57,315	1,746
Heifers	Medium1	Heifers	Pacific	59,540	3,822	57,976	2,513
Heifers	Medium1	Heifers	MidWest	60,974	4,670	58,741	3,221
Heifers	Medium2	Heifers	Central	78,060	8,637	73,069	7,956
Heifers	Medium2	Heifers	MidAtlantic	67,017	6,779	64,228	5,994
Heifers	Medium2	Heifers	South	64,827	6,183	62,227	5,254
Heifers	Medium2	Heifers	Pacific	65,335	6,333	63,257	5,659
Heifers	Medium2	Heifers	MidWest	68,558	7,132	65,644	6,421

Table A-20

Costs for Contract Hauling
N-Based Application

Animal	SizeClass	FarmType	Region	EPAOption	Category2Costs		Category3Costs	
					Capital	Annual	Capital	Annual
Beef	Large1	Beef	Central	No composting	-	45,623	-	-
Beef	Large1	Beef	MidAtlantic	No composting	-	22,812	-	-
Beef	Large1	Beef	South	No composting	-	24,885	-	-
Beef	Large1	Beef	Pacific	No composting	-	51,845	-	-
Beef	Large1	Beef	MidWest	No composting	-	26,959	-	-
Beef	Large2	Beef	Central	No composting	-	396,351	-	-
Beef	Large2	Beef	MidAtlantic	No composting	-	198,176	-	-
Beef	Large2	Beef	South	No composting	-	216,192	-	-
Beef	Large2	Beef	Pacific	No composting	-	450,399	-	-
Beef	Large2	Beef	MidWest	No composting	-	234,208	-	-
Beef	Medium1	Beef	Central	No composting	-	191	-	-
Beef	Medium1	Beef	MidAtlantic	No composting	-	95	-	-
Beef	Medium1	Beef	South	No composting	-	104	-	-
Beef	Medium1	Beef	Pacific	No composting	-	217	-	-
Beef	Medium1	Beef	MidWest	No composting	-	113	-	-
Beef	Medium2	Beef	Central	No composting	-	2,264	-	-
Beef	Medium2	Beef	MidAtlantic	No composting	-	1,132	-	-
Beef	Medium2	Beef	South	No composting	-	1,235	-	-
Beef	Medium2	Beef	Pacific	No composting	-	2,573	-	-
Beef	Medium2	Beef	MidWest	No composting	-	1,338	-	-
Dairy	Large1	Flush	Central	No composting	-	100,997	-	-
Dairy	Large1	Flush	MidAtlantic	No composting	-	50,498	-	-
Dairy	Large1	Flush	South	No composting	-	55,089	-	-
Dairy	Large1	Flush	Pacific	No composting	-	114,769	-	-
Dairy	Large1	Flush	MidWest	No composting	-	59,680	-	-
Dairy	Medium1	Flush	Central	No composting	-	4,537	-	-
Dairy	Medium1	Flush	MidAtlantic	No composting	-	2,269	-	-
Dairy	Medium1	Flush	South	No composting	-	2,475	-	-
Dairy	Medium1	Flush	Pacific	No composting	-	5,156	-	-
Dairy	Medium1	Flush	MidWest	No composting	-	2,681	-	-

Table A-20 (Continued)

Animal	SizeClass	FarmType	Region	EPAOption	Category2Costs		Category3Costs	
					Capital	Annual	Capital	Annual
Dairy	Medium2	Flush	Central	No composting	-	28,813	-	-
Dairy	Medium2	Flush	MidAtlantic	No composting	-	14,407	-	-
Dairy	Medium2	Flush	South	No composting	-	15,716	-	-
Dairy	Medium2	Flush	Pacific	No composting	-	32,742	-	-
Dairy	Medium2	Flush	MidWest	No composting	-	17,026	-	-
Dairy	Large1	Hose	Central	No composting	-	77,074	-	-
Dairy	Large1	Hose	MidAtlantic	No composting	-	38,537	-	-
Dairy	Large1	Hose	South	No composting	-	42,040	-	-
Dairy	Large1	Hose	Pacific	No composting	-	87,584	-	-
Dairy	Large1	Hose	MidWest	No composting	-	45,544	-	-
Dairy	Medium1	Hose	Central	No composting	-	576	-	-
Dairy	Medium1	Hose	MidAtlantic	No composting	-	288	-	-
Dairy	Medium1	Hose	South	No composting	-	314	-	-
Dairy	Medium1	Hose	Pacific	No composting	-	654	-	-
Dairy	Medium1	Hose	MidWest	No composting	-	340	-	-
Dairy	Medium2	Hose	Central	No composting	-	21,058	-	-
Dairy	Medium2	Hose	MidAtlantic	No composting	-	10,529	-	-
Dairy	Medium2	Hose	South	No composting	-	11,486	-	-
Dairy	Medium2	Hose	Pacific	No composting	-	23,930	-	-
Dairy	Medium2	Hose	MidWest	No composting	-	12,443	-	-
Heifers	Large1	Heifers	Central	No composting	-	512	-	-
Heifers	Large1	Heifers	MidAtlantic	No composting	-	256	-	-
Heifers	Large1	Heifers	South	No composting	-	279	-	-
Heifers	Large1	Heifers	Pacific	No composting	-	582	-	-
Heifers	Large1	Heifers	MidWest	No composting	-	302	-	-
Heifers	Medium1	Heifers	Central	No composting	-	1,848	-	-
Heifers	Medium1	Heifers	MidAtlantic	No composting	-	924	-	-
Heifers	Medium1	Heifers	South	No composting	-	1,008	-	-
Heifers	Medium1	Heifers	Pacific	No composting	-	2,100	-	-
Heifers	Medium1	Heifers	MidWest	No composting	-	2,781	-	-
Heifers	Medium2	Heifers	Central	No composting	-	512	-	-
Heifers	Medium2	Heifers	MidAtlantic	No composting	-	256	-	-
Heifers	Medium2	Heifers	South	No composting	-	279	-	-
Heifers	Medium2	Heifers	Pacific	No composting	-	582	-	-

Table A-20 (Continued)

Animal	SizeClass	FarmType	Region	EPAOption	Category2Costs		Category3Costs	
					Capital	Annual	Capital	Annual
Heifers	Medium2	Heifers	MidWest	No composting	-	2,216	-	-
Veal	Medium1	Flush	Central	No composting	-	-	-	-
Veal	Medium1	Flush	MidAtlantic	No composting	-	-	-	-
Veal	Medium1	Flush	South	No composting	-	-	-	-
Veal	Medium1	Flush	Pacific	No composting	-	-	-	-
Veal	Medium1	Flush	MidWest	No composting	-	-	-	-
Veal	Medium2	Flush	Central	No composting	-	-	-	-
Veal	Medium2	Flush	MidAtlantic	No composting	-	-	-	-
Veal	Medium2	Flush	South	No composting	-	-	-	-
Veal	Medium2	Flush	Pacific	No composting	-	-	-	-
Veal	Medium2	Flush	MidWest	No composting	-	-	-	-
Beef	Large1	Beef	Central	Composting	-	45,457	-	-
Beef	Large1	Beef	MidAtlantic	Composting	-	22,729	-	-
Beef	Large1	Beef	South	Composting	-	24,795	-	-
Beef	Large1	Beef	Pacific	Composting	-	51,656	-	-
Beef	Large1	Beef	MidWest	Composting	-	26,861	-	-
Beef	Large2	Beef	Central	Composting	-	393,583	-	-
Beef	Large2	Beef	MidAtlantic	Composting	-	196,792	-	-
Beef	Large2	Beef	South	Composting	-	214,682	-	-
Beef	Large2	Beef	Pacific	Composting	-	447,254	-	-
Beef	Large2	Beef	MidWest	Composting	-	232,572	-	-
Beef	Medium1	Beef	Central	Composting	-	178	-	-
Beef	Medium1	Beef	MidAtlantic	Composting	-	89	-	-
Beef	Medium1	Beef	South	Composting	-	97	-	-
Beef	Medium1	Beef	Pacific	Composting	-	202	-	-
Beef	Medium1	Beef	MidWest	Composting	-	105	-	-
Beef	Medium2	Beef	Central	Composting	-	2,195	-	-
Beef	Medium2	Beef	MidAtlantic	Composting	-	1,098	-	-
Beef	Medium2	Beef	South	Composting	-	1,197	-	-
Beef	Medium2	Beef	Pacific	Composting	-	2,494	-	-
Beef	Medium2	Beef	MidWest	Composting	-	1,297	-	-
Dairy	Large1	Flush	Central	Composting	-	100,957	-	-
Dairy	Large1	Flush	MidAtlantic	Composting	-	50,479	-	-
Dairy	Large1	Flush	South	Composting	-	55,068	-	-

Table A-20 (Continued)

Animal	SizeClass	FarmType	Region	EPAOption	Category2Costs		Category3Costs	
					Capital	Annual	Capital	Annual
Dairy	Large1	Flush	Pacific	Composting	-	114,724	-	-
Dairy	Large1	Flush	MidWest	Composting	-	59,657	-	-
Dairy	Medium1	Flush	Central	Composting	-	4,531	-	-
Dairy	Medium1	Flush	MidAtlantic	Composting	-	2,265	-	-
Dairy	Medium1	Flush	South	Composting	-	2,471	-	-
Dairy	Medium1	Flush	Pacific	Composting	-	5,149	-	-
Dairy	Medium1	Flush	MidWest	Composting	-	2,677	-	-
Dairy	Medium2	Flush	Central	Composting	-	28,800	-	-
Dairy	Medium2	Flush	MidAtlantic	Composting	-	14,400	-	-
Dairy	Medium2	Flush	South	Composting	-	15,709	-	-
Dairy	Medium2	Flush	Pacific	Composting	-	32,728	-	-
Dairy	Medium2	Flush	MidWest	Composting	-	17,018	-	-
Dairy	Large1	Hose	Central	Composting	-	76,878	-	-
Dairy	Large1	Hose	MidAtlantic	Composting	-	38,439	-	-
Dairy	Large1	Hose	South	Composting	-	41,933	-	-
Dairy	Large1	Hose	Pacific	Composting	-	87,361	-	-
Dairy	Large1	Hose	MidWest	Composting	-	45,428	-	-
Dairy	Medium1	Hose	Central	Composting	-	543	-	-
Dairy	Medium1	Hose	MidAtlantic	Composting	-	272	-	-
Dairy	Medium1	Hose	South	Composting	-	296	-	-
Dairy	Medium1	Hose	Pacific	Composting	-	617	-	-
Dairy	Medium1	Hose	MidWest	Composting	-	321	-	-
Dairy	Medium2	Hose	Central	Composting	-	20,995	-	-
Dairy	Medium2	Hose	MidAtlantic	Composting	-	10,497	-	-
Dairy	Medium2	Hose	South	Composting	-	11,452	-	-
Dairy	Medium2	Hose	Pacific	Composting	-	23,857	-	-
Dairy	Medium2	Hose	MidWest	Composting	-	12,406	-	-
Heifers	Large1	Heifers	Central	Composting	-	478	-	-
Heifers	Large1	Heifers	MidAtlantic	Composting	-	239	-	-
Heifers	Large1	Heifers	South	Composting	-	261	-	-
Heifers	Large1	Heifers	Pacific	Composting	-	543	-	-
Heifers	Large1	Heifers	MidWest	Composting	-	282	-	-
Heifers	Medium1	Heifers	Central	Composting	-	1,823	-	-
Heifers	Medium1	Heifers	MidAtlantic	Composting	-	911	-	-

Table A-20 (Continued)

Animal	SizeClass	FarmType	Region	EPAOption	Category2Costs		Category3Costs	
					Capital	Annual	Capital	Annual
Heifers	Medium1	Heifers	South	Composting	-	994	-	-
Heifers	Medium1	Heifers	Pacific	Composting	-	2,071	-	-
Heifers	Medium1	Heifers	MidWest	Composting	-	2,777	-	-
Heifers	Medium2	Heifers	Central	Composting	-	478	-	-
Heifers	Medium2	Heifers	MidAtlantic	Composting	-	239	-	-
Heifers	Medium2	Heifers	South	Composting	-	261	-	-
Heifers	Medium2	Heifers	Pacific	Composting	-	543	-	-
Heifers	Medium2	Heifers	MidWest	Composting	-	2,209	-	-
Veal	Medium1	Flush	Central	Composting	-	-	-	-
Veal	Medium1	Flush	MidAtlantic	Composting	-	-	-	-
Veal	Medium1	Flush	South	Composting	-	-	-	-
Veal	Medium1	Flush	Pacific	Composting	-	-	-	-
Veal	Medium1	Flush	MidWest	Composting	-	-	-	-
Veal	Medium2	Flush	Central	Composting	-	-	-	-
Veal	Medium2	Flush	MidAtlantic	Composting	-	-	-	-
Veal	Medium2	Flush	South	Composting	-	-	-	-
Veal	Medium2	Flush	Pacific	Composting	-	-	-	-
Veal	Medium2	Flush	MidWest	Composting	-	-	-	-

Table A-21

Costs for Contract Hauling
P-Based Application

Animal	Size Class	Farm Type	Region	EPA Option	Category 2 Costs		Category 3 Costs	
					Capital	Annual	Capital	Annual
Beef	Large1	Beef	Central	Composting	232,520	17,367	0	0
Beef	Large1	Beef	MidAtlantic	Composting	232,520	11,075	0	0
Beef	Large1	Beef	South	Composting	232,520	11,647	0	0
Beef	Large1	Beef	Pacific	Composting	232,520	19,083	0	0
Beef	Large1	Beef	MidWest	Composting	232,520	12,219	0	0
Beef	Large2	Beef	Central	Composting	627,728	134,312	0	0
Beef	Large2	Beef	MidAtlantic	Composting	648,498	92,488	0	0
Beef	Large2	Beef	South	Composting	648,498	97,372	0	0
Beef	Large2	Beef	Pacific	Composting	648,497	147,895	0	0
Beef	Large2	Beef	MidWest	Composting	648,498	102,256	0	0
Beef	Medium1	Beef	Central	Composting	91,728	306	0	0
Beef	Medium1	Beef	MidAtlantic	Composting	91,728	201	0	0
Beef	Medium1	Beef	South	Composting	91,728	211	0	0
Beef	Medium1	Beef	Pacific	Composting	91,728	335	0	0
Beef	Medium1	Beef	MidWest	Composting	91,728	220	0	0
Beef	Medium2	Beef	Central	Composting	175,990	2,457	0	0
Beef	Medium2	Beef	MidAtlantic	Composting	175,990	1,609	0	0
Beef	Medium2	Beef	South	Composting	175,990	1,686	0	0
Beef	Medium2	Beef	Pacific	Composting	175,990	2,689	0	0
Beef	Medium2	Beef	MidWest	Composting	175,990	1,763	0	0
Dairy	Large1	Flush	Central	Composting	373,312	32,363	0	0
Dairy	Large1	Flush	MidAtlantic	Composting	373,312	20,486	0	0
Dairy	Large1	Flush	South	Composting	373,312	21,565	0	0
Dairy	Large1	Flush	Pacific	Composting	373,312	35,603	0	0
Dairy	Large1	Flush	MidWest	Composting	373,312	22,645	0	0
Dairy	Medium1	Flush	Central	Composting	175,990	3,210	0	0
Dairy	Medium1	Flush	MidAtlantic	Composting	175,990	2,089	0	0
Dairy	Medium1	Flush	South	Composting	175,990	2,191	0	0
Dairy	Medium1	Flush	Pacific	Composting	175,990	3,515	0	0
Dairy	Medium1	Flush	MidWest	Composting	175,990	2,293	0	0

Table A-21 (Continued)

Animal	Size Class	Farm Type	Region	EPA Option	Category 2 Costs		Category 3 Costs	
					Capital	Annual	Capital	Annual
Dairy	Medium2	Flush	Central	Composting	204,789	13,781	0	0
Dairy	Medium2	Flush	MidAtlantic	Composting	204,789	8,835	0	0
Dairy	Medium2	Flush	South	Composting	204,789	9,284	0	0
Dairy	Medium2	Flush	Pacific	Composting	232,520	10,215	0	0
Dairy	Medium2	Flush	MidWest	Composting	204,789	9,734	0	0
Dairy	Large1	Hose	Central	Composting	373,312	27,787	0	0
Dairy	Large1	Hose	MidAtlantic	Composting	317,850	25,366	0	0
Dairy	Large1	Hose	South	Composting	373,312	18,600	0	0
Dairy	Large1	Hose	Pacific	Composting	373,312	30,543	0	0
Dairy	Large1	Hose	MidWest	Composting	373,312	19,519	0	0
Dairy	Medium1	Hose	Central	Composting	175,990	845	0	0
Dairy	Medium1	Hose	MidAtlantic	Composting	175,990	554	0	0
Dairy	Medium1	Hose	South	Composting	175,990	581	0	0
Dairy	Medium1	Hose	Pacific	Composting	175,990	924	0	0
Dairy	Medium1	Hose	MidWest	Composting	175,990	607	0	0
Dairy	Medium2	Hose	Central	Composting	204,789	10,946	0	0
Dairy	Medium2	Hose	MidAtlantic	Composting	175,990	9,962	0	0
Dairy	Medium2	Hose	South	Composting	175,990	10,447	0	0
Dairy	Medium2	Hose	Pacific	Composting	204,789	12,012	0	0
Dairy	Medium2	Hose	MidWest	Composting	175,990	10,933	0	0
Heifers	Large1	Heifers	Central	Composting	91,728	791	0	0
Heifers	Large1	Heifers	MidAtlantic	Composting	91,728	519	0	0
Heifers	Large1	Heifers	South	Composting	91,728	544	0	0
Heifers	Large1	Heifers	Pacific	Composting	91,728	865	0	0
Heifers	Large1	Heifers	MidWest	Composting	91,728	569	0	0
Heifers	Medium1	Heifers	Central	Composting	175,990	1,597	0	0
Heifers	Medium1	Heifers	MidAtlantic	Composting	175,990	1,042	0	0
Heifers	Medium1	Heifers	South	Composting	175,990	1,093	0	0
Heifers	Medium1	Heifers	Pacific	Composting	175,990	1,748	0	0
Heifers	Medium1	Heifers	MidWest	Composting	175,990	2,387	0	0
Heifers	Medium2	Heifers	Central	Composting	91,728	791	0	0
Heifers	Medium2	Heifers	MidAtlantic	Composting	91,728	519	0	0
Heifers	Medium2	Heifers	South	Composting	91,728	544	0	0
Heifers	Medium2	Heifers	Pacific	Composting	91,728	865	0	0

Table A-21 (Continued)

Animal	Size Class	Farm Type	Region	EPA Option	Category 2 Costs		Category 3 Costs	
					Capital	Annual	Capital	Annual
Heifers	Medium2	Heifers	MidWest	Composting	175,990	1,985	0	0
Veal	Medium1	Flush	Central	Composting	-	-	0	0
Veal	Medium1	Flush	MidAtlantic	Composting	-	-	0	0
Veal	Medium1	Flush	South	Composting	-	-	0	0
Veal	Medium1	Flush	Pacific	Composting	-	-	0	0
Veal	Medium1	Flush	MidWest	Composting	-	-	0	0
Veal	Medium2	Flush	Central	Composting	-	-	0	0
Veal	Medium2	Flush	MidAtlantic	Composting	-	-	0	0
Veal	Medium2	Flush	South	Composting	-	-	0	0
Veal	Medium2	Flush	Pacific	Composting	-	-	0	0
Veal	Medium2	Flush	MidWest	Composting	-	-	0	0
Beef	Large1	Beef	Central	No composting	232,520	17,647	0	0
Beef	Large1	Beef	MidAtlantic	No composting	232,520	11,260	0	0
Beef	Large1	Beef	South	No composting	232,520	11,840	0	0
Beef	Large1	Beef	Pacific	No composting	232,520	19,389	0	0
Beef	Large1	Beef	MidWest	No composting	232,520	12,421	0	0
Beef	Large2	Beef	Central	No composting	652,376	135,971	0	0
Beef	Large2	Beef	MidAtlantic	No composting	648,498	94,083	0	0
Beef	Large2	Beef	South	No composting	578,218	90,273	0	0
Beef	Large2	Beef	Pacific	No composting	674,624	149,728	0	0
Beef	Large2	Beef	MidWest	No composting	585,634	94,843	0	0
Beef	Medium1	Beef	Central	No composting	91,728	332	0	0
Beef	Medium1	Beef	MidAtlantic	No composting	91,728	218	0	0
Beef	Medium1	Beef	South	No composting	91,728	228	0	0
Beef	Medium1	Beef	Pacific	No composting	91,728	363	0	0
Beef	Medium1	Beef	MidWest	no	91,728	238	0	0
Beef	Medium2	Beef	Central	No composting	175,990	2,559	0	0
Beef	Medium2	Beef	MidAtlantic	No composting	175,990	1,676	0	0
Beef	Medium2	Beef	South	No composting	175,990	1,756	0	0
Beef	Medium2	Beef	Pacific	No composting	175,990	2,800	0	0
Beef	Medium2	Beef	MidWest	No composting	175,990	1,836	0	0
Dairy	Large1	Flush	Central	No composting	373,312	32,440	0	0
Dairy	Large1	Flush	MidAtlantic	No composting	373,312	20,536	0	0
Dairy	Large1	Flush	South	No composting	373,312	21,618	0	0

Table A-21 (Continued)

Animal	Size Class	Farm Type	Region	EPA Option	Category 2 Costs		Category 3 Costs	
					Capital	Annual	Capital	Annual
Dairy	Large1	Flush	Pacific	No composting	373,312	35,686	0	0
Dairy	Large1	Flush	MidWest	No composting	373,312	22,700	0	0
Dairy	Medium1	Flush	Central	No composting	175,990	3,235	0	0
Dairy	Medium1	Flush	MidAtlantic	No composting	175,990	2,106	0	0
Dairy	Medium1	Flush	South	No composting	175,990	2,208	0	0
Dairy	Medium1	Flush	Pacific	No composting	175,990	3,543	0	0
Dairy	Medium1	Flush	MidWest	No composting	175,990	2,311	0	0
Dairy	Medium2	Flush	Central	No composting	204,789	13,807	0	0
Dairy	Medium2	Flush	MidAtlantic	No composting	204,789	8,851	0	0
Dairy	Medium2	Flush	South	No composting	204,789	9,302	0	0
Dairy	Medium2	Flush	Pacific	No composting	232,520	10,243	0	0
Dairy	Medium2	Flush	MidWest	No composting	204,789	9,752	0	0
Dairy	Large1	Hose	Central	No composting	373,312	28,093	0	0
Dairy	Large1	Hose	MidAtlantic	No composting	317,850	25,567	0	0
Dairy	Large1	Hose	South	No composting	373,312	18,811	0	0
Dairy	Large1	Hose	Pacific	No composting	373,312	30,877	0	0
Dairy	Large1	Hose	MidWest	No composting	373,312	19,739	0	0
Dairy	Medium1	Hose	Central	No composting	175,990	896	0	0
Dairy	Medium1	Hose	MidAtlantic	No composting	175,990	588	0	0
Dairy	Medium1	Hose	South	No composting	175,990	616	0	0
Dairy	Medium1	Hose	Pacific	No composting	175,990	980	0	0
Dairy	Medium1	Hose	MidWest	No composting	175,990	644	0	0
Dairy	Medium2	Hose	Central	No composting	204,789	11,048	0	0
Dairy	Medium2	Hose	MidAtlantic	No composting	175,990	10,029	0	0
Dairy	Medium2	Hose	South	No composting	175,990	10,517	0	0
Dairy	Medium2	Hose	Pacific	No composting	204,789	12,124	0	0
Dairy	Medium2	Hose	MidWest	No composting	175,990	11,006	0	0
Heifers	Large1	Heifers	Central	No composting	91,728	867	0	0
Heifers	Large1	Heifers	MidAtlantic	No composting	91,728	570	0	0
Heifers	Large1	Heifers	South	No composting	91,728	597	0	0
Heifers	Large1	Heifers	Pacific	No composting	91,728	948	0	0
Heifers	Large1	Heifers	MidWest	No composting	91,728	624	0	0
Heifers	Medium1	Heifers	Central	No composting	175,990	1,648	0	0
Heifers	Medium1	Heifers	MidAtlantic	No composting	175,990	1,076	0	0

Table A-21 (Continued)

Animal	Size Class	Farm Type	Region	EPA Option	Category 2 Costs		Category 3 Costs	
					Capital	Annual	Capital	Annual
Heifers	Medium1	Heifers	South	No composting	175,990	1,128	0	0
Heifers	Medium1	Heifers	Pacific	No composting	175,990	1,804	0	0
Heifers	Medium1	Heifers	MidWest	No composting	175,990	2,406	0	0
Heifers	Medium2	Heifers	Central	No composting	91,728	867	0	0
Heifers	Medium2	Heifers	MidAtlantic	No composting	91,728	570	0	0
Heifers	Medium2	Heifers	South	No composting	91,728	597	0	0
Heifers	Medium2	Heifers	Pacific	No composting	91,728	948	0	0
Heifers	Medium2	Heifers	MidWest	No composting	175,990	2,003	0	0
Veal	Medium1	Flush	Central	No composting	-	-	0	0
Veal	Medium1	Flush	MidAtlantic	No composting	-	-	0	0
Veal	Medium1	Flush	South	No composting	-	-	0	0
Veal	Medium1	Flush	Pacific	No composting	-	-	0	0
Veal	Medium1	Flush	MidWest	No composting	-	-	0	0
Veal	Medium2	Flush	Central	No composting	-	-	0	0
Veal	Medium2	Flush	MidAtlantic	No composting	-	-	0	0
Veal	Medium2	Flush	South	No composting	-	-	0	0
Veal	Medium2	Flush	Pacific	No composting	-	-	0	0
Veal	Medium2	Flush	MidWest	No composting	-	-	0	0

