Appendix A Profile of Farms with Livestock, 1997

Introduction

The Census of Agriculture shows that 1,315,051 farms in the United States in 1997 had some kind of livestock on the farm or had sales from livestock products, representing about two of every three farms in the country. These farms vary from primarily crop-producing farms with a few livestock, to farms with large numbers of confined livestock, to producers of specialty livestock (ducks, geese, fur-bearing animals, and exotic livestock), to farms with large numbers of pastured livestock, to small farms with few acres and few livestock.

The purpose of this appendix is to identify the predominant groups of livestock farms in the United States and to summarize the number and kind of livestock and the amount of livestock sales associated with each farm group.

Classification of farms with livestock

A farm is defined for purposes of the Census of Agriculture as an enterprise with $1,000 or more of gross agricultural product sales, or has enough land and/or livestock to generate sales at this level. Some of the farms in the Census of Agriculture report no sales, but have a combination of acres and livestock that still qualify them as a farm. (For example, an enterprise with 5 cattle of any kind, 5 horses, 7 hogs and pigs, 142 poultry of any kind, or 25 sheep and goats qualifies as a farm even without any sales or farmland. For criteria used to define farms without reported sales, see USDA NASS, 1997.)

The Census of Agriculture reports end-of-year inventories and sometimes the number of animals sold during the year for the following livestock types:

- Beef cows
- Milk cows
- Heifers and heifer calves
- Steers and bulls of all ages
- Hogs and pigs used for breeding
- Other hogs and pigs
- Sheep and lambs
- Chicken layers 20 weeks old and older
- Chicken pullets for laying flock replacement
- Chicken broilers
- Turkeys for slaughter
- Turkeys for breeding
- Other poultry, including ducks, geese, pigeons, pheasants, quail, and other
- Poultry hatched and placed or sold
- Horses and ponies
- Colonies of bees
- Milk, Angora, and other goats
- Mules, burros, and donkeys
- Mink and rabbits
- Fish and aquaculture products
- Other livestock

The average number of cattle, swine, chickens, and turkeys on the farm during the year was estimated from sales and end-of-year inventory according to procedures described in Kellogg et al. (2000). The estimates were in the form of USDA animal units (AU), where an animal unit is equivalent to 1,000 pounds of live weight. For the other livestock types, end-of-year inventories were used to represent livestock populations on the farm.

Using this information on livestock types and number on each farm, farms with livestock were uniquely categorized into the following four groups:

- Farms with few livestock of all types
- Farms with specialty livestock types
- Farms with pastured livestock types and few other livestock
- Farms with confined livestock types

Farms with few livestock were defined to be farms with

- less than 4 animal units of any combination of fattened cattle, milk cows, swine, chickens, or turkeys;
- less than 8 animal units of cattle other than fattened cattle or milk cows;
- less than 10 horses, ponies, mules, burros, or donkeys;
- less than 25 sheep, lambs, or goats; and
- less than $5,000 in sales of specialty livestock products.

Farms with specialty livestock types were defined to be farms with

- few livestock (as defined above), but with sales of livestock products from fish, bees, rabbits, mink, poultry other than chickens and turkeys, and exotic livestock of more than $5,000, or

- significant number of other livestock, but sales from specialty livestock that were more than 75 percent of the total livestock sales for the farm.

Farms with confined livestock types were defined to be farms with

- 4 or more animal units of any combination of fattened cattle, milk cows, swine, chickens, or turkeys, or
- calves or heifers that appeared to be raised in confinement.

Farms with pastured livestock types and few other livestock were defined to be farms with

- less than 4 animal units of any combination of fattened cattle, milk cows, swine, chickens, or turkeys;
- 8 or more animal units of cattle other than milk cows and fattened cattle;
- 10 or more horses, ponies, mules, burros, or donkeys; or
- 25 or more sheep, lambs, or goats.

Farms that met criteria for veal farms or confined heifer farms were excluded from this group and counted as ***farms with confined livestock types***.

Veal farms were identified in the Census of Agriculture as farms with annual sales of more than 210 calves and no beef cow or milk cow end-of-year inventory and little or no land available for grazing. Confined heifer farms were identified as farms with annual sales of more than 50 heifers and no beef cow or milk cow end-of-year inventory and little or no land available for grazing. Veal and confined heifers were identified only on farms with less than 5 acres of rangeland and pastureland and without grazing land permits. There are undoubtedly additional veal and confined heifer farms, but they could not be distinguished from farms with pastured animals based on the information available in the Census of Agriculture. It is also likely that some of these farms did not raise confined heifers or veal. Nevertheless, the census data suggest that calves or heifers on all of these farms were being held in confinement.

The dominant livestock type on each farm was defined as the livestock type with the most animal units.

Farms with confined livestock types also may have significant populations of pastured livestock types, which were sometimes the dominant livestock type on the farm. If more than 35 animal units of any fattened cattle, milk cows, swine, chickens, or turkeys were present on the farm, they were used to define the dominant livestock type, even if cattle (excluding milk cows and fattened cattle) were the most abundant livestock type on the farm.

Included in ***farms with confined livestock types*** were a small number of farms (2,291 farms) that did not meet the criteria listed above. These three special cases are

- Farms with no chicken layers, pullets, broilers, or turkeys, but more than 5,000 poultry hatched and placed or sold, or more than 10,000 incubator-egg capacity. Most of these farms produce chicks for the broiler industry. Poultry sales for these farms totaled $1.6 billion dollars.
- Farms that had more than $5,000 in dairy products sold, but no end-of-year milk cow inventory. These are most likely dairies that went out of business in 1997. (Farms with other livestock types that had no end-of-year inventories, but reported livestock sales were automatically classified as farms with confined livestock types because data on the number of animals sold was incorporated into the calculation of animal units. Milk cow animal units, however, are only based on the end-of-year inventory.)
- Farms with sales of feeder pigs, but no other hogs or pigs on the farm. Animal units are not estimated for feeder pigs because the calculation for hogs for slaughter assumes the animals were on the farm from birth to market. A separate calculation for feeder pigs would therefore result in an unknown amount of double counting. Only 15 of these farms had significant numbers of feeder pigs, and were most likely swine nursery operations that raise weaned pigs to feeder pig size.

Farms that met criteria for special cases, but had more than four animal units of fattened cattle, milk cows, swine, chickens, or turkeys were classified according to the dominant confined livestock type, and were thus not categorized as a "special case" farm.

Profile of farms with few livestock

Farms with few livestock numbered 361,031, comprising 27 percent of all farms with livestock or livestock sales (table A–1). About 75 percent of ***farms with few livestock*** had only pastured livestock types; 23 percent had at least some fattened cattle, milk cows, swine, chickens, or turkeys; and about 2 percent primarily had specialty livestock with specialty livestock sales below $5,000 (table A–2). Even on the farms that also had confined livestock types, most of the livestock were pastured livestock types. Gross livestock sales for ***farms with few livestock*** totaled $776 million, representing less than 1 percent of livestock sales for all farms with livestock. Of this, $48 million was reported for about 300 farms with high-value livestock sales such as horses or breeding stock, most of which were horse sales. The average gross livestock sales per farm were only $2,149 ($2,017 excluding the 300 farms with high value livestock sales). No livestock sales were reported for 34 percent of the farms, 50 percent had gross livestock sales less than $900, and 75 percent had gross livestock sales less than $2,450. Five percent of the farms had gross livestock sales more than $8,000.

The total number of livestock on all ***farms with few livestock*** is almost negligible when compared to the number of livestock on other farms (table A–2). These 361,031 farms accounted for only 1 percent of cattle (all types), swine, turkey, and chicken animal units on all farms and 3.6 percent of sheep and goats. Horses are the exception. About one-fourth of all the horses, ponies, mules, burros, and donkeys were on ***farms with few livestock*** (even though the maximum number on any farm was less than 10). On average, ***farms with few livestock*** have about 2.3 animal units of beef cattle, 0.2 animal units of fattened cattle, swine, turkeys, and chickens combined; 1 to 2 horses, ponies, mules, burros, and donkeys; and 1 sheep or goat.

Table A–1 Number of farms with livestock or livestock sales in the 1997 Census of Agriculture, categorized into four farm groups, by State

	Farms with few livestock	Farms with specialty livestock types	Farms with pastured livestock types & few other livestock	Farms with confined livestock types	All farms with livestock
Alabama	8,142	236	21,415	4,038	33,831
Alaska	192	38	85	37	352
Arizona	1,603	67	2,338	233	4,241
Arkansas	7,209	314	21,391	6,491	35,405
California	10,881	817	12,964	3,478	28,140
Colorado	6,576	166	12,905	1,457	21,104
Connecticut	1,052	38	592	400	2,082
Delaware	314	8	186	981	1,489
Florida	6,670	673	11,812	1,241	20,396
Georgia	7,100	177	15,950	4,984	28,211
Hawaii	752	50	498	147	1,447
Idaho	5,936	169	8,460	1,644	16,209
Illinois	10,403	135	13,128	11,197	34,863
Indiana	11,573	164	11,207	10,006	32,950
Iowa	9,697	156	19,354	26,081	55,288
Kansas	8,465	100	28,483	4,939	41,987
Kentucky	16,044	45	36,138	4,816	57,043
Louisiana	4,327	305	11,277	1,254	17,163
Maine	1,474	58	818	709	3,059

Table A–1 Number of farms with livestock or livestock sales in the 1997 Census of Agriculture, categorized into four farm groups, by State—Continued

	Farms with few livestock	Farms with specialty livestock types	Farms with pastured livestock types & few other livestock	Farms with confined livestock types	All farms with livestock
Maryland	2,732	73	2,554	2,440	7,799
Massachusetts	1,555	71	689	541	2,856
Michigan	10,466	326	6,958	6,565	24,315
Minnesota	10,554	330	12,930	19,171	42,985
Mississippi	5,025	411	15,089	2,578	23,103
Missouri	16,608	139	49,727	9,627	76,101
Montana	4,120	141	13,078	772	18,111
North Carolina	9,447	187	15,309	6,435	31,378
New Hampshire	997	32	460	315	1,804
Nebraska	5,011	101	19,929	9,893	34,934
Nevada	764	13	1,418	141	2,336
New Jersey	2,862	65	1,193	374	4,494
New Mexico	3,674	41	6,661	454	10,830
New York	6,709	211	5,626	9,076	21,622
North Dakota	2,184	195	12,114	2,269	16,762
Ohio	15,088	203	13,937	10,996	40,224
Oklahoma	15,166	91	46,256	3,440	64,953
Oregon	11,570	278	11,367	1,093	24,308
Pennsylvania	10,122	247	9,306	14,215	33,890
Rhode Island	218	10	107	65	400
South Carolina	4,561	71	7,410	1,415	13,457
South Dakota	2,782	147	15,293	5,789	24,011
Tennessee	18,530	107	38,217	3,566	60,420
Texas	42,210	495	114,373	6,516	163,594
Utah	4,117	193	5,907	1,197	11,414
Vermont	1,305	40	943	1,940	4,228
Virginia	8,599	91	20,178	3,359	32,227
Washington	8,262	249	7,577	1,497	17,585
West Virginia	5,304	34	8,368	959	14,665
Wisconsin	10,483	471	9,250	26,628	46,832
Wyoming	1,596	55	6,140	362	8,153
All states	361,031	8,834	707,365	237,821	1,315,051

Table A–2 Profile of ***farms with few livestock*** in the 1997 Census of Agriculture

	Farms with sales of specialty livestock products >75% of livestock sales*	Farms with only sheep and goats**	Farms with only horses, ponies, mules, burros, or donkeys**		Farms with beef cattle or a mix of cattle and other pastured livestock types**		Farms with any fattened cattle, milk cows, swine, chickens, or turkeys*	All farms with few livestock	% of total for all farms with livestock
			Farms with <$50,000 in livestock sales	Farms with $50,000 or more in livestock sales	Farms with <$50,000 in livestock sales	Farms with $50,000 or more in livestock sales			
Number of farms	9,194	8,752	78,645	188	181,763	107	82,382	361,031	27.5
Percent	2.5	2.4	21.8	0.1	50.3	<0.1	22.8	100.0	
Total agricultural sales ($)	135,718,022	181,653,572	1,645,568,234	30,153,774	1,856,154,469	21,109,205	1,002,993,042	4,873,350,318	3.8
Sales per farm	14,762	20,756	20,924	160,392	10,212	197,282	12,175	13,498	13.7
Livestock sales ($)	14,968,005	7,744,496	84,862,759	30,004,565	437,748,522	18,245,588	182,304,685	775,878,620	0.8
Sales per farm									
Mean	1,628	885	1,079	159,599	2,408	170,520	2,213	2,149	2.9
25th percentile	300	10	0	60,000	0	57,100	278	0	
50th percentile	1,260	516	0	76,250	1,200	75,000	1,318	900	
75th percentile	2,513	1,235	500	127,500	2,815	135,000	2,936	2,450	
90th percentile	3,995	2,000	3,000	235,986	6,122	250,000	5,298	5,189	
95th percentile	4,500	2,662	5,600	476,000	9,568	536,350	7,181	8,000	
Dollar value for sale of:									
Cattle other than fattened cattle	34,973	0	0	0	403,024,176	1,635,840	61,610,241	466,305,230	2.3
Fattened cattle	1,200	0	0	0	0	0	56,183,340	56,184,540	0.3
Dairy products	0	0	0	0	0	0	1,026,771	1,026,771	<0.1
Hogs and pigs	7,549	0	0	0	0	0	29,237,942	29,245,491	0.2
Chicken & turkey products	56,259	0	0	0	0	0	16,730,861	16,787,120	0.1
Specialty livestock products	14,813,081	109,107	152,301	0	603,955	4,800	1,741,800	17,425,044	1.0
Horses, ponies, mules, burros, donkeys	9,520	103,757	84,082,849	29,552,605	25,775,947	13,629,797	10,009,346	163,163,821	15.8
Sheep & goat products	45,423	7,531,632	627,609	451,960	8,344,444	2,975,151	5,764,384	25,740,603	3.4
Animal units									
Fattened cattle	1	0	0	0	0	0	28,502	28,503	0.3
Beef cows	1,041	0	0	0	305,721	5	88,563	395,331	1.1
Other beef cattle	584	0	0	0	355,645	216	85,880	442,325	2.2
Milk cows	99	0	0	0	0	0	11,142	11,241	0.1
Other dairy cattle	21	0	0	0	0	0	5,768	5,789	0.2
Hogs and pigs	46	0	0	0	0	0	24,936	24,981	0.3
Chickens	79	0	0	0	0	0	3,840	3,919	0.1
Turkeys	12	0	0	0	0	0	592	605	<0.1
All types	1,882	0	0	0	661,367	222	249,223	912,693	1.0

Table A–2 Profile of ***farms with few livestock*** in the 1997 Census of Agriculture

	Farms with sales of specialty livestock products >75% of livestock sales*	Farms with only sheep and goats**	Farms with only horses, ponies, mules, burros, or donkeys**		Farms with beef cattle or a mix of cattle and other pastured livestock types**		Farms with any fattened cattle, milk cows, swine, chickens, or turkeys*	All farms with few livestock	% of total for all farms with livestock
			Farms with <$50,000 in livestock sales	Farms with $50,000 or more in livestock sales	Farms with <$50,000 in livestock sales	Farms with $50,000 or more in livestock sales			
End-of-year inventory									
Sheep & goats	4,325	102,379	0	0	123,271	42	120,203	350,220	3.6
Horses, ponies, mules, burros, donkeys	4,754	0	348,723	1,076	154,444	147	87,223	596,367	23.6

* Farms may also have any of the other livestock types.
** Farms may also have specialty livestock where sales of specialty livestock products are less than 75 percent of total livestock sales.

Profile of farms with specialty livestock types

In the 1997 Census of Agriculture, there were 8,834 farms with specialty livestock types, comprising 0.7 percent of all farms with livestock (table A–1). These 8,834 farms accounted for $1.6 billion in gross livestock sales (table A–3). Most of these farms (91 percent) had few other livestock, but 786 farms would also qualify as ***farms with pastured livestock types and few other livestock*** and 50 farms would also qualify as ***farms with confined livestock types***. Overall, ***farms with specialty livestock types*** had negligible amounts of other livestock types (table A–3). Although the other three farm groups all had some specialty livestock, ***farms with specialty livestock types*** accounted for 96 percent of all specialty livestock sales. The dominant specialty livestock types on these farms—based on sales—were fish and other aquaculture species on 2,449 farms (28 percent), colonies of bees on 2,331 farms (26 percent), poultry other than chickens and turkeys (such as ducks and geese) on 1,490 farms (17 percent), mink and rabbits on 641 farms (7 percent), and other exotic livestock on 1,923 farms (22 percent).

Table A–3 Profile of ***farms with specialty livestock types*** in the 1997 Census of Agriculture

	Farms that meet criteria for "farms with few livestock," but specialty livestock sales were >$5,000		Farms that meet criteria for farms with pastured livestock types & few other livestock, but specialty livestock sales were >75% of total livestock sales	Farms that meet criteria for farms with confined livestock types, but specialty livestock sales were >75% of total livestock sales	All farms with specialty livestock types	Percent of total for all farms with livestock
	Farms with only specialty livestock types	Farms with a mix of specialty livestock types & other livestock types				
Number of farms	6,826	1,172	786	50	8,834	0.7
Percent	77.3	13.3	8.9	0.6	100.0	
Total agricultural sales ($)	1,533,175,707	106,925,267	214,946,962	65,420,064	1,920,468,000	1.5
Sales per farm	224,608	91,233	273,469	1,308,401	217,395	221.4
Livestock sales ($)	1,263,909,162	90,662,252	202,967,572	57,702,731	1,615,241,717	1.6
Sales per farm						
Mean	185,161	77,357	258,228	1,154,055	182,844	243.3
25th percentile	12,000	10,000	3,400	65,979	11,016	
50th percentile	30,000	20,051	26,796	228,802	28,900	
75th percentile	99,385	50,000	112,991	469,551	94,200	
90th percentile	300,000	160,000	356,402	2,209,875	298,262	
95th percentile	700,000	315,000	902,522	6,642,000	650,000	
Dollar value for sale of						
Cattle other than fattened cattle	0	749,928	5,736,573	1,153,934	7,640,435	<0.1
Fattened cattle	0	65,217	47,517	544,658	657,392	<0.1
Dairy products	0	2,952	55,267	383,339	441,558	<0.1
Hogs and pigs	0	119,838	11,095	190,073	321,006	<0.1
Chicken and turkey products	867	457,055	20,231	446,235	924,389	<0.1

Table A–3 Profile of ***farms with specialty livestock types*** in the 1997 Census of Agriculture—Continued

	Farms that meet criteria for "farms with few livestock," but specialty livestock sales were >$5,000		Farms that meet criteria for farms with pastured livestock types & few other livestock, but specialty livestock sales were >75% of total livestock sales	Farms that meet criteria for farms with confined livestock types, but specialty livestock sales were >75% of total livestock sales	All farms with specialty livestock types	Percent of total for all farms with livestock
	Farms with only specialty livestock types	Farms with a mix of specialty livestock types & other livestock types				
Dollar value for sale of (cont.)						
Specialty livestock products	1,263,891,745	88,808,094	196,659,443	54,955,942	1,604,315,223	96.1
Horses, ponies, mules, burros, & donkeys	12,650	331,078	230,195	6,037	579,960	0.1
Sheep & goat products	3,900	128,090	207,251	22,513	361,754	<0.1
Animal units						
Fattened cattle	0	35	21	200	256	<0.1
Beef cows	0	372	18,261	379	19,012	0.1
Other beef cattle	0	584	6,772	828	8,184	<0.1
Milk cows	0	36	16	459	512	<0.1
Other dairy cattle	0	12	17	116	145	<0.1
Hogs & pigs	0	63	17	246	326	<0.1
Chickens	0	69	11	227	307	<0.1
Turkeys	0	24	4	0	27	<0.1
All types	0	1,196	25,119	2,456	28,771	<0.1
End-of-year inventory						
Sheep & goats	0	2,271	8,712	317	11,300	0.1
Horses, ponies, mules, burros, & donkeys	0	2,173	6,465	150	8,788	0.3

Profile of farms with pastured livestock types and few other livestock

Farms with pastured livestock types and few other livestock comprised the largest group of farms, consisting of 707,365 farms representing 54 percent of all farms with livestock (table A–1). The majority of farms in this group—59 percent—were farms with only beef cattle other than fattened cattle (table A–4). About 2 percent of the farms had only sheep and goats, and about 4 percent had only horses, ponies, mules, burros, or donkeys. The remaining 35 percent of these farms had a mixture of pastured livestock types, of which about 40 percent also had up to 4 animal units of fattened cattle, milk cows, swine, chickens, or turkeys. ***Farms with pastured livestock types and few other livestock*** accounted for about 86 percent of all beef cow animal units on all farms, about 68 percent of all beef cattle animal units other than fattened cattle or beef cows, about 88 percent of all sheep and goats, and about 68 percent of all horses, ponies, mules, burros, and donkeys. Fattened cattle, milk cows, other dairy cattle, swine, chickens, and turkeys totaled only 82,186 animal units, which is a negligible proportion (0.2 percent) of these livestock types on all farms.