Table A-22

Costs for Purchase-Truck Transportation
N-Based Application

Animal	Size Class	Farm Type	Region	EPA Option	Category 2 Costs		Category 3 Costs	
					Capital	Annual	Capital	Annual
Beef	Large1	Beef	Central	Composting	232,520	17,367	0	0
Beef	Large1	Beef	MidAtlantic	Composting	232,520	11,075	0	0
Beef	Large1	Beef	South	Composting	232,520	11,647	0	0
Beef	Large1	Beef	Pacific	Composting	232,520	19,083	0	0
Beef	Large1	Beef	MidWest	Composting	232,520	12,219	0	0
Beef	Large2	Beef	Central	Composting	627,728	134,312	0	0
Beef	Large2	Beef	MidAtlantic	Composting	648,498	92,488	0	0
Beef	Large2	Beef	South	Composting	648,498	97,372	0	0
Beef	Large2	Beef	Pacific	Composting	648,497	147,895	0	0
Beef	Large2	Beef	MidWest	Composting	648,498	102,256	0	0
Beef	Medium1	Beef	Central	Composting	91,728	306	0	0
Beef	Medium1	Beef	MidAtlantic	Composting	91,728	201	0	0
Beef	Medium1	Beef	South	Composting	91,728	211	0	0
Beef	Medium1	Beef	Pacific	Composting	91,728	335	0	0
Beef	Medium1	Beef	MidWest	Composting	91,728	220	0	0
Beef	Medium2	Beef	Central	Composting	175,990	2,457	0	0
Beef	Medium2	Beef	MidAtlantic	Composting	175,990	1,609	0	0
Beef	Medium2	Beef	South	Composting	175,990	1,686	0	0
Beef	Medium2	Beef	Pacific	Composting	175,990	2,689	0	0
Beef	Medium2	Beef	MidWest	Composting	175,990	1,763	0	0
Dairy	Large1	Flush	Central	Composting	373,312	32,363	0	0
Dairy	Large1	Flush	MidAtlantic	Composting	373,312	20,486	0	0
Dairy	Large1	Flush	South	Composting	373,312	21,565	0	0
Dairy	Large1	Flush	Pacific	Composting	373,312	35,603	0	0
Dairy	Large1	Flush	MidWest	Composting	373,312	22,645	0	0
Dairy	Medium1	Flush	Central	Composting	175,990	3,210	0	0
Dairy	Medium1	Flush	MidAtlantic	Composting	175,990	2,089	0	0
Dairy	Medium1	Flush	South	Composting	175,990	2,191	0	0
Dairy	Medium1	Flush	Pacific	Composting	175,990	3,515	0	0
Dairy	Medium1	Flush	MidWest	Composting	175,990	2,293	0	0

Table A-22 (Continued)

Animal	Size Class	Farm Type	Region	EPA Option	Category 2 Costs		Category 3 Costs	
					Capital	Annual	Capital	Annual
Dairy	Medium2	Flush	Central	Composting	204,789	13,781	0	0
Dairy	Medium2	Flush	MidAtlantic	Composting	204,789	8,835	0	0
Dairy	Medium2	Flush	South	Composting	204,789	9,284	0	0
Dairy	Medium2	Flush	Pacific	Composting	232,520	10,215	0	0
Dairy	Medium2	Flush	MidWest	Composting	204,789	9,734	0	0
Dairy	Large1	Hose	Central	Composting	373,312	27,787	0	0
Dairy	Large1	Hose	MidAtlantic	Composting	317,850	25,366	0	0
Dairy	Large1	Hose	South	Composting	373,312	18,600	0	0
Dairy	Large1	Hose	Pacific	Composting	373,312	30,543	0	0
Dairy	Large1	Hose	MidWest	Composting	373,312	19,519	0	0
Dairy	Medium1	Hose	Central	Composting	175,990	845	0	0
Dairy	Medium1	Hose	MidAtlantic	Composting	175,990	554	0	0
Dairy	Medium1	Hose	South	Composting	175,990	581	0	0
Dairy	Medium1	Hose	Pacific	Composting	175,990	924	0	0
Dairy	Medium1	Hose	MidWest	Composting	175,990	607	0	0
Dairy	Medium2	Hose	Central	Composting	204,789	10,946	0	0
Dairy	Medium2	Hose	MidAtlantic	Composting	175,990	9,962	0	0
Dairy	Medium2	Hose	South	Composting	175,990	10,447	0	0
Dairy	Medium2	Hose	Pacific	Composting	204,789	12,012	0	0
Dairy	Medium2	Hose	MidWest	Composting	175,990	10,933	0	0
Heifers	Large1	Heifers	Central	Composting	91,728	791	0	0
Heifers	Large1	Heifers	MidAtlantic	Composting	91,728	519	0	0
Heifers	Large1	Heifers	South	Composting	91,728	544	0	0
Heifers	Large1	Heifers	Pacific	Composting	91,728	865	0	0
Heifers	Large1	Heifers	MidWest	Composting	91,728	569	0	0
Heifers	Medium1	Heifers	Central	Composting	175,990	1,597	0	0
Heifers	Medium1	Heifers	MidAtlantic	Composting	175,990	1,042	0	0
Heifers	Medium1	Heifers	South	Composting	175,990	1,093	0	0
Heifers	Medium1	Heifers	Pacific	Composting	175,990	1,748	0	0
Heifers	Medium1	Heifers	MidWest	Composting	175,990	2,387	0	0
Heifers	Medium2	Heifers	Central	Composting	91,728	791	0	0
Heifers	Medium2	Heifers	MidAtlantic	Composting	91,728	519	0	0
Heifers	Medium2	Heifers	South	Composting	91,728	544	0	0
Heifers	Medium2	Heifers	Pacific	Composting	91,728	865	0	0

Table A-22 (Continued)

Animal	Size Class	Farm Type	Region	EPA Option	Category 2 Costs		Category 3 Costs	
					Capital	Annual	Capital	Annual
Heifers	Medium2	Heifers	MidWest	Composting	175,990	1,985	0	0
Veal	Medium1	Flush	Central	Composting	-	-	0	0
Veal	Medium1	Flush	MidAtlantic	Composting	-	-	0	0
Veal	Medium1	Flush	South	Composting	-	-	0	0
Veal	Medium1	Flush	Pacific	Composting	-	-	0	0
Veal	Medium1	Flush	MidWest	Composting	-	-	0	0
Veal	Medium2	Flush	Central	Composting	-	-	0	0
Veal	Medium2	Flush	MidAtlantic	Composting	-	-	0	0
Veal	Medium2	Flush	South	Composting	-	-	0	0
Veal	Medium2	Flush	Pacific	Composting	-	-	0	0
Veal	Medium2	Flush	MidWest	Composting	-	-	0	0
Beef	Large1	Beef	Central	No composting	232,520	17,647	0	0
Beef	Large1	Beef	MidAtlantic	No composting	232,520	11,260	0	0
Beef	Large1	Beef	South	No composting	232,520	11,840	0	0
Beef	Large1	Beef	Pacific	No composting	232,520	19,389	0	0
Beef	Large1	Beef	MidWest	No composting	232,520	12,421	0	0
Beef	Large2	Beef	Central	No composting	652,376	135,971	0	0
Beef	Large2	Beef	MidAtlantic	No composting	648,498	94,083	0	0
Beef	Large2	Beef	South	No composting	578,218	90,273	0	0
Beef	Large2	Beef	Pacific	No composting	674,624	149,728	0	0
Beef	Large2	Beef	MidWest	No composting	585,634	94,843	0	0
Beef	Medium1	Beef	Central	No composting	91,728	332	0	0
Beef	Medium1	Beef	MidAtlantic	No composting	91,728	218	0	0
Beef	Medium1	Beef	South	No composting	91,728	228	0	0
Beef	Medium1	Beef	Pacific	No composting	91,728	363	0	0
Beef	Medium1	Beef	MidWest	No composting	91,728	238	0	0
Beef	Medium2	Beef	Central	No composting	175,990	2,559	0	0
Beef	Medium2	Beef	MidAtlantic	No composting	175,990	1,676	0	0
Beef	Medium2	Beef	South	No composting	175,990	1,756	0	0
Beef	Medium2	Beef	Pacific	No composting	175,990	2,800	0	0
Beef	Medium2	Beef	MidWest	No composting	175,990	1,836	0	0
Dairy	Large1	Flush	Central	No composting	373,312	32,440	0	0
Dairy	Large1	Flush	MidAtlantic	No composting	373,312	20,536	0	0
Dairy	Large1	Flush	South	No composting	373,312	21,618	0	0

Table A-22 (Continued)

Animal	Size Class	Farm Type	Region	EPA Option	Category 2 Costs		Category 3 Costs	
					Capital	Annual	Capital	Annual
Dairy	Large1	Flush	Pacific	No composting	373,312	35,686	0	0
Dairy	Large1	Flush	MidWest	No composting	373,312	22,700	0	0
Dairy	Medium1	Flush	Central	No composting	175,990	3,235	0	0
Dairy	Medium1	Flush	MidAtlantic	No composting	175,990	2,106	0	0
Dairy	Medium1	Flush	South	No composting	175,990	2,208	0	0
Dairy	Medium1	Flush	Pacific	No composting	175,990	3,543	0	0
Dairy	Medium1	Flush	MidWest	No composting	175,990	2,311	0	0
Dairy	Medium2	Flush	Central	No composting	204,789	13,807	0	0
Dairy	Medium2	Flush	MidAtlantic	No composting	204,789	8,851	0	0
Dairy	Medium2	Flush	South	No composting	204,789	9,302	0	0
Dairy	Medium2	Flush	Pacific	No composting	232,520	10,243	0	0
Dairy	Medium2	Flush	MidWest	No composting	204,789	9,752	0	0
Dairy	Large1	Hose	Central	No composting	373,312	28,093	0	0
Dairy	Large1	Hose	MidAtlantic	No composting	317,850	25,567	0	0
Dairy	Large1	Hose	South	No composting	373,312	18,811	0	0
Dairy	Large1	Hose	Pacific	No composting	373,312	30,877	0	0
Dairy	Large1	Hose	MidWest	No composting	373,312	19,739	0	0
Dairy	Medium1	Hose	Central	No composting	175,990	896	0	0
Dairy	Medium1	Hose	MidAtlantic	No composting	175,990	588	0	0
Dairy	Medium1	Hose	South	No composting	175,990	616	0	0
Dairy	Medium1	Hose	Pacific	No composting	175,990	980	0	0
Dairy	Medium1	Hose	MidWest	No composting	175,990	644	0	0
Dairy	Medium2	Hose	Central	No composting	204,789	11,048	0	0
Dairy	Medium2	Hose	MidAtlantic	No composting	175,990	10,029	0	0
Dairy	Medium2	Hose	South	No composting	175,990	10,517	0	0
Dairy	Medium2	Hose	Pacific	No composting	204,789	12,124	0	0
Dairy	Medium2	Hose	MidWest	No composting	175,990	11,006	0	0
Heifers	Large1	Heifers	Central	No composting	91,728	867	0	0
Heifers	Large1	Heifers	MidAtlantic	No composting	91,728	570	0	0
Heifers	Large1	Heifers	South	No composting	91,728	597	0	0
Heifers	Large1	Heifers	Pacific	No composting	91,728	948	0	0
Heifers	Large1	Heifers	MidWest	No composting	91,728	624	0	0
Heifers	Medium1	Heifers	Central	No composting	175,990	1,648	0	0
Heifers	Medium1	Heifers	MidAtlantic	No composting	175,990	1,076	0	0

Table A-22 (Continued)

Animal	Size Class	Farm Type	Region	EPA Option	Category 2 Costs		Category 3 Costs	
					Capital	Annual	Capital	Annual
Heifers	Medium1	Heifers	South	No composting	175,990	1,128	0	0
Heifers	Medium1	Heifers	Pacific	No composting	175,990	1,804	0	0
Heifers	Medium1	Heifers	MidWest	No composting	175,990	2,406	0	0
Heifers	Medium2	Heifers	Central	No composting	91,728	867	0	0
Heifers	Medium2	Heifers	MidAtlantic	No composting	91,728	570	0	0
Heifers	Medium2	Heifers	South	No composting	91,728	597	0	0
Heifers	Medium2	Heifers	Pacific	No composting	91,728	948	0	0
Heifers	Medium2	Heifers	MidWest	No composting	175,990	2,003	0	0
Veal	Medium1	Flush	Central	No composting	-	-	0	0
Veal	Medium1	Flush	MidAtlantic	No composting	-	-	0	0
Veal	Medium1	Flush	South	No composting	-	-	0	0
Veal	Medium1	Flush	Pacific	No composting	-	-	0	0
Veal	Medium1	Flush	MidWest	No composting	-	-	0	0
Veal	Medium2	Flush	Central	No composting	-	-	0	0
Veal	Medium2	Flush	MidAtlantic	No composting	-	-	0	0
Veal	Medium2	Flush	South	No composting	-	-	0	0
Veal	Medium2	Flush	Pacific	No composting	-	-	0	0
Veal	Medium2	Flush	MidWest	No composting	-	-	0	0

Table A-23

Costs for Purchase Truck Transportation
P-Based Application

Animal	Size Class	Farm Type	Region	EPA Option	Category 2 Costs		Category 3 Costs	
					Capital	Annual	Capital	Annual
Beef	Large1	Beef	Central	Composting	34,878	2,705	55,997	3,304
Beef	Large1	Beef	MidAtlantic	Composting	63,570	8,146	74,662	40,053
Beef	Large1	Beef	South	Composting	232,520	16,296	373,312	102,015
Beef	Large1	Beef	Pacific	Composting	232,520	22,379	373,312	96,722
Beef	Large1	Beef	MidWest	Composting	18,431	1,516	33,598	2,515
Beef	Large1	Beef	Central	Composting	34,878	2,705	55,997	3,304
Beef	Large1	Beef	MidAtlantic	Composting	63,570	8,146	74,662	40,053
Beef	Large1	Beef	South	Composting	232,520	16,296	373,312	102,015
Beef	Large1	Beef	Pacific	Composting	232,520	22,379	373,312	96,722
Beef	Large1	Beef	MidWest	Composting	18,431	1,516	33,598	2,515
Beef	Large2	Beef	Central	Composting	105,582	27,947	97,275	52,054
Beef	Large2	Beef	MidAtlantic	Composting	179,544	62,880	164,314	652,673
Beef	Large2	Beef	South	Composting	676,188	168,011	593,114	1,665,249
Beef	Large2	Beef	Pacific	Composting	773,109	232,096	600,037	1,575,580
Beef	Large2	Beef	MidWest	Composting	55,249	11,420	58,365	40,398
Beef	Medium1	Beef	Central	Composting	91,728	377	175,990	10,649
Beef	Medium1	Beef	MidAtlantic	Composting	72,465	491	294,917	36,189
Beef	Medium1	Beef	South	Composting	91,728	342	373,312	23,317
Beef	Medium1	Beef	Pacific	Composting	91,728	464	373,312	22,102
Beef	Medium1	Beef	MidWest	Composting	91,728	263	204,789	9,566
Beef	Medium2	Beef	Central	Composting	175,990	2,642	232,520	9,123
Beef	Medium2	Beef	MidAtlantic	Composting	139,032	3,451	294,917	65,547
Beef	Medium2	Beef	South	Composting	175,990	2,396	373,312	42,252
Beef	Medium2	Beef	Pacific	Composting	175,990	3,259	373,312	40,067
Beef	Medium2	Beef	MidWest	Composting	175,990	1,841	317,850	17,356
Dairy	Large1	Flush	Central	Composting	175,457	23,009	175,457	48,445
Dairy	Large1	Flush	MidAtlantic	Composting	257,585	56,867	257,585	240,132
Dairy	Large1	Flush	South	Composting	186,656	22,088	186,656	76,790
Dairy	Large1	Flush	Pacific	Composting	373,312	60,905	373,312	157,437
Dairy	Large1	Flush	MidWest	Composting	115,727	10,360	115,727	25,995

Table A-23 (Continued)

Animal	Size Class	Farm Type	Region	EPA Option	Category 2 Costs		Category 3 Costs	
					Capital	Annual	Capital	Annual
Dairy	Medium1	Flush	Central	Composting	175,990	3,326	373,312	20,786
Dairy	Medium1	Flush	MidAtlantic	Composting	146,072	4,579	309,849	57,276
Dairy	Medium1	Flush	South	Composting	175,990	3,013	373,312	30,348
Dairy	Medium1	Flush	Pacific	Composting	175,990	4,108	373,312	31,199
Dairy	Medium1	Flush	MidWest	Composting	175,990	2,309	373,312	16,815
Dairy	Medium2	Flush	Central	Composting	232,520	12,652	373,312	39,966
Dairy	Medium2	Flush	MidAtlantic	Composting	263,816	25,995	309,849	110,277
Dairy	Medium2	Flush	South	Composting	232,520	11,417	373,312	58,429
Dairy	Medium2	Flush	Pacific	Composting	232,520	15,739	373,312	60,040
Dairy	Medium2	Flush	MidWest	Composting	204,789	12,882	373,312	32,363
Dairy	Large1	Hose	Central	Composting	175,457	20,025	96,251	6,084
Dairy	Large1	Hose	MidAtlantic	Composting	257,585	49,373	257,585	42,172
Dairy	Large1	Hose	South	Composting	186,656	19,235	186,656	15,147
Dairy	Large1	Hose	Pacific	Composting	373,312	52,945	373,312	29,193
Dairy	Large1	Hose	MidWest	Composting	115,727	9,041	72,081	3,146
Dairy	Medium1	Hose	Central	Composting	175,990	894	175,990	4,738
Dairy	Medium1	Hose	MidAtlantic	Composting	146,072	1,225	169,975	14,968
Dairy	Medium1	Hose	South	Composting	175,990	811	175,990	12,696
Dairy	Medium1	Hose	Pacific	Composting	175,990	1,102	175,990	12,316
Dairy	Medium1	Hose	MidWest	Composting	175,990	624	175,990	4,803
Dairy	Medium2	Hose	Central	Composting	204,789	14,855	175,990	7,524
Dairy	Medium2	Hose	MidAtlantic	Composting	192,992	14,747	263,816	26,334
Dairy	Medium2	Hose	South	Composting	204,789	13,434	232,520	10,868
Dairy	Medium2	Hose	Pacific	Composting	204,789	18,409	232,520	10,541
Dairy	Medium2	Hose	MidWest	Composting	204,789	10,235	175,990	7,979
Heifers	Large1	Heifers	Central	Composting	13,759	195	55,997	5,283
Heifers	Large1	Heifers	MidAtlantic	Composting	18,346	430	74,662	21,506
Heifers	Large1	Heifers	South	Composting	91,728	1,181	373,312	46,345
Heifers	Large1	Heifers	Pacific	Composting	91,728	1,604	373,312	51,918
Heifers	Large1	Heifers	MidWest	Composting	8,256	82	33,598	2,502
Heifers	Medium1	Heifers	Central	Composting	175,990	3,263	232,520	11,091
Heifers	Medium1	Heifers	MidAtlantic	Composting	139,032	4,271	294,917	26,764
Heifers	Medium1	Heifers	South	Composting	175,990	2,957	204,789	9,819
Heifers	Medium1	Heifers	Pacific	Composting	175,990	4,028	204,789	10,201

Table A-23 (Continued)

Animal	Size Class	Farm Type	Region	EPA Option	Category 2 Costs Capital	Category 2 Costs Annual	Category 3 Costs Capital	Category 3 Costs Annual
Heifers	Medium1	Heifers	MidWest	Composting	175,990	3,902	373,312	16,393
Heifers	Medium2	Heifers	Central	Composting	91,728	1,302	373,312	20,811
Heifers	Medium2	Heifers	MidAtlantic	Composting	72,465	1,697	294,917	45,777
Heifers	Medium2	Heifers	South	Composting	91,728	1,181	204,789	11,342
Heifers	Medium2	Heifers	Pacific	Composting	91,728	1,604	373,312	28,485
Heifers	Medium2	Heifers	MidWest	Composting	175,990	3,348	373,312	34,564
Veal	Medium1	Flush	Central	Composting	-	-	-	-
Veal	Medium1	Flush	MidAtlantic	Composting	-	-	-	-
Veal	Medium1	Flush	South	Composting	-	-	-	-
Veal	Medium1	Flush	Pacific	Composting	-	-	-	-
Veal	Medium1	Flush	MidWest	Composting	-	-	-	-
Veal	Medium2	Flush	Central	Composting	-	-	-	-
Veal	Medium2	Flush	MidAtlantic	Composting	-	-	-	-
Veal	Medium2	Flush	South	Composting	-	-	-	-
Veal	Medium2	Flush	Pacific	Composting	-	-	-	-
Veal	Medium2	Flush	MidWest	Composting	-	-	-	-
Beef	Large1	Beef	Central	No composting	232,520	18,411	373,312	46,341
Beef	Large1	Beef	MidAtlantic	No composting	317,850	41,351	373,312	300,537
Beef	Large1	Beef	MidWest	No composting	204,789	17,107	373,312	52,338
Beef	Large1	Beef	Pacific	No composting	232,520	22,843	373,312	185,971
Beef	Large1	Beef	South	No composting	232,520	16,638	373,312	168,884
Beef	Large2	Beef	Central	No composting	733,951	188,600	648,498	750,705
Beef	Large2	Beef	MidAtlantic	No composting	941,594	318,298	860,020	4,929,165
Beef	Large2	Beef	MidWest	No composting	637,545	128,435	648,498	854,344
Beef	Large2	Beef	Pacific	No composting	808,109	234,962	622,713	3,060,627
Beef	Large2	Beef	South	No composting	704,287	170,071	615,297	2,777,155
Beef	Medium2	Beef	Central	No composting	175,990	2,391	317,850	22,218
Beef	Medium2	Beef	MidAtlantic	No composting	175,990	3,952	373,312	96,610
Beef	Medium2	Beef	MidWest	No composting	175,990	1,667	373,312	16,806
Beef	Medium2	Beef	Pacific	No composting	175,990	2,949	373,312	59,728
Beef	Medium2	Beef	South	No composting	175,990	2,168	373,312	54,254
Dairy	Large1	Flush	Central	No composting	373,312	49,058	373,312	243,947
Dairy	Large1	Flush	MidAtlantic	No composting	373,312	82,585	373,312	787,530
Dairy	Large1	Flush	MidWest	No composting	373,312	33,492	373,312	196,384

Table A-23 (Continued)

Animal	Size Class	Farm Type	Region	EPA Option	Category 2 Costs		Category 3 Costs	
					Capital	Annual	Capital	Annual
Dairy	Large1	Flush	Pacific	No composting	373,312	61,032	373,312	365,580
Dairy	Large1	Flush	South	No composting	373,312	44,269	373,312	348,907
Dairy	Medium2	Flush	Central	No composting	232,520	12,727	373,312	84,528
Dairy	Medium2	Flush	MidAtlantic	No composting	317,850	31,376	373,312	271,876
Dairy	Medium2	Flush	MidWest	No composting	204,789	12,906	373,312	67,954
Dairy	Medium2	Flush	Pacific	No composting	232,520	15,833	373,312	125,859
Dairy	Medium2	Flush	South	No composting	232,520	11,485	373,312	120,197
Dairy	Large1	Hose	Central	No composting	373,312	42,456	373,312	172,147
Dairy	Large1	Hose	MidAtlantic	No composting	373,312	71,270	373,312	567,221
Dairy	Large1	Hose	MidWest	No composting	373,312	29,078	373,312	139,857
Dairy	Large1	Hose	Pacific	No composting	373,312	52,747	373,312	267,156
Dairy	Large1	Hose	South	No composting	373,312	38,340	373,312	254,292
Dairy	Medium2	Hose	Central	No composting	204,789	14,704	373,312	55,897
Dairy	Medium2	Hose	MidAtlantic	No composting	232,520	17,732	373,312	183,912
Dairy	Medium2	Hose	MidWest	No composting	175,990	14,098	373,312	45,367
Dairy	Medium2	Hose	Pacific	No composting	204,789	18,219	373,312	86,548
Dairy	Medium2	Hose	South	No composting	204,789	13,298	373,312	82,407
Veal	Medium2	Flush	Central	No composting	-	-	-	-
Veal	Medium2	Flush	MidAtlantic	No composting	-	-	-	-
Veal	Medium2	Flush	MidWest	No composting	-	-	-	-
Veal	Medium2	Flush	Pacific	No composting	-	-	-	-
Veal	Medium2	Flush	South	No composting	-	-	-	-

Table A-24

Costs for the Implementation of Underpit Storage and Covered Storage NSPS Option 8

Animal	Size Class	Farm Type	Region	Capital Costs	Annual Costs
Dairy	Large1	Flush	Central	6,497,370	290,344
Dairy	Large1	Flush	MidAtlantic	6,497,370	290,344
Dairy	Large1	Flush	MidWest	6,497,370	290,344
Dairy	Large1	Flush	Pacific	6,497,370	290,344
Dairy	Large1	Flush	South	6,497,370	290,344
Dairy	Large1	Hose	Central	6,257,558	281,121
Dairy	Large1	Hose	MidAtlantic	6,257,558	281,121
Dairy	Large1	Hose	MidWest	6,257,558	281,121
Dairy	Large1	Hose	Pacific	6,257,558	281,121
Dairy	Large1	Hose	South	6,257,558	281,121
Dairy	Medium2	Flush	Central	2,149,126	94,122
Dairy	Medium2	Flush	MidAtlantic	2,149,126	94,122
Dairy	Medium2	Flush	MidWest	2,149,126	94,122
Dairy	Medium2	Flush	Pacific	2,149,126	94,122
Dairy	Medium2	Flush	South	2,149,126	94,122
Dairy	Medium2	Hose	Central	2,071,387	91,132
Dairy	Medium2	Hose	MidAtlantic	2,071,387	91,132
Dairy	Medium2	Hose	MidWest	2,071,387	91,132
Dairy	Medium2	Hose	Pacific	2,071,387	91,132
Dairy	Medium2	Hose	South	2,071,387	91,132
Dairy	Medium1	Flush	Central	1,126,858	48,084
Dairy	Medium1	Flush	MidAtlantic	1,126,858	48,084
Dairy	Medium1	Flush	MidWest	1,126,858	48,084
Dairy	Medium1	Flush	Pacific	1,126,858	48,084
Dairy	Medium1	Flush	South	1,126,858	48,084
Dairy	Medium1	Hose	Central	1,087,143	46,556
Dairy	Medium1	Hose	MidAtlantic	1,087,143	46,556
Dairy	Medium1	Hose	MidWest	1,087,143	46,556
Dairy	Medium1	Hose	Pacific	1,087,143	46,556
Dairy	Medium1	Hose	South	1,087,143	46,556

Appendix B

TRANSPORTATION OPTION SELECTION

Table B-1

Transportation Scenario by Model Farm

Animal	Region	Size Class	Option 1	Option 2 - 4	Option 5	Option 6	Option 7	Option 8
Beef	Central	>8000	Purchase Option	Purchase Option	Compost Purchase Option	Purchase Option	Purchase Option	Purchase Option
Beef	MidAtlantic	>8000	Purchase Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Beef	MidWest	>8000	Purchase Option	Purchase Option	Compost Purchase Option	Purchase Option	Purchase Option	Purchase Option
Beef	Pacific	>8000	Purchase Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Beef	South	>8000	Purchase Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Beef	Central	1000-8000	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Beef	MidAtlantic	1000-8000	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Beef	MidWest	1000-8000	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Beef	Pacific	1000-8000	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Beef	South	1000-8000	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Beef	Central	300-500	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Beef	MidAtlantic	300-500	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Beef	MidWest	300-500	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option

Table B-1 (Continued)

Animal	Region	Size Class	Option 1	Option 2 - 4	Option 5	Option 6	Option 7	Option 8
Beef	Pacific	300-500	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Beef	South	300-500	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Beef	Central	500-1000	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Beef	MidAtlantic	500-1000	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Beef	MidWest	500-1000	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Beef	Pacific	500-1000	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Beef	South	500-1000	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Dairy	Central	>700	Purchase Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Dairy	MidAtlantic	>700	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Dairy	MidWest	>700	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Dairy	Pacific	>700	Purchase Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Dairy	South	>700	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Dairy	Central	200-350	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Dairy	MidAtlantic	200-350	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Dairy	MidWest	200-350	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option

Table B-1 (Continued)

Animal	Region	Size Class	Option 1	Option 2 - 4	Option 5	Option 6	Option 7	Option 8
Dairy	Pacific	200-350	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Dairy	South	200-350	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Dairy	Central	350-700	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Dairy	MidAtlantic	350-700	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Dairy	MidWest	350-700	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Dairy	Pacific	350-700	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Dairy	South	350-700	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Heifers	Central	>1000	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Heifers	MidAtlantic	>1000	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Heifers	MidWest	>1000	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Heifers	Pacific	>1000	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Heifers	South	>1000	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Heifers	Central	300-500	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Heifers	MidAtlantic	300-500	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Heifers	MidWest	300-500	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option

Table B-1 (Continued)

Animal	Region	Size Class	Option 1	Option 2 - 4	Option 5	Option 6	Option 7	Option 8
Heifers	Pacific	300-500	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Heifers	South	300-500	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Heifers	Central	500-1000	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Heifers	MidAtlantic	500-1000	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Heifers	MidWest	500-1000	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Heifers	Pacific	500-1000	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Heifers	South	500-1000	Contract Haul Option	Contract Haul Option	Compost Contract Haul	Contract Haul Option	Contract Haul Option	Contract Haul Option
Veal	Central	>500	Purchase Option	Purchase Option	No Compost	Purchase Option	Purchase Option	Purchase Option
Veal	MidAtlantic	>500	Purchase Option	Purchase Option	No Compost	Purchase Option	Purchase Option	Purchase Option
Veal	MidWest	>500	Purchase Option	Purchase Option	No Compost	Purchase Option	Purchase Option	Purchase Option
Veal	Pacific	>500	Purchase Option	Purchase Option	No Compost	Purchase Option	Purchase Option	Purchase Option
Veal	South	>500	Purchase Option	Purchase Option	No Compost	Purchase Option	Purchase Option	Purchase Option
Veal	Central	300-500	Purchase Option	Purchase Option	No Compost	Purchase Option	Purchase Option	Purchase Option
Veal	MidAtlantic	300-500	Purchase Option	Purchase Option	No Compost Compost	Purchase Option	Purchase Option	Purchase Option
Veal	MidWest	300-500	Purchase Option	Purchase Option	No Compost	Purchase Option	Purchase Option	Purchase Option
Veal	Pacific	300-500	Purchase Option	Purchase Option	No Compost	Purchase Option	Purchase Option	Purchase Option
Veal	South	300-500	Purchase Option	Purchase Option	No Compost	Purchase Option	Purchase Option	Purchase Option

Appendix C

MODEL FACILITY COSTS FOR BAT AND NSPS

Table C-1

Model Farm Costs for EPA Regulatory Option 1

Animal	Size Group	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M	3-Year Recurring O&M Costs
Beef	Large1	Central	1	226	2628	869	1,941	2,061	2,962
Beef	Large1	Central	2	70	2628	869	1,283	47,302	1,717
Beef	Large1	Central	3	37	2628	869	190	1,253	600
Beef	Large1	MidAtlantic	1	17	2628	2,464	2,014	2,184	3,100
Beef	Large1	MidAtlantic	2	5	2628	2,464	1,264	24,559	1,671
Beef	Large1	MidAtlantic	3	3	2628	2,464	190	1,333	600
Beef	Large1	MidWest	1	840	2628	2,321	2,476	2,445	3,961
Beef	Large1	MidWest	2	260	2628	2,321	1,464	28,815	2,060
Beef	Large1	MidWest	3	136	2628	2,321	190	1,326	600
Beef	Large1	Pacific	1	37	2628	1,741	2,330	2,331	3,685
Beef	Large1	Pacific	2	12	2628	1,741	1,487	53,685	2,091
Beef	Large1	Pacific	3	6	2628	1,741	190	1,297	600
Beef	Large1	South	1	4	2628	3,771	2,272	2,399	3,567
Beef	Large1	South	2	1	2628	3,771	1,375	26,763	1,881
Beef	Large1	South	3	1	2628	3,771	190	1,399	600
Beef	Large2	Central	1	15	43805	12,238	21,531	14,027	39,812
Beef	Large2	Central	2	96	43805	664,614	13,927	145,574	25,512
Beef	Large2	Central	3	71	43805	12,238	190	1,822	600
Beef	Large2	MidAtlantic	1	0	43805	38,849	22,767	16,077	42,133
Beef	Large2	MidAtlantic	2	0	43805	687,347	14,089	105,111	25,809
Beef	Large2	MidAtlantic	3	0	43805	38,849	190	3,152	600

Table C-1 (Continued)

Animal	Size Group	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M	3-Year Recurring O&M Costs
Beef	Large2	MidWest	1	17	43805	36,430	30,494	20,451	56,680
Beef	Large2	MidWest	2	115	43805	622,064	18,774	108,476	34,627
Beef	Large2	MidWest	3	85	43805	36,430	190	3,032	600
Beef	Large2	Pacific	1	2	43805	26,754	28,019	18,527	52,032
Beef	Large2	Pacific	2	12	43805	701,378	18,285	162,592	33,710
Beef	Large2	Pacific	3	9	43805	26,754	190	2,548	600
Beef	Large2	South	1	0	43805	60,622	27,068	19,667	50,234
Beef	Large2	South	2	0	43805	638,840	16,695	103,905	30,712
Beef	Large2	South	3	0	43805	60,622	190	4,241	600
Dairy	Large1	Central	1	109	1419	66,157	1,980	3,364	3,034
Dairy	Large1	Central	2	206	1419	439,469	1,006	34,150	1,184
Dairy	Large1	Central	3	89	1419	66,157	190	2,533	600
Dairy	Large1	MidAtlantic	1	22	1419	45,347	2,334	3,153	3,690
Dairy	Large1	MidAtlantic	2	41	1419	45,347	1,006	46,898	1,184
Dairy	Large1	MidAtlantic	3	18	1419	45,347	190	2,117	600
Dairy	Large1	MidWest	1	24	1419	45,347	2,492	3,245	3,982
Dairy	Large1	MidWest	2	46	1419	45,347	1,164	55,084	1,497
Dairy	Large1	MidWest	3	20	1419	45,347	190	2,117	600
Dairy	Large1	Pacific	1	212	1419	66,157	2,234	3,511	3,495
Dairy	Large1	Pacific	2	401	1419	439,469	986	37,270	1,158
Dairy	Large1	Pacific	3	173	1419	66,157	190	2,533	600
Dairy	Large1	South	1	23	1419	66,157	2,111	3,440	3,270
Dairy	Large1	South	2	43	1419	66,157	782	54,494	764
Dairy	Large1	South	3	18	1419	66,157	190	2,533	600

Table C-1 (Continued)

Animal	Size Group	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M	3-Year Recurring O&M Costs
Beef	Medium2	Central	1	109	1088	40,168	1,206	5,024	1,573
Beef	Medium2	Central	2	12	1088	38,706	1,090	6,719	1,358
Beef	Medium2	Central	3	9	1088	7,501	190	1,477	600
Beef	Medium2	MidAtlantic	1	29	1088	46,348	1,237	5,445	1,635
Beef	Medium2	MidAtlantic	2	3	1088	44,611	1,102	5,939	1,374
Beef	Medium2	MidAtlantic	3	2	1088	13,266	190	1,766	600
Beef	Medium2	MidWest	1	680	1088	45,620	1,429	5,981	1,994
Beef	Medium2	MidWest	2	73	1088	42,943	1,248	6,658	1,650
Beef	Medium2	MidWest	3	57	1088	9,702	190	1,593	600
Beef	Medium2	Pacific	1	16	1088	49,009	1,368	5,984	1,871
Beef	Medium2	Pacific	2	2	1088	46,865	1,217	7,974	1,589
Beef	Medium2	Pacific	3	1	1088	14,043	190	1,804	600
Beef	Medium2	South	1	6	1088	49,496	1,345	5,944	1,820
Beef	Medium2	South	2	1	1088	47,240	1,183	6,524	1,522
Beef	Medium2	South	3	0	1088	14,877	190	1,846	600
Dairy	Medium2	Central	1	217	460	31,721	1,106	2,560	1,379
Dairy	Medium2	Central	2	156	460	31,426	829	27,117	866
Dairy	Medium2	Central	3	61	460	28,581	190	1,964	600
Dairy	Medium2	MidAtlantic	1	244	460	26,056	1,225	2,732	1,599
Dairy	Medium2	MidAtlantic	2	175	460	25,400	840	13,629	882
Dairy	Medium2	MidAtlantic	3	68	460	21,117	190	1,854	600
Dairy	Medium2	MidWest	1	249	460	25,046	1,275	2,734	1,707
Dairy	Medium2	MidWest	2	179	460	24,363	894	15,789	974
Dairy	Medium2	MidWest	3	70	460	20,003	190	1,801	600

Table C-1 (Continued)

Animal	Size Group	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M	3-Year Recurring O&M Costs
Dairy	Medium2	Pacific	1	363	460	34,281	1,191	2,769	1,533
Dairy	Medium2	Pacific	2	261	460	33,882	832	30,648	871
Dairy	Medium2	Pacific	3	102	460	31,034	190	2,087	600
Dairy	Medium2	South	1	85	460	33,730	1,152	2,706	1,461
Dairy	Medium2	South	2	61	460	33,357	767	15,809	744
Dairy	Medium2	South	3	24	460	30,533	190	2,062	600
Veal	Medium2	Central	1	3	540	-	1,075	1,514	1,318
Veal	Medium2	Central	2	0	540	-	690	1,290	600
Veal	Medium2	Central	3	0	540	-	190	1,210	600
Veal	Medium2	MidAtlantic	1	1	540	-	1,075	1,514	1,318
Veal	Medium2	MidAtlantic	2	0	540	-	690	1,290	600
Veal	Medium2	MidAtlantic	3	0	540	-	190	1,210	600
Veal	Medium2	MidWest	1	81	540	-	1,075	1,514	1,318
Veal	Medium2	MidWest	2	0	540	-	690	1,290	600
Veal	Medium2	MidWest	3	0	540	-	190	1,210	600
Veal	Medium2	Pacific	1	0	540	-	1,075	1,514	1,318
Veal	Medium2	Pacific	2	0	540	-	690	1,290	600
Veal	Medium2	Pacific	3	0	540	-	190	1,210	600
Veal	Medium2	South	1	0	540	-	1,075	1,514	1,318
Veal	Medium2	South	2	0	540	-	690	1,290	600
Veal	Medium2	South	3	0	540	-	190	1,210	600
Heifers	Medium2	Central	1	210	750	37,198	859	2,730	908
Heifers	Medium2	Central	2	23	750	36,983	836	2,938	877
Heifers	Medium2	Central	3	18	750	8,468	190	1,586	600

Table C-1 (Continued)

Animal	Size Group	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M	3-Year Recurring O&M Costs
Heifers	Medium2	MidAtlantic	1	0	750	41,877	890	3,297	969
Heifers	Medium2	MidAtlantic	2	0	750	41,618	863	3,252	933
Heifers	Medium2	MidAtlantic	3	0	750	12,851	190	1,806	600
Heifers	Medium2	MidWest	1	84	750	39,428	913	3,395	1,020
Heifers	Medium2	MidWest	2	9	750	39,125	883	5,300	959
Heifers	Medium2	MidWest	3	7	750	10,174	190	1,674	600
Heifers	Medium2	Pacific	1	126	750	42,674	909	3,520	1,015
Heifers	Medium2	Pacific	2	14	750	42,409	883	3,827	959
Heifers	Medium2	Pacific	3	11	750	13,458	190	1,836	600
Heifers	Medium2	South	1	0	750	42,754	863	3,053	933
Heifers	Medium2	South	2	0	750	42,468	832	2,927	871
Heifers	Medium2	South	3	0	750	13,988	190	1,863	600
Heifers	Large1	Central	1	122	1500	532	1,025	1,511	1,230
Heifers	Large1	Central	2	38	1500	532	1,006	2,012	1,184
Heifers	Large1	Central	3	20	1500	532	190	1,237	600
Heifers	Large1	MidAtlantic	1	0	1500	1,386	1,094	1,594	1,363
Heifers	Large1	MidAtlantic	2	0	1500	1,386	1,063	1,833	1,302
Heifers	Large1	MidAtlantic	3	0	1500	1,386	190	1,279	600
Heifers	Large1	MidWest	1	0	1500	1,308	1,133	1,613	1,435
Heifers	Large1	MidWest	2	0	1500	1,308	1,102	1,898	1,374
Heifers	Large1	MidWest	3	0	1500	1,308	190	1,275	600
Heifers	Large1	Pacific	1	82	1500	999	1,133	1,598	1,435
Heifers	Large1	Pacific	2	25	1500	999	1,102	2,161	1,374
Heifers	Large1	Pacific	3	13	1500	999	190	1,260	600

Table C-1 (Continued)

Animal	Size Group	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M	3-Year Recurring O&M Costs
Heifers	Large1	South	1	0	1500	2,084	1,040	1,598	1,251
Heifers	Large1	South	2	0	1500	2,084	1,010	1,859	1,190
Heifers	Large1	South	3	0	1500	2,084	190	1,314	600
Beef	Medium1	Central	1	72	400	37,279	879	2,930	954
Beef	Medium1	Central	2	8	400	37,095	859	2,897	908
Beef	Medium1	Central	3	6	400	8,366	190	1,563	600
Beef	Medium1	MidAtlantic	1	126	400	40,380	890	3,204	969
Beef	Medium1	MidAtlantic	2	14	400	40,195	871	3,088	943
Beef	Medium1	MidAtlantic	3	11	400	11,355	190	1,712	600
Beef	Medium1	MidWest	1	575	400	39,249	963	3,772	1,107
Beef	Medium1	MidWest	2	62	400	38,928	933	3,630	1,046
Beef	Medium1	MidWest	3	48	400	9,479	190	1,622	600
Beef	Medium1	Pacific	1	29	400	41,387	940	3,699	1,076
Beef	Medium1	Pacific	2	3	400	41,113	913	3,675	1,020
Beef	Medium1	Pacific	3	2	400	11,859	190	1,738	600
Beef	Medium1	South	1	35	400	41,550	933	3,646	1,046
Beef	Medium1	South	2	4	400	41,278	906	3,501	1,010
Beef	Medium1	South	3	3	400	12,101	190	1,750	600
Dairy	Medium1	Central	1	297	235	20,442	902	2,024	1,005
Dairy	Medium1	Central	2	213	235	20,394	852	4,499	897
Dairy	Medium1	Central	3	83	235	17,528	190	1,681	600
Dairy	Medium1	MidAtlantic	1	435	235	17,832	963	2,142	1,107
Dairy	Medium1	MidAtlantic	2	313	235	17,726	894	2,798	974
Dairy	Medium1	MidAtlantic	3	122	235	13,367	190	1,616	600

Table C-1 (Continued)

Animal	Size Group	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M	3-Year Recurring O&M Costs
Dairy	Medium1	MidWest	1	472	235	17,220	990	2,154	1,164
Dairy	Medium1	MidWest	2	339	235	17,110	921	2,961	1,031
Dairy	Medium1	MidWest	3	132	235	12,711	190	1,585	600
Dairy	Medium1	Pacific	1	361	235	21,924	944	2,157	1,082
Dairy	Medium1	Pacific	2	260	235	21,863	883	4,972	959
Dairy	Medium1	Pacific	3	101	235	18,968	190	1,753	600
Dairy	Medium1	South	1	127	235	21,593	925	2,115	1,036
Dairy	Medium1	South	2	91	235	21,526	856	3,400	903
Dairy	Medium1	South	3	35	235	18,656	190	1,737	600
Heifers	Medium1	Central	1	21	400	35,474	779	1,877	759
Heifers	Medium1	Central	2	2	400	35,474	759	3,714	733
Heifers	Medium1	Central	3	2	400	7,236	190	1,538	600
Heifers	Medium1	MidAtlantic	1	0	400	38,395	798	2,035	805
Heifers	Medium1	MidAtlantic	2	0	400	38,395	767	2,941	744
Heifers	Medium1	MidAtlantic	3	0	400	10,157	190	1,684	600
Heifers	Medium1	MidWest	1	168	400	36,618	809	2,017	820
Heifers	Medium1	MidWest	2	18	400	36,584	779	4,716	759
Heifers	Medium1	MidWest	3	14	400	8,346	190	1,596	600
Heifers	Medium1	Pacific	1	21	400	38,887	809	2,129	820
Heifers	Medium1	Pacific	2	2	400	38,853	779	4,146	759
Heifers	Medium1	Pacific	3	2	400	10,615	190	1,707	600
Heifers	Medium1	South	1	0	400	39,071	782	2,059	764
Heifers	Medium1	South	2	0	400	39,071	752	3,049	723
Heifers	Medium1	South	3	0	400	10,833	190	1,718	600

Table C-1 (Continued)

Animal	Size Group	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M	3-Year Recurring O&M Costs
Veal	Medium1	Central	1	5	540	-	1,075	1,514	1,318
Veal	Medium1	Central	2	0	540	-	690	1,290	600
Veal	Medium1	Central	3	0	540	-	190	1,210	600
Veal	Medium1	MidAtlantic	1	1	540	-	1,075	1,514	1,318
Veal	Medium1	MidAtlantic	2	0	540	-	690	1,290	600
Veal	Medium1	MidAtlantic	3	0	540	-	190	1,210	600
Veal	Medium1	MidWest	1	119	540	-	1,075	1,514	1,318
Veal	Medium1	MidWest	2	0	540	-	690	1,290	600
Veal	Medium1	MidWest	3	0	540	-	190	1,210	600
Veal	Medium1	Pacific	1	0	540	-	1,075	1,514	1,318
Veal	Medium1	Pacific	2	0	540	-	690	1,290	600
Veal	Medium1	Pacific	3	0	540	-	190	1,210	600
Veal	Medium1	South	1	0	540	-	1,075	1,514	1,318
Veal	Medium1	South	2	0	540	-	690	1,290	600
Veal	Medium1	South	3	0	540	-	190	1,210	600
Beef	Large1	Central	1	152	2628	20,155	3,352	3,846	5,612
Beef	Large1	MidAtlantic	1	13	2628	47,073	2,420	4,650	3,862
Beef	Large1	MidWest	1	801	2628	14,357	2,548	3,089	4,096
Beef	Large1	Pacific	1	22	2628	45,036	3,144	4,970	5,216
Beef	Large1	South	1	3	2628	3,771	2,778	2,693	4,521

Table C-2

Model Farm Costs for EPA Regulatory Option 2

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Beef	Large1	Central	1	152	2,628	869	3,352	2,882	5,612
Beef	Large1	MidAtlantic	1	13	2,628	2,464	2,420	2,420	3,862
Beef	Large1	MidWest	1	801	2,628	2,321	2,548	2,487	4,096
Beef	Large1	Pacific	1	22	2,628	1,741	3,144	2,805	5,216
Beef	Large1	South	1	3	2,628	3,771	2,778	2,693	4,521
Beef	Large1	Central	2	143	2,628	869	3,985	16,029	6,797
Beef	Large1	MidAtlantic	2	9	2,628	2,464	2,298	13,469	3,621
Beef	Large1	MidWest	2	299	2,628	2,321	1,811	23,912	2,713
Beef	Large1	Pacific	2	27	2,628	1,741	2,812	23,255	4,583
Beef	Large1	South	2	2	2,628	3,771	2,614	17,620	4,214
Beef	Large1	Central	3	37	2,628	869	190	1,253	600
Beef	Large1	MidAtlantic	3	3	2,628	2,464	190	1,333	600
Beef	Large1	MidWest	3	136	2,628	2,321	190	1,326	600
Beef	Large1	Pacific	3	6	2,628	1,741	190	1,297	600
Beef	Large1	South	3	1	2,628	3,771	190	1,399	600
Beef	Large2	Central	1	8	43,805	12,238	32,110	20,182	59,719
Beef	Large2	MidAtlantic	1	-	43,805	38,849	25,630	17,743	47,522
Beef	Large2	MidWest	1	16	43,805	36,430	30,960	20,722	57,556
Beef	Large2	Pacific	1	1	43,805	26,754	34,574	22,341	64,367
Beef	Large2	South	1	-	43,805	60,622	30,666	21,761	57,004
Beef	Large2	Central	2	103	43,805	387,507	46,972	109,774	87,690

Table C-2 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Beef	Large2	MidAtlantic	2	-	43,805	38,849	24,601	161,515	45,589
Beef	Large2	MidWest	2	116	43,805	580,585	21,138	103,312	39,075
Beef	Large2	Pacific	2	13	43,805	26,754	35,006	305,125	65,170
Beef	Large2	South	2	-	43,805	60,622	29,544	201,385	54,892
Beef	Large2	Central	3	71	43,805	12,238	190	1,822	600
Beef	Large2	MidAtlantic	3	-	43,805	38,849	190	3,152	600
Beef	Large2	MidWest	3	85	43,805	36,430	190	3,032	600
Beef	Large2	Pacific	3	9	43,805	26,754	190	2,548	600
Beef	Large2	South	3	-	43,805	60,622	190	4,241	600
Beef	Medium1	Central	1	65	400	41,488	1,162	4,162	1,485
Beef	Medium1	MidAtlantic	1	116	400	41,610	991	3,791	1,160
Beef	Medium1	MidWest	1	557	400	39,795	1,005	3,973	1,185
Beef	Medium1	Pacific	1	25	400	43,854	1,139	4,770	1,448
Beef	Medium1	South	1	31	400	44,360	1,148	4,728	1,458
Beef	Medium1	Central	2	15	400	45,174	1,429	5,584	1,981
Beef	Medium1	MidAtlantic	2	23	400	42,861	1,098	4,628	1,366
Beef	Medium1	MidWest	2	80	400	40,581	1,064	4,329	1,293
Beef	Medium1	Pacific	2	8	400	44,588	1,204	5,390	1,561
Beef	Medium1	South	2	8	400	45,668	1,258	5,479	1,671
Beef	Medium1	Central	3	6	400	8,366	190	1,563	600
Beef	Medium1	MidAtlantic	3	10	400	11,355	190	1,712	600
Beef	Medium1	MidWest	3	48	400	9,479	190	1,622	600
Beef	Medium1	Pacific	3	2	400	11,859	190	1,738	600
Beef	Medium1	South	3	3	400	12,101	190	1,750	600

Table C-2 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Beef	Medium2	Central	1	99	1,088	61,325	1,974	6,535	3,018
Beef	Medium2	MidAtlantic	1	27	1,088	51,874	1,510	6,130	2,145
Beef	Medium2	MidWest	1	659	1,088	48,199	1,543	6,225	2,206
Beef	Medium2	Pacific	1	13	1,088	60,336	1,910	7,261	2,894
Beef	Medium2	South	1	5	1,088	62,761	1,935	7,253	2,935
Beef	Medium2	Central	2	22	1,088	72,897	2,518	9,190	4,040
Beef	Medium2	MidAtlantic	2	5	1,088	54,889	1,683	7,945	2,470
Beef	Medium2	MidWest	2	94	1,088	49,580	1,585	7,304	2,283
Beef	Medium2	Pacific	2	4	1,088	60,737	1,969	9,068	3,001
Beef	Medium2	South	2	1	1,088	64,706	2,080	8,673	3,213
Beef	Medium2	Central	3	9	1,088	7,501	190	1,477	600
Beef	Medium2	MidAtlantic	3	2	1,088	13,266	190	1,766	600
Beef	Medium2	MidWest	3	57	1,088	9,702	190	1,593	600
Beef	Medium2	Pacific	3	1	1,088	14,043	190	1,804	600
Beef	Medium2	South	3	0	1,088	14,877	190	1,846	600
Dairy	Large1	Central	1	88	1,419	66,157	2,458	3,642	3,933
Dairy	Large1	MidAtlantic	1	15	1,419	45,347	2,759	3,401	4,491
Dairy	Large1	MidWest	1	18	1,419	45,347	2,795	3,422	4,554
Dairy	Large1	Pacific	1	132	1,419	66,157	2,530	3,683	4,057
Dairy	Large1	South	1	17	1,419	66,157	2,382	3,598	3,783
Dairy	Large1	Central	2	227	1,419	66,157	1,228	67,770	1,603
Dairy	Large1	MidAtlantic	2	49	1,419	45,347	1,075	42,794	1,314
Dairy	Large1	MidWest	2	52	1,419	45,347	1,281	33,491	1,709
Dairy	Large1	Pacific	2	481	1,419	66,157	1,010	65,545	1,203

Table C-2 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Dairy	Large1	South	2	49	1,419	66,157	742	35,267	690
Dairy	Large1	Central	3	89	1,419	66,157	190	2,533	600
Dairy	Large1	MidAtlantic	3	18	1,419	45,347	190	2,117	600
Dairy	Large1	MidWest	3	20	1,419	45,347	190	2,117	600
Dairy	Large1	Pacific	3	173	1,419	66,157	190	2,533	600
Dairy	Large1	South	3	18	1,419	66,157	190	2,533	600
Dairy	Medium1	Central	1	230	235	20,653	1,064	2,193	1,310
Dairy	Medium1	MidAtlantic	1	333	235	17,964	1,037	2,241	1,249
Dairy	Medium1	MidWest	1	372	235	17,349	1,060	2,244	1,294
Dairy	Medium1	Pacific	1	253	235	21,991	1,004	2,229	1,187
Dairy	Medium1	South	1	111	235	21,627	955	2,150	1,093
Dairy	Medium1	Central	2	280	235	20,717	1,122	3,741	1,412
Dairy	Medium1	MidAtlantic	2	415	235	17,932	1,019	3,035	1,214
Dairy	Medium1	MidWest	2	438	235	17,328	1,048	2,824	1,268
Dairy	Medium1	Pacific	2	368	235	21,954	971	3,676	1,121
Dairy	Medium1	South	2	107	235	21,592	919	3,212	1,025
Dairy	Medium1	Central	3	83	235	17,528	190	1,681	600
Dairy	Medium1	MidAtlantic	3	122	235	13,367	190	1,616	600
Dairy	Medium1	MidWest	3	132	235	12,711	190	1,585	600
Dairy	Medium1	Pacific	3	101	235	18,968	190	1,753	600
Dairy	Medium1	South	3	35	235	18,656	190	1,737	600
Dairy	Medium2	Central	1	168	460	32,299	1,422	2,818	1,972
Dairy	Medium2	MidAtlantic	1	186	460	26,402	1,368	2,872	1,872
Dairy	Medium2	MidWest	1	196	460	25,392	1,411	2,863	1,959