Overall, ***farms with pastured livestock types and few other livestock*** accounted for only 17 percent of all livestock sales ($17.2 billion) even though this group represented over half of all farms with livestock (table A–4). Twenty-five percent had livestock sales less than $2,800, 50 percent had livestock sales less than $6,250, and 75 percent had livestock sales less than $15,400. In general, ***farms with pastured livestock types and few other livestock*** are dominated by small farms that primarily raise livestock (mostly beef cattle) and have low gross livestock sales. A significant minority, however, raises large numbers of livestock and has relatively high gross livestock sales.

Table A–4 Profile of ***farms with pastured livestock types and few other livestock*** in the 1997 Census of Agriculture

	Farms with only sheep & goats	Farms with only horses, ponies, mules, burros, & donkeys	Farms with only beef cattle (other than fattened cattle)	Farms with mixture of pastured livestock, but no fattened cattle, milk cows, swine, chickens, or turkeys	Farms with mixture of pastured livestock & up to 4 AU of fattened cattle, milk cows, swine, chickens, or turkeys	All farms with pastured livestock	Percent of total for all farms with livestock
Number of farms	11,937	30,083	417,066	147,665	100,614	707,365	53.8
Percent	1.7	4.3	59.0	20.9	14.2	100.0	
Total agricultural sales ($)	542,999,683	795,274,493	18,074,489,373	9,114,058,317	3,576,474,880	32,103,296,746	24.9
Sales per farm	45,489	26,436	43,337	61,721	35,546	45,384	46.2
Livestock sales ($)	259,647,277	561,468,897	8,454,255,790	6,157,315,387	1,758,488,797	17,191,176,148	17.4
Sales per farm							
Mean	21,751	18,664	20,271	41,698	17,478	24,303	32.3
25th percentile	1,060	0	3,000	3,300	2,800	2,800	
50th percentile	2,500	1,000	6,400	8,423	5,720	6,250	
75th percentile	5,879	6,000	14,854	25,800	12,464	15,400	
90th percentile	16,000	20,000	35,000	79,758	31,000	40,200	
95th percentile	32,000	42,000	61,600	152,378	59,856	78,108	

Table A–4 Profile of ***farms with pastured livestock types and few other livestock*** in the 1997 Census of Agriculture—Continued

	Farms with only sheep & goats	Farms with only horses, ponies, mules, burros, & donkeys	Farms with only beef cattle (other than fattened cattle)	Farms with mixture of pastured livestock, but no fattened cattle, milk cows, swine, chickens, or turkeys	Farms with mixture of pastured livestock & up to 4 AU of fattened cattle, milk cows, swine, chickens, or turkeys	All farms with pastured livestock	Percent of total for all farms with livestock
Dollar value for sale of:							
Cattle other than fattened cattle	0	0	8,441,232,799	5,595,179,752	1,545,594,644	15,582,007,195	77.3
Fattened cattle	0	0	0	0	87,335,894	87,335,894	0.4
Dairy products	0	0	0	0	2,520,548	2,520,548	<0.1
Hogs & pigs	0	0	0	0	18,421,074	18,421,074	0.1
Chicken & turkey products	0	0	0	0	5,325,405	5,325,405	<0.1
Specialty livestock products	343,747	1,211,586	7,138,540	7,576,669	3,568,821	19,839,363	1.2
Horses, ponies, mules, burros, & donkeys	35,778	560,090,350	3,032,335	239,052,983	39,944,522	842,155,968	81.3
Sheep and goat products	259,267,752	166,961	2,852,116	315,505,983	55,777,889	633,570,701	84.7
Animal units							
Fattened cattle	0	0	0	0	44,361	44,361	0.5
Beef cows	0	0	16,651,685	10,305,181	3,630,671	30,587,537	86.0
Other beef cattle	0	0	7,527,475	4,819,392	1,566,561	13,913,428	68.3
Milk cows	0	0	0	0	10,834	10,834	0.1
Other dairy cattle	0	0	0	0	8,346	8,346	0.3
Hogs & pigs	0	0	0	0	15,857	15,857	0.2
Chickens	0	0	0	0	2,466	2,466	0.1
Turkeys	0	0	0	0	322	322	<0.1
All types	0	0	24,179,160	15,124,573	5,279,417	44,583,150	46.8
End-of-year inventory							
Sheep & goats	2,202,044	0	0	5,532,589	924,664	8,659,297	88.3
Horses, ponies, mules, burros, & donkeys	0	666,526	0	848,530	212,227	1,727,283	68.3

Profile of farms with confined livestock types

Of the 1,315,051 farms with livestock, 18 percent (237,821 farms) were ***farms with confined livestock types*** (table A–1). These 237,821 farms accounted for $79 billion in gross livestock sales, which was 80 percent of gross livestock sales for all farms (table A–5). Of the ***farms with confined livestock types,*** 25 percent had gross livestock sales above $223,870, 50 percent had sales above $93,620, and 75 percent had sales above $33,204. The top 5 percent had gross livestock sales above $1 million.

Farms with confined livestock types accounted for 99 percent or more of all animal units on all farms with livestock for each of fattened cattle, milk cows, other dairy cattle, swine, chickens, and turkeys (table A–5). Dairies comprised 40 percent of the farms (94,787 farms), swine were the dominant livestock type on 22 percent of the farms (51,772 farms), poultry were dominant on 12 percent (27,530 farms), fattened cattle were dominant on 8 percent (17,796 farms), and veal and confined heifers were dominant on about 2 percent (4,011 farms). The remaining farms were special cases (1 percent) or small farms where beef cattle (other than fattened cattle) were the dominant livestock type (17 percent).

Farms with confined livestock types were broken down into two groups: farms with less than 35 animal units of either fattened cattle, milk cows, swine, chickens, or turkeys, and farms with more than 35 AU of either fattened cattle, milk cows, swine, chickens, or turkeys, or were defined as veal or confined heifer farms. The 35-AU threshold was selected to correspond to the lower threshold used to derive representative farms in the main body of this report.

Farms with less than 35 AU of confined livestock types totaled 84,297, representing about 35 percent of ***farms with confined livestock types***. This group accounted for only 4 percent of livestock sales and only 8 percent of the animal units among ***farms with confined livestock types***. The median per-farm livestock sales were about $23,000 for these small farms.

There were 151,233 of the larger ***farms with confined livestock types.*** These farms accounted for the bulk of fattened cattle, milk cow, swine, and poultry animal units on all farms (table A–5). The median per-farm livestock sales were about $165,000. Of these farms, 10 percent had livestock sales above $835,000.

Table A–5 Profile of ***farms with confined livestock types*** in the 1997 Census of Agriculture

	Farms with < 35 AU of each livestock type	Farms with > 35 AU of one or more livestock types	Special cases*	All farms with confined livestock types	Percent of total for all farms with livestock
Number of farms	84,297	151,233	2,291	237,821	18.1
Percent	35.4	63.6	1.0	100.0	
Number of farms by dominant livestock type					
Fattened cattle	7,637	10,159	0	17,796	
Milk cows	15,469	79,318	0	94,787	
Swine	18,817	32,955	0	51,772	
Turkeys	96	3,213	0	3,309	
Broilers	1,525	16,251	0	17,776	
Layers	862	4,052	0	4,914	
Pullets	257	1,274	0	1,531	
Cattle other than fattened cattle or milk cows	39,634	**	0	39,634	
Veal	***	168	0	168	
Confined heifers	***	3,843	0	3,843	

Table A–5 Profile of ***farms with confined livestock types*** in the 1997 Census of Agriculture—Continued

	Farms with < 35 AU of each livestock type	Farms with > 35 AU of one or more livestock types	Special cases*	All farms with confined livestock types	Percent of total for all farms with livestock
Total agricultural sales ($)	6,148,781,785	82,190,842,232	1,874,465,200	90,214,089,217	69.9
Sales per farm	72,942	543,472	818,186	379,336	386.4
Livestock sales ($)	2,857,757,966	74,547,113,675	1,821,824,733	79,226,696,374	80.2
Sales per farm					
Mean	33,901	492,929	795,209	333,136	443.4
25th percentile	11,748	94,000	37,444	33,204	
50th percentile	22,718	164,950	73,150	93,620	
75th percentile	41,254	367,850	150,000	223,870	
90th percentile	67,500	834,707	825,800	588,052	
95th percentile	94,536	1,340,075	6,026,130	1,002,200	
Dollar value for sale of:					
Cattle other than fattened cattle	677,436,808	3,335,114,564	90,437,150	4,102,988,522	20.4
Fattened cattle	754,433,949	19,466,751,517	531,036	20,221,716,502	99.3
Dairy products	370,748,781	18,504,517,230	118,079,251	18,993,345,262	100.0
Hogs & pigs	673,213,197	13,081,903,100	1,731,127	13,756,847,424	99.7
Chicken & turkey products	337,894,928	20,057,865,509	1,609,770,017	22,005,530,454	99.9
Specialty livestock products	5,308,151	22,493,827	191,020	27,992,998	1.7
Horses, ponies, mules, burros, & donkeys	12,959,394	16,483,323	473,954	29,916,671	2.9
Sheep and goat products	25,762,758	61,984,605	611,178	88,358,541	11.8
Animal units					
Fattened cattle	369,674	9,145,786	260	9,515,719	99.2
Beef cows	1,829,930	2,709,553	31,725	4,571,207	12.9
Other beef cattle	889,940	5,069,077	40,766	5,999,783	29.5
Milk cows	385,541	11,883,007	0	12,268,547	99.8
Other dairy cattle	102,206	2,697,856	0	2,800,062	99.5
Hogs & pigs	479,683	8,008,825	41	8,488,548	99.5
Chickens	82,454	3,929,991	7	4,012,452	99.8
Turkeys	1,839	2,103,032	0	2,104,871	100.0
All types	4,141,265	45,547,126	72,798	49,761,190	52.2
End-of-year inventory					
Sheep and goats	350,843	413,664	16,460	780,967	8.0
Horses, ponies, mules, burros, & donkeys	89,262	104,716	1,449	195,427	7.7

* Farms classified as special cases include dairies that went out of business, farms with only feeder pigs, and egg-hatching operations (see text).

** If more than 35 animal units of any fattened cattle, milk cows, swine, chickens, or turkeys were present on the farm, they were used to define the dominant livestock type, even if cattle were the most abundant livestock type on the farm. There were 11,782 farms that met this condition, of which 34 percent were classified as fattened cattle farms, 31 percent were classified as swine farms, and 22 percent were classified as dairies.

*** For small farms, veal and confined heifers are included with cattle other than fattened cattle or milk cows.

Note: Confined livestock types include fattened cattle, milk cows, swine, chickens, turkeys, veal, and confined heifers.

Profile of potential concentrated animal feeding operations

Potential Concentrated Animal Feeding Operations (CAFOs) are an important subset of ***farms with confined livestock.*** Under the National Pollutant Discharge Elimination System (NPDES) program, CAFOs are defined as livestock operations that (USEPA, 2000)

- Confine more than 1,000 animal units, where 1,000 AUs are defined as 1,000 slaughter and feeder cattle, 700 mature dairy cows, 2,500 swine (other than feeder pigs), 30,000 laying hens or broilers if facility uses a liquid system, and 100,000 laying hens or broilers if facility uses continuous overflow watering.
- Confine between 300 and 1,000 animal units (as defined above) and discharge pollutants into water through a constructed ditch, flushing system, or similar manufactured device, or directly into water that passes through the facility.

CAFOs are required to have NPDES permits, which restrict discharge of pollutants to water except in the event of a 25-year, 24-hour storm.

EPA uses the following headcount thresholds to define the 1,000 and 300 animal unit categories (USEPA, 2001).

Number of animals needed to qualify as a CAFO:

	1,000 EPA AU	300 EPA AU
Cattle and heifers	1,000 head	300 head
Veal	1,000 head	300 head
Mature dairy cattle	700 head	200 head
Swine over 55 pounds	2,500 head	750 head
Immature swine	10,000 head	3,000 head
Chickens	100,000 head	30,000 head
Turkeys	55,000 head	16,500 head

EPA animal units are thus different from USDA animal units. A USDA animal unit is 1,000 pounds of live weight. The table below presents equivalent thresholds in terms of USDA animal units for each of the two EPA thresholds. Animals per USDA animal unit were taken from Kellogg et al. (2000) and are presented in appendix B, table B–1. The comparison assumes that the number of animals represented by the EPA headcount thresholds is the average number of animals on the farm throughout the year. The EPA thresholds are actually more restrictive since they apply to the maximum number of animals in confinement on the farm in any 45 days within a year.

USDA animal units (1,000 lb of live weight) equivalent to EPA's headcount thresholds for CAFOs:

	1,000 EPA AU criteria	300 EPA AU criteria
Fattened cattle	877	263
Milk cows	946	270
Confined heifers	1,064	319
Veal	250	75
Breeding hogs	936	281
Hogs for slaughter	275	83
Chicken layers	400	120
Chicken broilers	220	66
Turkeys for breeding	1,100	330
Turkeys for slaughter	821	246

Although the information in the Census of Agriculture is not adequate to identify a farm as a CAFO, **potential** CAFOs can be estimated based on the livestock type and the estimated number of animals on the farm. Results indicate that in 1997 there were 11,398 potential CAFOs at the 1,000 EPA animal unit level, representing about 5 percent of all farms with confined livestock types (table A–6). There were 44,366 potential CAFOs at the 300 EPA animal unit level (19 percent of all farms with confined livestock types).

For potential CAFOs at the 1,000 EPA animal unit level, median gross livestock sales per farm were $1.5 million (table A–6). Seventy-five percent had gross livestock sales above $1 million, and 25 percent had gross livestock sales above $2.6 million. Livestock sales for this collection of farms are about $40 billion, which is 41 percent of the total livestock sales for all farms with livestock. Of these 11,398 farms, 34 percent are swine farms, 26 percent are broiler farms, 15 percent are fattened cattle farms, 13 percent are dairies, and the remaining 12 percent are farms with turkeys, layers, pullets, veal, or confined heifers (table A–6). Overall, these farms accounted for 85 percent of all fattened cattle on ***farms with confined livestock types***, 23 percent of milk cows, 54 percent of swine, 46 percent of turkeys, and 51 percent of chickens (table A–6).

At the 300 EPA animal unit level, the number of potential CAFOs increases to nearly 4 times the number of potential CAFOs at the 1,000 EPA animal unit level, and account for an additional $18 billion in livestock sales (table A–6). Overall, these farms accounted for 91 percent of all fattened cattle on ***farms with confined livestock types***, 44 percent of milk cows, 78 percent of swine, 89 percent of turkeys, and 90 percent of chickens.

Correspondence between farm groups and CNMP farms

In the main body of the publication, criteria were presented for identifying farms that are expected to need a CNMP. Of the 237,821 ***farms with confined livestock types***, 230,373 farms (97 percent) were identified as CNMP farms (table A–7). Of the 707,365 ***farms with pastured livestock types and few other livestock***, 24,697 farms (3 percent) were identified as CNMP farms. Including the 2,131 farms with specialty livestock types, the total number of CNMP farms is 257,201, which represents about 13 percent of all farms in the 1997 Census of Agriculture. Table A–8 provides a breakdown of CNMP farms by livestock type and farm size for the 237,821 ***farms with confined livestock types***.

Table A–6 Profile of potential CAFOs, derived from the 1997 Census of Agriculture*

	1,000 EPA animal units		300 EPA animal units	
	Amount	Percent of total for farms with confined livestock types	Amount	Percent of total for farms with confined livestock types
Number of farms	11,398	4.8	44,366	18.7
Number of farms by dominant livestock type				
Fattened cattle	1,766	9.9	4,448	25.0
Milk cows	1,450	1.5	7,230	7.6
Swine	3,924	7.6	13,825	26.7
Turkeys	388	11.7	2,003	60.5
Broilers	2,945	16.6	13,694	77.0
Layers	546	11.1	1,420	28.9
Pullets	125	8.2	711	46.4
Veal	12	7.1	69	41.1
Confined heifers	242	6.3	966	25.1
Total agricultural sales ($)	41,612,719,837	46.1	62,247,146,870	69.0
Sales per farm	3,650,879		1,403,037	
Livestock sales ($)	40,421,733,048	51.0	58,823,823,880	74.2
Sales per farm				
Mean	3,546,388		1,325,876	
25th percentile	1,059,606		373,287	
50th percentile (median)	1,510,469		607,611	
75th percentile	2,614,725		1,031,801	
90th percentile	5,500,000		1,946,800	
95th percentile	10,983,000		3,240,000	

Table A–6 Profile of potential CAFOs, derived from the 1997 Census of Agriculture*—Continued

	1,000 EPA animal units		300 EPA animal units	
	Amount	Percent of total for farms with confined livestock types	Amount	Percent of total for farms with confined livestock types
Dollar value for sale of:				
Cattle other than fattened cattle	1,023,604,897	24.9	1,877,369,257	45.8
Fattened cattle	17,122,605,326	84.7	18,427,802,297	91.1
Dairy products	4,817,922,724	25.4	9,040,243,783	47.6
Hogs & pigs	7,676,788,204	55.8	11,007,852,819	80.0
Chicken & turkey products	9,752,180,693	44.3	18,410,985,099	83.7
Specialty livestock products	6,003,016	21.4	16,734,000	59.8
Horses, ponies, mules, burros, & donkeys	1,282,479	4.3	5,257,772	17.6
Sheep & goat products	21,345,709	24.2	37,578,853	42.5
Animal units				
Fattened cattle	8,054,276	84.6	8,657,463	91.0
Beef cows	580,686	12.7	1,394,393	30.5
Other beef cattle	3,238,360	54.0	4,053,264	67.6
Milk cows	2,798,343	22.8	5,359,939	43.7
Other dairy cattle	562,326	20.1	1,109,515	39.6
Hogs and pigs	4,559,021	53.7	6,610,933	77.9
Chickens	2,032,327	50.7	3,595,434	89.6
Turkeys	962,703	45.7	1,864,350	88.6
All types	22,788,043	45.8	32,645,291	65.6
End-of-year inventory				
Sheep and goats	69,723	8.9	175,755	22.5
Horses, ponies, mules, burros, & donkeys	10,866	5.6	31,604	16.2

* Information in the Census of Agriculture is not adequate to precisely identify a farm as a CAFO. Potential CAFOs were estimated based on the livestock type and the estimated number of animals on the farm.

Table A–7 Breakdown of farms that are expected to need CNMPs (i.e., CNMP farms) according to farm group

Farm group	Number of farms	Farms identified as CNMP farms	
		number	percent
Farms with no livestock	596,808	0	0
Farms with few livestock	361,031	0	0
Farms with specialty livestock types	8,834	2,131	24
Farms with pastured livestock types and few other livestock	707,365	24,697	3
Farms with confined livestock types	237,821	230,373	97
Total	1,911,859	257,201	13

Table A–8 Breakdown of farms that are expected to need CNMPs (i.e., CNMP farms) according to farm size and livestock type for ***farms with confined livestock types***

Category	Number of farms	Farms identified as CNMP farms	
		number	percent
Farms with >35 animal units of the dominant livestock type, by dominant livestock type	151,233	151,233	100
Fattened cattle	10,159	10,159	100
Milk cows	79,318	79,318	100
Swine	32,955	32,955	100
Turkeys	3,213	3,213	100
Broilers	16,251	16,251	100
Layers/pullets	5,326	5,326	100
Confined heifers/veal	4,011	4,011	100
Farms with <35 animal units of any livestock type	84,297	79,140	94
Confined livestock types dominant	44,663	42,565	95
Beef cattle dominant (other than fattened cattle)	39,634	36,575	92
Special cases	2,291	0	0
Total	237,821	230,373	97

Appendix B Estimating Recoverable Manure and Modeling Land Application

The Census of Agriculture includes enough information on the number and type of livestock, crop production, and cropland and pastureland acreage to make reasonable estimates of the amount of manure produced and the potential for land application on each farm. This appendix presents the methods for making these estimates, the assumptions and rationale underlying the estimates, and a summary of the results that were used in calculations of CNMP costs.

An earlier version of this simulation model was used to generate the estimates published in *Manure Nutrients Relative to the Capacity of Cropland and Pastureland to Assimilate Nutrients: Spatial and Temporal Trends for the United States*, December 2000, by Robert L. Kellogg, Charles H. Lander, David C. Moffitt, and Noel Gollehon. The main differences between the estimates made in this study and those reported in Kellogg, et al. (2000) are

- Recoverability factors and nutrient recovery parameters were revised to be consistent with the representative farms used in this study to characterize manure management and handling on CNMP farms, and
- Land application assumptions were tailored to the two scenarios used to estimate CNMP costs. (The two land application scenarios are described in the main body of this report.)