Table C-2 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Dairy	Medium2	Pacific	1	254	460	34,450	1,306	2,873	1,757
Dairy	Medium2	South	1	74	460	33,815	1,209	2,756	1,569
Dairy	Medium2	Central	2	205	460	31,683	1,057	17,230	1,289
Dairy	Medium2	MidAtlantic	2	233	460	25,547	937	13,359	1,060
Dairy	Medium2	MidWest	2	231	460	24,548	1,006	10,818	1,192
Dairy	Medium2	Pacific	2	370	460	33,949	902	17,367	993
Dairy	Medium2	South	2	72	460	33,376	802	13,303	812
Dairy	Medium2	Central	3	61	460	28,581	190	1,964	600
Dairy	Medium2	MidAtlantic	3	68	460	21,117	190	1,854	600
Dairy	Medium2	MidWest	3	70	460	20,003	190	1,801	600
Dairy	Medium2	Pacific	3	102	460	31,034	190	2,087	600
Dairy	Medium2	South	3	24	460	30,533	190	2,062	600
Heifers	Large1	Central	1	83	1,500	532	1,372	1,713	1,881
Heifers	Large1	MidAtlantic	1	-	1,500	1,386	1,202	1,657	1,565
Heifers	Large1	MidWest	1	-	1,500	1,308	1,152	1,624	1,472
Heifers	Large1	Pacific	1	48	1,500	999	1,325	1,710	1,798
Heifers	Large1	South	1	-	1,500	2,084	1,139	1,656	1,439
Heifers	Large1	Central	2	78	1,500	532	2,038	2,295	3,139
Heifers	Large1	MidAtlantic	2	-	1,500	1,386	1,485	2,052	2,092
Heifers	Large1	MidWest	2	-	1,500	1,308	1,247	1,929	1,646
Heifers	Large1	Pacific	2	58	1,500	999	1,548	2,565	2,205
Heifers	Large1	South	2	-	1,500	2,084	1,378	2,222	1,890
Heifers	Large1	Central	3	20	1,500	532	190	1,237	600
Heifers	Large1	MidAtlantic	3	-	1,500	1,386	190	1,279	600

Table C-2 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Heifers	Large1	MidWest	3	-	1,500	1,308	190	1,275	600
Heifers	Large1	Pacific	3	13	1,500	999	190	1,260	600
Heifers	Large1	South	3	-	1,500	2,084	190	1,314	600
Heifers	Medium1	Central	1	19	400	36,722	901	2,816	990
Heifers	Medium1	MidAtlantic	1	-	400	38,836	844	2,511	890
Heifers	Medium1	MidWest	1	163	400	36,821	829	2,218	858
Heifers	Medium1	Pacific	1	18	400	39,674	890	3,037	971
Heifers	Medium1	South	1	-	400	39,701	858	2,818	909
Heifers	Medium1	Central	2	4	400	37,038	945	4,782	1,076
Heifers	Medium1	MidAtlantic	2	-	400	38,877	841	5,176	878
Heifers	Medium1	MidWest	2	23	400	36,946	825	3,368	847
Heifers	Medium1	Pacific	2	6	400	39,481	869	4,530	931
Heifers	Medium1	South	2	-	400	39,399	830	3,590	859
Heifers	Medium1	Central	3	2	400	7,236	190	1,538	600
Heifers	Medium1	MidAtlantic	3	-	400	10,157	190	1,684	600
Heifers	Medium1	MidWest	3	14	400	8,346	190	1,596	600
Heifers	Medium1	Pacific	3	2	400	10,615	190	1,707	600
Heifers	Medium1	South	3	-	400	10,833	190	1,718	600
Heifers	Medium2	Central	1	190	750	40,313	1,088	3,877	1,341
Heifers	Medium2	MidAtlantic	1	-	750	42,915	978	3,833	1,133
Heifers	Medium2	MidWest	1	81	750	39,888	951	3,605	1,090
Heifers	Medium2	Pacific	1	106	750	44,488	1,065	4,499	1,308
Heifers	Medium2	South	1	-	750	44,339	1,004	4,039	1,191
Heifers	Medium2	Central	2	43	750	42,350	1,259	7,144	1,672

Table C-2 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Heifers	Medium2	MidAtlantic	2	-	750	43,575	1,039	4,862	1,262
Heifers	Medium2	MidWest	2	12	750	40,362	990	4,101	1,160
Heifers	Medium2	Pacific	2	33	750	44,653	1,086	5,442	1,349
Heifers	Medium2	South	2	-	750	44,527	1,028	4,789	1,228
Heifers	Medium2	Central	3	18	750	8,468	190	1,586	600
Heifers	Medium2	MidAtlantic	3	-	750	12,851	190	1,806	600
Heifers	Medium2	MidWest	3	7	750	10,174	190	1,674	600
Heifers	Medium2	Pacific	3	11	750	13,458	190	1,836	600
Heifers	Medium2	South	3	-	750	13,988	190	1,863	600
Veal	Medium1	Central	1	5	400	-	1,075	1,514	1,318
Veal	Medium1	MidAtlantic	1	1	400	-	1,075	1,514	1,317
Veal	Medium1	MidWest	1	119	400	-	1,075	1,514	1,317
Veal	Medium1	Pacific	1	-	400	-	1,075	1,514	1,318
Veal	Medium1	South	1	-	400	-	1,075	1,514	1,318
Veal	Medium1	Central	2	-	400	-	690	1,290	600
Veal	Medium1	MidAtlantic	2	-	400	-	690	1,290	600
Veal	Medium1	MidWest	2	-	400	-	690	1,290	600
Veal	Medium1	Pacific	2	-	400	-	690	1,290	600
Veal	Medium1	South	2	-	400	-	690	1,290	600
Veal	Medium1	Central	3	-	400	-	190	1,210	600
Veal	Medium1	MidAtlantic	3	-	400	-	190	1,210	600
Veal	Medium1	MidWest	3	-	400	-	190	1,210	600
Veal	Medium1	Pacific	3	-	400	-	190	1,210	600
Veal	Medium1	South	3	-	400	-	190	1,210	600

Table C-2 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Veal	Medium2	Central	1	3	540	-	1,075	1,514	1,318
Veal	Medium2	MidAtlantic	1	1	540	-	1,075	1,514	1,317
Veal	Medium2	MidWest	1	81	540	-	1,075	1,514	1,317
Veal	Medium2	Pacific	1	-	540	-	1,075	1,514	1,318
Veal	Medium2	South	1	-	540	-	1,075	1,514	1,318
Veal	Medium2	Central	2	-	540	-	690	1,290	600
Veal	Medium2	MidAtlantic	2	-	540	-	690	1,290	600
Veal	Medium2	MidWest	2	-	540	-	690	1,290	600
Veal	Medium2	Pacific	2	-	540	-	690	1,290	600
Veal	Medium2	South	2	-	540	-	690	1,290	600
Veal	Medium2	Central	3	-	540	-	190	1,210	600
Veal	Medium2	MidAtlantic	3	-	540	-	190	1,210	600
Veal	Medium2	MidWest	3	-	540	-	190	1,210	600
Veal	Medium2	Pacific	3	-	540	-	190	1,210	600
Veal	Medium2	South	3	-	540	-	190	1,210	600

Table C-3

Model Farm Costs for EPA Regulatory Option 3

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Beef	Large1	Central	1	152	2,628	43,694	5,760	4,466	5,612
Beef	Large1	MidAtlantic	1	13	2,628	126,820	5,101	7,645	3,862
Beef	Large1	MidWest	1	801	2,628	109,638	5,601	6,693	4,096
Beef	Large1	Pacific	1	22	2,628	67,590	5,250	5,602	5,216
Beef	Large1	South	1	3	2,628	127,811	5,424	7,953	4,521
Beef	Large1	Central	2	143	2,628	43,694	3,985	17,613	6,797
Beef	Large1	MidAtlantic	2	9	2,628	126,820	2,298	18,694	3,621
Beef	Large1	MidWest	2	299	2,628	109,638	1,811	28,118	2,713
Beef	Large1	Pacific	2	27	2,628	67,590	2,812	26,053	4,583
Beef	Large1	South	2	2	2,628	127,811	2,614	22,880	4,214
Beef	Large1	Central	3	37	2,628	43,694	190	2,837	600
Beef	Large1	MidAtlantic	3	3	2,628	126,820	190	6,558	600
Beef	Large1	MidWest	3	136	2,628	109,638	190	5,532	600
Beef	Large1	Pacific	3	6	2,628	67,590	190	4,094	600
Beef	Large1	South	3	1	2,628	127,811	190	6,659	600
Beef	Large2	Central	1	8	43,805	460,625	34,915	33,080	59,719
Beef	Large2	MidAtlantic	1	-	43,805	1,249,800	28,569	61,283	47,522
Beef	Large2	MidWest	1	16	43,805	1,116,166	34,059	54,907	57,556
Beef	Large2	Pacific	1	1	43,805	658,940	37,208	45,465	64,367
Beef	Large2	South	1	-	43,805	1,276,807	33,588	66,488	57,004
Beef	Large2	Central	2	103	43,805	835,894	46,972	122,672	87,690

Table C-3 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Beef	Large2	MidAtlantic	2	-	43,805	1,249,800	24,601	205,056	45,589
Beef	Large2	MidWest	2	116	43,805	1,660,321	21,138	137,496	39,075
Beef	Large2	Pacific	2	13	43,805	658,940	35,006	328,249	65,170
Beef	Large2	South	2	-	43,805	1,276,807	29,544	246,112	54,892
Beef	Large2	Central	3	71	43,805	460,625	190	14,720	600
Beef	Large2	MidAtlantic	3	-	43,805	1,249,800	190	46,693	600
Beef	Large2	MidWest	3	85	43,805	1,116,166	190	37,216	600
Beef	Large2	Pacific	3	9	43,805	658,940	190	25,671	600
Beef	Large2	South	3	-	43,805	1,276,807	190	48,969	600
Beef	Medium1	Central	1	65	400	53,321	3,344	4,643	1,485
Beef	Medium1	MidAtlantic	1	116	400	76,294	3,394	5,328	1,160
Beef	Medium1	MidWest	1	557	400	70,522	3,847	5,280	1,185
Beef	Medium1	Pacific	1	25	400	62,755	2,623	5,616	1,448
Beef	Medium1	South	1	31	400	79,171	2,917	6,282	1,458
Beef	Medium1	Central	2	15	400	57,007	1,429	6,065	1,981
Beef	Medium1	MidAtlantic	2	23	400	77,544	1,098	6,164	1,366
Beef	Medium1	MidWest	2	80	400	71,308	1,064	5,636	1,293
Beef	Medium1	Pacific	2	8	400	63,489	1,204	6,237	1,561
Beef	Medium1	South	2	8	400	80,479	1,258	7,032	1,671
Beef	Medium1	Central	3	6	400	20,199	190	2,044	600
Beef	Medium1	MidAtlantic	3	10	400	46,039	190	3,249	600
Beef	Medium1	MidWest	3	48	400	40,207	190	2,929	600
Beef	Medium1	Pacific	3	2	400	30,760	190	2,584	600
Beef	Medium1	South	3	3	400	46,912	190	3,304	600

Table C-3 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Beef	Medium2	Central	1	99	1,088	84,414	4,156	7,481	3,018
Beef	Medium2	MidAtlantic	1	27	1,088	117,418	3,913	9,039	2,145
Beef	Medium2	MidWest	1	659	1,088	106,151	4,385	8,690	2,206
Beef	Medium2	Pacific	1	13	1,088	95,342	3,394	8,828	2,894
Beef	Medium2	South	1	5	1,088	128,175	3,704	10,172	2,935
Beef	Medium2	Central	2	22	1,088	95,986	2,518	10,137	4,040
Beef	Medium2	MidAtlantic	2	5	1,088	120,433	1,683	10,855	2,470
Beef	Medium2	MidWest	2	94	1,088	107,532	1,585	9,770	2,283
Beef	Medium2	Pacific	2	4	1,088	95,744	1,969	10,635	3,001
Beef	Medium2	South	2	1	1,088	130,120	2,080	11,592	3,213
Beef	Medium2	Central	3	9	1,088	30,590	190	2,424	600
Beef	Medium2	MidAtlantic	3	2	1,088	78,810	190	4,675	600
Beef	Medium2	MidWest	3	57	1,088	67,654	190	4,059	600
Beef	Medium2	Pacific	3	1	1,088	49,050	190	3,371	600
Beef	Medium2	South	3	0	1,088	80,290	190	4,766	600
Dairy	Large1	Central	1	88	1,419	205,246	5,140	10,396	3,933
Dairy	Large1	MidAtlantic	1	15	1,419	296,252	4,966	15,660	4,491
Dairy	Large1	MidWest	1	18	1,419	322,071	5,324	16,925	4,554
Dairy	Large1	Pacific	1	132	1,419	212,269	4,540	10,808	4,057
Dairy	Large1	South	1	17	1,419	321,901	4,827	16,037	3,783
Dairy	Large1	Central	2	227	1,419	205,246	1,228	74,524	1,603
Dairy	Large1	MidAtlantic	2	49	1,419	296,252	1,075	55,052	1,314
Dairy	Large1	MidWest	2	52	1,419	322,071	1,281	46,995	1,709
Dairy	Large1	Pacific	2	481	1,419	212,269	1,010	72,669	1,203

Table C-3 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Dairy	Large1	South	2	49	1,419	321,901	742	47,706	690
Dairy	Large1	Central	3	89	1,419	205,246	190	9,287	600
Dairy	Large1	MidAtlantic	3	18	1,419	296,252	190	14,376	600
Dairy	Large1	MidWest	3	20	1,419	322,071	190	15,621	600
Dairy	Large1	Pacific	3	173	1,419	212,269	190	9,657	600
Dairy	Large1	South	3	18	1,419	321,901	190	14,972	600
Dairy	Medium1	Central	1	230	235	58,077	3,284	4,014	1,310
Dairy	Medium1	MidAtlantic	1	333	235	87,351	3,204	5,634	1,249
Dairy	Medium1	MidWest	1	372	235	91,593	3,356	5,868	1,294
Dairy	Medium1	Pacific	1	253	235	62,841	2,791	4,225	1,187
Dairy	Medium1	South	1	111	235	98,010	3,636	5,882	1,093
Dairy	Medium1	Central	2	280	235	58,142	1,122	5,562	1,412
Dairy	Medium1	MidAtlantic	2	415	235	87,319	1,019	6,428	1,214
Dairy	Medium1	MidWest	2	438	235	91,573	1,048	6,448	1,268
Dairy	Medium1	Pacific	2	368	235	62,804	971	5,673	1,121
Dairy	Medium1	South	2	107	235	97,975	919	6,944	1,025
Dairy	Medium1	Central	3	83	235	54,953	190	3,501	600
Dairy	Medium1	MidAtlantic	3	122	235	82,754	190	5,009	600
Dairy	Medium1	MidWest	3	132	235	86,955	190	5,209	600
Dairy	Medium1	Pacific	3	101	235	59,818	190	3,749	600
Dairy	Medium1	South	3	35	235	95,039	190	5,469	600
Dairy	Medium2	Central	1	168	460	86,664	3,642	5,515	1,972
Dairy	Medium2	MidAtlantic	1	186	460	126,691	3,535	7,877	1,872
Dairy	Medium2	MidWest	1	196	460	135,126	3,708	8,336	1,959

Table C-3 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Dairy	Medium2	Pacific	1	254	460	92,200	3,093	5,742	1,757
Dairy	Medium2	South	1	74	460	141,772	3,890	8,116	1,569
Dairy	Medium2	Central	2	205	460	86,048	1,057	19,928	1,289
Dairy	Medium2	MidAtlantic	2	233	460	125,836	937	18,365	1,060
Dairy	Medium2	MidWest	2	231	460	134,282	1,006	16,291	1,192
Dairy	Medium2	Pacific	2	370	460	91,699	902	20,237	993
Dairy	Medium2	South	2	72	460	141,332	802	18,662	812
Dairy	Medium2	Central	3	61	460	82,947	190	4,662	600
Dairy	Medium2	MidAtlantic	3	68	460	121,406	190	6,860	600
Dairy	Medium2	MidWest	3	70	460	129,738	190	7,274	600
Dairy	Medium2	Pacific	3	102	460	88,784	190	4,956	600
Dairy	Medium2	South	3	24	460	138,490	190	7,421	600
Heifers	Large1	Central	1	83	1,500	17,194	3,781	2,609	1,881
Heifers	Large1	MidAtlantic	1	-	1,500	63,166	3,883	4,861	1,565
Heifers	Large1	MidWest	1	-	1,500	48,366	4,206	4,107	1,472
Heifers	Large1	Pacific	1	48	1,500	34,401	3,431	3,437	1,798
Heifers	Large1	South	1	-	1,500	64,315	3,786	4,872	1,439
Heifers	Large1	Central	2	78	1,500	17,194	2,038	3,191	3,139
Heifers	Large1	MidAtlantic	2	-	1,500	63,166	1,485	5,256	2,092
Heifers	Large1	MidWest	2	-	1,500	48,366	1,247	4,412	1,646
Heifers	Large1	Pacific	2	58	1,500	34,401	1,548	4,293	2,205
Heifers	Large1	South	2	-	1,500	64,315	1,378	5,438	1,890
Heifers	Large1	Central	3	20	1,500	17,194	190	2,132	600
Heifers	Large1	MidAtlantic	3	-	1,500	63,166	190	4,483	600

Table C-3 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Heifers	Large1	MidWest	3	-	1,500	48,366	190	3,758	600
Heifers	Large1	Pacific	3	13	1,500	34,401	190	2,987	600
Heifers	Large1	South	3	-	1,500	64,315	190	4,531	600
Heifers	Medium1	Central	1	19	400	44,768	3,083	3,216	990
Heifers	Medium1	MidAtlantic	1	-	400	66,364	3,248	3,883	890
Heifers	Medium1	MidWest	1	163	400	59,466	3,671	3,346	858
Heifers	Medium1	Pacific	1	18	400	54,895	2,375	3,796	971
Heifers	Medium1	South	1	-	400	67,532	2,627	4,206	909
Heifers	Medium1	Central	2	4	400	45,084	945	6,546	1,076
Heifers	Medium1	MidAtlantic	2	-	400	66,404	841	5,422	878
Heifers	Medium1	MidWest	2	23	400	59,591	825	5,767	847
Heifers	Medium1	Pacific	2	6	400	54,702	869	6,498	931
Heifers	Medium1	South	2	-	400	67,230	830	4,978	859
Heifers	Medium1	Central	3	2	400	15,282	190	1,939	600
Heifers	Medium1	MidAtlantic	3	-	400	37,684	190	3,057	600
Heifers	Medium1	MidWest	3	14	400	30,991	190	2,724	600
Heifers	Medium1	Pacific	3	2	400	25,836	190	2,466	600
Heifers	Medium1	South	3	-	400	38,664	190	3,106	600
Heifers	Medium2	Central	1	190	750	51,275	3,270	4,488	1,341
Heifers	Medium2	MidAtlantic	1	-	750	81,183	3,381	5,862	1,133
Heifers	Medium2	MidWest	1	81	750	70,809	3,793	5,281	1,090
Heifers	Medium2	Pacific	1	106	750	65,502	2,550	5,607	1,308
Heifers	Medium2	South	1	-	750	83,247	2,773	6,090	1,191
Heifers	Medium2	Central	2	43	750	53,312	1,259	6,051	1,672

Table C-3 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Heifers	Medium2	MidAtlantic	2	-	750	81,842	1,039	8,370	1,262
Heifers	Medium2	MidWest	2	12	750	71,283	990	7,263	1,160
Heifers	Medium2	Pacific	2	33	750	65,666	1,086	6,550	1,349
Heifers	Medium2	South	2	-	750	83,435	1,028	6,840	1,228
Heifers	Medium2	Central	3	18	750	19,431	190	2,197	600
Heifers	Medium2	MidAtlantic	3	-	750	51,119	190	3,834	600
Heifers	Medium2	MidWest	3	7	750	41,096	190	3,350	600
Heifers	Medium2	Pacific	3	11	750	34,472	190	2,944	600
Heifers	Medium2	South	3	-	750	52,896	190	3,913	600
Veal	Medium1	Central	1	5	400	250	2,795	1,519	1,318
Veal	Medium1	MidAtlantic	1	1	400	455	2,733	1,523	1,317
Veal	Medium1	MidWest	1	119	400	524	2,889	1,524	1,317
Veal	Medium1	Pacific	1	-	400	228	2,326	1,519	1,318
Veal	Medium1	South	1	-	400	432	3,421	1,523	1,318
Veal	Medium1	Central	2	-	400	250	690	1,295	600
Veal	Medium1	MidAtlantic	2	-	400	455	690	1,299	600
Veal	Medium1	MidWest	2	-	400	524	690	1,300	600
Veal	Medium1	Pacific	2	-	400	228	690	1,295	600
Veal	Medium1	South	2	-	400	432	690	1,299	600
Veal	Medium1	Central	3	-	400	250	190	1,215	600
Veal	Medium1	MidAtlantic	3	-	400	455	190	1,219	600
Veal	Medium1	MidWest	3	-	400	524	190	1,220	600
Veal	Medium1	Pacific	3	-	400	228	190	1,215	600
Veal	Medium1	South	3	-	400	432	190	1,219	600

Table C-3 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Veal	Medium2	Central	1	3	540	1,085	2,795	1,624	1,318
Veal	Medium2	MidAtlantic	1	1	540	1,996	2,733	1,717	1,317
Veal	Medium2	MidWest	1	81	540	2,259	2,889	1,743	1,317
Veal	Medium2	Pacific	1	-	540	998	2,326	1,616	1,318
Veal	Medium2	South	1	-	540	1,847	3,421	1,701	1,318
Veal	Medium2	Central	2	-	540	1,085	690	1,400	600
Veal	Medium2	MidAtlantic	2	-	540	1,996	690	1,493	600
Veal	Medium2	MidWest	2	-	540	2,259	690	1,519	600
Veal	Medium2	Pacific	2	-	540	998	690	1,392	600
Veal	Medium2	South	2	-	540	1,847	690	1,477	600
Veal	Medium2	Central	3	-	540	1,085	190	1,320	600
Veal	Medium2	MidAtlantic	3	-	540	1,996	190	1,413	600
Veal	Medium2	MidWest	3	-	540	2,259	190	1,439	600
Veal	Medium2	Pacific	3	-	540	998	190	1,312	600
Veal	Medium2	South	3	-	540	1,847	190	1,397	600

Table C-4

Model Farm Costs for EPA Regulatory Option 4

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Beef	Large1	Central	1	152	2,628	44,086	5,760	10,718	5,612
Beef	Large1	MidAtlantic	1	13	2,628	127,212	5,101	13,897	3,862
Beef	Large1	MidWest	1	801	2,628	110,030	5,601	12,945	4,096
Beef	Large1	Pacific	1	22	2,628	67,982	5,250	11,854	5,216
Beef	Large1	South	1	3	2,628	128,203	5,424	14,205	4,521
Beef	Large1	Central	2	143	2,628	44,086	3,985	23,865	6,797
Beef	Large1	MidAtlantic	2	9	2,628	127,212	2,298	24,946	3,621
Beef	Large1	MidWest	2	299	2,628	110,030	1,811	34,370	2,713
Beef	Large1	Pacific	2	27	2,628	67,982	2,812	32,305	4,583
Beef	Large1	South	2	2	2,628	128,203	2,614	29,132	4,214
Beef	Large1	Central	3	37	2,628	44,086	190	9,089	600
Beef	Large1	MidAtlantic	3	3	2,628	127,212	190	12,810	600
Beef	Large1	MidWest	3	136	2,628	110,030	190	11,784	600
Beef	Large1	Pacific	3	6	2,628	67,982	190	10,346	600
Beef	Large1	South	3	1	2,628	128,203	190	12,911	600
Beef	Large2	Central	1	8	43,805	461,017	34,915	39,332	59,719
Beef	Large2	MidAtlantic	1	-	43,805	1,250,192	28,569	67,535	47,522
Beef	Large2	MidWest	1	16	43,805	1,116,558	34,059	61,159	57,556
Beef	Large2	Pacific	1	1	43,805	659,332	37,208	51,717	64,367
Beef	Large2	South	1	-	43,805	1,277,199	33,588	72,740	57,004
Beef	Large2	Central	2	103	43,805	836,286	46,972	128,924	87,690

Table C-4 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Beef	Large2	MidAtlantic	2	-	43,805	1,250,192	24,601	211,308	45,589
Beef	Large2	MidWest	2	116	43,805	1,660,713	21,138	143,748	39,075
Beef	Large2	Pacific	2	13	43,805	659,332	35,006	334,501	65,170
Beef	Large2	South	2	-	43,805	1,277,199	29,544	252,364	54,892
Beef	Large2	Central	3	71	43,805	461,017	190	20,972	600
Beef	Large2	MidAtlantic	3	-	43,805	1,250,192	190	52,945	600
Beef	Large2	MidWest	3	85	43,805	1,116,558	190	43,468	600
Beef	Large2	Pacific	3	9	43,805	659,332	190	31,923	600
Beef	Large2	South	3	-	43,805	1,277,199	190	55,221	600
Beef	Medium1	Central	1	65	400	53,713	3,344	10,895	1,485
Beef	Medium1	MidAtlantic	1	116	400	76,686	3,394	11,580	1,160
Beef	Medium1	MidWest	1	557	400	70,914	3,847	11,532	1,185
Beef	Medium1	Pacific	1	25	400	63,147	2,623	11,868	1,448
Beef	Medium1	South	1	31	400	79,563	2,917	12,534	1,458
Beef	Medium1	Central	2	15	400	57,399	1,429	12,317	1,981
Beef	Medium1	MidAtlantic	2	23	400	77,936	1,098	12,416	1,366
Beef	Medium1	MidWest	2	80	400	71,700	1,064	11,888	1,293
Beef	Medium1	Pacific	2	8	400	63,881	1,204	12,489	1,561
Beef	Medium1	South	2	8	400	80,871	1,258	13,284	1,671
Beef	Medium1	Central	3	6	400	20,591	190	8,296	600
Beef	Medium1	MidAtlantic	3	10	400	46,431	190	9,501	600
Beef	Medium1	MidWest	3	48	400	40,599	190	9,181	600
Beef	Medium1	Pacific	3	2	400	31,152	190	8,836	600
Beef	Medium1	South	3	3	400	47,304	190	9,556	600

Table C-4 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Beef	Medium2	Central	1	99	1,088	84,806	4,156	13,733	3,018
Beef	Medium2	MidAtlantic	1	27	1,088	117,810	3,913	15,291	2,145
Beef	Medium2	MidWest	1	659	1,088	106,543	4,385	14,942	2,206
Beef	Medium2	Pacific	1	13	1,088	95,734	3,394	15,080	2,894
Beef	Medium2	South	1	5	1,088	128,567	3,704	16,424	2,935
Beef	Medium2	Central	2	22	1,088	96,378	2,518	16,389	4,040
Beef	Medium2	MidAtlantic	2	5	1,088	120,825	1,683	17,107	2,470
Beef	Medium2	MidWest	2	94	1,088	107,924	1,585	16,022	2,283
Beef	Medium2	Pacific	2	4	1,088	96,136	1,969	16,887	3,001
Beef	Medium2	South	2	1	1,088	130,512	2,080	17,844	3,213
Beef	Medium2	Central	3	9	1,088	30,982	190	8,676	600
Beef	Medium2	MidAtlantic	3	2	1,088	79,202	190	10,927	600
Beef	Medium2	MidWest	3	57	1,088	68,046	190	10,311	600
Beef	Medium2	Pacific	3	1	1,088	49,442	190	9,623	600
Beef	Medium2	South	3	0	1,088	80,682	190	11,018	600
Dairy	Large1	Central	1	88	1,419	205,638	5,140	16,648	3,933
Dairy	Large1	MidAtlantic	1	15	1,419	296,644	4,966	21,912	4,491
Dairy	Large1	MidWest	1	18	1,419	322,463	5,324	23,177	4,554
Dairy	Large1	Pacific	1	132	1,419	212,661	4,540	17,060	4,057
Dairy	Large1	South	1	17	1,419	322,293	4,827	22,289	3,783
Dairy	Large1	Central	2	227	1,419	205,638	1,228	80,776	1,603
Dairy	Large1	MidAtlantic	2	49	1,419	296,644	1,075	61,304	1,314
Dairy	Large1	MidWest	2	52	1,419	322,463	1,281	53,247	1,709
Dairy	Large1	Pacific	2	481	1,419	212,661	1,010	78,921	1,203

Table C-4 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Dairy	Large1	South	2	49	1,419	322,293	742	53,958	690
Dairy	Large1	Central	3	89	1,419	205,638	190	15,539	600
Dairy	Large1	MidAtlantic	3	18	1,419	296,644	190	20,628	600
Dairy	Large1	MidWest	3	20	1,419	322,463	190	21,873	600
Dairy	Large1	Pacific	3	173	1,419	212,661	190	15,909	600
Dairy	Large1	South	3	18	1,419	322,293	190	21,224	600
Dairy	Medium1	Central	1	230	235	58,469	3,284	10,266	1,310
Dairy	Medium1	MidAtlantic	1	333	235	87,743	3,204	11,886	1,249
Dairy	Medium1	MidWest	1	372	235	91,985	3,356	12,120	1,294
Dairy	Medium1	Pacific	1	253	235	63,233	2,791	10,477	1,187
Dairy	Medium1	South	1	111	235	98,402	3,636	12,134	1,093
Dairy	Medium1	Central	2	280	235	58,534	1,122	11,814	1,412
Dairy	Medium1	MidAtlantic	2	415	235	87,711	1,019	12,680	1,214
Dairy	Medium1	MidWest	2	438	235	91,965	1,048	12,700	1,268
Dairy	Medium1	Pacific	2	368	235	63,196	971	11,925	1,121
Dairy	Medium1	South	2	107	235	98,367	919	13,196	1,025
Dairy	Medium1	Central	3	83	235	55,345	190	9,753	600
Dairy	Medium1	MidAtlantic	3	122	235	83,146	190	11,261	600
Dairy	Medium1	MidWest	3	132	235	87,347	190	11,461	600
Dairy	Medium1	Pacific	3	101	235	60,210	190	10,001	600
Dairy	Medium1	South	3	35	235	95,431	190	11,721	600
Dairy	Medium2	Central	1	168	460	87,056	3,642	11,767	1,972
Dairy	Medium2	MidAtlantic	1	186	460	127,083	3,535	14,129	1,872
Dairy	Medium2	MidWest	1	196	460	135,518	3,708	14,588	1,959

Table C-4 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Dairy	Medium2	Pacific	1	254	460	92,592	3,093	11,994	1,757
Dairy	Medium2	South	1	74	460	142,164	3,890	14,368	1,569
Dairy	Medium2	Central	2	205	460	86,440	1,057	26,180	1,289
Dairy	Medium2	MidAtlantic	2	233	460	126,228	937	24,617	1,060
Dairy	Medium2	MidWest	2	231	460	134,674	1,006	22,543	1,192
Dairy	Medium2	Pacific	2	370	460	92,091	902	26,489	993
Dairy	Medium2	South	2	72	460	141,724	802	24,914	812
Dairy	Medium2	Central	3	61	460	83,339	190	10,914	600
Dairy	Medium2	MidAtlantic	3	68	460	121,798	190	13,112	600
Dairy	Medium2	MidWest	3	70	460	130,130	190	13,526	600
Dairy	Medium2	Pacific	3	102	460	89,176	190	11,208	600
Dairy	Medium2	South	3	24	460	138,882	190	13,673	600
Heifers	Large1	Central	1	83	1,500	17,586	3,781	8,861	1,881
Heifers	Large1	MidAtlantic	1	-	1,500	63,558	3,883	11,113	1,565
Heifers	Large1	MidWest	1	-	1,500	48,758	4,206	10,359	1,472
Heifers	Large1	Pacific	1	48	1,500	34,793	3,431	9,689	1,798
Heifers	Large1	South	1	-	1,500	64,707	3,786	11,124	1,439
Heifers	Large1	Central	2	78	1,500	17,586	2,038	9,443	3,139
Heifers	Large1	MidAtlantic	2	-	1,500	63,558	1,485	11,508	2,092
Heifers	Large1	MidWest	2	-	1,500	48,758	1,247	10,664	1,646
Heifers	Large1	Pacific	2	58	1,500	34,793	1,548	10,545	2,205
Heifers	Large1	South	2	-	1,500	64,707	1,378	11,690	1,890
Heifers	Large1	Central	3	20	1,500	17,586	190	8,384	600
Heifers	Large1	MidAtlantic	3	-	1,500	63,558	190	10,735	600

Table C-4 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Heifers	Large1	MidWest	3	-	1,500	48,758	190	10,010	600
Heifers	Large1	Pacific	3	13	1,500	34,793	190	9,239	600
Heifers	Large1	South	3	-	1,500	64,707	190	10,783	600
Heifers	Medium1	Central	1	19	400	45,160	3,083	9,468	990
Heifers	Medium1	MidAtlantic	1	-	400	66,756	3,248	10,135	890
Heifers	Medium1	MidWest	1	163	400	59,858	3,671	9,598	858
Heifers	Medium1	Pacific	1	18	400	55,287	2,375	10,048	971
Heifers	Medium1	South	1	-	400	67,924	2,627	10,458	909
Heifers	Medium1	Central	2	4	400	45,476	945	11,434	1,076
Heifers	Medium1	MidAtlantic	2	-	400	66,796	841	11,674	878
Heifers	Medium1	MidWest	2	23	400	59,983	825	10,748	847
Heifers	Medium1	Pacific	2	6	400	55,094	869	11,541	931
Heifers	Medium1	South	2	-	400	67,622	830	11,999	859
Heifers	Medium1	Central	3	2	400	15,674	190	8,191	600
Heifers	Medium1	MidAtlantic	3	-	400	38,076	190	9,309	600
Heifers	Medium1	MidWest	3	14	400	31,383	190	8,976	600
Heifers	Medium1	Pacific	3	2	400	26,228	190	8,718	600
Heifers	Medium1	South	3	-	400	39,056	190	9,358	600
Heifers	Medium2	Central	1	190	750	51,667	3,270	10,740	1,341
Heifers	Medium2	MidAtlantic	1	-	750	81,575	3,381	12,114	1,133
Heifers	Medium2	MidWest	1	81	750	71,201	3,793	11,533	1,090
Heifers	Medium2	Pacific	1	106	750	65,894	2,550	11,859	1,308
Heifers	Medium2	South	1	-	750	83,639	2,773	12,342	1,191
Heifers	Medium2	Central	2	43	750	53,704	1,259	12,303	1,672

Table C-4 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Heifers	Medium2	MidAtlantic	2	-	750	82,234	1,039	14,622	1,262
Heifers	Medium2	MidWest	2	12	750	71,675	990	13,515	1,160
Heifers	Medium2	Pacific	2	33	750	66,058	1,086	12,802	1,349
Heifers	Medium2	South	2	-	750	83,827	1,028	13,092	1,228
Heifers	Medium2	Central	3	18	750	19,823	190	8,449	600
Heifers	Medium2	MidAtlantic	3	-	750	51,511	190	10,086	600
Heifers	Medium2	MidWest	3	7	750	41,488	190	9,602	600
Heifers	Medium2	Pacific	3	11	750	34,864	190	9,196	600
Heifers	Medium2	South	3	-	750	53,288	190	10,165	600
Veal	Medium1	Central	1	5	400	642	2,795	7,771	1,318
Veal	Medium1	MidAtlantic	1	1	400	847	2,733	7,775	1,317
Veal	Medium1	MidWest	1	119	400	916	2,889	7,776	1,317
Veal	Medium1	Pacific	1	-	400	620	2,326	7,771	1,318
Veal	Medium1	South	1	-	400	824	3,421	7,775	1,318
Veal	Medium1	Central	2	-	400	642	690	7,547	600
Veal	Medium1	MidAtlantic	2	-	400	847	690	7,551	600
Veal	Medium1	MidWest	2	-	400	916	690	7,552	600
Veal	Medium1	Pacific	2	-	400	620	690	7,547	600
Veal	Medium1	South	2	-	400	824	690	7,551	600
Veal	Medium1	Central	3	-	400	642	190	7,467	600
Veal	Medium1	MidAtlantic	3	-	400	847	190	7,471	600
Veal	Medium1	MidWest	3	-	400	916	190	7,472	600
Veal	Medium1	Pacific	3	-	400	620	190	7,467	600
Veal	Medium1	South	3	-	400	824	190	7,471	600

Table C-4 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Veal	Medium2	Central	1	3	540	1,477	2,795	7,876	1,318
Veal	Medium2	MidAtlantic	1	1	540	2,388	2,733	7,969	1,317
Veal	Medium2	MidWest	1	81	540	2,651	2,889	7,995	1,317
Veal	Medium2	Pacific	1	-	540	1,390	2,326	7,868	1,318
Veal	Medium2	South	1	-	540	2,239	3,421	7,953	1,318
Veal	Medium2	Central	2	-	540	1,477	690	7,652	600
Veal	Medium2	MidAtlantic	2	-	540	2,388	690	7,745	600
Veal	Medium2	MidWest	2	-	540	2,651	690	7,771	600
Veal	Medium2	Pacific	2	-	540	1,390	690	7,644	600
Veal	Medium2	South	2	-	540	2,239	690	7,729	600
Veal	Medium2	Central	3	-	540	1,477	190	7,572	600
Veal	Medium2	MidAtlantic	3	-	540	2,388	190	7,665	600
Veal	Medium2	MidWest	3	-	540	2,651	190	7,691	600
Veal	Medium2	Pacific	3	-	540	1,390	190	7,564	600
Veal	Medium2	South	3	-	540	2,239	190	7,649	600

Table C-5

Model Farm Costs for EPA Regulatory Option 5

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Beef	Large1	Central	1	152	2,628	10,026	3,352	100,067	5,612
Beef	Large1	MidAtlantic	1	13	2,628	11,621	2,420	86,435	3,862
Beef	Large1	MidWest	1	801	2,628	11,478	2,548	89,251	4,096
Beef	Large1	Pacific	1	22	2,628	10,897	3,144	86,829	5,216
Beef	Large1	South	1	3	2,628	12,927	2,778	86,609	4,521
Beef	Large1	Central	2	143	2,628	10,026	3,985	113,155	6,797
Beef	Large1	MidAtlantic	2	9	2,628	11,621	2,298	97,417	3,621
Beef	Large1	MidWest	2	299	2,628	11,478	1,811	110,595	2,713
Beef	Large1	Pacific	2	27	2,628	10,897	2,812	107,079	4,583
Beef	Large1	South	2	2	2,628	12,927	2,614	101,415	4,214
Beef	Large1	Central	3	37	2,628	10,026	190	98,439	600
Beef	Large1	MidAtlantic	3	3	2,628	11,621	190	85,349	600
Beef	Large1	MidWest	3	136	2,628	11,478	190	88,090	600
Beef	Large1	Pacific	3	6	2,628	10,897	190	85,321	600
Beef	Large1	South	3	1	2,628	12,927	190	85,314	600
Beef	Large2	Central	1	8	43,805	21,395	32,110	1,639,971	59,719
Beef	Large2	MidAtlantic	1	-	43,805	48,006	25,630	1,418,158	47,522
Beef	Large2	MidWest	1	16	43,805	45,587	30,960	1,466,719	57,556
Beef	Large2	Pacific	1	1	43,805	35,911	34,574	1,422,903	64,367
Beef	Large2	South	1	-	43,805	69,779	30,666	1,420,514	57,004
Beef	Large2	Central	2	103	43,805	382,306	46,972	1,728,577	87,690

Table C-5 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Beef	Large2	MidAtlantic	2	-	43,805	48,006	24,601	1,560,703	45,589
Beef	Large2	MidWest	2	116	43,805	647,503	21,138	1,556,128	39,075
Beef	Large2	Pacific	2	13	43,805	35,911	35,006	1,702,393	65,170
Beef	Large2	South	2	-	43,805	69,779	29,544	1,598,328	54,892
Beef	Large2	Central	3	71	43,805	21,395	190	1,621,611	600
Beef	Large2	MidAtlantic	3	-	43,805	48,006	190	1,403,567	600
Beef	Large2	MidWest	3	85	43,805	45,587	190	1,449,029	600
Beef	Large2	Pacific	3	9	43,805	35,911	190	1,403,110	600
Beef	Large2	South	3	-	43,805	69,779	190	1,402,994	600
Beef	Medium1	Central	1	65	400	50,645	1,162	18,957	1,485
Beef	Medium1	MidAtlantic	1	116	400	50,767	991	16,579	1,160
Beef	Medium1	MidWest	1	557	400	48,951	1,005	17,186	1,185
Beef	Medium1	Pacific	1	25	400	53,011	1,139	17,559	1,448
Beef	Medium1	South	1	31	400	53,517	1,148	17,501	1,458
Beef	Medium1	Central	2	15	400	54,331	1,429	20,368	1,981
Beef	Medium1	MidAtlantic	2	23	400	52,018	1,098	17,404	1,366
Beef	Medium1	MidWest	2	80	400	49,737	1,064	17,535	1,293
Beef	Medium1	Pacific	2	8	400	53,744	1,204	18,165	1,561
Beef	Medium1	South	2	8	400	54,824	1,258	18,243	1,671
Beef	Medium1	Central	3	6	400	17,522	190	16,358	600
Beef	Medium1	MidAtlantic	3	10	400	20,512	190	14,500	600
Beef	Medium1	MidWest	3	48	400	18,636	190	14,835	600
Beef	Medium1	Pacific	3	2	400	21,016	190	14,527	600
Beef	Medium1	South	3	3	400	21,257	190	14,522	600

Table C-5 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Beef	Medium2	Central	1	99	1,088	70,481	1,974	46,776	3,018
Beef	Medium2	MidAtlantic	1	27	1,088	61,030	1,510	40,912	2,145
Beef	Medium2	MidWest	1	659	1,088	57,355	1,543	42,149	2,206
Beef	Medium2	Pacific	1	13	1,088	69,492	1,910	42,047	2,894
Beef	Medium2	South	1	5	1,088	71,918	1,935	41,994	2,935
Beef	Medium2	Central	2	22	1,088	82,054	2,518	49,374	4,040
Beef	Medium2	MidAtlantic	2	5	1,088	64,046	1,683	42,667	2,470
Beef	Medium2	MidWest	2	94	1,088	58,737	1,585	43,191	2,283
Beef	Medium2	Pacific	2	4	1,088	69,894	1,969	43,783	3,001
Beef	Medium2	South	2	1	1,088	73,863	2,080	43,369	3,213
Beef	Medium2	Central	3	9	1,088	16,658	190	41,719	600
Beef	Medium2	MidAtlantic	3	2	1,088	22,423	190	36,548	600
Beef	Medium2	MidWest	3	57	1,088	18,859	190	37,518	600
Beef	Medium2	Pacific	3	1	1,088	23,200	190	36,591	600
Beef	Medium2	South	3	0	1,088	24,033	190	36,588	600
Dairy	Large1	Central	1	88	1,419	75,314	2,458	31,227	3,933
Dairy	Large1	MidAtlantic	1	15	1,419	54,504	2,759	43,339	4,491
Dairy	Large1	MidWest	1	18	1,419	54,504	2,795	44,823	4,554
Dairy	Large1	Pacific	1	132	1,419	75,314	2,530	27,480	4,057
Dairy	Large1	South	1	17	1,419	75,314	2,382	26,422	3,783
Dairy	Large1	Central	2	227	1,419	75,314	1,228	101,067	1,603
Dairy	Large1	MidAtlantic	2	49	1,419	54,504	1,075	82,623	1,314
Dairy	Large1	MidWest	2	52	1,419	54,504	1,281	70,773	1,709
Dairy	Large1	Pacific	2	481	1,419	75,314	1,010	82,352	1,203

Table C-5 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Dairy	Large1	South	2	49	1,419	75,314	742	52,255	690
Dairy	Large1	Central	3	89	1,419	75,314	190	30,119	600
Dairy	Large1	MidAtlantic	3	18	1,419	54,504	190	42,055	600
Dairy	Large1	MidWest	3	20	1,419	54,504	190	43,518	600
Dairy	Large1	Pacific	3	173	1,419	75,314	190	26,329	600
Dairy	Large1	South	3	18	1,419	75,314	190	25,358	600
Dairy	Medium1	Central	1	230	235	29,810	1,064	9,121	1,310
Dairy	Medium1	MidAtlantic	1	333	235	27,120	1,037	11,362	1,249
Dairy	Medium1	MidWest	1	372	235	26,505	1,060	11,488	1,294
Dairy	Medium1	Pacific	1	253	235	31,147	1,004	8,737	1,187
Dairy	Medium1	South	1	111	235	30,784	955	8,546	1,093
Dairy	Medium1	Central	2	280	235	29,874	1,122	11,680	1,412
Dairy	Medium1	MidAtlantic	2	415	235	27,089	1,019	12,131	1,214
Dairy	Medium1	MidWest	2	438	235	26,485	1,048	11,734	1,268
Dairy	Medium1	Pacific	2	368	235	31,111	971	9,214	1,121
Dairy	Medium1	South	2	107	235	30,749	919	10,397	1,025
Dairy	Medium1	Central	3	83	235	26,685	190	8,608	600
Dairy	Medium1	MidAtlantic	3	122	235	22,524	190	10,736	600
Dairy	Medium1	MidWest	3	132	235	21,867	190	10,829	600
Dairy	Medium1	Pacific	3	101	235	28,124	190	8,261	600
Dairy	Medium1	South	3	35	235	27,813	190	8,133	600
Dairy	Medium2	Central	1	168	460	41,456	1,422	16,367	1,972
Dairy	Medium2	MidAtlantic	1	186	460	35,559	1,368	20,721	1,872
Dairy	Medium2	MidWest	1	196	460	34,549	1,411	20,955	1,959

Table C-5 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Dairy	Medium2	Pacific	1	254	460	43,606	1,306	15,601	1,757
Dairy	Medium2	South	1	74	460	42,972	1,209	15,270	1,569
Dairy	Medium2	Central	2	205	460	40,840	1,057	30,979	1,289
Dairy	Medium2	MidAtlantic	2	233	460	34,704	937	31,154	1,060
Dairy	Medium2	MidWest	2	231	460	33,704	1,006	30,870	1,192
Dairy	Medium2	Pacific	2	370	460	43,106	902	30,278	993
Dairy	Medium2	South	2	72	460	42,533	802	25,792	812
Dairy	Medium2	Central	3	61	460	37,738	190	15,513	600
Dairy	Medium2	MidAtlantic	3	68	460	30,274	190	19,703	600
Dairy	Medium2	MidWest	3	70	460	29,160	190	19,893	600
Dairy	Medium2	Pacific	3	102	460	40,191	190	14,815	600
Dairy	Medium2	South	3	24	460	39,690	190	14,576	600
Heifers	Large1	Central	1	83	1,500	9,689	1,372	2,199	1,881
Heifers	Large1	MidAtlantic	1	-	1,500	10,542	1,202	2,142	1,565
Heifers	Large1	MidWest	1	-	1,500	10,465	1,152	2,110	1,472
Heifers	Large1	Pacific	1	48	1,500	10,156	1,325	2,195	1,798
Heifers	Large1	South	1	-	1,500	11,241	1,139	2,141	1,439
Heifers	Large1	Central	2	78	1,500	9,689	2,038	2,768	3,139
Heifers	Large1	MidAtlantic	2	-	1,500	10,542	1,485	2,522	2,092
Heifers	Large1	MidWest	2	-	1,500	10,465	1,247	2,398	1,646
Heifers	Large1	Pacific	2	58	1,500	10,156	1,548	3,002	2,205
Heifers	Large1	South	2	-	1,500	11,241	1,378	2,679	1,890
Heifers	Large1	Central	3	20	1,500	9,689	190	1,722	600
Heifers	Large1	MidAtlantic	3	-	1,500	10,542	190	1,765	600

Table C-5 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Heifers	Large1	MidWest	3	-	1,500	10,465	190	1,761	600
Heifers	Large1	Pacific	3	13	1,500	10,156	190	1,745	600
Heifers	Large1	South	3	-	1,500	11,241	190	1,800	600
Heifers	Medium1	Central	1	19	400	45,878	901	3,114	990
Heifers	Medium1	MidAtlantic	1	-	400	47,993	844	2,809	890
Heifers	Medium1	MidWest	1	163	400	45,978	829	2,516	858
Heifers	Medium1	Pacific	1	18	400	48,831	890	3,335	971
Heifers	Medium1	South	1	-	400	48,858	858	3,116	909
Heifers	Medium1	Central	2	4	400	46,194	945	5,055	1,076
Heifers	Medium1	MidAtlantic	2	-	400	48,034	841	5,467	878
Heifers	Medium1	MidWest	2	23	400	46,103	825	4,933	847
Heifers	Medium1	Pacific	2	6	400	48,638	869	4,798	931
Heifers	Medium1	South	2	-	400	48,556	830	3,868	859
Heifers	Medium1	Central	3	2	400	16,393	190	1,836	600
Heifers	Medium1	MidAtlantic	3	-	400	19,314	190	1,982	600
Heifers	Medium1	MidWest	3	14	400	17,503	190	1,893	600
Heifers	Medium1	Pacific	3	2	400	19,772	190	2,005	600
Heifers	Medium1	South	3	-	400	19,990	190	2,016	600
Heifers	Medium2	Central	1	190	750	49,469	1,088	4,435	1,341
Heifers	Medium2	MidAtlantic	1	-	750	52,072	978	4,392	1,133
Heifers	Medium2	MidWest	1	81	750	49,044	951	4,163	1,090
Heifers	Medium2	Pacific	1	106	750	53,644	1,065	5,057	1,308
Heifers	Medium2	South	1	-	750	53,495	1,004	4,598	1,191
Heifers	Medium2	Central	2	43	750	51,507	1,259	5,962	1,672

Table C-5 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Heifers	Medium2	MidAtlantic	2	-	750	52,731	1,039	5,380	1,262
Heifers	Medium2	MidWest	2	12	750	49,519	990	4,638	1,160
Heifers	Medium2	Pacific	2	33	750	53,809	1,086	5,952	1,349
Heifers	Medium2	South	2	-	750	53,684	1,028	5,317	1,228
Heifers	Medium2	Central	3	18	750	17,625	190	2,145	600
Heifers	Medium2	MidAtlantic	3	-	750	22,008	190	2,364	600
Heifers	Medium2	MidWest	3	7	750	19,331	190	2,233	600
Heifers	Medium2	Pacific	3	11	750	22,615	190	2,394	600
Heifers	Medium2	South	3	-	750	23,145	190	2,421	600
Veal	Medium1	Central	1	5	400	-	1,075	1,514	1,318
Veal	Medium1	MidAtlantic	1	1	400	-	1,075	1,514	1,317
Veal	Medium1	MidWest	1	119	400	-	1,075	1,514	1,317
Veal	Medium1	Pacific	1	-	400	-	1,075	1,514	1,318
Veal	Medium1	South	1	-	400	-	1,075	1,514	1,318
Veal	Medium1	Central	2	-	400	-	690	1,290	600
Veal	Medium1	MidAtlantic	2	-	400	-	690	1,290	600
Veal	Medium1	MidWest	2	-	400	-	690	1,290	600
Veal	Medium1	Pacific	2	-	400	-	690	1,290	600
Veal	Medium1	South	2	-	400	-	690	1,290	600
Veal	Medium1	Central	3	-	400	-	190	1,210	600
Veal	Medium1	MidAtlantic	3	-	400	-	190	1,210	600
Veal	Medium1	MidWest	3	-	400	-	190	1,210	600
Veal	Medium1	Pacific	3	-	400	-	190	1,210	600
Veal	Medium1	South	3	-	400	-	190	1,210	600