All measures of nitrogen and phosphorus in this report—manure nutrients *as excreted*, recoverable manure nutrients, excess manure nutrients, and application rates—are in terms of **elemental nitrogen** and **elemental phosphorus**.

Manure and manure nutrients

The amount of manure and manure nutrients produced on livestock operations was estimated using the Census of Agriculture database and generalizations regarding the amount of manure produced per animal and the amount of nitrogen and phosphorus in the manure. The amount of manure produced and the amount of manure nutrients produced per animal actually varies from farm to farm depending on the how much and how often the animals are fed, the quality of the feed and grazing materials (especially the nitrogen and phosphorus content), the extent to which the animals are held in confinement, and the extent to which animals are allowed access to grazing land. Actual values for specific farms are expected to differ from estimates based on the Census of Agriculture database. Overall, however, it is believed that these estimates are good approximations to the total amounts of manure produced on livestock operations.

The amount of manure *as excreted* that is produced on a farm is calculated as the number of animal units times the amount of manure produced by an animal unit. The amount of manure nutrients is then calculated as a percentage of the amount of manure *as excreted*. An animal unit (AU) is 1,000 pounds of live weight. Census of Agriculture information on livestock sales during the year and end-of-year inventory was used to estimate the average annual number of AUs of each livestock type on each farm using procedures described in Kellogg, et al. (2000). Some of the algorithms used to estimate beef cattle AUs were refined and improved. The major modification was to estimate veal and confined heifer farms separately from other cattle farms, as described in appendix A. Conversion factors for grass-fed beef cattle were used to estimate manure produced by sheep, goats, horses, ponies, mules, donkeys, and burros. Manure production was not calculated for specialty livestock types because appropriate conversion factors were not available. Conversion factors used to estimate the amount of *as excreted* manure and manure nutrients by livestock type are presented in table B–1. The resulting estimates of manure nutrients *as excreted* are shown in table B–2 for all farms in all 50 states. Estimates could not be made for farms in the Pacific Basin or in Puerto Rico because Census of Agriculture information for these areas was not readily available. National totals are nearly the same as those previously reported in Kellogg et al. (2000) for all livestock.

Table B–1 Parameters used to calculate the quantity of manure and manure nutrients *as excreted*

Livestock type	Number of animals per AU	Tons of manure per - - - - AU per year - - - - wet weight	oven-dry weight	Pounds of nutrient per wet weight ton of manure* nitrogen	phosphorus
Fattened cattle	1.14	10.59	1.27	10.98	3.37
Beef calves	4	11.32	1.36	8.52	2.33
Beef heifers	1.14	12.05	1.45	6.06	1.30
Beef breeding cows and bulls	1	11.50	1.33	10.95	3.79
Beef stockers and grass-fed beef	1.73	11.32	1.36	8.52	2.33
Horses, ponies, mules, donkeys, & burros	1.25	11.32	1.36	8.52	2.33
Sheep and goats	8	11.32	1.36	8.52	2.33
Milk cows	0.74	15.24	2.20	10.69	1.92
Dairy calves	4	12.05	1.45	6.06	1.30
Dairy heifers	0.94	12.05	1.45	6.06	1.30
Dairy stockers & grass-fed animals marketed as beef	1.73	12.05	1.45	6.06	1.30
Hogs for breeding	2.67	6.11	0.55	13.26	4.28
Hogs for slaughter	9.09	14.69	1.33	11.30	3.29
Chicken layers	250	11.45	2.86	26.93	9.98
Chicken pullets, less than 3 months old	455	8.32	2.08	27.20	10.53
Chicken pullets, more than 3 months old	250	8.32	2.08	27.20	10.53
Chicken broilers	455	14.97	3.74	26.83	7.80
Turkeys for breeding	50	9.12	2.28	22.41	13.21
Turkeys for slaughter	67	8.18	2.04	30.36	11.83

* Includes nitrogen and phosphorus in urine.

Table B–2 Number of farms, animal units, and quantities of manure nutrients *as excreted* for all livestock on all farms

Farm group and dominant livestock type*	Number of farms	Animal units	Pounds of manure nitrogen	Pounds of manure phosphorus
Farms with no livestock	596,808	0	0	0
Farms with few livestock	361,031	1,433,564	152,597,724	45,476,482
Farms with specialty livestock types**	8,834	37,214	4,255,609	1,337,147
Farms with pastured livestock types and few other livestock	707,365	47,047,388	5,412,011,193	1,755,347,275
Farms with confined livestock types				
Farms with >35 AU of the dominant livestock type, by dominant livestock type				
Fattened cattle	10,159	13,193,896	1,481,784,875	449,201,459
Milk cows	79,318	15,448,663	2,235,427,462	425,073,626
Swine	32,955	9,073,203	1,256,177,612	375,873,882
Turkeys	3,213	2,206,628	525,875,015	207,734,091
Broilers	16,251	2,966,935	1,041,747,587	305,145,588
Layers	4,052	1,374,533	398,365,032	146,767,400
Pullets	1,274	209,374	44,011,426	16,582,152
Confined heifers	168	26,827	2,962,551	882,549
Veal	3,843	1,182,548	120,000,451	33,802,682
Farms with <35 AU of any livestock type				
Confined livestock types dominant	44,663	1,054,576	154,107,500	39,981,908
Beef cattle dominant (other than fattened cattle)	39,634	3,277,969	389,252,366	123,422,081
Special cases	2,291	0	0	0
All farms	1,911,859	98,533,319	13,218,576,402	3,926,628,320

* See appendix A for definitions of farm groups.
** Excludes AU and manure produced by specialty livestock types. Values reported in table represent nonspecialty livestock types on these farms.

Recoverable manure and recoverable manure nutrients

Recoverable manure is the portion of manure *as excreted* that could be collected from buildings and lots where livestock are held, and thus would be available for land application. Recoverable manure nutrients are the amounts of manure nitrogen and phosphorus that would be expected to be available for land application. They are estimated by adjusting the quantity of recoverable manure for nutrient loss during collection, transfer, storage, and treatment. Recoverable manure nutrients are **not** adjusted for losses of nutrients at the time of land application.

Estimates of manure produced *as excreted* were converted to estimates of recoverable manure using recoverability factors. The **manure recoverability factor** is the proportion of manure *as excreted* that can be collected and made available for land application or other use. **Nutrient recovery parameters** are the proportions of nitrogen and phosphorus in the recoverable manure relative to the amount of manure nutrients *as excreted*. Recoverability factors were derived for each model farm. Model farms are defined in the main body of this publication. The model farm analytical structure was expanded somewhat to account for recoverable manure on small farms and regional variability.

Manure recoverability factors and nutrient recovery parameters for fattened cattle, milk cows, veal, confined heifers, swine, chickens, and turkeys are presented in table B–3. Separate estimates of recoverable manure and manure nutrients were made for each of the two land application scenarios defined in the main body of this publication. Estimates for the **baseline scenario** were made using manure recoverability factors and nutrient recovery parameters that are expected to generally represent conditions in about 1997, prior to implementation of CNMPs and most State and local regulations. Estimates for the **after-CNMP scenario** reflect adjustments for improved manure management and handling. Manure recoverability factors were higher for most model farms in the after-CNMP scenario. Most nutrient recovery parameters were the same in both land application scenarios. Nitrogen recovery parameters were lower in the after-CNMP scenario for some liquid waste handling systems (dairies) under the assumption that more of the solid manure on the farm would be incorporated into the liquid system where volatilization rates are higher. For some liquid systems, the system changes typically needed to meet CNMP criteria would significantly increase the storage time, and wastewater would be more dilute. This would be especially true upgrading a storage pond to a storage lagoon. The longer storage time provides more time for volatilization, so N losses in the after-CNMP scenario could be greater.

Estimates of recoverable manure for pastured livestock types (e.g., beef cattle, horses, sheep, and goats) were limited to farms with more than one animal unit of these types per acre of pastureland and rangeland. Recoverability factors reflect the extent to which these livestock are expected to be held in confinement or the extent that the livestock are expected to congregate in lots and barnyards for shelter or feeding. Recoverability factors for beef cows, calves, heifers, and stockers presented in Kellogg et al. (2000) were adjusted upward to account for the exclusion of farms with less than one animal unit per acre of pastureland and rangeland. Manure recoverability factors for this group were 0.05 (5 percent) for 17 states (mostly in the West, Southeast, and South Central States), 0.10 for 29 states, and 0.15 or 0.20 for four states (mostly in the Northeast). Nutrient recovery parameters for beef cattle are the same as those reported in Kellogg et al. (2000), table 8.

Estimates of recoverable manure for dairy cattle other than milk cows (exclusive of dairy calves and dairy heifers on veal and confined heifer farms) were based on recoverability factors and nutrient recovery parameters reported in Kellogg et al. (2000) for these livestock types. Recoverable manure for sheep, goats, horses, ponies, mules, donkeys, and burros was estimated using manure recoverability factors and nutrient recovery parameters for grass-fed beef cattle.

Recoverable manure was not calculated for farms with few livestock or for farms with specialty livestock types (ducks, geese, mink, and rabbits). Farms with few livestock, as described in appendix A, have less than 4 AU of fattened cattle, milk cows, swine, or poultry and small numbers of pastured livestock types. Since few livestock on these farms are raised in confined settings, the amount of recoverable manure is expected to be negligible. Significant amounts of

recoverable manure are expected on most farms with specialty livestock types, but appropriate conversion factors were not available at the time the study was conducted.

Recoverable manure and recoverable manure nutrients were estimated for each livestock type on each farm using the manure recoverability factors and nutrient recovery parameters described above, and then aggregated for each farm. For farms with more than one assigned representative farm, the probabilities associated with each representative farm were used as weights to obtain the farm totals. These probabilities are included in table B–3. For example, there are two possible representative farms for larger dairies in the Southeast (dairies with more than 135 milk cow animal units): a solids system, with a probability of 0.3 (representative farm #2 for dairies), and a liquid waste handling system, with a probability of 0.7 (representative farm #5 for dairies). Each of the manure-handling systems has different manure recoverability and nutrient recovery parameters. Recoverable manure nutrients were calculated for each system and then multiplied by the probabilities associated with each system. These weighted totals for each system were then added to represent the estimate of recoverable manure nutrients for a specific farm.

Recoverable manure and recoverable manure nutrients were estimated in this manner for **all** livestock types on each farm. For example, assume the large dairy farm described above also had 80 animal units of fattened cattle. In the Southeast, the two representative farm possibilities for farms with more than 35 animal units of fattened cattle are a scrape and stack system, with a probability of 0.3, and a manure pack system, with a probability of 0.7. Recoverable manure and manure nutrients would be estimated for these fattened cattle in the same manner as for the dairy (i.e., a weighted total). The estimates for the dairy and the fattened cattle would be added to obtain the total amount of recoverable manure and manure nutrients for the farm.

Table B–3 Manure recoverability factors and nutrient recovery parameters used to estimate manure nutrients available for application for fattened cattle, milk cows, veal, confined heifers, swine, chickens, and turkeys

Livestock type and region	Size class (AU)	Representative farm (RF)	Probability (%)	Before CNMPs			After CNMPs		
				Proportion of manure that is recoverable	Proportion of N retained in recoverable manure	Proportion of P retained in recoverable manure	Proportion of manure that is recoverable	Proportion of N retained in recoverable manure	Proportion of P retained in recoverable manure
Milk cows									
All Regions	<35	RF #1: no storage	100	0.45	0.60	0.80	0.50	0.60	0.80
North Central, Northeast	35-135	RF #1: no storage	29	0.45	0.60	0.80	0.50	0.60	0.80
		RF #2: solids storage	47	0.60	0.80	0.90	0.75	0.80	0.90
		RF #3: liquid storage in deep pit or slurry	7	0.55	0.75	0.90	0.75	0.75	0.90
		RF #4: liquid storage—basin, pond, lagoon	17	0.60	0.40	0.90	0.75	0.30	0.90
	135-270	RF #1: no storage	15	0.50	0.60	0.85	0.50	0.80	0.90
		RF #2: solids storage	28	0.55	0.80	0.90	0.75	0.80	0.90
		RF #3: liquid storage in deep pit or slurry	14	0.55	0.75	0.90	0.75	0.75	0.90
		RF #4: liquid storage—basin, pond, lagoon	43	0.60	0.40	0.90	0.75	0.30	0.90
	>270	RF #2: solids storage (converted to liquid)	14	0.50	0.70	0.90	0.75	0.40	0.90
		RF #3: liquid storage in deep pit or slurry	18	0.55	0.75	0.90	0.75	0.75	0.90

Table B–3 Manure recoverability factors and nutrient recovery parameters used to estimate manure nutrients available for application for fattened cattle, milk cows, veal, confined heifers, swine, chickens, and turkeys—Continued

Livestock type and region	Size class (AU)	Representative farm (RF)	Probability (%)	Before CNMPs			After CNMPs		
				Proportion of manure that is recoverable	Proportion of N retained in recoverable manure	Proportion of P retained in recoverable manure	Proportion of manure that is recoverable	Proportion of N retained in recoverable manure	Proportion of P retained in recoverable manure
		RF #4: liquid storage—basin, pond, lagoon	68	0.55	0.40	0.90	0.75	0.30	0.90
Southeast	35-135	RF #2: solids storage	59	0.50	0.65	0.80	0.65	0.60	0.80
		RF #5: any liquid storage	41	0.55	0.65	0.90	0.70	0.65	0.90
	>135	RF #2: solids storage	30	0.50	0.70	0.85	0.65	0.67	0.90
		RF #5: any liquid storage	70	0.55	0.35	0.90	0.70	0.25	0.90
West	35-135	RF #2: solids storage	50	0.55	0.55	0.90	0.65	0.55	0.90
		RF #5: any liquid storage, with manure pack	50	0.50	0.65	0.90	0.75	0.65	0.90
	135-270	RF #2: solids storage	11	0.50	0.65	0.85	0.65	0.55	0.90
		RF #5: any liquid storage, with manure pack	89	0.55	0.40	0.85	0.75	0.30	0.90
	>270	RF #5: any liquid storage, with manure pack	100	0.60	0.40	0.85	0.75	0.30	0.90
Fattened cattle									
All Regions	<35	RF #1: feedlot scrape, stack	100	0.60	0.60	0.80	0.75	0.60	0.80
New England	>35	RF #1: feedlot scrape, stack	100	0.55	0.70	0.85	0.75	0.70	0.85
PA, NY, NJ	>35	RF #1: feedlot scrape, stack	100	0.60	0.70	0.85	0.75	0.70	0.85
Southeast	>35	RF #1: feedlot scrape, stack	30	0.55	0.60	0.80	0.75	0.60	0.80
		RF #2: feedlot with manure pack, runoff	70	0.60	0.55	0.75	0.80	0.55	0.75
Midwest	35-500	RF #1: feedlot scrape, stack	30	0.60	0.60	0.80	0.75	0.60	0.80
		RF #2: feedlot with manure pack, runoff	70	0.60	0.50	0.80	0.80	0.50	0.80
	> 500	RF #2: feedlot with manure pack, runoff	100	0.65	0.50	0.80	0.80	0.50	0.80
MT, WY, SD, MN	35-500	RF #2: feedlot with manure pack, runoff	100	0.60	0.55	0.80	0.80	0.55	0.80
	>500	RF #2: feedlot with manure pack, runoff	100	0.65	0.55	0.80	0.80	0.55	0.80
CO, KS, NE, SD	35-1000	RF #2: feedlot with manure pack, runoff	100	0.60	0.50	0.80	0.80	0.50	0.80
	>1000	RF #2: feedlot with manure pack, runoff	100	0.60	0.50	0.80	0.80	0.50	0.80
TX, OK, NM	35-1000	RF #2: feedlot with manure pack, runoff	100	0.60	0.45	0.80	0.80	0.45	0.80

Table B–3 Manure recoverability factors and nutrient recovery parameters used to estimate manure nutrients available for application for fattened cattle, milk cows, veal, confined heifers, swine, chickens, and turkeys—Continued

Livestock type and region	Size class (AU)	Representative farm (RF)	Probability (%)	Before CNMPs			After CNMPs		
				Proportion of manure that is recoverable	Proportion of N retained in recoverable manure	Proportion of P retained in recoverable manure	Proportion of manure that is recoverable	Proportion of N retained in recoverable manure	Proportion of P retained in recoverable manure
	>1000	RF #2: feedlot with manure pack, runoff	100	0.60	0.45	0.80	0.80	0.45	0.80
West	35-500	RF #2: feedlot with manure pack, runoff	100	0.60	0.45	0.80	0.80	0.45	0.80
	>500	RF #2: feedlot with manure pack, runoff	100	0.60	0.45	0.80	0.80	0.45	0.80
Confined heifers									
Northeast	All	RF #1: confinement barn/ bedded manure	70	0.65	0.70	0.85	0.85	0.70	0.85
	All	RF #2: feedlot scrape, stack	30	0.60	0.65	0.80	0.80	0.65	0.80
Midwest	All	RF #1: confinement barn/ bedded manure	40	0.65	0.65	0.85	0.85	0.65	0.85
	All	RF #2: feedlot scrape, stack	60	0.65	0.45	0.80	0.80	0.45	0.80
Southeast	All	RF #2: feedlot scrape, stack	100	0.65	0.50	0.80	0.80	0.50	0.80
West	All	RF #2: feedlot scrape, stack	100	0.65	0.45	0.80	0.80	0.45	0.80
Veal									
All Regions	All	RF #1: confinement house with liquid manure	100	0.75	0.50	0.80	0.95	0.50	0.80
Broilers									
Northeast	All	RF #1: confinement, standard broiler house	100	0.75	0.70	0.95	0.98	0.70	0.95
Southeast	All	RF #1: confinement, standard broiler house	100	0.85	0.60	0.95	0.98	0.60	0.95
Northwest	All	RF #1: confinement, standard broiler house	100	0.75	0.70	0.95	0.98	0.70	0.95
Southwest	All	RF #1: confinement, standard broiler house	100	0.75	0.55	0.95	0.98	0.55	0.95
Layers									
All Regions	<35	RF #1: shallow pit, ground level	100	0.75	0.80	0.90	0.95	0.80	0.90
Southeast	35-400	RF #1: high rise, pit at ground level	30	0.75	0.60	0.95	0.95	0.60	0.95
		RF #1: shallow pit, ground level	27	0.75	0.80	0.90	0.95	0.80	0.90
		RF #2: flush system with lagoon	43	0.80	0.35	0.50	0.95	0.25	0.90
	> 400	RF #1: high rise, pit at ground level	52	0.75	0.60	0.95	0.95	0.60	0.95

Table B–3 Manure recoverability factors and nutrient recovery parameters used to estimate manure nutrients available for application for fattened cattle, milk cows, veal, confined heifers, swine, chickens, and turkeys—Continued

Livestock type and region	Size class (AU)	Representative farm (RF)	Probability (%)	Before CNMPs			After CNMPs		
				Proportion of manure that is recoverable	Proportion of N retained in recoverable manure	Proportion of P retained in recoverable manure	Proportion of manure that is recoverable	Proportion of N retained in recoverable manure	Proportion of P retained in recoverable manure
		RF #2: flush system with lagoon	48	0.80	0.35	0.90	0.95	0.25	0.90
West	35-400	RF #1: shallow pit, ground level	49	0.75	0.80	0.90	0.95	0.80	0.90
		RF #3: scraper system	51	0.75	0.60	0.95	0.95	0.60	0.95
	> 400	RF #1: high rise, pit at ground level	18	0.75	0.60	0.95	0.95	0.60	0.95
		RF #3: manure belt	14	0.75	0.60	0.95	0.95	0.60	0.95
		RF #3: scraper system	68	0.75	0.55	0.95	0.95	0.55	0.95
South Central	35-400	RF #1: shallow pit, ground level	45	0.75	0.80	0.90	0.95	0.80	0.90
		RF #3: scraper system	55	0.75	0.55	0.95	0.95	0.55	0.95
	> 400	RF #2: flush system with lagoon	100	0.80	0.25	0.90	0.95	0.25	0.90
North Central & Northeast	35-400	RF #1: high rise, pit at ground level	55	0.85	0.70	0.95	0.95	0.70	0.95
		RF #1: shallow pit, ground level	25	0.85	0.85	0.90	0.95	0.85	0.90
		RF #3: manure belt	20	0.85	0.70	0.95	0.95	0.70	0.95
	>400	RF #1: high rise, pit at ground level	81	0.85	0.70	0.95	0.95	0.70	0.95
		RF #3: manure belt	19	0.85	0.70	0.95	0.95	0.70	0.95
Pullets									
North central & Northeast	All	RF #1: layer-type confinement houses	100	0.85	0.70	0.90	0.95	0.70	0.90
Southeast	All	RF #1: layer-type confinement houses	100	0.80	0.60	0.90	0.95	0.60	0.90
West	All	RF #1: layer-type confinement houses	100	0.80	0.55	0.90	0.95	0.55	0.90
South Central	All	RF #1: layer-type confinement houses	100	0.80	0.55	0.90	0.95	0.55	0.90
Turkeys									
All Regions	<35	RF #2: turkey ranch	100	0.45	0.60	0.75	0.50	0.60	0.75
East	>35	RF #1: confinement houses	90	0.80	0.60	0.95	0.98	0.60	0.95
		RF #2: turkey ranch	10	0.45	0.60	0.75	0.50	0.60	0.75
South Central	>35	RF #1: confinement houses	100	0.80	0.55	0.95	0.98	0.55	0.95
North central	>35	RF #1: confinement houses	90	0.80	0.65	0.95	0.98	0.65	0.95
		RF #2: turkey ranch	10	0.45	0.65	0.75	0.50	0.65	0.75