Table C-5 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Veal	Medium2	Central	1	3	540	-	1,075	1,514	1,318
Veal	Medium2	MidAtlantic	1	1	540	-	1,075	1,514	1,317
Veal	Medium2	MidWest	1	81	540	-	1,075	1,514	1,317
Veal	Medium2	Pacific	1	-	540	-	1,075	1,514	1,318
Veal	Medium2	South	1	-	540	-	1,075	1,514	1,318
Veal	Medium2	Central	2	-	540	-	690	1,290	600
Veal	Medium2	MidAtlantic	2	-	540	-	690	1,290	600
Veal	Medium2	MidWest	2	-	540	-	690	1,290	600
Veal	Medium2	Pacific	2	-	540	-	690	1,290	600
Veal	Medium2	South	2	-	540	-	690	1,290	600
Veal	Medium2	Central	3	-	540	-	190	1,210	600
Veal	Medium2	MidAtlantic	3	-	540	-	190	1,210	600
Veal	Medium2	MidWest	3	-	540	-	190	1,210	600
Veal	Medium2	Pacific	3	-	540	-	190	1,210	600
Veal	Medium2	South	3	-	540	-	190	1,210	600

Table C-6

Model Farm Costs for EPA Regulatory Option 6

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Beef	Large1	Central	1	152	2,628	869	3,352	2,882	5,612
Beef	Large1	MidAtlantic	1	13	2,628	2,464	2,420	2,420	3,862
Beef	Large1	MidWest	1	801	2,628	2,321	2,548	2,487	4,096
Beef	Large1	Pacific	1	22	2,628	1,741	3,144	2,805	5,216
Beef	Large1	South	1	3	2,628	3,771	2,778	2,693	4,521
Beef	Large1	Central	2	143	2,628	869	3,985	16,029	6,797
Beef	Large1	MidAtlantic	2	9	2,628	2,464	2,298	13,469	3,621
Beef	Large1	MidWest	2	299	2,628	2,321	1,811	23,912	2,713
Beef	Large1	Pacific	2	27	2,628	1,741	2,812	23,255	4,583
Beef	Large1	South	2	2	2,628	3,771	2,614	17,620	4,214
Beef	Large1	Central	3	37	2,628	869	190	1,253	600
Beef	Large1	MidAtlantic	3	3	2,628	2,464	190	1,333	600
Beef	Large1	MidWest	3	136	2,628	2,321	190	1,326	600
Beef	Large1	Pacific	3	6	2,628	1,741	190	1,297	600
Beef	Large1	South	3	1	2,628	3,771	190	1,399	600
Beef	Large2	Central	1	8	43,805	12,238	32,110	20,182	59,719
Beef	Large2	MidAtlantic	1	-	43,805	38,849	25,630	17,743	47,522
Beef	Large2	MidWest	1	16	43,805	36,430	30,960	20,722	57,556
Beef	Large2	Pacific	1	1	43,805	26,754	34,574	22,341	64,367
Beef	Large2	South	1	-	43,805	60,622	30,666	21,761	57,004
Beef	Large2	Central	2	103	43,805	387,507	46,972	109,774	87,690

Table C-6 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Beef	Large2	MidAtlantic	2	-	43,805	38,849	24,601	161,515	45,589
Beef	Large2	MidWest	2	116	43,805	580,585	21,138	103,312	39,075
Beef	Large2	Pacific	2	13	43,805	26,754	35,006	305,125	65,170
Beef	Large2	South	2	-	43,805	60,622	29,544	201,385	54,892
Beef	Large2	Central	3	71	43,805	12,238	190	1,822	600
Beef	Large2	MidAtlantic	3	-	43,805	38,849	190	3,152	600
Beef	Large2	MidWest	3	85	43,805	36,430	190	3,032	600
Beef	Large2	Pacific	3	9	43,805	26,754	190	2,548	600
Beef	Large2	South	3	-	43,805	60,622	190	4,241	600
Beef	Medium1	Central	1	65	400	41,488	1,162	4,162	1,485
Beef	Medium1	MidAtlantic	1	116	400	41,610	991	3,791	1,160
Beef	Medium1	MidWest	1	557	400	39,795	1,005	3,973	1,185
Beef	Medium1	Pacific	1	25	400	43,854	1,139	4,770	1,448
Beef	Medium1	South	1	31	400	44,360	1,148	4,728	1,458
Beef	Medium1	MidAtlantic	3	10	400	11,355	190	1,712	600
Beef	Medium1	MidWest	3	48	400	9,479	190	1,622	600
Beef	Medium1	Pacific	3	2	400	11,859	190	1,738	600
Beef	Medium1	South	3	3	400	12,101	190	1,750	600
Beef	Medium1	Central	2	15	400	45,174	1,429	5,584	1,981
Beef	Medium1	MidAtlantic	2	23	400	42,861	1,098	4,628	1,366
Beef	Medium1	MidWest	2	80	400	40,581	1,064	4,329	1,293
Beef	Medium1	Pacific	2	8	400	44,588	1,204	5,390	1,561
Beef	Medium1	South	2	8	400	45,668	1,258	5,479	1,671
Beef	Medium1	Central	3	6	400	8,366	190	1,563	600

Table C-6 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Beef	Medium2	Central	1	99	1,088	61,325	1,974	6,535	3,018
Beef	Medium2	MidAtlantic	1	27	1,088	51,874	1,510	6,130	2,145
Beef	Medium2	MidWest	1	659	1,088	48,199	1,543	6,225	2,206
Beef	Medium2	Pacific	1	13	1,088	60,336	1,910	7,261	2,894
Beef	Medium2	South	1	5	1,088	62,761	1,935	7,253	2,935
Beef	Medium2	Central	2	22	1,088	72,897	2,518	9,190	4,040
Beef	Medium2	MidAtlantic	2	5	1,088	54,889	1,683	7,945	2,470
Beef	Medium2	MidWest	2	94	1,088	49,580	1,585	7,304	2,283
Beef	Medium2	Pacific	2	4	1,088	60,737	1,969	9,068	3,001
Beef	Medium2	South	2	1	1,088	64,706	2,080	8,673	3,213
Beef	Medium2	Central	3	9	1,088	7,501	190	1,477	600
Beef	Medium2	MidAtlantic	3	2	1,088	13,266	190	1,766	600
Beef	Medium2	MidWest	3	57	1,088	9,702	190	1,593	600
Beef	Medium2	Pacific	3	1	1,088	14,043	190	1,804	600
Beef	Medium2	South	3	0	1,088	14,877	190	1,846	600
Dairy	Large1	Central	1	88	1,419	321,284	2,458	(39,295)	3,933
Dairy	Large1	MidAtlantic	1	15	1,419	341,247	2,759	(40,410)	4,491
Dairy	Large1	MidWest	1	18	1,419	341,247	2,795	(40,389)	4,554
Dairy	Large1	Pacific	1	132	1,419	321,284	2,530	(39,253)	4,057
Dairy	Large1	South	1	17	1,419	321,284	2,382	(39,339)	3,783
Dairy	Large1	Central	2	227	1,419	321,284	1,228	30,562	1,603
Dairy	Large1	MidAtlantic	2	49	1,419	341,247	1,075	4,346	1,314
Dairy	Large1	MidWest	2	52	1,419	341,247	1,281	(5,383)	1,709
Dairy	Large1	Pacific	2	481	1,419	321,284	1,010	27,515	1,203

Table C-6 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Dairy	Large1	South	2	49	1,419	321,284	742	(4,907)	690
Dairy	Large1	Central	3	89	1,419	321,284	190	(40,403)	600
Dairy	Large1	MidAtlantic	3	18	1,419	341,247	190	(41,694)	600
Dairy	Large1	MidWest	3	20	1,419	341,247	190	(41,694)	600
Dairy	Large1	Pacific	3	173	1,419	321,284	190	(40,403)	600
Dairy	Large1	South	3	18	1,419	321,284	190	(40,403)	600
Dairy	Medium1	Central	1	230	235	20,653	1,064	2,193	1,310
Dairy	Medium1	Central	3	83	235	17,528	190	1,681	600
Dairy	Medium1	MidAtlantic	3	122	235	13,367	190	1,616	600
Dairy	Medium1	MidWest	3	132	235	12,711	190	1,585	600
Dairy	Medium1	Pacific	3	101	235	18,968	190	1,753	600
Dairy	Medium1	South	3	35	235	18,656	190	1,737	600
Dairy	Medium1	MidAtlantic	1	333	235	17,964	1,037	2,241	1,249
Dairy	Medium1	MidWest	1	372	235	17,349	1,060	2,244	1,294
Dairy	Medium1	Pacific	1	253	235	21,991	1,004	2,229	1,187
Dairy	Medium1	South	1	111	235	21,627	955	2,150	1,093
Dairy	Medium1	Central	2	280	235	20,717	1,122	4,998	1,412
Dairy	Medium1	MidAtlantic	2	415	235	17,932	1,019	4,249	1,214
Dairy	Medium1	MidWest	2	438	235	17,328	1,048	3,922	1,268
Dairy	Medium1	Pacific	2	368	235	21,954	971	4,843	1,121
Dairy	Medium1	South	2	107	235	21,592	919	4,188	1,025
Dairy	Medium2	Central	1	168	460	180,161	1,422	(6,133)	1,972
Dairy	Medium2	MidAtlantic	1	186	460	188,664	1,368	(7,555)	1,872
Dairy	Medium2	MidWest	1	196	460	187,653	1,411	(7,564)	1,959

Table C-6 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Dairy	Medium2	Pacific	1	254	460	182,312	1,306	(6,078)	1,757
Dairy	Medium2	South	1	74	460	181,678	1,209	(6,195)	1,569
Dairy	Medium2	Central	2	205	460	179,546	1,057	10,865	1,289
Dairy	Medium2	MidAtlantic	2	233	460	187,808	937	5,610	1,060
Dairy	Medium2	MidWest	2	231	460	186,809	1,006	2,649	1,192
Dairy	Medium2	Pacific	2	370	460	181,811	902	10,904	993
Dairy	Medium2	South	2	72	460	181,238	802	6,331	812
Dairy	Medium2	Central	3	61	460	176,444	190	(6,987)	600
Dairy	Medium2	MidAtlantic	3	68	460	183,378	190	(8,572)	600
Dairy	Medium2	MidWest	3	70	460	182,265	190	(8,625)	600
Dairy	Medium2	Pacific	3	102	460	178,897	190	(6,864)	600
Dairy	Medium2	South	3	24	460	178,395	190	(6,889)	600
Heifers	Large1	Central	1	83	1,500	532	1,372	1,713	1,881
Heifers	Large1	MidAtlantic	1	-	1,500	1,386	1,202	1,657	1,565
Heifers	Large1	MidWest	1	-	1,500	1,308	1,152	1,624	1,472
Heifers	Large1	Pacific	1	48	1,500	999	1,325	1,710	1,798
Heifers	Large1	South	1	-	1,500	2,084	1,139	1,656	1,439
Heifers	Large1	Central	2	78	1,500	532	2,038	2,295	3,139
Heifers	Large1	MidAtlantic	2	-	1,500	1,386	1,485	2,052	2,092
Heifers	Large1	MidWest	2	-	1,500	1,308	1,247	1,929	1,646
Heifers	Large1	Pacific	2	58	1,500	999	1,548	2,565	2,205
Heifers	Large1	South	2	-	1,500	2,084	1,378	2,222	1,890
Heifers	Large1	Central	3	20	1,500	532	190	1,237	600
Heifers	Large1	MidAtlantic	3	-	1,500	1,386	190	1,279	600

Table C-6 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Heifers	Large1	MidWest	3	-	1,500	1,308	190	1,275	600
Heifers	Large1	Pacific	3	13	1,500	999	190	1,260	600
Heifers	Large1	South	3	-	1,500	2,084	190	1,314	600
Heifers	Medium1	Central	3	2	400	7,236	190	1,538	600
Heifers	Medium1	MidAtlantic	3	-	400	10,157	190	1,684	600
Heifers	Medium1	MidWest	3	14	400	8,346	190	1,596	600
Heifers	Medium1	Pacific	3	2	400	10,615	190	1,707	600
Heifers	Medium1	South	3	-	400	10,833	190	1,718	600
Heifers	Medium1	Central	1	19	400	36,722	901	2,816	990
Heifers	Medium1	MidAtlantic	1	-	400	38,836	844	2,511	890
Heifers	Medium1	MidWest	1	163	400	36,821	829	2,218	858
Heifers	Medium1	Pacific	1	18	400	39,674	890	3,037	971
Heifers	Medium1	South	1	-	400	39,701	858	2,818	909
Heifers	Medium1	Central	2	4	400	37,038	945	4,782	1,076
Heifers	Medium1	MidAtlantic	2	-	400	38,877	841	4,049	878
Heifers	Medium1	MidWest	2	23	400	36,946	825	3,368	847
Heifers	Medium1	Pacific	2	6	400	39,481	869	4,530	931
Heifers	Medium1	South	2	-	400	39,399	830	3,590	859
Heifers	Medium2	Central	1	190	750	40,313	1,088	3,877	1,341
Heifers	Medium2	MidAtlantic	1	-	750	42,915	978	3,833	1,133
Heifers	Medium2	MidWest	1	81	750	39,888	951	3,605	1,090
Heifers	Medium2	Pacific	1	106	750	44,488	1,065	4,499	1,308
Heifers	Medium2	South	1	-	750	44,339	1,004	4,039	1,191
Heifers	Medium2	Central	2	43	750	42,350	1,259	5,440	1,672

Table C-6 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Heifers	Medium2	MidAtlantic	2	-	750	43,575	1,039	4,862	1,262
Heifers	Medium2	MidWest	2	12	750	40,362	990	4,101	1,160
Heifers	Medium2	Pacific	2	33	750	44,653	1,086	5,442	1,349
Heifers	Medium2	South	2	-	750	44,527	1,028	4,789	1,228
Heifers	Medium2	Central	3	18	750	8,468	190	1,586	600
Heifers	Medium2	MidAtlantic	3	-	750	12,851	190	1,806	600
Heifers	Medium2	MidWest	3	7	750	10,174	190	1,674	600
Heifers	Medium2	Pacific	3	11	750	13,458	190	1,836	600
Heifers	Medium2	South	3	-	750	13,988	190	1,863	600
Veal	Medium1	Central	1	5	400	-	1,075	1,514	1,318
Veal	Medium1	MidAtlantic	1	1	400	-	1,075	1,514	1,317
Veal	Medium1	MidWest	1	119	400	-	1,075	1,514	1,317
Veal	Medium1	Pacific	1	-	400	-	1,075	1,514	1,318
Veal	Medium1	South	1	-	400	-	1,075	1,514	1,318
Veal	Medium1	Central	2	-	400	-	690	1,290	600
Veal	Medium1	MidAtlantic	2	-	400	-	690	1,290	600
Veal	Medium1	MidWest	2	-	400	-	690	1,290	600
Veal	Medium1	Pacific	2	-	400	-	690	1,290	600
Veal	Medium1	South	2	-	400	-	690	1,290	600
Veal	Medium1	Central	3	-	400	-	190	1,210	600
Veal	Medium1	MidAtlantic	3	-	400	-	190	1,210	600
Veal	Medium1	MidWest	3	-	400	-	190	1,210	600
Veal	Medium1	Pacific	3	-	400	-	190	1,210	600
Veal	Medium1	South	3	-	400	-	190	1,210	600

Table C-6 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Veal	Medium2	Central	1	3	540	-	1,075	1,514	1,318
Veal	Medium2	MidAtlantic	1	1	540	-	1,075	1,514	1,317
Veal	Medium2	MidWest	1	81	540	-	1,075	1,514	1,317
Veal	Medium2	Pacific	1	-	540	-	1,075	1,514	1,318
Veal	Medium2	South	1	-	540	-	1,075	1,514	1,318
Veal	Medium2	Central	2	-	540	-	690	1,290	600
Veal	Medium2	MidAtlantic	2	-	540	-	690	1,290	600
Veal	Medium2	MidWest	2	-	540	-	690	1,290	600
Veal	Medium2	Pacific	2	-	540	-	690	1,290	600
Veal	Medium2	South	2	-	540	-	690	1,290	600
Veal	Medium2	Central	3	-	540	-	190	1,210	600
Veal	Medium2	MidAtlantic	3	-	540	-	190	1,210	600
Veal	Medium2	MidWest	3	-	540	-	190	1,210	600
Veal	Medium2	Pacific	3	-	540	-	190	1,210	600
Veal	Medium2	South	3	-	540	-	190	1,210	600

Table C-7

Model Farm Costs for EPA Regulatory Option 7

Animal	Size Group	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M	3-Year Recurring O&M Costs
Beef	Large1	Central	1	152	2,628	20,155	3,352	3,846	5,612
Beef	Large1	MidAtlantic	1	13	2,628	47,073	2,420	4,650	3,862
Beef	Large1	MidWest	1	801	2,628	14,357	2,548	3,089	4,096
Beef	Large1	Pacific	1	22	2,628	45,036	3,144	4,970	5,216
Beef	Large1	South	1	3	2,628	3,771	2,778	2,693	4,521
Beef	Large2	Central	1	8	43,805	128,183	32,110	25,979	59,719
Beef	Large2	MidAtlantic	1	-	43,805	297,158	25,630	30,658	47,522
Beef	Large2	MidWest	1	16	43,805	105,992	30,960	24,200	57,556
Beef	Large2	Pacific	1	1	43,805	287,781	34,574	35,392	64,367
Beef	Large2	South	1	-	43,805	60,622	30,666	21,761	57,004
Dairy	Large1	Central	1	88	1,419	273,999	2,458	14,034	3,933
Dairy	Large1	MidAtlantic	1	15	1,419	349,278	2,759	18,597	4,491
Dairy	Large1	MidWest	1	18	1,419	280,372	2,795	15,173	4,554
Dairy	Large1	Pacific	1	132	1,419	290,359	2,530	14,893	4,057
Dairy	Large1	South	1	17	1,419	168,524	2,382	8,716	3,783
Beef	Medium2	Central	1	99	1,088	78,618	1,974	7,400	3,018
Beef	Medium2	MidAtlantic	1	27	1,088	66,676	1,510	6,870	2,145
Beef	Medium2	MidWest	1	659	1,088	55,271	1,543	6,578	2,206
Beef	Medium2	Pacific	1	13	1,088	74,817	1,910	7,985	2,894
Beef	Medium2	South	1	5	1,088	62,761	1,935	7,253	2,935
Dairy	Medium2	Central	1	168	460	109,228	1,422	6,665	1,972

Table C-7 (Continued)

Animal	Size Group	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M	3-Year Recurring O&M Costs
Dairy	Medium2	MidAtlantic	1	186	460	136,137	1,368	8,359	1,872
Dairy	Medium2	MidWest	1	196	460	108,918	1,411	7,039	1,959
Dairy	Medium2	Pacific	1	254	460	119,249	1,306	7,112	1,757
Dairy	Medium2	South	1	74	460	74,211	1,209	4,776	1,569
Veal	Medium2	Central	1	3	540	-	1,075	1,514	1,318
Veal	Medium2	MidAtlantic	1	1	540	-	1,075	1,514	1,317
Veal	Medium2	MidWest	1	81	540	-	1,075	1,514	1,317
Veal	Medium2	Pacific	1	-	540	-	1,075	1,514	1,318
Veal	Medium2	South	1	-	540	-	1,075	1,514	1,318
Heifers	Medium2	Central	1	190	750	40,313	1,088	3,877	1,341
Heifers	Medium2	MidAtlantic	1	-	750	42,915	978	3,833	1,133
Heifers	Medium2	MidWest	1	81	750	39,888	951	3,605	1,090
Heifers	Medium2	Pacific	1	106	750	44,488	1,065	4,499	1,308
Heifers	Medium2	South	1	-	750	44,339	1,004	4,039	1,191
Heifers	Large1	Central	1	83	1,500	532	1,372	1,713	1,881
Heifers	Large1	MidAtlantic	1	-	1,500	1,386	1,202	1,657	1,565
Heifers	Large1	MidWest	1	-	1,500	1,308	1,152	1,624	1,472
Heifers	Large1	Pacific	1	48	1,500	999	1,325	1,710	1,798
Heifers	Large1	South	1	-	1,500	2,084	1,139	1,656	1,439
Beef	Medium1	Central	1	65	400	41,488	1,162	4,162	1,485
Beef	Medium1	MidAtlantic	1	116	400	41,610	991	3,791	1,160
Beef	Medium1	MidWest	1	557	400	39,795	1,005	3,973	1,185
Beef	Medium1	Pacific	1	25	400	43,854	1,139	4,770	1,448
Beef	Medium1	South	1	31	400	44,360	1,148	4,728	1,458

Table C-7 (Continued)

Animal	Size Group	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M	3-Year Recurring O&M Costs
Dairy	Medium1	Central	1	230	235	20,653	1,064	2,193	1,310
Dairy	Medium1	MidAtlantic	1	333	235	17,964	1,037	2,241	1,249
Dairy	Medium1	MidWest	1	372	235	17,349	1,060	2,244	1,294
Dairy	Medium1	Pacific	1	253	235	21,991	1,004	2,229	1,187
Dairy	Medium1	South	1	111	235	21,627	955	2,150	1,093
Heifers	Medium1	Central	1	19	400	36,722	901	2,816	990
Heifers	Medium1	MidAtlantic	1	-	400	38,836	844	2,511	890
Heifers	Medium1	MidWest	1	163	400	36,821	829	2,218	858
Heifers	Medium1	Pacific	1	18	400	39,674	890	3,037	971
Heifers	Medium1	South	1	-	400	39,701	858	2,818	909
Veal	Medium1	Central	1	5	540	-	1,075	1,514	1,318
Veal	Medium1	MidAtlantic	1	1	540	-	1,075	1,514	1,317
Veal	Medium1	MidWest	1	119	540	-	1,075	1,514	1,317
Veal	Medium1	Pacific	1	-	540	-	1,075	1,514	1,318
Veal	Medium1	South	1	-	540	-	1,075	1,514	1,318
Beef	Large1	Central	2	143	2,628	20,155	3,985	16,993	6,797
Beef	Large1	MidAtlantic	2	9	2,628	47,073	2,298	15,699	3,621
Beef	Large1	MidWest	2	299	2,628	14,357	1,811	24,514	2,713
Beef	Large1	Pacific	2	27	2,628	45,036	2,812	25,420	4,583
Beef	Large1	South	2	2	2,628	3,771	2,614	17,620	4,214
Beef	Large2	Central	2	103	43,805	503,452	46,972	115,571	87,690
Beef	Large2	MidAtlantic	2	-	43,805	297,158	24,601	174,430	45,589
Beef	Large2	MidWest	2	116	43,805	650,147	21,138	106,790	39,075
Beef	Large2	Pacific	2	13	43,805	287,781	35,006	318,176	65,170

Table C-7 (Continued)

Animal	Size Group	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M	3-Year Recurring O&M Costs
Beef	Large2	South	2	-	43,805	60,622	29,544	201,385	54,892
Dairy	Large1	Central	2	227	1,419	273,999	1,228	78,162	1,603
Dairy	Large1	MidAtlantic	2	49	1,419	349,278	1,075	57,990	1,314
Dairy	Large1	MidWest	2	52	1,419	280,372	1,281	45,242	1,709
Dairy	Large1	Pacific	2	481	1,419	290,359	1,010	76,755	1,203
Dairy	Large1	South	2	49	1,419	168,524	742	40,386	690
Beef	Medium2	Central	2	22	1,088	90,190	2,518	10,055	4,040
Beef	Medium2	MidAtlantic	2	5	1,088	69,691	1,683	8,685	2,470
Beef	Medium2	MidWest	2	94	1,088	56,652	1,585	7,658	2,283
Beef	Medium2	Pacific	2	4	1,088	75,218	1,969	9,792	3,001
Beef	Medium2	South	2	1	1,088	64,706	2,080	8,673	3,213
Dairy	Medium2	Central	2	205	460	108,613	1,057	21,077	1,289
Dairy	Medium2	MidAtlantic	2	233	460	135,282	937	18,846	1,060
Dairy	Medium2	MidWest	2	231	460	108,074	1,006	14,994	1,192
Dairy	Medium2	Pacific	2	370	460	118,748	902	21,607	993
Dairy	Medium2	South	2	72	460	73,771	802	15,323	812
Veal	Medium2	Central	2	-	540	-	690	1,290	600
Veal	Medium2	MidAtlantic	2	-	540	-	690	1,290	600
Veal	Medium2	MidWest	2	-	540	-	690	1,290	600
Veal	Medium2	Pacific	2	-	540	-	690	1,290	600
Veal	Medium2	South	2	-	540	-	690	1,290	600
Heifers	Medium2	Central	2	43	750	42,350	1,259	7,144	1,672
Heifers	Medium2	MidAtlantic	2	-	750	43,575	1,039	4,862	1,262
Heifers	Medium2	MidWest	2	12	750	40,362	990	4,101	1,160

Table C-7 (Continued)

Animal	Size Group	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M	3-Year Recurring O&M Costs
Heifers	Medium2	Pacific	2	33	750	44,653	1,086	5,442	1,349
Heifers	Medium2	South	2	-	750	44,527	1,028	4,789	1,228
Heifers	Large1	Central	2	78	1,500	532	2,038	2,295	3,139
Heifers	Large1	MidAtlantic	2	-	1,500	1,386	1,485	2,052	2,092
Heifers	Large1	MidWest	2	-	1,500	1,308	1,247	1,929	1,646
Heifers	Large1	Pacific	2	58	1,500	999	1,548	2,565	2,205
Heifers	Large1	South	2	-	1,500	2,084	1,378	2,222	1,890
Beef	Medium1	Central	2	15	400	45,174	1,429	5,584	1,981
Beef	Medium1	MidAtlantic	2	23	400	42,861	1,098	4,628	1,366
Beef	Medium1	MidWest	2	80	400	40,581	1,064	4,329	1,293
Beef	Medium1	Pacific	2	8	400	44,588	1,204	5,390	1,561
Beef	Medium1	South	2	8	400	45,668	1,258	5,479	1,671
Dairy	Medium1	Central	2	280	235	20,717	1,122	3,741	1,412
Dairy	Medium1	MidAtlantic	2	415	235	17,932	1,019	3,035	1,214
Dairy	Medium1	MidWest	2	438	235	17,328	1,048	2,824	1,268
Dairy	Medium1	Pacific	2	368	235	21,954	971	3,676	1,121
Dairy	Medium1	South	2	107	235	21,592	919	3,212	1,025
Heifers	Medium1	Central	2	4	400	37,038	945	6,146	1,076
Heifers	Medium1	MidAtlantic	2	-	400	38,877	841	4,049	878
Heifers	Medium1	MidWest	2	23	400	36,946	825	3,368	847
Heifers	Medium1	Pacific	2	6	400	39,481	869	4,530	931
Heifers	Medium1	South	2	-	400	39,399	830	4,359	859
Veal	Medium1	Central	2	-	540	-	690	1,290	600
Veal	Medium1	MidAtlantic	2	-	540	-	690	1,290	600