Table B–3 Manure recoverability factors and nutrient recovery parameters used to estimate manure nutrients available for application for fattened cattle, milk cows, veal, confined heifers, swine, chickens, and turkeys—Continued

Livestock type and region	Size class (AU)	Representative farm (RF)	Probability (%)	Before CNMPs			After CNMPs		
				Proportion of manure that is recoverable	Proportion of N retained in recoverable manure	Proportion of P retained in recoverable manure	Proportion of manure that is recoverable	Proportion of N retained in recoverable manure	Proportion of P retained in recoverable manure
West other than CA	>35	RF #1: confinement houses	50	0.80	0.55	0.95	0.98	0.55	0.95
		RF #2: turkey ranch	50	0.40	0.50	0.75	0.50	0.50	0.75
California	>35	RF #1: confinement houses	80	0.80	0.55	0.95	0.98	0.55	0.95
		RF #2: turkey ranch	20	0.40	0.50	0.75	0.50	0.50	0.75
Hogs for breeding									
All Regions	<35	RF #5: pasture or lot, with or without hut	100	0.50	0.45	0.75	0.50	0.45	0.75
North Central, Northeast	35-500	RF #1: confinement, liquid, lagoon	10	0.85	0.25	0.85	0.97	0.25	0.85
		RF #2: confinement, slurry, no lagoon	76	0.80	0.80	0.90	0.97	0.80	0.90
		RF #4: building with outside access, solids	14	0.75	0.70	0.80	0.90	0.70	0.80
	>500	RF #1: confinement, liquid, lagoon	85	0.85	0.25	0.85	0.97	0.25	0.85
		RF #2: confinement, slurry, no lagoon	15	0.80	0.80	0.90	0.97	0.80	0.90
Southeast	35-100	RF #1: confinement, liquid, lagoon	70	0.85	0.20	0.85	0.97	0.20	0.85
		RF #2: confinement, slurry, no lagoon	5	0.80	0.70	0.90	0.97	0.70	0.90
		RF #5: pasture or lot, with or without hut	25	0.50	0.45	0.75	0.50	0.45	0.75
	>100	RF #1: confinement, liquid, lagoon	95	0.85	0.20	0.85	0.97	0.20	0.85
		RF #2: confinement, slurry, no lagoon	5	0.80	0.80	0.90	0.97	0.80	0.90
West	35-500	RF #1: confinement, liquid, lagoon	45	0.85	0.25	0.85	0.97	0.25	0.85
		RF #2: confinement, slurry, no lagoon	25	0.80	0.70	0.90	0.97	0.70	0.90
		RF #5: pasture or lot	30	0.50	0.40	0.75	0.50	0.40	0.75
	>500	RF #1: confinement, liquid, lagoon	65	0.85	0.20	0.85	0.97	0.20	0.85
		RF #2: confinement, slurry, no lagoon	35	0.80	0.70	0.90	0.97	0.70	0.90
Hogs for slaughter									
All Regions	<35	RF #4: building with outside access, solids	100	0.75	0.70	0.80	0.90	0.70	0.80

Table B–3 Manure recoverability factors and nutrient recovery parameters used to estimate manure nutrients available for application for fattened cattle, milk cows, veal, confined heifers, swine, chickens, and turkeys—Continued

Livestock type and region	Size class (AU)	Representative farm (RF)	Probability (%)	Before CNMPs			After CNMPs		
				Proportion of manure that is recoverable	Proportion of N retained in recoverable manure	Proportion of P retained in recoverable manure	Proportion of manure that is recoverable	Proportion of N retained in recoverable manure	Proportion of P retained in recoverable manure
North Central, Northeast	35-500	RF #1: confinement, liquid, lagoon	6	0.85	0.25	0.85	0.97	0.25	0.85
		RF #2: confinement, slurry, no lagoon	53	0.80	0.80	0.90	0.97	0.80	0.90
		RF #3: building with outside access, liquid	14	0.70	0.75	0.90	0.95	0.75	0.90
		RF #4: building with outside access, solids	27	0.75	0.70	0.80	0.90	0.70	0.80
	>500	RF #1: confinement, liquid, lagoon	27	0.85	0.25	0.85	0.97	0.25	0.85
		RF #2: confinement, slurry, no lagoon	73	0.80	0.80	0.90	0.97	0.80	0.90
Southeast	35-100	RF #1: confinement, liquid, lagoon	90	0.85	0.20	0.85	0.97	0.20	0.85
		RF #2: confinement, slurry, no lagoon	10	0.80	0.70	0.90	0.97	0.70	0.90
	>100	RF #1: confinement, liquid, lagoon	100	0.85	0.20	0.85	0.97	0.20	0.85
West	35-500	RF #1: confinement, liquid, lagoon	50	0.85	0.25	0.85	0.97	0.25	0.85
		RF #2: confinement, slurry, no lagoon	50	0.80	0.70	0.90	0.97	0.70	0.90
	>500	RF #1: confinement, liquid, lagoon	50	0.85	0.20	0.85	0.97	0.20	0.85
		RF #2: confinement, slurry, no lagoon	50	0.80	0.70	0.90	0.97	0.70	0.90

Farms with a minimum amount of total recoverable manure produced annually were classified as **manure-producing farms**. Manure-producing farms were defined to be farms that produce more than 200 pounds of recoverable manure nitrogen annually. Farms at this threshold generate about 45 tons of recoverable manure, *as excreted*, which is equivalent to about 11 tons of manure for land application (transport weight), or less than a pickup truck load per month. This lower threshold was used as a practical matter to exclude numerous small farms that produced no more recoverable manure than the largest of the farms with few livestock. It is also questionable that the manure recovery factors and manure nutrient recovery parameters would apply to these small farms since they were derived for larger operations. Recoverable manure for farms below this threshold was set equal to zero for all subsequent calculations. There were 255,070 manure-producing farms in 1997, excluding specialty livestock farms.

Estimates of recoverable manure nutrients for the baseline scenario and for the after-CNMP scenario are compared to estimates previously published in Kellogg et al. (2000) in table B–4. The largest difference in recoverable manure between the revised estimates

Table B–4 Estimates of recoverable manure and recoverable manure nutrients for manure-producing farms, 1997*

	Published in Kellogg et al. (2000)	Baseline scenario	After-CNMP scenario	Percent change in the after-CNMP scenario as compared to the baseline scenario
Number of manure-producing farms	529,658**	255,070	255,070	0
Pounds of recoverable manure nitrogen				
Fattened cattle	389,900,000	327,007,586	432,098,907	32
Milk cows	635,700,000	601,051,133	673,290,892	12
Swine	274,100,000	521,975,775	629,395,784	21
Poultry	1,152,900,000	977,656,262	1,160,981,406	19
Other beef and dairy	130,600,000	105,383,686	113,076,052	7
Horses, sheep, goats	No estimate	713,584	713,584	0
All types	2,583,200,000	2,533,788,026	3,009,556,624	19
Pounds of recoverable manure phosphorus				
Fattened cattle	254,000,000	163,443,118	216,222,176	32
Milk cows	243,900,000	175,074,365	225,637,803	29
Swine	276,800,000	245,696,950	291,700,481	19
Poultry	553,900,000	501,727,122	600,495,014	20
Other beef and dairy	108,200,000	64,651,344	68,014,510	5
Horses, sheep, goats	No estimate	551,913	551,913	0
All types	1,436,800,000	1,151,144,811	1,402,621,897	22
Tons of recoverable manure, *as excreted* wet weight	Not reported	355,033,803	430,173,338	21
Tons of recoverable manure, *as excreted* oven-dry weight	Not reported	50,178,583	60,823,028	21

* Excludes 2,131 specialty livestock farms.
** Previously published estimates of the number of farms are not directly comparable to the revised estimates because they apply to livestock that were treated as confined livestock in Kellogg et al. (2000). About half of the farms in Kellogg et al. (2000) with confined livestock produced negligible amounts of recoverable manure.

and the previously published estimates is for swine. For the previously published estimates, the nutrient loss parameters for swine were based on the presence of a lagoon, which has higher nitrogen volatilization losses than other manure handling technologies for swine. The revised parameters for swine are specific to lagoon systems only for farm sizes and regions of the country where survey information indicated lagoon systems were typically present. Overall, recoverable manure nutrients are about 20 percent higher in the after-CNMP scenario than in the baseline scenario, reflecting CNMP-related improvements in practices and facilities.

The spatial distribution of the amount of recoverable manure nutrients produced by manure-producing farms is shown in figures B-1 and B-2 for the baseline scenario. The spatial distribution is the same for the after-CNMP scenario, but the amount of recoverable manure nutrients is about 20 percent higher, overall. Recoverable manure and manure nutrient estimates by model farm are presented in table B–5.

Table B–5 Per-farm estimates of recoverable manure nutrients and farm-level excess manure nutrients by model farm region and size class*

Dominant livestock type	Model farm region	Model farm size class (AU)	Number of farms	Recoverable manure N (lb)		Recoverable manure P (lb)		Farm-level excess manure N (lb)		Farm-level excess manure P (lb)		Number farms with excess manure	
				Baseline scenario	After-CNMP scenario	Baseline scenario	After-CNMP scenario	Baseline scenario	After-CNMP scenario	Baseline scenario	After-CNMP scenario	Baseline scenario	After-CNMP scenario
Fattened cattle	Central Plains	35-1000	3,499	6,557	8,619	3,232	4,237	666	1,590	339	794	310	601
		>1000	666	341,424	448,462	176,789	231,498	266,766	417,930	139,005	216,013	405	615
	Midwest	35-500	3,765	5,001	6,388	2,273	2,898	149	430	70	197	122	285
		>500	233	51,332	62,586	25,193	30,630	8,344	29,538	4,187	14,542	26	135
	Northern Plains	35-500	925	4,746	6,199	2,120	2,754	243	500	114	228	41	83
		>500	52	76,524	93,532	34,836	42,369	32,377	56,560	14,913	25,783	12	27
	Northeast	>35	277	6,889	8,521	2,660	3,281	496	2,023	190	789	27	85
	Southeast	>35	371	4,804	6,319	2,123	2,760	391	960	171	420	25	48
	West	35-500	278	4,118	5,396	2,316	3,011	925	1,605	539	913	48	69
		>500	93	285,282	373,779	157,790	206,096	248,619	357,764	137,243	197,160	57	78
Milk cows	N. Central, Northeast	35-135	53,053	4,765	5,647	1,232	1,475	99	257	26	68	1,649	5,548
		135-270	8,688	10,220	12,385	3,067	3,791	189	682	56	212	227	1,143
		>270	2,616	22,919	24,817	7,872	10,473	1,310	3,825	442	1,606	111	748
	Southeast	35-135	4,349	4,706	5,743	1,213	1,520	181	510	50	149	275	797
		>135	2,815	13,071	13,823	4,865	6,187	1,254	3,087	459	1,372	215	695
	West	35-135	2,349	4,356	5,766	1,278	1,647	538	1,118	159	323	406	808
		135-270	1,825	7,608	7,865	2,879	3,983	1,154	2,359	437	1,194	356	896
		>270	3,623	41,119	38,783	16,388	21,102	15,845	26,891	6,290	14,627	1,432	2,901
Swine farrowing farms	N. Central, Northeast	35-500	1,029	7,652	9,275	2,926	3,534	3,356	5,018	1,284	1,911	366	512
		>500	119	33,017	38,974	22,468	26,089	19,875	33,984	13,484	22,819	89	112
	Southeast	35-100	43	1,524	1,759	1,354	1,548	323	871	285	701	10	25
		>100	270	12,337	14,244	13,588	15,594	6,710	12,210	7,483	13,565	157	238
	West	35-500	89	5,537	6,397	3,488	3,988	1,888	3,688	1,165	2,277	38	65
		>500	22	62,956	74,864	44,833	52,379	53,523	71,352	38,118	49,897	18	22
Swine grower farms	N. Central, Northeast	35-500	9,350	11,088	13,589	3,893	4,758	2,338	4,679	816	1,633	1,906	3,515
		>500	442	116,627	140,394	48,280	57,528	71,727	113,199	29,807	46,389	222	395
	Southeast	35-100	282	2,415	2,807	2,306	2,649	703	1,305	643	1,194	90	151
		>100	1,389	21,533	24,779	23,887	27,386	11,263	22,110	12,469	24,403	909	1,321
	West	35-500	113	9,671	11,512	5,227	6,159	4,001	6,601	2,181	3,547	55	74
		>500	39	181,225	216,418	106,009	124,810	153,248	200,920	90,250	116,156	27	32

Table B–5 Per-farm estimates of recoverable manure nutrients and farm-level excess manure nutrients by model farm region and size class*—Continued

Dominant livestock type	Model farm region	Model farm size class (AU)	Number of farms	Recoverable manure N (lb)		Recoverable manure P (lb)		Farm-level excess manure N (lb)		Farm-level excess manure P (lb)		Number farms with excess manure	
				Baseline scenario	After-CNMP scenario	Baseline scenario	After-CNMP scenario	Baseline scenario	After-CNMP scenario	Baseline scenario	After-CNMP scenario	Baseline scenario	After-CNMP scenario
Swine farrow-to-finish farms	N. Central, Northeast	35-500	16,837	9,407	11,496	3,383	4,120	1,004	2,314	361	829	1,746	4,273
		>500	1,069	82,659	99,179	38,036	45,030	47,264	74,608	21,797	33,937	493	915
	Southeast	35-100	583	1,811	2,089	1,740	1,989	196	492	195	469	79	203
		>100	869	22,377	25,675	26,278	30,056	11,128	21,091	13,222	24,846	338	629
	West	35-500	351	6,220	7,373	3,489	4,090	2,226	3,458	1,268	1,941	140	201
		>500	59	229,640	274,190	142,521	167,440	192,669	252,019	119,620	154,447	37	45
Turkeys	California	>35	135	123,339	151,351	84,587	103,814	120,085	150,714	82,422	103,389	132	135
	East	>35	1,408	57,922	70,529	36,119	44,023	43,147	66,704	26,969	41,648	1,209	1,399
	N. Central	>35	852	98,486	119,823	56,205	68,461	74,545	112,749	42,758	64,531	588	834
	S. Central	>35	740	65,522	80,246	45,168	55,320	49,203	74,270	33,972	51,216	637	729
	West except CA	>35	78	58,629	72,278	38,210	47,076	45,049	67,195	29,373	43,781	55	73
	N. Central & West	>35	836	49,997	65,271	21,558	28,144	40,460	60,134	17,782	26,117	660	814
	East & South	>35	15,415	29,750	35,002	13,417	15,748	21,241	30,285	9,593	13,623	13,040	14,906
Layers	N. Central, Northeast	<400	953	26,938	30,164	12,667	14,176	16,215	25,603	7,647	12,046	652	886
		>400	289	338,433	378,483	169,917	190,036	273,916	366,518	137,673	184,056	241	289
	S. Central	<400	879	13,452	17,005	7,056	8,911	6,812	12,555	3,579	6,586	610	805
		>400	39	113,140	134,235	144,179	170,953	86,926	128,583	110,111	163,665	35	38
	Southeast	<400	1,607	11,242	12,879	5,709	8,653	7,010	10,978	3,560	7,374	1,258	1,553
		>400	80	151,633	169,156	108,288	132,927	128,965	164,945	92,449	129,658	79	80
	West	<400	103	34,335	43,452	17,212	21,753	32,381	42,789	16,185	21,405	102	103
		>400	102	220,397	278,434	137,302	173,194	209,415	277,142	130,463	172,392	102	102
Pullets	N. Central & Northeast	>35	369	25,338	28,067	12,948	14,273	15,059	23,854	7,701	12,130	233	340
	South & West	>35	905	12,263	14,350	7,445	8,633	7,430	11,581	4,501	6,956	611	825
Veal	All	All	168	4,995	6,284	2,478	3,107	3,734	5,561	1,854	2,752	135	147
Confined heifers	Midwest	All	2,436	10,414	13,192	4,498	5,674	2,614	5,310	1,165	2,329	525	898
	Northeast	All	167	5,504	7,077	1,998	2,531	2,290	4,099	851	1,494	62	90
	South & West	All	1,240	10,817	13,311	5,362	6,581	5,963	9,364	3,001	4,668	486	672
Small farms with confined livestock types	All states	All	42,565	1,229	1,443	437	513	313	466	125	186	8,777	11,571
Pastured livestock types	All states	All	61,272	689	781	379	414	51	78	36	51	4,869	6,420
All manure-producing farms			255,070	9,934	11,799	4,513	5,499	4,678	7,230	2,406	3,769	47,562	71,999

* Excludes 2,131 specialty livestock farms.

Figure B–1 Recoverable manure nitrogen, baseline scenario

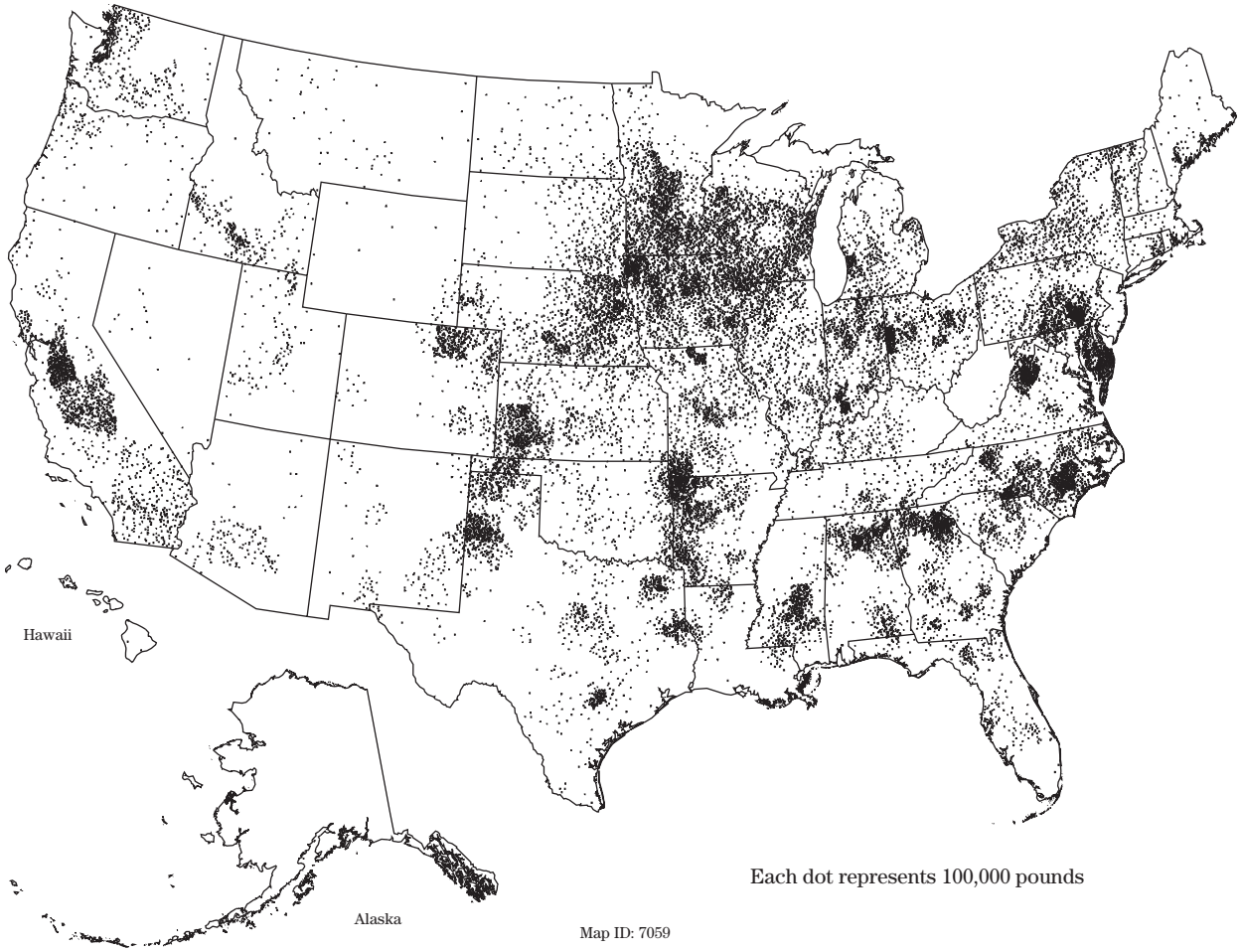
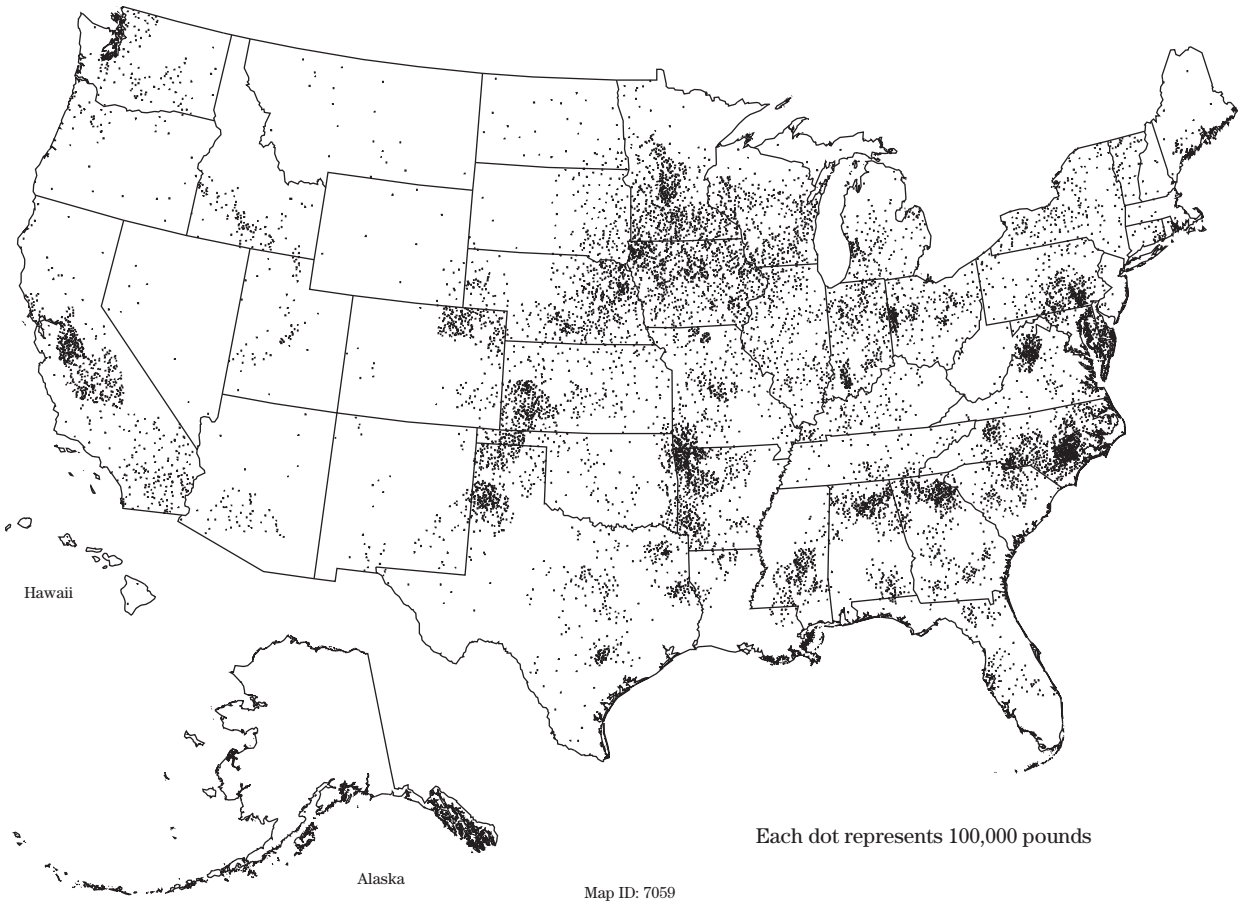


Figure B–2 Recoverable manure phosphorus, baseline scenario



Tons of recoverable manure for handling and transport

The CNMP cost assessment requires estimates of the tons of manure to be collected, stored, and transported to the field for application. Neither the wet as excreted weight nor the oven-dry weight estimate is appropriate for these calculations because the moisture content does not represent the moisture content of the manure that is actually handled. For solids, the weight would be something between the dry and wet weights. For manure handled as a liquid or slurry, additional water is added to the manure during collection. Wastewater collected in runoff storage ponds is largely runoff from rainfall.

Tons of recoverable manure for handling and transport were calculated by adjusting either the wet weight estimate or the dry weight estimate for moisture content. The literature contains a wide range of estimates of moisture content for manure handled as a solid, slurry, or liquid. Table B–6 presents the typical moisture content of manure by livestock type and manure consistency used here, in part, as a basis for developing the algorithms used to convert wet or dry weight to handling and transport weight. Algorithms were devised for each model farm to reflect characteristics of the manure management systems specific to each representative farm as well as for expected runoff that would be collected in runoff storage ponds. For most solids, handling and transport weight is about equal to two times the dry weight, and includes the weight of bedding. For systems producing manure as a slurry, handling and transport weight was typically calculated as one or two times the wet weight, depending on how much wash water would be used. Liquid manure was generally assumed to be 1 percent solids for most systems, accounting for the additional water used to flush the system and, in some cases, runoff from the lot. However, a higher percentage of solids was assumed for some systems that would be expected to have less dilute liquid wastes.

Separate algorithms for estimating tons of manure at handling and transport weight were constructed for the baseline scenario and for the after-CNMP scenario. The specific algorithms and assumptions used for each system are presented in table B–7. These algorithms were used to make estimates of tons of solid, slurry, and liquid manure generated on each farm. The estimates were higher for the after-CNMP scenario than for the baseline scenario for most liquid systems, reflecting more recoverable manure and additional flush or wash water. For wastewater collected in runoff storage ponds, an estimate was needed only for the additional volume expected as a result of CNMP implementation. This was estimated by multiplying the volume expected to be collected in runoff storage ponds times the CNMP needs percentage for runoff storage ponds. CNMP needs for runoff storage ponds were taken from appendix D, table D–1.

Table B–6 Assumptions about moisture content in manure used a basis for calculating tons of manure at handling and transport weight

Livestock type	Manure consistency	Percent moisture
Dairy	Solid	50
	Slurry	90
	Liquid	99
Beef	Solid	50
	Slurry	90
	Liquid	99
Swine	Solid	50
	Slurry	90
	Liquid	99
Broilers	Solid	76
Layers and pullets	Solid	50
	Liquid	99
Turkeys	Solid	66

Table B–7 Algorithms used to convert tons of recoverable manure as either wet weight (as excreted weight) or dry weight (oven-dry weight) to tons at handling and transport weight

Livestock type	Representative farm	Model farm region	Model farm size class (AU)	Consistency of recoverable manure	- - -Algorithm for calculating handling and transport weight - - -			
					baseline scenario	after-CNMP scenario	Wastwater from runoff - - - - storage pond - - - - quantity	CNMP needs
Milk cows	#1: no storage	N. Central, Northeast	35–135	Solids	2×dry weight	no change (filter strip used for milkhouse washings & runoff)	none	
	#2: solids storage	All regions	35–135	Solids	2×dry weight	no change (filter strip used for milkhouse washings & runoff)	none	
	#1: no storage	N. Central, Northeast	135–270	Solids (replace filter strip with liquid components for milkhouse washings)	2×dry weight	2×dry weight + wet weight	9×dry weight	80
	#2: solids storage	N. Central, Northeast	135–270	Solids (replace filter strip with liquid components for milkhouse washings)	2×dry weight	2×dry weight + wet weight	9×dry weight	80
	#2: solids storage	Southeast	>135	Solids (replace filter strip with liquid components for milkhouse washings)	2×dry weight	2×dry weight + wet weight	13×dry weight	80
	#2: solids storage	West	135–270	Solids (replace filter strip with liquid components for milkhouse washings)	2×dry weight	2×dry weight + wet weight	1.5×dry weight	80
	#2: solids storage	N. Central, Northeast	>270	Solids (convert to liquid system)	2×dry weight	dryweight/.01	none	
	#3: liquid storage–deep pit or slurry	N. Central, Northeast	All	Slurry (runoff included)	wet weight	2×wet weight	none	
	#4: liquid storage–basin, pond, lagoon	N. Central, Northeast	All	Liquid (runoff included)	dryweight/0.03	dryweight/0.01	none	

Table B–7 Algorithms used to convert tons of recoverable manure as either wet weight (as excreted weight) or dry weight (oven-dry weight) to tons at handling and transport weight—Continued

Livestock type	Representative farm	Model farm region	Model farm size class (AU)	Consistency of recoverable manure	- - -Algorithm for calculating handling and transport weight - - -			
					baseline scenario	after-CNMP scenario	Wastwater from runoff - - - - storage pond - - - - quantity	CNMP needs
	#5: any liquid storage	Southeast	All	Liquid (runoff included)	dryweight/0.03	dryweight/0.01	none	
	#5: any liquid storage, manure pack	West	All	1/2 liquid, 1/2 solids, runoff	half dryweight/ 0.03 + half 2× dry weight + dry weight	half dryweight/ 0.01" + half 2× dry weight + 2×dry weight	none	
Fattened cattle	#1: scrape & stack	Southeast	All	Solids	2×dry weight	no change	18×dry weight	50
	#1: scrape & stack	Midwest	All	Solids	2×dry weight	no change	18×dry weight	40
	#1: scrape & stack	Northeast	All	Solids	2×dry weight	no change	18×dry weight	40
	#2: manure pack, runoff collection	Midwest, Southeast	All	Solids	2×dry weight	no change	18×dry weight	70
	#2: manure pack, runoff collection	Northern Plains	All	Solids	2×dry weight	no change	3×dry weight	70
	#2: manure pack, runoff collection	Central Plains, West	All	Solids	2×dry weight	no change	2×dry weight	70
Confined heifers	#1: confinement barn/bedded manure	Northeast, Midwest	All	Solids	2×dry weight	no change	none	
	#2: open lots with scraped solids	Northeast	All	Solids	2×dry weight	no change	13×dry weight	40
	#2: open lots with scraped solids	Midwest	All	Solids	2×dry weight	no change	9×dry weight	40
	#2: open lots with scraped solids	Southeast	All	Solids	2×dry weight	no change	15×dry weight	50
	#2: open lots with scraped solids	West	All	Solids	2×dry weight	no change	1.5×dry weight	50
Veal	#1: confinement house	All	All	Slurry	wet weight	no change	none	
Broilers	#1: confinement houses	All	All	Solids	dry weight/0.76	no change	none	
Layers	#1: high-rise or shallow pit	All	All	Solids	2×dry weight	no change	none	
	#2: flush with lagoon	All	All	Liquid	dry weight/0.02	dry weight/0.01	none	
	#3: manure belt or scraper system	All	All	Solids	2×dry weight	no change	none	
Pullets	#1: layer-type confinement houses	All	All	Solids	2×dry weight	no change	none	
	#2: turkey ranch	East	All	Solids	dry weight/0.65	no change	3.5×dry weight	90
	#2: turkey ranch	WI, IA, MN, NE, SD, ND	All	Solids	dry weight/0.65	no change	2×dry weight	90
	#2: turkey ranch	OH, IN, KY, IL, MI	All	Solids	dry weight/0.65	no change	3.3×dry weight	90
	#2: turkey ranch	West other than CA	All	Solids	dry weight/0.65	no change	0.2×dry weight	90
	#2: turkey ranch	California	All	Solids	dry weight/0.65	no change	2×dry weight	90

Table B–7 Algorithms used to convert tons of recoverable manure as either wet weight (as excreted weight) or dry weight (oven-dry weight) to tons at handling and transport weight—Continued

Livestock type	Representative farm	Model farm region	Model farm size class (AU)	Consistency of recoverable manure	Algorithm for calculating handling and transport weight			
					baseline scenario	after-CNMP scenario	Wastwater from runoff storage pond quantity	Wastwater from runoff storage pond CNMP needs
Swine	#1: total confinement, liquid, lagoon	All	All	Liquid	dry weight/0.02	dry weight/0.01	none	
	#2: total confinement, slurry, no lagoon	All	All	Slurry	wet	no change	none	
	#3: building with outside access, liquid	Midwest, Northeast	All	Liquid (runoff included)	dry weight/0.01 + dry weight	dry weight/0.01 + 2×dry weight	none	
	#4: building with outside access, solids	Midwest, Northeast	All	Solids	2×dry weight	no change	2×dry weight	20
	#5: pasture or lot	West	All	Solids	2×dry weight	no change	3×dry weight	50
	#5: pasture or lot	Southeast	All	Solids	2×dry weight	no change	6×dry weight	50
Pastured livestock	All	All	All	Solids	2×dry weight	no change	none	

Estimates of the tons of recoverable manure as solids, slurry, and liquid for model farms are presented in table B–8. These estimates include manure and wastewater from all livestock on each manure-producing farm. Consequently, it is possible for a farm to have manure of all three consistencies—solids, slurry, and liquid. For example, if a farm in the Southeast with broilers as the dominant livestock type also has layers on the farm, a portion of the manure generated for layers will be for a flush-to-lagoon system (representative farm #2 for layers), which handles manure as a liquid. If this farm also has swine, a portion of the manure will be for swine representative farm #2, which handles manure as a slurry. The average number of AU for the dominant livestock type and for other livestock types on the farm is included in table B–8 to provide a perspective on the amount of manure as a solid, slurry, or liquid reported for each model farm.

Table B–8 Per farm estimates of animal units and tons of recoverable manure at handling and transport weight as solids, slurry, and liquid for model farm regions and size classes

Dominant livestock type	Model farm region	Model farm size class	Number of farms	AU for dominant type	AU for other types	Tons of manure - - - as solids - - -		Tons of manure - - - as slurry- - -		Tons of manure - - - as liquid - - -		Increase in tons of wastewater from runoff storage pond after-CNMP scenario
						baseline scenario	after-CNMP scenario	baseline scenario	after-CNMP scenario	baseline scenario	after-CNMP scenario	
Fattened cattle	Central Plains	35-1000	3,499	169	252	282	369	28	35	70	123	350
		>1000	666	9,575	3,348	17,132	21,998	22	24	139	447	17,786
	Midwest	35-500	3,765	105	108	186	237	50	62	123	209	1,159
		>500	233	1,192	495	2,260	2,717	268	329	769	1,619	15,264
	Northern plains	35-500	925	104	189	184	239	26	35	79	171	224
		>500	52	1,695	1,181	3,071	3,720	247	319	706	1,438	5,182
	Northeast	>35	277	116	73	223	270	16	30	123	510	801
	Southeast	>35	371	111	220	189	247	0	0	97	221	1,278
	West	35-500	278	121	509	207	269	4	5	23	59	172
		>500	93	8,457	3,836	15,175	19,472	205	206	82	276	12,029
Milk cows	N. Central, Northeast	35-135	53,053	72	26	178	205	45	118	543	2,022	1
		135-270	8,688	172	56	286	330	212	1,311	3,281	12,255	785
		>270	2,616	469	126	417	274	721	1,946	12,899	63,529	22
	Southeast	35-135	4,349	79	34	135	166	0	0	2,605	9,938	0
		>135	2,815	307	92	313	376	0	912	8,709	33,183	1,372
	West	35-135	2,349	79	45	180	219	0	0	1,620	6,854	0
		135-270	1,825	185	64	333	420	1	204	3,741	14,440	35
		>270	3,623	972	230	1,743	2,066	1	1	23,529	83,415	2
Swine farrowing farms	N. Central, Northeast	35-500	1,029	140	22	31	37	566	688	588	1,165	12
		>500	119	1,062	16	15	18	1,831	2,222	20,504	46,818	16
	Southeast	35-100	43	63	22	13	15	25	30	1,369	3,124	11
		>100	270	600	39	42	50	128	157	15,965	36,469	5
	West	35-500	89	183	34	42	44	284	345	2,154	4,917	21
		>500	22	2,148	29	0	0	4,795	5,814	36,149	82,505	0
Swine grower farms	N. Central, Northeast	35-500	9,350	116	34	76	91	711	864	1,870	2,953	41
		>500	442	1,421	51	59	70	11,065	13,433	22,492	51,639	71
	Southeast	35-100	282	63	40	9	10	73	88	3,159	7,211	2
		>100	1,389	625	52	85	102	2	3	35,060	80,031	13

Table B–8 Per farm estimates of animal units and tons of recoverable manure at handling and transport weight as solids, slurry, and liquid for model farm regions and size classes—Continued

Dominant livestock type	Model farm region	Model farm size class	Number of farms	AU for dominant type	AU for other types	Tons of manure - - - as solids - - -		Tons of manure - - - as slurry- - -		Tons of manure - - - as liquid - - -		Increase in tons of waste-water from runoff storage pond
						baseline scenario	after-CNMP scenario	baseline scenario	after-CNMP scenario	baseline scenario	after-CNMP scenario	after-CNMP scenario
	West	35-500	113	145	82	23	27	816	992	4,036	9,342	2
		>500	39	3,216	194	115	142	16,938	20,569	85,540	196,429	8
Swine farrow-to-finish farms	N. Central, Northeast	35-500	16,837	118	39	60	71	627	763	1,347	2,206	34
		>500	1,069	1,285	40	48	58	7,259	8,813	21,878	50,013	82
	Southeast	35-100	583	59	50	9	10	48	58	2,227	5,091	6
		>100	869	912	65	39	46	98	123	37,866	86,517	18
	West	35-500	351	120	100	23	26	485	591	2,628	6,129	7
		>500	59	4,971	262	151	182	20,241	24,559	115,223	264,084	3
Turkeys	California	>35	135	1,283	14	2,933	3,601	0	0	111	395	526
	East	>35	1,408	505	45	1,233	1,502	2	12	834	2,091	201
	N. Central	>35	852	778	43	1,934	2,351	124	159	346	762	243
	S. Central	>35	740	601	69	1,535	1,880	5	9	47	152	6
	West except CA	>35	78	740	45	1,400	1,726	0	0	0	0	76
	N. Central & West	>35	836	257	29	962	1,255	5	9	30	93	1
	East & South	>35	15,415	144	33	596	699	1	1	47	126	1
Layers	N. Central, Northeast	<400	953	135	24	677	757	16	23	54	122	10
		>400	289	1,776	131	8,932	9,982	131	195	605	1,986	61
	S. Central	<400	879	87	40	375	474	0	0	161	389	0
		>400	39	1,688	192	257	303	6	7	193,114	458,643	0
	Southeast	<400	1,607	86	23	215	272	0	0	4,227	10,041	0
		>400	80	1,284	153	3,024	3,818	1	96	71,825	171,853	143
	West	<400	103	209	11	926	1,171	0	0	0	0	0
		>400	102	1,609	104	7,227	9,128	8	10	70	218	0
Pullets	N. Central, Northeast	>35	369	179	33	583	653	18	33	96	283	13
	South & West	>35	905	109	36	350	415	0	1	81	206	1
Veal	All	All	168	108	52	16	17	863	1,093	10	16	7
Confined heifers	Midwest	All	2,436	217	73	503	638	101	112	129	210	883
	Northeast	All	167	107	17	211	277	96	96	8	12	220
	South & West	All	1,240	311	56	651	807	120	120	1	2	486
Small farms with confined l ivestock types	All states	All	42,565	18	7	40	46	0	0	0	0	0
Pastured livestock types	All states	All	61,272	107	10	33	35	0	0	0	0	0
All manure-producing farms			255,070	166	45	258	308	158	264	1,663	5,084	152

Land available for manure application

The land base defined to be potentially available for manure application consisted of cropland, cropland used as pasture, and half of permanent pasture, as in Kellogg et al. (2000). For cropland, the acreage considered is defined by the production of 24 crops including corn for silage, corn for grain, small grain hay, other tame hay, wild hay, grass silage, sorghum hay, sorghum for silage, sorghum for grain, alfalfa hay, winter wheat, barley, soybeans, durum wheat, other spring wheat, oats, rye, Irish potatoes, sweet potatoes, cotton, sugar beets, rice, peanuts, and tobacco. (The census does not identify the acreage of these crops that are double cropped. Where double cropping occurs, it is assumed that each crop would be potentially available for manure application, which may result in more than one manure application per field in the model simulation.) Cropland used as pasture is a specific land use category in the Census of Agriculture database. Permanent pasture is not reported in the census, but was derived from acres of rangeland and pastureland combined (a land use category in the census) and separate estimates of pastureland and rangeland acres by county as reported in the 1997 National Resources Inventory (NRI). The NRI was used to determine the percentage of pastureland and rangeland that is pastureland in each county. This percentage was then applied to the census acres for pastureland and rangeland combined for each farm to estimate the acres of permanent pastureland on each farm. In the East, most of the pastureland and rangeland combined, as reported in the census, was classified as permanent pastureland with this calculation, while few of the acres in the West were classified as permanent pastureland. It was assumed that one-half of the permanent pastureland would not be accessible by manure spreading equipment because of location, terrain, or trees and other plant growth.