Table C-7 (Continued)

Animal	Size Group	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M	3-Year Recurring O&M Costs
Veal	Medium1	MidWest	2	-	540	-	690	1,290	600
Veal	Medium1	Pacific	2	-	540	-	690	1,290	600
Veal	Medium1	South	2	-	540	-	690	1,290	600
Beef	Large1	Central	3	37	2,628	20,155	190	2,217	600
Beef	Large1	MidAtlantic	3	3	2,628	47,073	190	3,563	600
Beef	Large1	MidWest	3	136	2,628	14,357	190	1,928	600
Beef	Large1	Pacific	3	6	2,628	45,036	190	3,462	600
Beef	Large1	South	3	1	2,628	3,771	190	1,399	600
Beef	Large2	Central	3	71	43,805	128,183	190	7,619	600
Beef	Large2	MidAtlantic	3	-	43,805	297,158	190	16,067	600
Beef	Large2	MidWest	3	85	43,805	105,992	190	6,510	600
Beef	Large2	Pacific	3	9	43,805	287,781	190	15,599	600
Beef	Large2	South	3	-	43,805	60,622	190	4,241	600
Dairy	Large1	Central	3	89	1,419	273,999	190	12,925	600
Dairy	Large1	MidAtlantic	3	18	1,419	349,278	190	17,313	600
Dairy	Large1	MidWest	3	20	1,419	280,372	190	13,868	600
Dairy	Large1	Pacific	3	173	1,419	290,359	190	13,743	600
Dairy	Large1	South	3	18	1,419	168,524	190	7,652	600
Beef	Medium2	Central	3	9	1,088	24,794	190	2,342	600
Beef	Medium2	MidAtlantic	3	2	1,088	28,068	190	2,506	600
Beef	Medium2	MidWest	3	57	1,088	16,774	190	1,947	600
Beef	Medium2	Pacific	3	1	1,088	28,524	190	2,528	600
Beef	Medium2	South	3	0	1,088	14,877	190	1,846	600
Dairy	Medium2	Central	3	61	460	105,511	190	5,811	600

Table C-7 (Continued)

Animal	Size Group	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M	3-Year Recurring O&M Costs
Dairy	Medium2	MidAtlantic	3	68	460	130,852	190	7,341	600
Dairy	Medium2	MidWest	3	70	460	103,530	190	5,978	600
Dairy	Medium2	Pacific	3	102	460	115,834	190	6,327	600
Dairy	Medium2	South	3	24	460	70,929	190	4,081	600
Veal	Medium2	Central	3	-	540	-	190	1,210	600
Veal	Medium2	MidAtlantic	3	-	540	-	190	1,210	600
Veal	Medium2	MidWest	3	-	540	-	190	1,210	600
Veal	Medium2	Pacific	3	-	540	-	190	1,210	600
Veal	Medium2	South	3	-	540	-	190	1,210	600
Heifers	Medium2	Central	3	18	750	8,468	190	1,586	600
Heifers	Medium2	MidAtlantic	3	-	750	12,851	190	1,806	600
Heifers	Medium2	MidWest	3	7	750	10,174	190	1,674	600
Heifers	Medium2	Pacific	3	11	750	13,458	190	1,836	600
Heifers	Medium2	South	3	-	750	13,988	190	1,863	600
Heifers	Large1	Central	3	20	1,500	532	190	1,237	600
Heifers	Large1	MidAtlantic	3	-	1,500	1,386	190	1,279	600
Heifers	Large1	MidWest	3	-	1,500	1,308	190	1,275	600
Heifers	Large1	Pacific	3	13	1,500	999	190	1,260	600
Heifers	Large1	South	3	-	1,500	2,084	190	1,314	600
Beef	Medium1	Central	3	6	400	8,366	190	1,563	600
Beef	Medium1	MidAtlantic	3	10	400	11,355	190	1,712	600
Beef	Medium1	MidWest	3	48	400	9,479	190	1,622	600
Beef	Medium1	Pacific	3	2	400	11,859	190	1,738	600
Beef	Medium1	South	3	3	400	12,101	190	1,750	600

Table C-7 (Continued)

Animal	Size Group	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M	3-Year Recurring O&M Costs
Dairy	Medium1	Central	3	83	235	17,528	190	1,681	600
Dairy	Medium1	MidAtlantic	3	122	235	13,367	190	1,616	600
Dairy	Medium1	MidWest	3	132	235	12,711	190	1,585	600
Dairy	Medium1	Pacific	3	101	235	18,968	190	1,753	600
Dairy	Medium1	South	3	35	235	18,656	190	1,737	600
Heifers	Medium1	Central	3	2	400	7,236	190	1,538	600
Heifers	Medium1	MidAtlantic	3	-	400	10,157	190	1,684	600
Heifers	Medium1	MidWest	3	14	400	8,346	190	1,596	600
Heifers	Medium1	Pacific	3	2	400	10,615	190	1,707	600
Heifers	Medium1	South	3	-	400	10,833	190	1,718	600
Veal	Medium1	Central	3	-	540	-	190	1,210	600
Veal	Medium1	MidAtlantic	3	-	540	-	190	1,210	600
Veal	Medium1	MidWest	3	-	540	-	190	1,210	600
Veal	Medium1	Pacific	3	-	540	-	190	1,210	600
Veal	Medium1	South	3	-	540	-	190	1,210	600

Table C-8

Model Farm Costs for EPA Regulatory Option 8

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Beef	Large1	Central	1	152	2,628	1,659	3,352	2,986	5,612
Beef	Large1	Central	2	143	2,628	1,659	3,985	16,133	6,797
Beef	Large1	Central	3	37	2,628	1,659	690	1,438	600
Beef	Large1	MidAtlantic	1	13	2,628	3,922	2,420	2,612	3,862
Beef	Large1	MidAtlantic	2	9	2,628	3,922	2,298	13,662	3,621
Beef	Large1	MidAtlantic	3	3	2,628	3,922	690	1,606	600
Beef	Large1	MidWest	1	801	2,628	3,961	2,548	2,703	4,096
Beef	Large1	MidWest	2	299	2,628	3,961	1,811	24,128	2,713
Beef	Large1	MidWest	3	136	2,628	3,961	690	1,622	600
Beef	Large1	Pacific	1	22	2,628	2,470	3,144	2,901	5,216
Beef	Large1	Pacific	2	27	2,628	2,470	2,812	23,352	4,583
Beef	Large1	Pacific	3	6	2,628	2,470	690	1,473	600
Beef	Large1	South	1	3	2,628	5,107	2,778	2,870	4,521
Beef	Large1	South	2	2	2,628	5,107	2,614	17,796	4,214
Beef	Large1	South	3	1	2,628	5,107	690	1,655	600
Beef	Large2	Central	1	8	43,805	13,028	32,110	20,286	59,719
Beef	Large2	Central	2	103	43,805	388,297	46,972	109,878	87,690
Beef	Large2	Central	3	71	43,805	13,028	690	2,006	600
Beef	Large2	MidAtlantic	1	-	43,805	40,307	25,630	17,935	47,522
Beef	Large2	MidAtlantic	2	-	43,805	40,307	24,601	161,707	45,589
Beef	Large2	MidAtlantic	3	-	43,805	40,307	690	3,425	600

Table C-8 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Beef	Large2	MidWest	1	16	43,805	38,070	30,960	20,939	57,556
Beef	Large2	MidWest	2	116	43,805	582,226	21,138	103,528	39,075
Beef	Large2	MidWest	3	85	43,805	38,070	690	3,328	600
Beef	Large2	Pacific	1	1	43,805	27,483	34,574	22,437	64,367
Beef	Large2	Pacific	2	13	43,805	27,483	35,006	305,221	65,170
Beef	Large2	Pacific	3	9	43,805	27,483	690	2,724	600
Beef	Large2	South	1	-	43,805	61,958	30,666	21,937	57,004
Beef	Large2	South	2	-	43,805	61,958	29,544	201,561	54,892
Beef	Large2	South	3	-	43,805	61,958	690	4,497	600
Beef	Medium1	Central	1	65	600	49,643	1,399	5,337	1,936
Beef	Medium1	Central	2	15	600	57,322	1,837	6,922	2,750
Beef	Medium1	Central	3	6	600	11,883	690	1,869	600
Beef	Medium1	MidAtlantic	1	116	600	49,340	1,144	5,090	1,449
Beef	Medium1	MidAtlantic	2	23	600	51,877	1,324	6,020	1,791
Beef	Medium1	MidAtlantic	3	10	600	17,058	690	2,182	600
Beef	Medium1	MidWest	1	557	600	46,893	1,161	5,234	1,486
Beef	Medium1	MidWest	2	80	600	48,681	1,273	5,702	1,692
Beef	Medium1	MidWest	3	48	600	14,596	690	2,079	600
Beef	Medium1	Pacific	1	25	600	54,218	1,363	6,095	1,862
Beef	Medium1	Pacific	2	8	600	55,967	1,489	6,826	2,105
Beef	Medium1	Pacific	3	2	600	18,871	690	2,213	600
Beef	Medium1	South	1	31	600	54,467	1,378	6,079	1,899
Beef	Medium1	South	2	8	600	57,339	1,573	6,952	2,264
Beef	Medium1	South	3	3	600	18,567	690	2,248	600

Table C-8 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Beef	Medium2	Central	1	99	1,088	64,745	1,974	6,770	3,018
Beef	Medium2	Central	2	22	1,088	76,318	2,518	9,426	4,040
Beef	Medium2	Central	3	9	1,088	10,921	690	1,793	600
Beef	Medium2	MidAtlantic	1	27	1,088	56,766	1,510	6,494	2,145
Beef	Medium2	MidAtlantic	2	5	1,088	59,782	1,683	8,309	2,470
Beef	Medium2	MidAtlantic	3	2	1,088	18,158	690	2,209	600
Beef	Medium2	MidWest	1	659	1,088	53,059	1,543	6,603	2,206
Beef	Medium2	MidWest	2	94	1,088	54,441	1,585	7,682	2,283
Beef	Medium2	MidWest	3	57	1,088	14,563	690	2,051	600
Beef	Medium2	Pacific	1	13	1,088	67,653	1,910	7,686	2,894
Beef	Medium2	Pacific	2	4	1,088	68,055	1,969	9,494	3,001
Beef	Medium2	Pacific	3	1	1,088	21,361	690	2,310	600
Beef	Medium2	South	1	5	1,088	68,670	1,935	7,658	2,935
Beef	Medium2	South	2	1	1,088	70,615	2,080	9,078	3,213
Beef	Medium2	South	3	0	1,088	20,786	690	2,331	600
Dairy	Large1	Central	1	88	1,419	6,306,619	2,458	283,589	3,933
Dairy	Large1	Central	2	227	1,419	6,306,619	1,228	347,717	1,603
Dairy	Large1	Central	3	89	1,419	6,306,619	690	282,560	600
Dairy	Large1	MidAtlantic	1	15	1,419	6,146,236	2,759	278,075	4,491
Dairy	Large1	MidAtlantic	2	49	1,419	6,146,236	1,075	317,468	1,314
Dairy	Large1	MidAtlantic	3	18	1,419	6,146,236	690	276,871	600
Dairy	Large1	MidWest	1	18	1,419	6,174,845	2,795	279,541	4,554
Dairy	Large1	MidWest	2	52	1,419	6,174,845	1,281	309,611	1,709
Dairy	Large1	MidWest	3	20	1,419	6,174,845	690	278,317	600

Table C-8 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Dairy	Large1	Pacific	1	132	1,419	6,313,518	2,530	283,970	4,057
Dairy	Large1	Pacific	2	481	1,419	6,313,518	1,010	345,831	1,203
Dairy	Large1	Pacific	3	173	1,419	6,313,518	690	282,900	600
Dairy	Large1	South	1	17	1,419	6,667,534	2,382	300,282	3,783
Dairy	Large1	South	2	49	1,419	6,667,534	742	331,951	690
Dairy	Large1	South	3	18	1,419	6,667,534	690	299,297	600
Dairy	Medium1	Central	1	230	235	1,105,290	1,064	48,861	1,310
Dairy	Medium1	Central	2	280	235	1,105,354	1,122	50,409	1,412
Dairy	Medium1	Central	3	83	235	1,102,165	690	48,429	600
Dairy	Medium1	MidAtlantic	1	333	235	1,090,736	1,037	48,717	1,249
Dairy	Medium1	MidAtlantic	2	415	235	1,090,704	1,019	49,511	1,214
Dairy	Medium1	MidAtlantic	3	122	235	1,086,139	690	48,172	600
Dairy	Medium1	MidWest	1	372	235	1,093,061	1,060	48,882	1,294
Dairy	Medium1	MidWest	2	438	235	1,093,040	1,048	49,461	1,268
Dairy	Medium1	MidWest	3	132	235	1,088,423	690	48,303	600
Dairy	Medium1	Pacific	1	253	235	1,108,294	1,004	48,975	1,187
Dairy	Medium1	Pacific	2	368	235	1,108,257	971	50,422	1,121
Dairy	Medium1	Pacific	3	101	235	1,105,271	690	48,579	600
Dairy	Medium1	South	1	111	235	1,184,840	955	52,470	1,093
Dairy	Medium1	South	2	107	235	1,184,805	919	53,532	1,025
Dairy	Medium1	South	3	35	235	1,181,869	690	52,137	600
Dairy	Medium2	Central	1	168	460	2,084,763	1,422	93,265	1,972
Dairy	Medium2	Central	2	205	460	2,084,147	1,057	107,677	1,289
Dairy	Medium2	Central	3	61	460	2,081,046	690	92,491	600

Table C-8 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Dairy	Medium2	MidAtlantic	1	186	460	2,041,316	1,368	92,088	1,872
Dairy	Medium2	MidAtlantic	2	233	460	2,040,460	937	102,576	1,060
Dairy	Medium2	MidAtlantic	3	68	460	2,036,031	690	91,151	600
Dairy	Medium2	MidWest	1	196	460	2,048,995	1,411	92,529	1,959
Dairy	Medium2	MidWest	2	231	460	2,048,151	1,006	100,484	1,192
Dairy	Medium2	MidWest	3	70	460	2,043,607	690	91,547	600
Dairy	Medium2	Pacific	1	254	460	2,088,898	1,306	93,413	1,757
Dairy	Medium2	Pacific	2	370	460	2,088,397	902	107,908	993
Dairy	Medium2	Pacific	3	102	460	2,085,482	690	92,708	600
Dairy	Medium2	South	1	74	460	2,218,038	1,209	99,320	1,569
Dairy	Medium2	South	2	72	460	2,217,599	802	109,867	812
Dairy	Medium2	South	3	24	460	2,214,756	690	98,706	600
Heifers	Large1	Central	1	83	1,500	1,322	1,372	1,818	1,881
Heifers	Large1	Central	2	78	1,500	1,322	2,038	2,400	3,139
Heifers	Large1	Central	3	20	1,500	1,322	690	1,421	600
Heifers	Large1	MidAtlantic	1	-	1,500	2,844	1,202	1,849	1,565
Heifers	Large1	MidAtlantic	2	-	1,500	2,844	1,485	2,244	2,092
Heifers	Large1	MidAtlantic	3	-	1,500	2,844	690	1,552	600
Heifers	Large1	MidWest	1	-	1,500	2,949	1,152	1,841	1,472
Heifers	Large1	MidWest	2	-	1,500	2,949	1,247	2,146	1,646
Heifers	Large1	MidWest	3	-	1,500	2,949	690	1,572	600
Heifers	Large1	Pacific	1	48	1,500	1,728	1,325	1,806	1,798
Heifers	Large1	Pacific	2	58	1,500	1,728	1,548	2,661	2,205
Heifers	Large1	Pacific	3	13	1,500	1,728	690	1,436	600

Table C-8 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Heifers	Large1	South	1	-	1,500	3,421	1,139	1,832	1,439
Heifers	Large1	South	2	-	1,500	3,421	1,378	2,398	1,890
Heifers	Large1	South	3	-	1,500	3,421	690	1,571	600
Heifers	Medium1	Central	1	19	400	38,801	901	2,985	990
Heifers	Medium1	Central	2	4	400	39,117	945	4,950	1,076
Heifers	Medium1	Central	3	2	400	9,315	690	1,787	600
Heifers	Medium1	MidAtlantic	1	-	400	41,912	844	2,784	890
Heifers	Medium1	MidAtlantic	2	-	400	41,953	841	4,322	878
Heifers	Medium1	MidAtlantic	3	-	400	13,232	690	2,037	600
Heifers	Medium1	MidWest	1	163	400	40,029	829	2,513	858
Heifers	Medium1	MidWest	2	23	400	40,155	825	3,663	847
Heifers	Medium1	MidWest	3	14	400	11,555	690	1,970	600
Heifers	Medium1	Pacific	1	18	400	43,531	890	3,290	971
Heifers	Medium1	Pacific	2	6	400	43,338	869	6,177	931
Heifers	Medium1	Pacific	3	2	400	14,472	690	2,040	600
Heifers	Medium1	South	1	-	400	43,211	858	3,104	909
Heifers	Medium1	South	2	-	400	42,909	830	3,875	859
Heifers	Medium1	South	3	-	400	14,343	690	2,083	600
Heifers	Medium2	Central	1	190	750	43,111	1,088	4,081	1,341
Heifers	Medium2	Central	2	43	750	45,149	1,259	5,645	1,672
Heifers	Medium2	Central	3	18	750	11,267	690	1,871	600
Heifers	Medium2	MidAtlantic	1	-	750	46,931	978	4,153	1,133
Heifers	Medium2	MidAtlantic	2	-	750	47,590	1,039	5,182	1,262
Heifers	Medium2	MidAtlantic	3	-	750	16,867	690	2,206	600

Table C-8 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Heifers	Medium2	MidWest	1	81	750	43,872	951	3,939	1,090
Heifers	Medium2	MidWest	2	12	750	44,347	990	4,435	1,160
Heifers	Medium2	MidWest	3	7	750	14,159	690	2,088	600
Heifers	Medium2	Pacific	1	106	750	49,983	1,065	4,833	1,308
Heifers	Medium2	Pacific	2	33	750	50,148	1,086	5,777	1,349
Heifers	Medium2	Pacific	3	11	750	18,953	690	2,250	600
Heifers	Medium2	South	1	-	750	48,917	1,004	4,377	1,191
Heifers	Medium2	South	2	-	750	49,105	1,028	5,127	1,228
Heifers	Medium2	South	3	-	750	18,566	690	2,281	600
Veal	Medium1	Central	1	5	400	790	1,075	1,618	1,318
Veal	Medium1	Central	2	-	400	790	690	1,394	600
Veal	Medium1	Central	3	-	400	790	690	1,394	600
Veal	Medium1	MidAtlantic	1	1	400	1,458	1,075	1,706	1,317
Veal	Medium1	MidAtlantic	2	-	400	1,458	690	1,482	600
Veal	Medium1	MidAtlantic	3	-	400	1,458	690	1,482	600
Veal	Medium1	MidWest	1	119	400	1,640	1,075	1,730	1,317
Veal	Medium1	MidWest	2	-	400	1,640	690	1,506	600
Veal	Medium1	MidWest	3	-	400	1,640	690	1,506	600
Veal	Medium1	Pacific	1	-	400	729	1,075	1,610	1,318
Veal	Medium1	Pacific	2	-	400	729	690	1,386	600
Veal	Medium1	Pacific	3	-	400	729	690	1,386	600
Veal	Medium1	South	1	-	400	1,337	1,075	1,690	1,318
Veal	Medium1	South	2	-	400	1,337	690	1,466	600
Veal	Medium1	South	3	-	400	1,337	690	1,466	600

Table C-8 (Continued)

Animal	Size Class	Region	Category	Number of Facilities	Average Head	Capital Costs	Fixed Costs	Annual O&M Costs	3-Year Recurring O&M Costs
Veal	Medium2	Central	1	3	540	790	1,075	1,618	1,318
Veal	Medium2	Central	2	-	540	790	690	1,394	600
Veal	Medium2	Central	3	-	540	790	690	1,394	600
Veal	Medium2	MidAtlantic	1	1	540	1,458	1,075	1,706	1,317
Veal	Medium2	MidAtlantic	2	-	540	1,458	690	1,482	600
Veal	Medium2	MidAtlantic	3	-	540	1,458	690	1,482	600
Veal	Medium2	MidWest	1	81	540	1,640	1,075	1,730	1,317
Veal	Medium2	MidWest	2	-	540	1,640	690	1,506	600
Veal	Medium2	MidWest	3	-	540	1,640	690	1,506	600
Veal	Medium2	Pacific	1	-	540	729	1,075	1,610	1,318
Veal	Medium2	Pacific	2	-	540	729	690	1,386	600
Veal	Medium2	Pacific	3	-	540	729	690	1,386	600
Veal	Medium2	South	1	-	540	1,337	1,075	1,690	1,318
Veal	Medium2	South	2	-	540	1,337	690	1,466	600
Veal	Medium2	South	3	-	540	1,337	690	1,466	600

Appendix D

SENSITIVITY ANALYSES

APPENDIX D: RESULTS OF THE SENSITIVITY ANALYSIS

The model-farm approach which was used in the Beef and Dairy Cost Model provides the average cost a facility is projected to incur under the proposed regulatory options. EPA recognizes that this approach may underestimate or overestimate the projected costs for facilities that are on the extreme ends of applicability. For example, some facilities may already meet the proposed regulatory requirements; therefore, those facility costs will be zero. Alternatively, some facilities may currently meet very few of the proposed regulatory requirements; therefore, these operations will incur costs that are much higher than the average model facility cost.

To evaluate the significance of these issues, EPA performed sensitivity analyses on the cost model to evaluate the major drivers for the model farm costs and to compare the average model farm cost to the maximum cost a farm may incur for the proposed regulatory options. EPA performed two sensitivity runs: the first to compare the effects of nitrogen-based nutrient management verses phosphorus-based nutrient management on the costs; the second to compare the effects of groundwater monitoring requirements on the costs.

Nutrient Application Basis Analysis:

Under the proposed regulatory options, a facility will be required to follow either nitrogen-based nutrient management or phosphorus-based nutrient management. More cropland is required to land apply manure waste at agronomic phosphorus-based rates than nitrogen-based rates; therefore, phosphorus-based nutrient management incurs more costs for land application, irrigation, nutrient management planning, and off-site transportation of manure waste than nitrogen-based nutrient management.

To evaluate the significance of the nutrient application basis on the costs, a sensitivity analysis was performed on Option 2. Option 2 costs are based on a combination of nitrogen-based and phosphorus-based nutrient management, and are also the basis for the costs in Options 3 through 8. To perform this analysis, the frequency of facilities that would be located in a phosphorus-based nutrient management area was set to 100 percent (no facilities were costed under the nitrogen-based management scenario.)

Because more cropland is required for phosphorus-based application, operations that are Category 1 operations under nitrogen-based nutrient management may be reclassified as a Category 2 operation under phosphorus-based nutrient management. That is, a facility with enough land to apply all of the manure waste on site under nitrogen-based application may not have enough land to apply all of their manure waste on site under phosphorus-based nutrient management. Because of this, the most dramatic comparison of the effects of changing the agronomic basis from nitrogen to phosphorus is seen by comparing the results of Option 1 (N-Based Application), Category 1 facilities to the sensitivity run Option 2A (P-based Application), Category 2 facilities.

Comparing these results shows a general 200 to 500% increase in the costs from Option 1, Category 1 to Option 2A, Category 2 for most model farms. This increase is due to the following factors:

- Shift of facilities from Category 1 to Category 2 (thereby incurring transportation costs);
- A portion of Category 2 facilities under N-based application are assumed to not incur transportation costs, while they do incur these costs under P-based application; and
- Larger acreage for phosphorus-based facilities, requiring more irrigation costs, soil sampling; and nutrient management planning.

Table D-1 presents the results of this analysis.

<u>Groundwater Protection Option Analysis</u>

Under the proposed regulatory Options 3 and 4, facilities will be required to assess if they are located in hydro-geologically sensitive areas and to implement groundwater protection if manure waste is stored or land applied on soil that has a hydrologic link to groundwater. If the facility has such a link, then the facility must take measures to ensure groundwater protection, including synthetically lining surface impoundments (e.g., lagoons and ponds), providing an impervious surface upon which to store dry manure, installing groundwater wells, and performing annual monitoring of these wells. If the facility is not located in a hydro-geologically sensitive area, then the facility does not incur any of these groundwater protection costs other than the hydro-geologic evaluation.

To evaluate the significance of the groundwater protection requirement on the costs for Options 3 and 4, a sensitivity analysis was performed on Option 3. Option 3 was selected to perform this evaluation because the basis for the costs in Option 3 is identical to the Option 2 costs (phosphorus-based application), with the addition of the groundwater protection costs; therefore, a direct comparison can be made between the costs for a facility with no groundwater protection requirements and a facility with these requirements by setting the groundwater frequency factors to 100%.

Facilities costed for Option 3A are those facilities where the groundwater assessment was found to be positive (all groundwater protection costs are included), and facilities costed for Option 3B are those where the groundwater assessment was found to be negative (no groundwater protection costs are included). The results show that a facility that incurs 100% of the groundwater protection costs incurs capital and annual O&M costs an order of magnitude higher than those facilities that do not incur groundwater protection costs. This increase is due to the following factors:

- Installation and monitoring of 4 groundwater wells;
- Installation and maintenance of concrete pad for manure storage; and
- Installation and maintenance of synthetic and clay lining for lagoons and ponds.

The results of this analysis are provided in Table D-2.