In the simulation model, the land available for manure application depends on whether the farm was a manure-producing farm or a manure-receiving farm. **Manure-receiving farms** are defined to be farms that are not manure-producing farms, have at least 10 acres of land potentially available for manure application, and are located in the same county as a manure-producing farm. All of the potentially available acres on manure-producing farms were assumed available for onfarm application. On manure-receiving farms, however, only a portion of the potentially available land was assumed available for off-farm manure application.

Acres with water erosion rates above the soil loss tolerance level, or T, were assumed unavailable on manure-receiving farms because of the potential for additional costs for installation or adoption of erosion control practices. The 1997 NRI was used to determine the proportion of cropland and pastureland acres in each county with sheet and rill erosion rates less than T. Separate proportions were obtained for cropland and pastureland. This proportion was multiplied times the number of cropland acres (each of 24 crops) or pastureland acres (cropland used as pasture and half of the permanent pasture) on manure-receiving farms to determine the potential number of acres suitable for manure application. This calculation implicitly assumes that the acres with sheet and rill erosion less than T were equally distributed among the various crops and pastureland types.

Another assumption was that some manure-receiving farms would be unwilling to accept manure because of odor or other undesirable aspects, timing problems related to climate or crop stage, soil phosphorus levels at or near threshold limits, or other factors making manure more costly than application of commercial fertilizers. To account for this willingness-to-accept factor, it was assumed that 50 percent of the acres potentially available with acceptable erosion rates would actually be available for land application of manure on manure-receiving farms. The 50-percent constraint was applied to the acreage for each of the 24 crops as well as cropland used as pasture and permanent pasture.

The analysis implicitly assumes that manure-producing farms would not accept manure from other manure-producing farms. That is, manure-producing farms and manure-receiving farms are mutually exclusive sets. This is a simplifying assumption that facilitates the construction of the simulation model. In actuality, some manure-producing farms would have additional acres available for manure application by other manure-producing farms, especially those livestock operations that primarily produce crops. In the model simulation, about 80 percent of the total acres available for land application on manure-producing farms is not needed for manure application even after CNMPs are fully implemented. However, the bulk of these

acres are in areas of the country where more than enough land is available for manure application on manure-receiving farms. Because of disease and other biosecurity concerns, some livestock producers would not be willing to accept manure from other livestock operations.

Acres available for manure application are summarized in table B–9. Acres available by model farm are presented with acres required for manure application in table B–11.

Acres required for onfarm manure application

Acres required for onfarm manure application depend on the amount of recoverable manure nitrogen and phosphorus produced on the farm, the acres harvested and yields of each crop available for application, and the application rate criteria.

Application rate criteria for the after-CNMP scenario depend on how the calculation will be used in the cost assessment, as described in the main body of this publication. For land application costs associated with the nutrient management element, only the acres receiving manure in a given year are needed. For land treatment costs, however, the total acres that would receive manure over time are required. The difference arises because farms with enough acres to meet a phosphorus standard can apply at nitrogen-standard rates in any given year and rotate to other sites when soil phosphorus levels approach the threshold. Acres that would potentially need land treatment would include all the acres that would receive manure over all the years.

For calculating land application costs, application rate criteria for the after-CNMP scenario depends on how many acres are available for manure application and whether phosphorus or nitrogen is the limiting nutrient. If phosphorus is the limiting nutrient, land application on farms without enough acres to meet a phosphorus standard was simulated using phosphorus-based application rates for all crops and pastureland.

Table B–9 Summary of acres available for manure application based on assumptions in the simulation model

	Million acres	Percent of total
Total acres of 24 crops, cropland used as pasture, and half of permanent pasture on all farms	389.8	100
Acres available for manure application on manure-producing farms	84.8	22
Acres potentially available for manure application on manure-receiving farms	294.6	76
Acres unavailable on manure-receiving farms because sheet and rill erosion rates are greater than T	46.8	12
Acres available for manure application on manure-receiving farms assuming willingness to accept is 50 percent	124.0	32
Acres not available for manure application (non-livestock operations with less than 10 acres available for manure application or farms in counties without any manure-producing farms)	10.4	3

For manure-producing farms that had enough acres to meet a phosphorus standard, land application was simulated using nitrogen-based application rates for all crops and pastureland. For a few manure-producing farms, nitrogen was the limiting nutrient, so land application was simulated using a nitrogen standard. **For calculating land treatment costs**, application rate criteria for the after-CNMP scenario were simulated using phosphorus-based application rates for all farms where phosphorus was the limiting nutrient and nitrogen-based application rates for all farms where nitrogen was the limiting nutrient.

Nitrogen-based application rates and phosphorus-based application rates that constitute application rate criteria for nutrient management plans are defined by Land Grant Universities and called **recommended rates**. Recommended rates are crop specific and vary from state to state and sometimes within a state. Recommended rates are set at a level that will provide the plant nutrients to achieve a desired yield, after accounting for nutrient losses from the crop system from volatilization, denitrification, erosion, leaching, and runoff. Since these recommended rates are not readily available in database form, recommended rates for use in the simulation model were approximated as a function of the amount of nutrients taken up by the crop and removed at harvest.

The phosphorus standard used in the after-CNMP scenario was approximated as the amount of phosphorus taken up and removed by the crop at harvest. Phosphorus uptake parameters are presented in table B–10 for each of the 24 crops. The amount of phosphorus taken up and removed at harvest per acre depends on the yield. The higher the yield, the more phosphorus removed at harvest. Thus, manure application rates per acre based on a phosphorus standard, as simulated in the model, are higher for farms with higher yields than for farms with lower yields. Limiting the phosphorus application to the amount taken up and removed at harvest guarantees that phosphorus levels will not continue to build up in the soil.

The nitrogen standard used in the after-CNMP scenario was approximated similar to that for the phosphorus standard, but included an additional nitrogen recovery factor to adjust for losses during and after application. Nitrogen uptake parameters for the 24 crops are presented in table B–10. Recommended rates were approximated by multiplying the amount of nitrogen taken up by the crop and removed at harvest by 1.43, which reflects a nitrogen recovery factor of 70 percent (1.43=1÷0.70). That is, recommended rates were simulated assuming that 70 percent of the manure nitrogen applied is available for crop growth. The nitrogen recovery factor is largely determined by volatilization losses during and after application, but also includes losses that are due to denitrification, erosion, leaching, and runoff. Nutrient management plans include provisions for keeping these losses at a minimum by addressing the method and timing of application, winter cover crops, and crop rotations, and by stipulating erosion control practices on acres with sheet and rill erosion rates greater than T.

Recommended rates of application for pastureland could not be established based on crop uptake and removal since a crop is not harvested. For pastureland, nitrogen and phosphorus rates of application were set at levels expected to provide the nutrients necessary for good levels of grass production assuming the pastureland is being grazed and accounting for the additional manure nutrients contributed by manure produced by the grazing animals. For model simulation, the nitrogen standard was defined to be 75 pounds of nitrogen per acre for cropland used as pasture and 30 pounds per acre for permanent pastureland. The lower rate for permanent pastureland reflects the generally lower productivity associated with permanent pastureland as compared to cropland used as pastureland. (The nitrogen recovery factor was not applied to pastureland.) The phosphorus rate was set at approximately equivalent levels after adjusting for the ratio of phosphorus to nitrogen in beef cattle manure. The phosphorus standard was defined to be 28 pounds of phosphorus per acre for cropland used as pasture and 11 pounds per acre for permanent pastureland.

A portion of manure nitrogen and phosphorus is bound up in organic compounds, which may not be available for the crop during the same year that manure is applied. In this simulation, no adjustment was made to account for the rate of mineralization of organic nutrients in the manure applied. The assumption is that the amount of manure nutrients not available to the crop during the year of application would be offset by nutrients available from manure applications in previous years.

For a few manure-producing farms (1,379 farms), more acres were required to meet a nitrogen standard than were required to meet a phosphorus standard, indicating that nitrogen was the limiting nutrient. For these farms, 97 percent of the acres with manure applied were for four crops—other tame hay, wild hay, cropland used as pasture, and permanent pasture. For the two pasture types, the difference in application rates for nitrogen and phosphorus generally reflected the proportion of nitrogen to phosphorus in manure. For other tame hay and wild hay, the uptake of phosphorus approached the uptake for nitrogen (table B–10) more closely than other crops. When the ratio of recoverable nitrogen to recoverable phosphorus in the manure is relatively high, as would be the case for systems with higher nitrogen recovery parameters, more acres may be required to meet a nitrogen standard than are required to meet a phosphorus standard on these crops and pastureland.

Application rate criteria for the baseline scenario are applications at rates above the nitrogen standard for some crops and pastureland and applications at rates similar to the nitrogen-standard rates for other crops, emulating pre-CNMP land application practices. For the baseline scenario, the model simulated manure application rates on manure-producing farms at the nitrogen standard with a 50 percent nitrogen recovery factor for 15 of the 24 crops (alfalfa hay, winter wheat, barley, soybeans, durum wheat, other spring wheat,

Table B–10 Nutrient uptake and removal at harvest for 24 crops

Crop	Yield unit	Nutrient uptake per yield unit (lb)		Acres receiving manure on manure-producing farms		
		nitrogen	phosphorus	avg yield	avg lb N uptake per acre	avg lb P uptake per acre
Sorghum for silage	Tons/acre	14.76	2.440	13.4	198	33
Alfalfa hay	Tons/acre	50.40	4.720	3.3	166	16
Potatoes	100 pound bags/acre	0.36	0.060	322.1	116	19
Soybeans	Bushels/acre	3.55	0.360	32.4	115	12
Corn for silage	Tons/acre	7.09	1.050	14.3	101	15
Corn for grain	Bushels/acre	0.80	0.150	117.4	94	18
Sugar beets for sugar	Tons/acre	4.76	0.940	19.2	91	18
Rice	100-lb bags/acre	1.25	0.290	70.4	88	20
Peanuts for nuts (with pods)	Pounds/acre	0.04	0.003	2,198.3	88	7
Grass silage	Tons/acre	13.60	1.600	5.9	80	9
Tobacco	Pounds/acre	0.03	0.002	2,149.0	64	4
Sorghum for grain	Bushels/acre	0.98	0.180	65.4	64	12
Barley	Bushels/acre	0.90	0.180	60.1	54	11
Small grain hay	Tons/acre	25.60	4.480	1.9	49	9
Other spring wheat	Bushels/acre	1.39	0.230	31.4	44	7
Other tame hay	Tons/acre	19.80	15.300	2.1	42	32
Winter wheat	Bushels/acre	1.02	0.200	39.5	40	8
Durum wheat	Bushels/acre	1.29	0.220	27.6	36	6
Oats	Bushels/acre	0.59	0.110	54.5	32	6
Wild hay	Tons/acre	19.80	15.300	1.5	30	23
Sweet potatoes	Bushels/acre	0.13	0.020	217.2	28	4
Rye for grain	Bushels/acre	1.07	0.180	24.4	26	4
Cotton (lint and seed)	500-lb bales/acre	15.19	1.890	1.3	20	2
Sorghum hay	Tons/acre	2.39	1.010	2.7	6	3

Note: Taken from Kellogg et al. (2000), table 9.

oats, rye, Irish potatoes, sweet potatoes, cotton, sugar beets, rice, peanuts, and tobacco). Application rates above the nitrogen standard on these crops could result in impairment of crop quality. The nitrogen recovery factor was set at 50 percent instead of the 70 percent used in the after-CNMP scenario under the assumption that, prior to a CNMP, appropriate erosion controls would generally not be in place, nor would application timing, application method, crop rotations, or cover crops be tailored to minimize manure nutrient losses on fields receiving manure. At 50 percent, the nitrogen recovery factor is thus equal to the amount of nitrogen taken up and removed at harvest.

Higher application rates were simulated for permanent pasture, cropland used as pasture, and the remaining nine feed and forage crops (corn for silage, corn for grain, small grain hay, other tame hay, wild hay, grass silage, sorghum hay, sorghum for silage, sorghum for grain). Application rates for this latter group of crops were set at one and a half times the amount of nitrogen taken up and removed at harvest for farms that had enough land for onfarm application, plus the 50 percent nitrogen recovery factor. For pastureland, nitrogen-standard application rates were increased 50 percent. For farms that did not have sufficient land at these application rates, application rates were further increased to two times the amount of nitrogen taken up and removed at harvest for these nine crops, plus the 50 percent nitrogen recovery factor. Nitrogen standard application rates for pastureland were doubled. The upper limit for application rates under this application scheme—three times the amount of nitrogen taken up and removed at harvest—was established to be below rates that would result in poor crop quality or the possibility of yield reductions because of nitrogen intolerance.

Before estimating the assimilative capacity of each crop, the farm-level yields were adjusted to eliminate very high and very low yields. Some of the very low yields reported in the Census of Agriculture were the result of local droughts or other detrimental weather conditions and are not representative of the assimilative capacity of the land under normal conditions. Similarly, some of the very high yields might also not be sustainable and would lead to an overestimation of the assimilative capacity of the land. The 10th percentile yield and the 95th percentile yield for each crop was determined for each Land Resource Region. (A map of Land Resource Regions is presented in figure 16 in the main body of this publication.) Each Land Resource Region is characterized by a particular pattern of soils, climate, water resources, and land use, so would generally be expected to have a sustainable yield potential different from other Land Resource Regions. Farm-level yields below the 10th percentile yield for the region were adjusted upward to equal the 10th percentile yield. Farm-level yields above the 95th percentile yield for the region were adjusted downward to equal the 95th percentile yield. All yields were adjusted in this way, including crop yields on manure-receiving farms.

The model allocates manure to each crop separately. To estimate the acres required to meet CNMP application criteria on each farm, it is necessary to first establish the order in which crops are selected for application on the farm. For a manure-producing farm, the model allocates manure to crops according to a set of priorities established by NRCS agronomists. These priorities generally represent current practices on livestock operations. The highest to lowest priorities established for manure application by crop type are corn for silage, corn for grain, small grain hay, other tame hay, wild hay, grass silage, sorghum hay, cropland used as pasture, permanent pasture, sorghum for silage, sorghum for grain, alfalfa hay, winter wheat, barley, soybeans, durum wheat, other spring wheat, oats, rye, Irish potatoes, sweet potatoes, cotton, sugar beets, rice, peanuts, and tobacco. The model allocates manure to the highest priority crop present on the farm and applies manure to that crop according to the appropriate application rate criteria. If the acres of the first priority crop are insufficient to assimilate all of the manure produced on the farm, the model allocates manure to the next priority crop. This allocation process is repeated for each of the 24 crops and pastureland on the farm or until all of the manure has been allocated. Sensitivity analysis showed that reasonable changes in the priority order of crops had a trivial effect on estimates of total acres with manure applied.

Farms that do not have enough acres available to meet land application criteria have **farm-level excess manure**. Farm-level excess manure must either be exported off the farm for land application on surrounding properties or used in some manner other than land application. A portion of the farms in both land application scenarios will have excess manure and thus excess manure nutrients. Excess manure phosphorus and excess manure nitrogen were calculated jointly as

a function of excess manure. For example, when a phosphorus standard is being simulated, manure is applied to each crop at a rate that does not exceed the uptake and removal of phosphorus by the crop, and manure nitrogen is applied proportionately (i.e., at a rate proportional to the ratio of phosphorus to nitrogen in the recoverable manure). Similarly, when a nitrogen standard is simulated, the manure phosphorus rate is determined by the acres applied to meet the nitrogen standard. Thus, farm-level excess manure contains both nitrogen and phosphorus in a proportion determined by the mix of livestock on the farm and the manure handling and storage systems assigned to the farm. (Farm-level excess manure nutrients were not calculated this way in Kellogg et al. (2000). In that publication farm-level excess manure nutrients were calculated separately for nitrogen and phosphorus, simulating a nitrogen standard for nitrogen and a phosphorus standard for phosphorus. Whereas in Kellogg et al. (2000) a farm may have excess phosphorus, but no excess nitrogen, in this study every farm with excess manure has both excess phosphorus and excess nitrogen.)

To prevent the count of farms with excess manure from being artificially inflated by farms with small amounts of excess manure, a farm was classified as having excess manure if the amount of excess manure nitrogen produced annually exceeded 100 pounds. (The model is a precise calculator; however, it is questionable that farms with very small amounts of excess manure as calculated by the model would actually have any excess manure. It is even more questionable that these farms would actually export that small amount to surrounding properties. The cutoff used for identifying farms with excess manure is half the amount used to identify a CNMP farm, and so is small enough to be considered a trivial amount.)

The number of onfarm acres required to meet CNMP application criteria is the difference between baseline acres with manure applied and the after-CNMP scenario acres with manure applied. Estimates of additional acres required for estimating onfarm land application costs and additional acres required for estimating onfarm land treatment costs are both shown in table B–11. Farm-level excess manure nutrients and the number of farms with excess manure are shown in table B–5 along with estimates of recoverable manure nutrients. (Additional summary tables are provided in the main body of this publication.)

Table B–11 Per-farm estimates of total acres on farms, acres available for application of manure, acres with manure applied, and acres required to meet CNMP application criteria on manure-producing farms*

Dominant livestock type	Model farm region	Model farm size class	Number of farms	Total acres on farm	Acres available for land application	Acres with manure applied, baseline scenario	Acres with manure applied in a given year, after-CNMP scenario	Additional acres required for estimating land application costs	Total acres that would receive manure over time, after-CNMP scenario	Additional acres required for estimating land treatment costs
Fattened cattle	Central Plains	35-1000	3,499	2,895	1,016	33	85	52	197	164
		>1000	666	4,719	1,076	311	650	339	781	469
	Midwest	35-500	3,765	871	761	20	48	28	144	124
		>500	233	1,459	1,205	164	506	342	830	666
	Northern Plains	35-500	925	2,550	917	24	58	34	153	129
		>500	52	4,737	1,570	184	585	400	944	760
	Northeast	>35	277	497	415	28	79	51	150	122
	Southeast	>35	371	1,202	858	35	74	40	128	93
	West	35-500	278	4,151	770	26	52	26	104	78
		>500	93	5,304	871	148	281	133	380	232

Table B–11 Per-farm estimates of total acres on farms, acres available for application of manure, acres with manure applied, and acres required to meet CNMP application criteria on manure-producing farms*—Continued

Dominant livestock type	Model farm region	Model farm size class	Number of farms	Total acres on farm	Acres available for land application	Acres with manure applied, baseline scenario	Acres with manure applied in a given year, after-CNMP scenario	Additional acres required for estimating land application costs	Total acres that would receive manure over time, after-CNMP scenario	Additional acres required for estimating land treatment costs
Milk cows	N.Central, Northeast	35-135	53,053	340	264	25	53	28	90	65
		135-270	8,688	644	536	46	107	61	222	176
		>270	2,616	1,117	936	85	250	165	531	446
	Southeast	35-135	4,349	300	216	33	66	32	74	41
		>135	2,815	679	498	73	145	71	247	174
	West	35-135	2,349	475	217	33	62	30	66	34
		135-270	1,825	470	274	43	85	42	125	81
		>270	3,623	568	361	90	204	113	267	177
Swine farrowing farms	N. Central, Northeast	35-500	1,029	363	289	21	47	25	88	67
		>500	119	270	213	63	128	65	163	100
	Southeast	35-100	43	200	130	10	25	15	52	42
		>100	270	227	113	41	67	26	80	39
	West	35-500	89	529	134	40	61	21	72	32
		>500	22	1,142	146	122	146	24	146	24
Swine grower farms	N. Central, Northeast	35-500	9,350	575	501	37	90	53	169	132
		>500	442	810	678	203	472	269	578	374
	Southeast	35-100	282	425	343	14	44	30	105	91
		>100	1,389	356	254	73	173	99	204	131
	West	35-500	113	1,528	608	65	129	64	192	127
		>500	39	2,941	1,357	204	284	80	735	531
Swine farrow-to-finish farms	N. Central, Northeast	35-500	16,837	631	528	36	89	52	179	143
		>500	1,069	863	746	145	462	317	603	458
	Southeast	35-100	583	565	438	12	38	26	113	101
		>100	869	793	589	78	208	130	329	252
	West	35-500	351	2,664	562	36	81	45	162	126
		>500	59	5,311	1,942	325	518	194	899	574
Turkeys	California	>35	135	172	17	17	17	0	17	0
	East	>35	1,408	220	143	95	137	41	141	46
	N. Central	>35	852	348	247	107	233	127	241	134
	S. Central	>35	740	300	166	139	157	18	162	23
	West except CA	>35	78	396	186	76	113	37	130	53
	N. Central, West	>35	836	173	104	61	87	26	91	30
	East, South	>35	15,415	170	103	65	88	23	92	27
Layers	N. Central, Northeast	<400	953	199	141	55	102	47	117	63
		>400	289	436	333	244	333	89	333	89
	S. Central	<400	879	174	97	61	81	20	83	22
		>400	39	898	360	234	264	30	340	106
	Southeast	<400	1,607	125	66	35	51	15	55	19
		>400	80	386	157	149	157	8	157	8
	West	<400	103	60	13	13	13	0	13	0
		>400	102	178	40	40	40	0	40	0

Table B–11 Per-farm estimates of total acres on farms, acres available for application of manure, acres with manure applied, and acres required to meet CNMP application criteria on manure-producing farms*—Continued

Dominant livestock type	Model farm region	Model farm size class	Number of farms	Total acres on farm	Acres available for land application	Acres with manure applied, baseline scenario	Acres with manure applied in a given year, after-CNMP scenario	Additional acres required for estimating land application costs	Total acres that would receive manure over time, after-CNMP scenario	Additional acres required for estimating land treatment costs
Pullets	N. Central, Northeast	>35	369	199	144	55	100	45	112	57
	South & West	>35	905	165	84	43	61	18	65	22
Veal	All	All	168	182	77	6	11	5	19	13
Confined heifers	Midwest	All	2,436	662	565	31	94	63	188	157
	Northeast	All	167	267	200	15	39	24	70	55
	South & West	All	1,240	597	419	28	76	48	135	107
Small farms with confined livestock types	All states	All	42,565	215	165	6	11	5	20	14
Pastured livestock types	All States	All	61,272	590	352	5	10	5	22	17
All manure-producing farms			255,070	505	333	28	58	30	96	68

* Excludes 2,131 specialty livestock farms.

Acres required for off-farm manure application

Farm-level excess manure is transported off the farm for land application on manure-receiving farms located in the same county as the manure-producing farms if sufficient land is available, or is transported off the farm for alternative uses in counties where land is not available. Acres with manure applied on manure-receiving farms were calculated on a county basis. That is, all available acres on manure-receiving farms in the county were combined for making the calculation, thereby treating the county as if it was one large farm. Consequently, the acres required for manure application on manure-receiving farms depends on the amount of farm-level excess manure produced in each county, the acres of each crop available on manure-receiving farms in each county, and the application rate criteria.

Application rate criteria for manure-receiving farms were modeled the same as for manure-producing farms in the after-CNMP scenario with enough land to meet nutrient management criteria—application at nitrogen standard rates. The nitrogen recovery factor was set at 70 percent for both land application scenarios. Manure-receiving farms were treated the same in the simulation model as manure-producing farms after CNMP implementation for several reasons. First, it was assumed that manure-receiving farms would be unwilling to accept manure if they had to apply at phosphorus-standard rates because commercial fertilizers may offer a less costly option for providing the needed nutrients for crop production. Second, as presented earlier, it was assumed that manure-receiving farms would not be willing to accept manure on land with water erosion rates such that implementation of conservation practices might be required. Third, because manure-receiving farms are in the business of producing crops for profit and are not also concerned about manure disposal, it is assumed that manure-receiving farms would generally value the nutrient content of manure more than manure-producing farms and would take measures necessary to get the most benefit from the manure nutrients. Use of conservation tillage and crop residue management, especially no-till, is expected to be more prevalent on crop-producing farms. And last, if manure was applied off-farm using more relaxed practices than are used for onfarm application, CNMP implementation to some extent would simply move the potential pollution problem off the farm to surrounding properties. In simulating CNMP implementation, it is therefore assumed that other programs and policies, including State regulations, will be implemented to assure that land application of manure adheres to the same criteria regardless of where the manure is applied.

The crop priority used to similate manure application is different for manure-receiving farms than for manure-producing farms. Grain crops and other high-value crops have a higher priority than forage crops and pastureland. The highest to lowest priorities for manure application on manure-receiving farms are corn for grain, sorghum for grain, soybeans, winter wheat, barley, durum wheat, other spring wheat, oats, rye, Irish potatoes, sweet potatoes, cotton, corn for silage, small grain hay, other tame hay, wild hay, grass silage, sorghum hay, cropland used as pasture, permanent pasture, sorghum for silage, alfalfa hay, sugar beets, rice, peanuts, and tobacco.

In most counties sufficient acreage exists for off-farm land application of manure in accordance with NRCS nutrient management criteria. However, in some areas of the country, the production of manure nutrients exceeds the capacity of the land to assimilate nutrients (under the assumptions of the model simulation) resulting in excess manure. This excess manure is categorized as **county-level excess manure**.

Acres with manure applied and estimates of county-level excess manure for off-farm application are presented in table B–12. In the baseline scenario 2,707 counties had farm-level excess manure. In these counties 1,167,309 farms were classified as manure-receiving farms with about 121 million acres available for manure application. In the after-CNMP scenario, 1,198,371 manure-receiving farms had about 124 million acres available for manure application. (There were more manure-receiving farms for the after-CNMP scenario because 113 additional counties had farms with farm-level excess manure after CNMP implementation.)

About 9.5 million acres on manure-receiving farms had manure applied in the baseline scenario, compared to about 13.5 million acres in the after-CNMP scenario. Thus, about 4 million additional off-farm acres are required to meet CNMP application criteria.

In the baseline scenario, 184 counties had excess manure. County-level excess manure nitrogen totaled 238 million pounds in the baseline scenario, and excess manure phosphorus totaled 124 million pounds (table B–12), representing about 10 percent of the total recoverable manure nutrients. The presumption is that either this manure is presently being transported to areas outside of the county for application, is being used for purposes other than land application, is fed to animals as a feed supplement, or is held in storage temporarily. Lagoons, for example, accumulate manure nutrients as the solids settle to the bottom and the liquid is pumped off for land application. These solids are retained in the lagoon sometimes for many years before being cleaned out and applied to the land. In addition, manure is sometimes allowed to stack up for long periods in arid regions of the country, and is not removed for land application every year. It is also possible that some of this county-level excess manure, as measured by the simulation model, is actually land applied, but at rates higher than simulated in the baseline scenario.

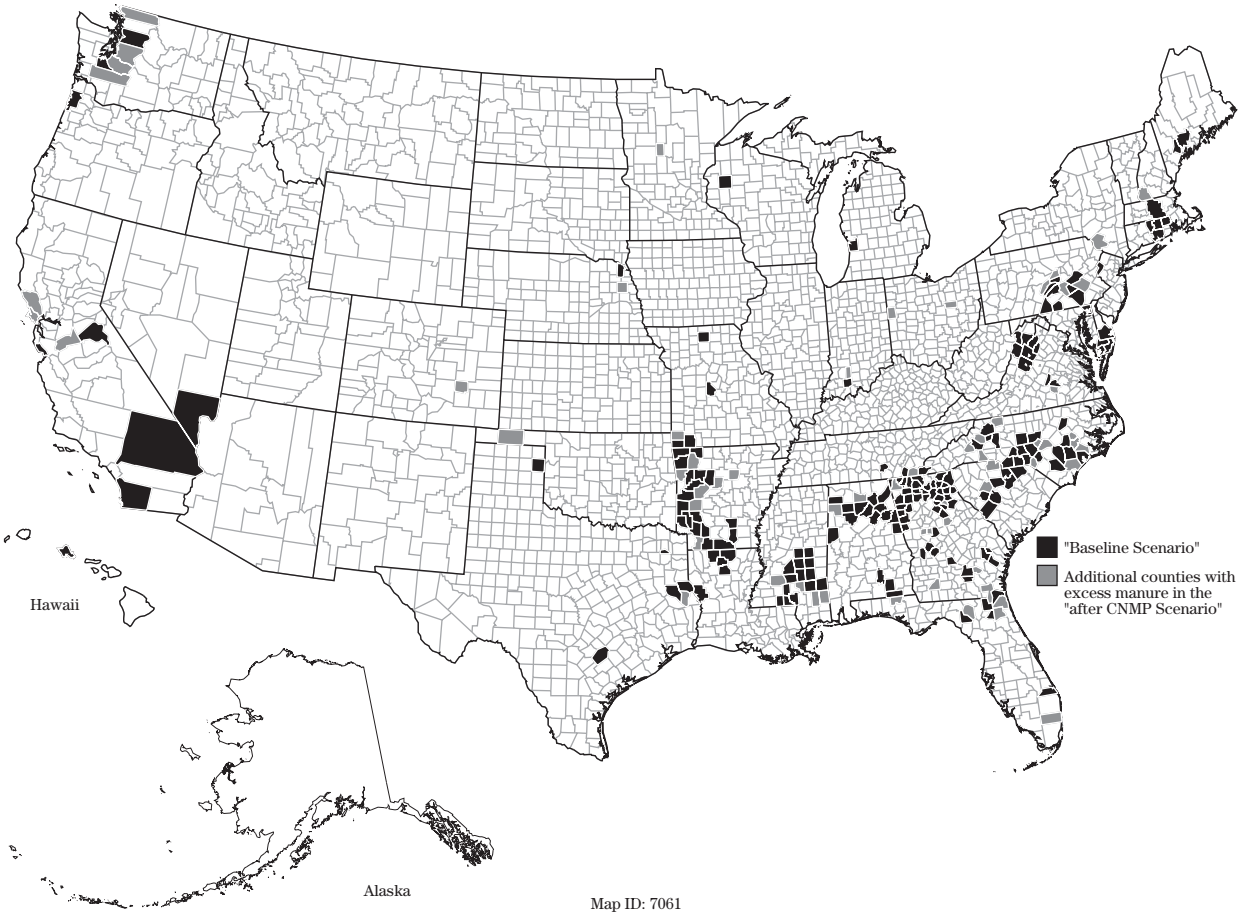
In the after-CNMP scenario, the number of counties with excess manure increased by 64 counties, shown in figure B–3. County-level excess manure increased to about 16 percent of the total amount of recoverable manure nutrients (table B–12). County-level excess manure in the after-CNMP scenario was 454 million pounds of nitrogen and 243 million pounds of phosphorus. This excess manure cannot be land applied under the assumptions of the model, and therefore must be disposed of using alternative methods or addressed through feed management options that decrease the nutrient content in manure.

Table B–12 Acres with manure applied and estimates of excess manure for manure-receiving farms

	Baseline scenario	After-CNMP scenario
Number of counties with manure-receiving farms*	2,707	2,820
Number of manure-receiving farms in these counties	1,167,309	1,198,371
Farm-level excess manure nitrogen, pounds	1,193,141,133	1,844,146,884
Farm-level excess manure phosphorus, pounds	613,628,308	961,462,003
Total acres of 24 crops and pastureland**	287,149,756	294,579,460
Acres available for manure application***	120,947,562	123,985,962
Acres with manure applied in a given year	9,474,818	13,486,869
Percent of total acres of 24 crops and pastureland	3.3	4.6
Percent of acres available for manure application	7.8	10.9
County-level excess manure nitrogen, pounds	237,595,809	454,286,181
Percent of farm-level excess manure nitrogen	19.9	24.6
Percent of recoverable manure nitrogen	9.4	15.1
County-level excess manure phosphorus, pounds	123,813,042	243,301,550
Percent of farm-level excess manure phosphorus	20.2	25.3
Percent of recoverable manure phosphorus	10.8	17.3
Number of counties with excess manure	184	248

* Counties with manure-receiving farms are counties that have one or more manure-producing farms with farm-level excess manure.
** Excludes half of permanent pasture acreage.
*** Excludes acres with sheet and rill erosion above T, 50 percent of the remaining acreage for each crop and cropland used as pasture, and 75 percent of permanent pastureland.

Figure B–3 Counties with county-level excess manure



Figures B–4 and B–5 show the amount of county-level excess manure nitrogen and phosphorus expected after CNMP implementation, presented in the same units as in figures B–1 and B–2 for comparison to the amount of recoverable manure nutrients.

(Kellogg et al. (2000) reported that 73 counties had county level excess manure nitrogen and 160 counties had county-level excess manure phosphorus, simulating a nitrogen standard for nitrogen and a phosphorus standard for phosphorus. The results reported in the present study are not directly comparable to results in Kellogg et al. because the land application criteria are different and because excess manure is determined for nitrogen and phosphorus simultaneously.)

Figure B–4 County-level excess manure nitrogen after implementing CNMPs

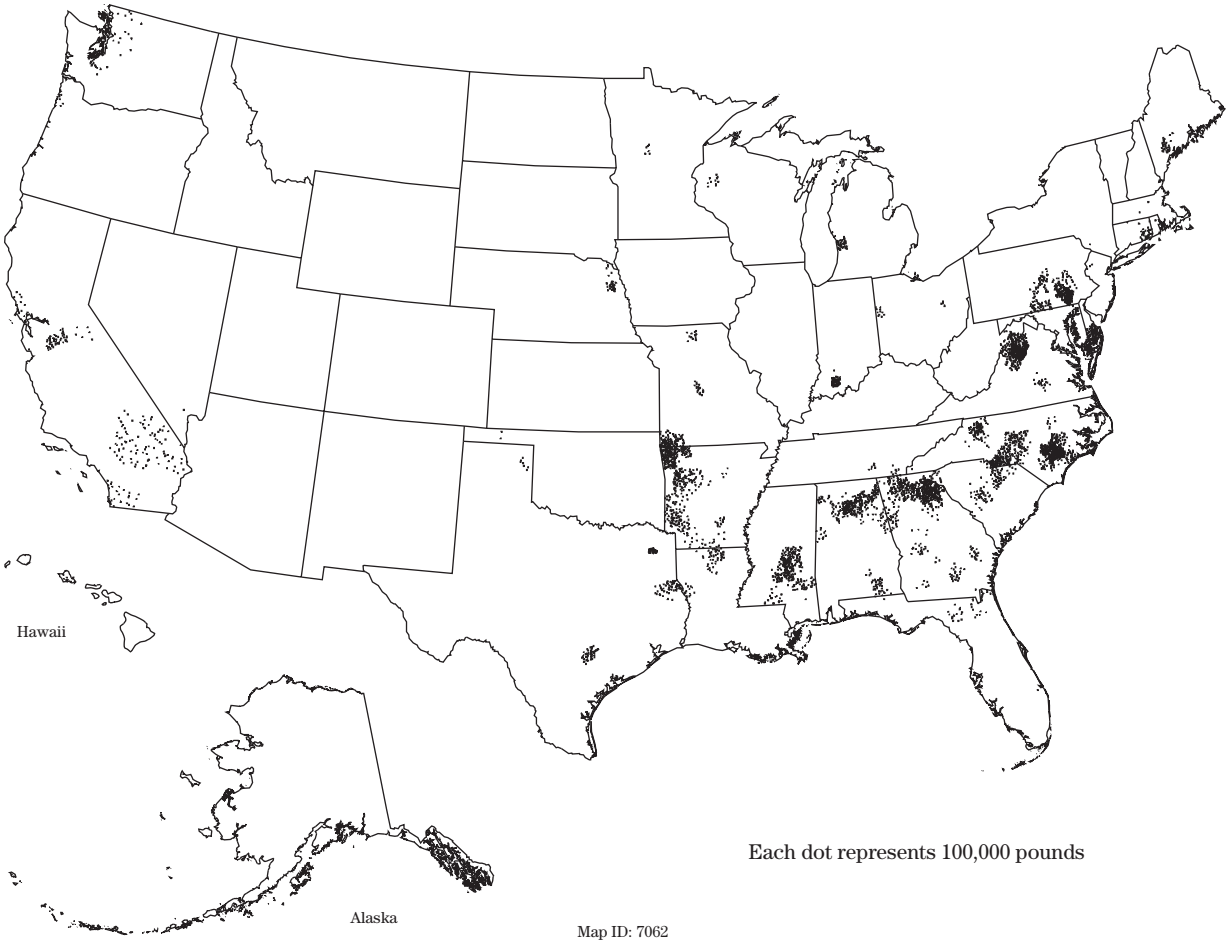
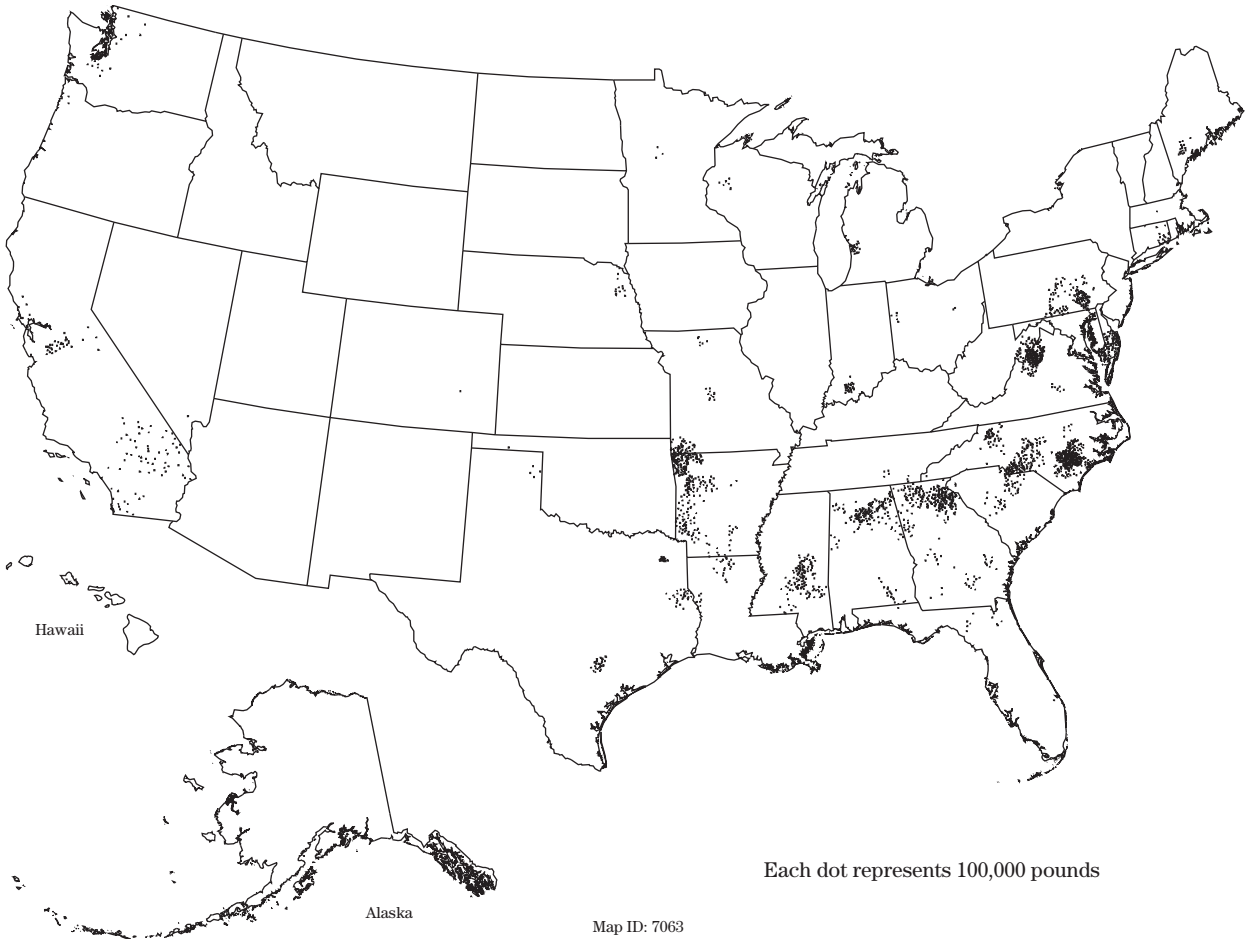


Figure B–5 County-level excess manure phosphorus after implementing CNMPs



Acres required for both onfarm and off-farm manure application are summarized in table B–13. Off-farm acres with manure applied were about the same as onfarm acres with manure applied, with off-farm acres being slightly higher in the baseline scenario and onfarm acres being slightly higher in the after-CNMP scenario. Overall, an additional 11.6 million acres are required to meet CNMP application criteria. About two-thirds of these are for onfarm application and the rest for off-farm application.