Table D-1

Option 2 Sensitivity Analysis

Animal	Man type	Operation	Option	GW Link	NM basis	Region	Category	Facilities	Size ID	Head/Bird	Farm Size	Cropland	Capital	Fixed	O&M	3 yr Rec	5 yr Rec	Fert Savings
Beef	0	0	2A	N	P	C/S/P	1	86	Large1	2628	1818	1790	1035	7581	5351	13558	0	-59149
Beef	0	0	2A	N	P	C/S/P	1	2	Large2	43805	30917	30455	13803	117947	70199	221240	0	-1017804
Beef	0	0	2A	N	P	C/S/P	1	101	Medium1	600	388	382	61893	2161	7794	3363	0	-12028
Beef	0	0	2A	N	P	C/S/P	1	97	Medium2	1088	704	693	98749	3357	9581	5615	0	-21812
Beef	0	0	2A	N	P	C/S/P	2	263	Large1	2628	1050	1022	1035	4624	7126	7997	0	-33753
Beef	0	0	2A	N	P	C/S/P	2	122	Large2	43805	19752	19289	13803	74957	83854	140346	0	-644468
Beef	0	0	2A	N	P	C/S/P	2	51	Medium1	600	365	358	59672	2069	7779	3190	0	-11276
Beef	0	0	2A	N	P	C/S/P	2	48	Medium2	1088	585	573	82186	2897	10043	4750	0	-18043
Beef	0	0	2A	N	P	C/S/P	3	43	Large1	2628	28	0	1035	190	1262	600	0	0
Beef	0	0	2A	N	P	C/S/P	3	80	Large2	43805	463	0	13803	190	1900	600	0	0
Beef	0	0	2A	N	P	C/S/P	3	11	Medium1	600	6	0	10852	190	1672	600	0	0
Beef	0	0	2A	N	P	C/S/P	3	11	Medium2	1088	11	0	9746	190	1589	600	0	0
Dairy	0	0	2A	N	P	C/S/P	1	127	Large1	1419	815	808	66157	3801	4423	6459	0	-22532
Dairy	0	0	2A	N	P	C/S/P	1	392	Medium1	235	140	139	21718	1224	2429	1603	0	-3931
Dairy	0	0	2A	N	P	C/S/P	1	335	Medium2	460	274	272	34281	1736	3174	2567	0	-7695
Dairy	0	0	2A	N	P	C/S/P	2	866	Large1	1419	135	128	66157	1183	33143	1526	0	-3741
Dairy	0	0	2A	N	P	C/S/P	2	956	Medium1	235	113	112	21578	1121	3134	1406	0	-3184
Dairy	0	0	2A	N	P	C/S/P	2	817	Medium2	460	89	86	33141	1023	10924	1222	0	-2513
Dairy	0	0	2A	N	P	C/S/P	3	280	Large1	1419	7	0	66157	190	2533	600	0	0
Dairy	0	0	2A	N	P	C/S/P	3	220	Medium1	235	1	0	18409	190	1725	600	0	0
Dairy	0	0	2A	N	P	C/S/P	3	187	Medium2	460	2	0	30086	190	2040	600	0	0
Heifers	0	0	2A	N	P	C/S/P	1	66	Large1	1500	349	334	922	1977	2085	3022	0	-9247
Heifers	0	0	2A	N	P	C/S/P	1	31	Medium1	400	95	91	40126	1040	4249	1254	0	-2568
Heifers	0	0	2A	N	P	C/S/P	1	248	Medium2	750	178	171	46655	1348	5779	1840	0	-4816
Heifers	0	0	2A	N	P	C/S/P	2	201	Large1	1500	322	308	922	1874	2553	2823	0	-8515

Table D-1 (Continued)

Animal	Man type	Operation	Option	GW Link	NM basis	Region	Category	Facilities	Size ID	Head/Bird	Farm Size	Cropland	Capital	Fixed	O&M	3 yr Rec	5 yr Rec	Fert Savings
Heifers	0	0	2A	N	P	C/S/P	2	16	Medium1	400	67	64	38948	935	4726	1054	0	-1792
Heifers	0	0	2A	N	P	C/S/P	2	124	Medium2	750	150	143	45059	1241	6016	1638	0	-4040
Heifers	0	0	2A	N	P	C/S/P	3	33	Large1	1500	15	0	922	190	1256	600	0	0
Heifers	0	0	2A	N	P	C/S/P	3	4	Medium1	400	4	0	9446	190	1649	600	0	0
Heifers	0	0	2A	N	P	C/S/P	3	28	Medium2	750	7	0	11762	190	1751	600	0	0
Beef	0	0	2A	N	P	MW/MA	1	277	Large1	2628	1268	1240	2324	5463	4183	9589	0	-23531
Beef	0	0	2A	N	P	MW/MA	1	2	Large2	43805	21176	20713	36430	80439	49509	150670	0	-390444
Beef	0	0	2A	N	P	MW/MA	1	518	Medium1	600	286	280	52968	1768	7015	2620	0	-5483
Beef	0	0	2A	N	P	MW/MA	1	524	Medium2	1088	518	507	73423	2641	8622	4267	0	-9943
Beef	0	0	2A	N	P	MW/MA	2	845	Large1	2628	693	665	2324	3252	3555	5419	0	-12632
Beef	0	0	2A	N	P	MW/MA	2	130	Large2	43805	12979	12516	36430	48879	38836	91270	0	-235914
Beef	0	0	2A	N	P	MW/MA	2	259	Medium1	600	268	261	51579	1696	6948	2485	0	-5115
Beef	0	0	2A	N	P	MW/MA	2	262	Medium2	1088	425	413	63544	2280	8755	3587	0	-8100
Beef	0	0	2A	N	P	MW/MA	3	139	Large1	2628	28	0	2324	190	1326	600	0	0
Beef	0	0	2A	N	P	MW/MA	3	85	Large2	43805	463	0	36430	190	3032	600	0	0
Beef	0	0	2A	N	P	MW/MA	3	58	Medium1	600	6	0	11046	190	1686	600	0	0
Beef	0	0	2A	N	P	MW/MA	3	59	Medium2	1088	11	0	10093	190	1612	600	0	0
Dairy	0	0	2A	N	P	MW/MA	1	17	Large1	1419	849	843	45347	3934	4084	6704	0	-18692
Dairy	0	0	2A	N	P	MW/MA	1	453	Medium1	235	141	140	17976	1228	2480	1613	0	-3091
Dairy	0	0	2A	N	P	MW/MA	1	247	Medium2	460	275	273	26756	1740	3204	2572	0	-6051
Dairy	0	0	2A	N	P	MW/MA	2	116	Large1	1419	159	153	45347	1277	23273	1694	0	-3392
Dairy	0	0	2A	N	P	MW/MA	2	1106	Medium1	235	115	114	17781	1128	2946	1418	0	-2517
Dairy	0	0	2A	N	P	MW/MA	2	603	Medium2	460	96	94	25161	1051	9898	1276	0	-2070
Dairy	0	0	2A	N	P	MW/MA	3	38	Large1	1419	7	0	45347	190	2117	600	0	0
Dairy	0	0	2A	N	P	MW/MA	3	254	Medium1	235	1	0	13031	190	1600	600	0	0
Dairy	0	0	2A	N	P	MW/MA	3	138	Medium2	460	2	0	20547	190	1827	600	0	0
Heifers	0	0	2A	N	P	MW/MA	1	0	Large1	1500	330	315	1345	1902	2062	2880	0	-6979
Heifers	0	0	2A	N	P	MW/MA	1	124	Medium1	400	88	84	39550	1014	4151	1205	0	-1859
Heifers	0	0	2A	N	P	MW/MA	1	62	Medium2	750	165	157	45384	1295	5650	1734	0	-3485
Heifers	0	0	2A	N	P	MW/MA	2	0	Large1	1500	303	288	1345	1798	2120	2681	0	-6383

Table D-1 (Continued)

Animal	Man type	Operation	Option	GW Link	NM basis	Region	Category	Facilities	Size ID	Head/Bird	Farm Size	Cropland	Capital	Fixed	O&M	3 yr Rec	5 yr Rec	Fert Savings
Heifers	0	0	2A	N	P	MW/MA	2	62	Medium1	400	61	57	38451	910	4286	1006	0	-1263
Heifers	0	0	2A	N	P	MW/MA	2	31	Medium2	750	138	130	43958	1191	5810	1544	0	-2889
Heifers	0	0	2A	N	P	MW/MA	3	0	Large1	1500	15	0	1345	190	1277	600	0	0
Heifers	0	0	2A	N	P	MW/MA	3	14	Medium1	400	4	0	9230	190	1639	600	0	0
Heifers	0	0	2A	N	P	MW/MA	3	7	Medium2	750	7	0	11482	190	1738	600	0	0

Table D-2

Option 3 Sensitivity Analysis

Animal	Man Type	Operation	Option	GW Link	NM Basis	Region	Category	Facilities	Size ID	Head/Bird	Farm Size	Cropland	Capital	Ffixed	O&M	3 yr Rec	5 yr Rec	Fert Savings
Beef	0	0	3B	N	P	C/S/P	1	155	Large1	2,628	1,073	1,045	1,035	6,442	2,868	5,540	-	(13,892)
Beef	0	0	3B	N	P	C/S/P	1	8	Large2	43,805	18,130	17,667	13,803	35,504	20,415	60,220	-	(107,624)
Beef	0	0	3B	N	P	C/S/P	1	102	Medium1	600	209	202	47,911	4,517	5,346	1,918	-	(3,975)
Beef	0	0	3B	N	P	C/S/P	1	102	Medium2	1,088	378	367	61,368	5,085	6,768	2,983	-	(7,207)
Beef	0	0	3B	N	P	C/S/P	2	150	Large1	2,628	608	581	1,035	6,928	17,064	6,447	-	(25,329)
Beef	0	0	3B	N	P	C/S/P	2	100	Large2	43,805	11,662	11,199	348,618	48,810	130,833	85,262	-	(332,578)
Beef	0	0	3B	N	P	C/S/P	2	26	Medium1	600	196	190	53,840	4,864	6,677	2,565	-	(7,797)
Beef	0	0	3B	N	P	C/S/P	2	24	Medium2	1,088	310	299	69,557	5,484	9,089	3,735	-	(12,475)
Beef	0	0	3B	N	P	C/S/P	3	38	Large1	2,628	28	-	1,035	3,818	1,342	600	-	(0)
Beef	0	0	3B	N	P	C/S/P	3	69	Large2	43,805	463	-	13,803	3,818	1,980	600	-	(0)
Beef	0	0	3B	N	P	C/S/P	3	10	Medium1	600	6	-	10,852	3,818	1,752	600	-	(0)
Beef	0	0	3B	N	P	C/S/P	3	9	Medium2	1,088	11	-	9,746	3,818	1,669	600	-	(0)
Beef	0	0	3A	N	P	C/S/P	1	18	Medium1	600	209	202	208,925	4,517	11,967	1,918	-	(3,975)
Beef	0	0	3A	N	P	C/S/P	2	5	Medium1	600	196	190	214,854	4,864	13,297	2,565	-	(7,797)
Beef	0	0	3A	N	P	C/S/P	3	2	Medium1	600	6	-	171,866	3,818	8,373	600	-	(0)
Beef	0	0	3A	Y	P	C/S/P	1	23	Large1	2,628	1,073	1,045	393,923	6,442	17,372	5,540	-	(13,892)
Beef	0	0	3A	Y	P	C/S/P	1	1	Large2	43,805	18,130	17,667	4,108,923	35,504	138,707	60,220	-	(107,624)
Beef	0	0	3A	Y	P	C/S/P	1	16	Medium2	1,088	378	367	298,497	5,085	16,663	2,983	-	(7,207)
Beef	0	0	3A	Y	P	C/S/P	2	22	Large1	2,628	608	581	393,923	6,928	31,568	6,447	-	(25,329)
Beef	0	0	3A	Y	P	C/S/P	2	15	Large2	43,805	11,662	11,199	4,443,738	48,810	249,125	85,262	-	(332,578)
Beef	0	0	3A	Y	P	C/S/P	2	4	Medium2	1,088	310	299	306,686	5,484	18,984	3,735	-	(12,475)
Beef	0	0	3A	Y	P	C/S/P	3	6	Large1	2,628	28	-	393,923	3,818	15,846	600	-	(0)
Beef	0	0	3A	Y	P	C/S/P	3	10	Large2	43,805	463	-	4,108,923	3,818	120,272	600	-	(0)

Table D-2 (Continued)

Animal	Man Type	Operation	Option	GW Link	NM Basis	Region	Category	Facilities	Size ID	Head/Bird	Farm Size	Cropland	Capital	Ffixed	O&M	3 yr Rec	5 yr Rec	Fert Savings
Beef	0	0	3A	Y	P	C/S/P	3	1	Medium2	1,088	11	-	246,875	3,818	11,564	600	-	(0)
Dairy	0	0	3B	N	P	C/S/P	1	205	Large1	1,419	559	552	66,157	5,625	3,665	4,000	-	(5,104)
Dairy	0	0	3B	N	P	C/S/P	1	509	Medium1	235	98	97	21,460	4,146	2,204	1,217	-	(1,240)
Dairy	0	0	3B	N	P	C/S/P	1	427	Medium2	460	193	191	33,589	4,461	2,836	1,805	-	(2,427)
Dairy	0	0	3B	N	P	C/S/P	2	659	Large1	1,419	100	93	66,157	4,189	64,255	1,296	-	(1,748)
Dairy	0	0	3B	N	P	C/S/P	2	651	Medium1	235	78	77	21,460	4,145	3,630	1,210	-	(1,908)
Dairy	0	0	3B	N	P	C/S/P	2	559	Medium2	460	61	59	33,057	4,070	16,709	1,071	-	(1,520)
Dairy	0	0	3B	N	P	C/S/P	3	244	Large1	1,419	7	-	66,157	3,818	2,613	600	-	(0)
Dairy	0	0	3B	N	P	C/S/P	3	189	Medium1	235	1	-	18,409	3,818	1,805	600	-	(0)
Dairy	0	0	3B	N	P	C/S/P	3	161	Medium2	460	2	-	30,086	3,818	2,120	600	-	(0)
Dairy	0	0	3A	N	P	C/S/P	1	85	Medium1	235	98	97	378,583	4,146	19,602	1,217	-	(1,240)
Dairy	0	0	3A	N	P	C/S/P	2	104	Medium1	235	78	77	378,582	4,145	21,028	1,210	-	(1,908)
Dairy	0	0	3A	N	P	C/S/P	3	31	Medium1	235	1	-	375,531	3,818	19,203	600	-	(0)
Dairy	0	0	3A	Y	P	C/S/P	1	31	Large1	1,419	559	552	1,246,193	5,625	60,754	4,000	-	(5,104)
Dairy	0	0	3A	Y	P	C/S/P	1	69	Medium2	460	193	191	547,656	4,461	28,258	1,805	-	(2,427)
Dairy	0	0	3A	Y	P	C/S/P	2	98	Large1	1,419	100	93	1,246,193	4,189	121,345	1,296	-	(1,748)
Dairy	0	0	3A	Y	P	C/S/P	2	87	Medium2	460	61	59	547,124	4,070	42,131	1,071	-	(1,520)
Dairy	0	0	3A	Y	P	C/S/P	3	36	Large1	1,419	7	-	1,246,193	3,818	59,703	600	-	(0)
Dairy	0	0	3A	Y	P	C/S/P	3	25	Medium2	460	2	-	544,153	3,818	27,542	600	-	(0)
Heifers	0	0	3B	N	P	C/S/P	1	99	Large1	1,500	240	225	922	4,456	1,707	1,801	-	(2,454)
Heifers	0	0	3B	N	P	C/S/P	1	353	Medium1	400	60	56	38,628	4,017	2,926	968	-	(982)
Heifers	0	0	3B	N	P	C/S/P	1	353	Medium2	750	113	106	42,980	4,192	4,208	1,303	-	(1,841)
Heifers	0	0	3B	N	P	C/S/P	2	105	Large1	1,500	222	207	922	4,820	3,849	2,480	-	(6,595)
Heifers	0	0	3B	N	P	C/S/P	2	95	Medium1	400	44	40	38,600	4,018	4,017	972	-	(1,309)
Heifers	0	0	3B	N	P	C/S/P	2	95	Medium2	750	96	89	43,814	4,267	6,910	1,446	-	(2,952)
Heifers	0	0	3B	N	P	C/S/P	3	25	Large1	1,500	15	-	922	3,818	1,336	600	-	(0)
Heifers	0	0	3B	N	P	C/S/P	3	34	Medium1	400	4	-	9,446	3,818	1,729	600	-	(0)
Heifers	0	0	3B	N	P	C/S/P	3	34	Medium2	750	7	-	11,762	3,818	1,831	600	-	(0)
Heifers	0	0	3A	N	P	C/S/P	1	50	Medium1	400	60	56	156,019	4,017	8,777	968	-	(982)
Heifers	0	0	3A	N	P	C/S/P	2	13	Medium1	400	44	40	155,991	4,018	9,868	972	-	(1,309)

Table D-2 (Continued)

Animal	Man Type	Operation	Option	GW Link	NM Basis	Region	Category	Facilities	Size ID	Head/Bird	Farm Size	Cropland	Capital	Ffixed	O&M	3 yr Rec	5 yr Rec	Fert Savings
Heifers	0	0	3A	N	P	C/S/P	3	5	Medium1	400	4	-	126,837	3,818	7,580	600	-	(0)
Heifers	0	0	3A	Y	P	C/S/P	1	14	Large1	1,500	240	225	232,071	4,456	13,740	1,801	-	(2,454)
Heifers	0	0	3A	Y	P	C/S/P	1	50	Medium2	750	113	106	202,602	4,192	12,667	1,303	-	(1,841)
Heifers	0	0	3A	Y	P	C/S/P	2	15	Large1	1,500	222	207	232,071	4,820	15,881	2,480	-	(6,595)
Heifers	0	0	3A	Y	P	C/S/P	2	13	Medium2	750	96	89	203,437	4,267	15,369	1,446	-	(2,952)
Heifers	0	0	3A	Y	P	C/S/P	3	4	Large1	1,500	15	-	232,071	3,818	13,368	600	-	(0)
Heifers	0	0	3A	Y	P	C/S/P	3	5	Medium2	750	7	-	171,385	3,818	10,290	600	-	(0)
Beef	0	0	3B	N	P	MW/MA	1	594	Large1	2,628	548	520	2,324	5,673	2,486	4,091	-	(627)
Beef	0	0	3B	N	P	MW/MA	1	12	Large2	43,805	9,112	8,649	36,430	34,088	20,722	57,556	-	(3,639)
Beef	0	0	3B	N	P	MW/MA	1	495	Medium1	600	134	127	43,341	4,287	4,894	1,482	-	(603)
Beef	0	0	3B	N	P	MW/MA	1	502	Medium2	1,088	242	231	48,601	4,667	6,214	2,200	-	(1,093)
Beef	0	0	3B	N	P	MW/MA	2	225	Large1	2,628	263	235	2,324	4,949	23,705	2,731	-	(2,577)
Beef	0	0	3B	N	P	MW/MA	2	85	Large2	43,805	5,707	5,244	580,585	24,266	103,312	39,075	-	(18,524)
Beef	0	0	3B	N	P	MW/MA	2	76	Medium1	600	124	118	45,212	4,406	5,413	1,703	-	(1,813)
Beef	0	0	3B	N	P	MW/MA	2	73	Medium2	1,088	190	178	50,162	4,724	7,374	2,303	-	(2,871)
Beef	0	0	3B	N	P	MW/MA	3	101	Large1	2,628	28	-	2,324	3,818	1,406	600	-	(0)
Beef	0	0	3B	N	P	MW/MA	3	62	Large2	43,805	463	-	36,430	3,818	3,112	600	-	(0)
Beef	0	0	3B	N	P	MW/MA	3	43	Medium1	600	6	-	11,046	3,818	1,766	600	-	(0)
Beef	0	0	3B	N	P	MW/MA	3	43	Medium2	1,088	11	-	10,093	3,818	1,692	600	-	(0)
Beef	0	0	3A	N	P	MW/MA	1	178	Medium1	600	134	127	206,721	4,287	11,633	1,482	-	(603)
Beef	0	0	3A	N	P	MW/MA	2	27	Medium1	600	124	118	208,592	4,406	12,152	1,703	-	(1,813)
Beef	0	0	3A	N	P	MW/MA	3	15	Medium1	600	6	-	174,426	3,818	8,505	600	-	(0)
Beef	0	0	3A	Y	P	MW/MA	1	219	Large1	2,628	548	520	430,029	5,673	18,744	4,091	-	(627)
Beef	0	0	3A	Y	P	MW/MA	1	4	Large2	43,805	9,112	8,649	4,463,504	34,088	155,893	57,556	-	(3,639)
Beef	0	0	3A	Y	P	MW/MA	1	184	Medium2	1,088	242	231	289,485	4,667	16,297	2,200	-	(1,093)
Beef	0	0	3A	Y	P	MW/MA	2	83	Large1	2,628	263	235	430,029	4,949	39,963	2,731	-	(2,577)
Beef	0	0	3A	Y	P	MW/MA	2	31	Large2	43,805	5,707	5,244	5,007,659	24,266	238,483	39,075	-	(18,524)
Beef	0	0	3A	Y	P	MW/MA	2	27	Medium2	1,088	190	178	291,045	4,724	17,457	2,303	-	(2,871)
Beef	0	0	3A	Y	P	MW/MA	3	37	Large1	2,628	28	-	430,029	3,818	17,665	600	-	(0)
Beef	0	0	3A	Y	P	MW/MA	3	23	Large2	43,805	463	-	4,463,504	3,818	138,282	600	-	(0)

Table D-2 (Continued)

Animal	Man Type	Operation	Option	GW Link	NM Basis	Region	Category	Facilities	Size ID	Head/Bird	Farm Size	Cropland	Capital	Ffixed	O&M	3 yr Rec	5 yr Rec	Fert Savings
Beef	0	0	3A	Y	P	MW/MA	3	16	Medium2	1,088	11	-	250,976	3,818	11,774	600	-	(0)
Dairy	0	0	3B	N	P	MW/MA	1	24	Large1	1,419	634	627	45,347	5,906	3,412	4,524	-	(4,448)
Dairy	0	0	3B	N	P	MW/MA	1	525	Medium1	235	105	103	17,649	4,177	2,243	1,272	-	(881)
Dairy	0	0	3B	N	P	MW/MA	1	285	Medium2	460	204	202	25,885	4,518	2,867	1,916	-	(1,725)
Dairy	0	0	3B	N	P	MW/MA	2	75	Large1	1,419	131	125	45,347	4,311	37,898	1,522	-	(1,727)
Dairy	0	0	3B	N	P	MW/MA	2	636	Medium1	235	83	82	17,623	4,162	2,927	1,242	-	(1,444)
Dairy	0	0	3B	N	P	MW/MA	2	345	Medium2	460	69	67	25,036	4,101	12,059	1,127	-	(1,184)
Dairy	0	0	3B	N	P	MW/MA	3	28	Large1	1,419	7	-	45,347	3,818	2,197	600	-	(0)
Dairy	0	0	3B	N	P	MW/MA	3	189	Medium1	235	1	-	13,031	3,818	1,680	600	-	(0)
Dairy	0	0	3B	N	P	MW/MA	3	103	Medium2	460	2	-	20,547	3,818	1,907	600	-	(0)
Dairy	0	0	3A	N	P	MW/MA	1	180	Medium1	235	105	103	314,249	4,177	16,690	1,272	-	(881)
Dairy	0	0	3A	N	P	MW/MA	2	218	Medium1	235	83	82	314,223	4,162	17,374	1,242	-	(1,444)
Dairy	0	0	3A	N	P	MW/MA	3	65	Medium1	235	1	-	309,631	3,818	16,127	600	-	(0)
Dairy	0	0	3A	Y	P	MW/MA	1	8	Large1	1,419	634	627	1,090,593	5,906	54,142	4,524	-	(4,448)
Dairy	0	0	3A	Y	P	MW/MA	1	98	Medium2	460	204	202	461,538	4,518	24,504	1,916	-	(1,725)
Dairy	0	0	3A	Y	P	MW/MA	2	26	Large1	1,419	131	125	1,090,593	4,311	88,628	1,522	-	(1,727)
Dairy	0	0	3A	Y	P	MW/MA	2	118	Medium2	460	69	67	460,688	4,101	33,696	1,127	-	(1,184)
Dairy	0	0	3A	Y	P	MW/MA	3	10	Large1	1,419	7	-	1,090,593	3,818	52,927	600	-	(0)
Dairy	0	0	3A	Y	P	MW/MA	3	35	Medium2	460	2	-	456,200	3,818	23,544	600	-	(0)
Heifers	0	0	3B	N	P	MW/MA	1	18	Large1	1,500	164	150	1,345	4,304	1,640	1,516	-	(541)
Heifers	0	0	3B	N	P	MW/MA	1	119	Medium1	400	44	40	37,805	3,965	2,361	874	-	(291)
Heifers	0	0	3B	N	P	MW/MA	1	119	Medium2	750	83	75	41,366	4,092	3,716	1,111	-	(546)
Heifers	0	0	3B	N	P	MW/MA	2	7	Large1	1,500	153	138	1,345	4,487	3,198	1,857	-	(2,462)
Heifers	0	0	3B	N	P	MW/MA	2	17	Medium1	400	33	29	37,889	3,961	3,238	863	-	(556)
Heifers	0	0	3B	N	P	MW/MA	2	17	Medium2	750	71	64	41,931	4,142	5,955	1,210	-	(1,276)
Heifers	0	0	3B	N	P	MW/MA	3	3	Large1	1,500	15	-	1,345	3,818	1,357	600	-	(0)
Heifers	0	0	3B	N	P	MW/MA	3	10	Medium1	400	4	-	9,230	3,818	1,719	600	-	(0)
Heifers	0	0	3B	N	P	MW/MA	3	10	Medium2	750	7	-	11,482	3,818	1,818	600	-	(0)
Heifers	0	0	3A	N	P	MW/MA	1	44	Medium1	400	44	40	148,430	3,965	7,874	874	-	(291)
Heifers	0	0	3A	N	P	MW/MA	2	6	Medium1	400	33	29	148,514	3,961	8,750	863	-	(556)

Table D-2 (Continued)

Animal	Man Type	Operation	Option	GW Link	NM Basis	Region	Category	Facilities	Size ID	Head/Bird	Farm Size	Cropland	Capital	Ffixed	O&M	3 yr Rec	5 yr Rec	Fert Savings
Heifers	0	0	3A	N	P	MW/MA	3	4	Medium1	400	4	-	119,856	3,818	7,232	600	-	(0)
Heifers	0	0	3A	Y	P	MW/MA	1	7	Large1	1,500	164	150	215,130	4,304	12,804	1,516	-	(541)
Heifers	0	0	3A	Y	P	MW/MA	1	44	Medium2	750	83	75	191,878	4,092	11,720	1,111	-	(546)
Heifers	0	0	3A	Y	P	MW/MA	2	2	Large1	1,500	153	138	215,130	4,487	14,363	1,857	-	(2,462)
Heifers	0	0	3A	Y	P	MW/MA	2	6	Medium2	750	71	64	192,443	4,142	13,959	1,210	-	(1,276)
Heifers	0	0	3A	Y	P	MW/MA	3	1	Large1	1,500	15	-	215,130	3,818	12,522	600	-	(0)
Heifers	0	0	3A	Y	P	MW/MA	3	4	Medium2	750	7	-	161,994	3,818	9,822	600	-	(0)