Included in table B–13 is the amount of recoverable manure nutrients that would be applied on the farm, applied off the farm, and the amount that would remain as county-level excess manure. Overall, the percentage of recoverable manure nitrogen that would be applied on the farm falls from 53 percent in the baseline scenario to 39 percent in the after-CNMP scenario, whereas the percentage for off-farm application increases from 38 percent in the baseline scenario to 46 percent in the after-CNMP scenario. Similar changes are shown for manure phosphorus. County-level excess manure increases from about 10 percent in the baseline scenario to about 16 percent in the after-CNMP scenario as a result of CNMP implementation.

Table B–13 Summary of acres with manure applied and recoverable manure nutrients applied

Category	Onfarm application (manure-producing farms)	Off-farm application (manure-receiving farms)	Excess manure (county-level)	Total
Recoverable manure nitrogen, pounds				
Baseline scenario	1,340,621,108	955,543,104	237,595,809	2,533,788,026
Percent of total	52.9	37.7	9.4	100.0
After-CNMP scenario				
Farms applying at nitrogen-standard rates	871,617,297	1,389,860,703	NA	
Farms applying at phosphorus-standard rates	293,774,939	NA	NA	
Sum	1,165,392,236	1,389,860,703	454,286,181	3,009,556,624
Percent of total	38.7	46.2	15.1	100.0
Recoverable manure phosphorus, pounds				
Baseline scenario	537,504,867	489,814,215	123,813,042	1,151,144,811
Percent of total	46.7	42.6	10.8	100.0
After-CNMP scenario				
Farms applying at nitrogen-standard rates	306,991,912	718,160,454	NA	
Farms applying at phosphorus-standard rates	134,162,240	NA	NA	
Sum	441,154,152	718,160,454	243,301,550	1,402,621,897
Percent of total	31.5	51.2	17.3	100.0
Acres with manure applied in a given year				
Baseline scenario	7,187,142	9,474,818	NA	16,661,960
Percent of total	43.1	56.9	NA	100.0
After-CNMP scenario				
Farms applying at nitrogen-standard rates	7,580,869	13,486,869	NA	
Farms applying at phosphorus-standard rates	7,233,466	NA	NA	
Sum	14,814,335	13,486,869	NA	28,301,204
Percent of total	52.3	47.7	NA	100.0
Additional acres required	7,627,193	4,012,051	NA	11,639,244
Percent of total	65.5	34.5	NA	100.0

NA = not applicable.

Crop-specific manure application rates

The model simulated manure application for each crop on each manure-producing farm and for manure-receiving farms in each county to determine the number of acres required to meet CNMP application criteria. The percentage of each crop with manure applied is also obtained where not all of the acres of a particular crop are needed for manure application. The average application rates and percentage of acres with manure applied by crop for each group of farms are presented in tables B–14 through B–18. For the baseline scenario, average application rates are presented separately for manure-producing farms and manure-receiving farms. The same is done for the after-CNMP scenario except that the manure-producing farms are divided into two groups: farms that applied manure at nitrogen-standard rates and farms that applied manure at phosphorus-standard rates. The average yields on acres with manure applied are also presented for perspective. The average yields vary among groups because different farms are represented, which may come from different parts of the country.

Table B–14 Average manure nutrient application rates and acres with manure applied by crop for manure-producing farms, baseline scenario

Crop	Acres available for land application	Acres with manure applied	Percent of acres available	Percent of recoverable manure N **	Percent of recoverable manure P **	Pounds manure N per acre	Pounds manure P per acre	Average yield on acres with manure applied*	Yield units
Corn for silage	4,287,343	1,899,610	44.3	19.1	14.1	255	85	14.3	Tons/acre
Corn for grain	22,881,599	1,933,339	8.4	18.1	16.3	237	97	117.4	Bushels/acre
Small grain hay	755,959	128,610	17.0	0.6	0.6	123	55	1.9	Tons/acre
Other tame hay	4,898,893	1,048,467	21.4	4.6	4.9	112	53	2.1	Tons/acre
Wild hay	1,198,953	185,212	15.4	0.6	0.6	78	35	1.5	Tons/acre
Grass silage	3,652,969	124,404	3.4	1.0	0.9	209	81	5.9	Tons/acre
Sorghum hay	9,401	2,369	25.2	0.0	0.0	17	9	2.7	Tons/acre
Cropland used as pasture	9,744,642	936,085	9.6	4.6	4.8	124	59	—	—
Permanent pasture	3,363,277	497,714	14.8	0.9	1.0	47	22	—	—
Sorghum for silage	158,242	7,069	4.5	0.1	0.1	522	229	13.4	Tons/acre
Sorghum for grain	1,208,881	32,024	2.6	0.2	0.2	166	75	65.4	Bushels/acre
Alfalfa hay	6,882,979	84,423	1.2	1.1	1.1	335	150	3.3	Tons/acre
Soybeans	15,867,295	154,084	1.0	1.4	1.6	231	122	32.4	Bushels/acre
Winter wheat	4,902,025	73,925	1.5	0.2	0.3	81	44	39.5	Bushels/acre
Barley	874,271	10,279	1.2	0.0	0.0	109	51	60.1	Bushels/acre
Durum wheat	167,444	664	0.4	0.0	0.0	71	30	27.6	Bushels/acre
Other spring wheat	1,561,062	6,416	0.4	0.0	0.0	88	46	31.4	Bushels/acre
Oats	1,096,722	5,049	0.5	0.0	0.0	65	31	54.5	Bushels/acre
Rye	71,061	2,812	4.0	0.0	0.0	52	29	24.4	Bushels/acre
Irish potatoes	82,603	270	0.3	0.0	0.0	232	112	322.1	100-lb bags/acre
Sweet potatoes	3,880	494	12.7	0.0	0.0	57	39	217.2	Bushels/acre
Cotton	697,463	38,079	5.5	0.1	0.1	40	24	1.3	500-lb bales/acre
Sugar beets	131,035	467	0.4	0.0	0.0	183	83	19.2	Tons/acre
Rice	51,748	117	0.2	0.0	0.0	176	94	70.4	100-lb bags/acre
Peanuts	181,438	6,074	3.3	0.0	0.0	176	88	2,198.3	Pounds/acre
Tobacco	112,230	9,087	8.1	0.1	0.1	141	94	2,149.0	Pounds/acre
All crops	84,843,415	7,187,142	8.5	52.9	46.7				

* Farm-level yields below the 10th percentile yield within a land resource region were adjusted upward to equal the 10th percentile yield. Farm-level yields above the 95th percentile yield within a land resource region were adjusted downward to equal the 95th percentile yield.

** The percentage of manure nutrients applied is the amount applied on these farms divided by the total amount of recoverable manure nutrients for the baseline scenario. The sum is the percentage of recoverable manure nutrients applied to manure-producing farms. The column does not sum to 100 percent because additional manure was applied to manure-receiving farms or is county-level excess manure.

Table B–15 Average manure nutrient application rates and acres with manure applied by crop for manure-receiving farms, baseline scenario

Crop	Acres available for land application	Acres with manure applied	Percent of acres available	Percent of recoverable manure N **	Percent of recoverable manure P **	Pounds manure N per acre	Pounds manure P per acre	Average yield on acres with manure applied*	Yield units
Corn for silage	1,403,339	95,912	6.8	0.7	0.8	198	100	19.5	Tons/acre
Corn for grain	46,133,556	3,335,505	7.2	18.8	20.8	143	72	125.1	Bushels/acre
Small grain hay	2,041,118	90,963	4.5	0.3	0.3	70	38	1.9	Tons/acre
Other tame hay	17,707,616	813,819	4.6	1.9	2.2	60	31	2.1	Tons/acre
Wild hay	6,462,708	152,383	2.4	0.3	0.3	44	23	1.5	Tons/acre
Grass silage	960,757	39,965	4.2	0.2	0.3	143	74	7.3	Tons/acre
Sorghum hay	72,892	857	1.2	0.0	0.0	11	6	3.2	Tons/acre
Cropland used as pasture	51,427,685	1,892,175	3.7	5.6	6.3	75	38	—	—
Permanent pasture	19,603,370	465,740	2.4	0.5	0.6	28	14	—	—
Sorghum for silage	218,357	2,106	1.0	0.0	0.0	316	138	15.0	Tons/acre
Sorghum for grain	6,963,989	365,616	5.3	1.1	1.3	78	42	55.7	Bushels/acre
Alfalfa hay	13,420,362	70,124	0.5	1.0	1.1	346	179	4.8	Tons/acre
Soybeans	47,371,268	526,902	1.1	3.1	3.7	148	82	29.1	Bushels/acre
Winter wheat	31,878,378	827,459	2.6	2.0	2.4	63	33	42.8	Bushels/acre
Barley	4,651,474	82,074	1.8	0.3	0.3	98	48	76.5	Bushels/acre
Durum wheat	2,488,967	60,250	2.4	0.4	0.4	166	84	90.2	Bushels/acre
Other spring wheat	14,561,081	15,421	0.1	0.1	0.1	119	58	60.0	Bushels/acre
Oats	1,497,311	37,037	2.5	0.1	0.1	50	26	58.8	Bushels/acre
Rye	189,812	9,525	5.0	0.0	0.0	38	21	24.7	Bushels/acre
Irish potatoes	1,221,360	21,598	1.8	0.1	0.2	171	89	332.7	100-lb bags/acre
Sweet potatoes	68,382	8,447	12.4	0.0	0.0	55	35	295.7	Bushels/acre
Cotton	11,253,997	518,885	4.6	0.9	1.1	43	24	2.0	500-lb bales/acre
Sugar beets	1,311,671	51	0.0	0.0	0.0	192	86	28.2	Tons/acre
Rice	2,462,287	169	0.0	0.0	0.0	89	48	49.7	100-lb bags/acre
Peanuts	1,125,771	22,054	2.0	0.1	0.1	134	67	2,334.9	Pounds/acre
Tobacco	652,249	19,782	3.0	0.1	0.1	107	77	2,273.5	Pounds/acre
All crops	287,149,756	9,474,818	3.3	37.7	42.6				

* Farm-level yields below the 10th percentile yield within a land resource region were adjusted upward to equal the 10th percentile yield. Farm-level yields above the 95th percentile yield within a land resource region were adjusted downward to equal the 95th percentile yield.

** The percentage of manure nutrients applied is the amount applied on these farms divided by the total amount of recoverable manure nutrients for the baseline scenario. The sum is the percentage of recoverable manure nutrients applied to manure-receiving farms. The column does not sum to 100 percent because additional manure was applied to manure-producing farms or is county-level excess manure.

Table B–16 Average manure nutrient application rates and acres with manure applied by crop for manure-producing farms applying manure at nitrogen-standard rates in the after-CNMP scenario

Crop	Acres available for land application	Acres with manure applied	Percent of acres available	Percent of recoverable manure N **	Percent of recoverable manure P **	Pounds manure N per acre	Pounds manure P per acre	Average yield on acres with manure applied*	Yield units
Corn for silage	3,622,421	2,415,051	66.7	11.4	8.1	142	47	14.0	Tons/acre
Corn for grain	21,229,624	2,813,636	13.3	12.6	9.8	135	49	118.1	Bushels/acre
Small grain hay	653,199	125,757	19.3	0.3	0.2	66	26	1.8	Tons/acre
Other tame hay	4,323,377	996,098	23.0	1.8	1.5	55	22	2.0	Tons/acre
Wild hay	1,106,977	195,107	17.6	0.2	0.2	38	15	1.4	Tons/acre
Grass silage	3,204,386	160,983	5.0	0.5	0.3	91	29	4.7	Tons/acre
Sorghum hay	8,339	2,505	30.0	0.0	0.0	10	5	2.8	Tons/acre
Cropland used as pasture	8,783,328	560,576	6.4	1.4	1.1	75	28	—	—
Permanent pasture	2,802,556	193,622	6.9	0.2	0.2	28	11	—	—
Sorghum for silage	137,878	4,359	3.2	0.0	0.0	272	116	12.9	Tons/acre
Sorghum for grain	1,153,352	26,614	2.3	0.1	0.1	99	39	70.9	Bushels/acre
Alfalfa hay	6,465,021	40,126	0.6	0.3	0.2	195	73	2.7	Tons/acre
Soybeans	14,876,457	8,013	0.1	0.0	0.0	171	73	33.7	Bushels/acre
Winter wheat	4,577,969	20,485	0.4	0.0	0.0	50	25	34.5	Bushels/acre
Barley	829,783	11,374	1.4	0.0	0.0	61	29	47.7	Bushels/acre
Durum wheat	164,485	456	0.3	0.0	0.0	48	19	26.0	Bushels/acre
Other spring wheat	1,524,741	2,778	0.2	0.0	0.0	56	21	28.0	Bushels/acre
Oats	1,053,140	731	0.1	0.0	0.0	40	13	46.8	Bushels/acre
Rye	62,717	532	0.8	0.0	0.0	38	19	24.9	Bushels/acre
Irish potatoes	79,068	5	0.0	0.0	0.0	75	23	145.6	100-lb bags/acre
Sweet potatoes	2,307	0	0.0	0.0	0.0	0	0	—	Bushels/acre
Cotton	550,136	1,627	0.3	0.0	0.0	23	12	1.1	500-lb bales/acre
Sugar beets	122,682	79	0.1	0.0	0.0	133	62	19.6	Tons/acre
Rice	51,273	83	0.2	0.0	0.0	110	77	61.4	100-lb bags/acre
Peanuts	149,046	81	0.1	0.0	0.0	124	53	2,164.9	Pounds/acre
Tobacco	75,687	190	0.3	0.0	0.0	84	23	1,954.4	Pounds/acre
All crops	77,609,949	7,580,869	9.8	29.0	21.9				

* Farm-level yields below the 10th percentile yield within a land resource region were adjusted upward to equal the 10th percentile yield. Farm-level yields above the 95th percentile yield within a land resource region were adjusted downward to equal the 95th percentile yield.

** The percentage of manure nutrients applied is the amount applied on these farms divided by the total amount of recoverable manure nutrients for the after-CNMP scenario. The sum is the percentage of recoverable manure nutrients applied to manure-producing farms applying at nitrogen-standard rates. The column does not sum to 100 percent because additional manure was applied to farms at phosphorus-standard rates and to manure-receiving farms, or is county-level excess manure.

Table B–17 Average manure nutrient application rates and acres with manure applied by crop for manure-producing farms applying manure at phosphorus-standard rates in the after-CNMP scenario

Crop	Acres available for land application	Acres with manure applied	Percent of acres available	Percent of recoverable manure N **	Percent of recoverable manure P **	Pounds manure N per acre	Pounds manure P per acre	Average yield on acres with manure applied*	Yield units
Corn for silage	664,922	664,922	100.0	0.9	0.9	43	19	17.8	Tons/acre
Corn for grain	1,651,975	1,651,975	100.0	2.3	2.1	43	18	121.4	Bushels/acre
Small grain hay	102,760	102,760	100.0	0.1	0.1	21	10	2.3	Tons/acre
Other tame hay	575,516	575,516	100.0	1.3	1.5	70	35	2.3	Tons/acre
Wild hay	91,976	91,976	100.0	0.2	0.2	52	25	1.6	Tons/acre
Grass silage	448,583	448,583	100.0	0.4	0.4	28	12	7.5	Tons/acre
Sorghum hay	1,062	1,062	100.0	0.0	0.0	6	3	2.8	Tons/acre
Cropland used as pasture	961,314	961,314	100.0	2.0	2.1	62	30	—	—
Permanent pasture	560,720	560,720	100.0	0.5	0.4	25	11	—	—
Sorghum for silage	20,364	20,364	100.0	0.0	0.0	66	33	13.3	Tons/acre
Sorghum for grain	55,529	55,529	100.0	0.0	0.0	27	12	66.4	Bushels/acre
Alfalfa hay	417,958	417,958	100.0	0.5	0.5	39	17	3.6	Tons/acre
Soybeans	990,838	990,838	100.0	1.1	1.0	33	14	39.0	Bushels/acre
Winter wheat	324,056	324,056	100.0	0.2	0.2	19	9	46.7	Bushels/acre
Barley	44,488	44,488	100.0	0.0	0.0	27	12	67.0	Bushels/acre
Durum wheat	2,959	2,959	100.0	0.0	0.0	19	9	42.9	Bushels/acre
Other spring wheat	36,321	36,321	100.0	0.0	0.0	15	7	31.6	Bushels/acre
Oats	43,582	43,582	100.0	0.0	0.0	18	7	63.2	Bushels/acre
Rye	8,344	8,344	100.0	0.0	0.0	11	5	26.4	Bushels/acre
Irish potatoes	3,535	3,535	100.0	0.0	0.0	36	16	266.5	100-lb bags/acre
Sweet potatoes	1,573	1,573	100.0	0.0	0.0	6	5	243.4	Bushels/acre
Cotton	147,327	147,327	100.0	0.0	0.0	4	3	1.4	500-lb bales/acre
Sugar beets	8,353	8,353	100.0	0.0	0.0	40	18	18.8	Tons/acre
Rice	475	475	100.0	0.0	0.0	39	18	62.0	100-lb bags/acre
Peanuts	32,392	32,392	100.0	0.0	0.0	12	7	2,492.9	Pounds/acre
Tobacco	36,543	36,543	100.0	0.0	0.0	7	5	2,249.2	Pounds/acre
All crops	7,233,466	7,233,466	100.0	9.8	9.6				

* Farm-level yields below the 10th percentile yield within a land resource region were adjusted upward to equal the 10th percentile yield. Farm-level yields above the 95th percentile yield within a land resource region were adjusted downward to equal the 95th percentile yield.

** The percentage of manure nutrients applied is the amount applied on these farms divided by the total amount of recoverable manure nutrients for the after-CNMP scenario. The sum is the percentage of recoverable manure nutrients applied to manure-producing farms applying at phosphorus-standard rates. The column does not sum to 100 percent because additional manure was applied to farms with enough acres and to manure-receiving farms, or is county-level excess manure.

Table B–18 Average manure nutrient application rates and acres with manure applied by crop for manure-receiving farms, after-CNMP scenario

Crop	Acres available for land application	Acres with manure applied	Percent of acres available	Percent of recoverable manure N **	Percent of recoverable manure P **	Pounds manure N per acre	Pounds manure P per acre	Average yield on acres with manure applied*	Yield units
Corn for silage	1,423,856	126,400	8.9	0.8	0.9	193	103	19.1	Tons/acre
Corn for grain	46,362,105	4,792,009	10.3	22.8	24.1	143	71	125.1	Bushels/acre
Small grain hay	2,114,320	126,059	6.0	0.3	0.4	70	39	1.9	Tons/acre
Other tame hay	18,280,501	1,075,882	5.9	2.1	2.4	59	31	2.1	Tons/acre
Wild hay	6,645,415	202,261	3.0	0.3	0.3	43	23	1.5	Tons/acre
Grass silage	979,247	72,936	7.4	0.3	0.4	143	79	7.4	Tons/acre
Sorghum hay	73,920	1,602	2.2	0.0	0.0	9	5	2.8	Tons/acre
Cropland used as pasture	52,900,255	2,485,118	4.7	6.2	7.0	75	39	—	—
Permanent pasture	20,231,074	663,704	3.3	0.6	0.7	28	15	—	—
Sorghum for silage	222,114	7,332	3.3	0.1	0.1	299	162	14.2	Tons/acre
Sorghum for grain	7,038,302	543,628	7.7	1.4	1.7	80	43	56.7	Bushels/acre
Alfalfa hay	13,901,766	143,736	1.0	1.7	2.0	351	195	4.9	Tons/acre
Soybeans	47,988,525	847,963	1.8	4.4	5.1	157	85	30.8	Bushels/acre
Winter wheat	32,520,009	1,299,863	4.0	2.7	3.1	62	34	42.5	Bushels/acre
Barley	4,869,278	109,059	2.2	0.3	0.4	96	52	74.8	Bushels/acre
Durum wheat	2,917,644	78,962	2.7	0.4	0.5	168	93	90.9	Bushels/acre
Other spring wheat	15,471,323	40,236	0.3	0.1	0.2	109	59	54.8	Bushels/acre
Oats	1,546,402	50,931	3.3	0.1	0.1	50	26	58.8	Bushels/acre
Rye	194,433	13,192	6.8	0.0	0.0	37	20	23.9	Bushels/acre
Irish potatoes	1,247,337	35,826	2.9	0.2	0.2	171	91	332.2	100-lb bags/acre
Sweet potatoes	71,602	9,230	12.9	0.0	0.0	55	37	294.6	Bushels/acre
Cotton	11,808,195	695,752	5.9	1.0	1.2	41	24	1.9	500-lb bales/acre
Sugar beets	1,321,949	216	0.0	0.0	0.0	173	97	25.4	Tons/acre
Rice	2,617,406	3,149	0.1	0.0	0.0	112	59	62.7	100-lb bags/acre
Peanuts	1,162,324	29,536	2.5	0.1	0.1	137	71	2,386.2	Pounds/acre
Tobacco	670,158	32,289	4.8	0.1	0.2	106	79	2,260.8	Pounds/acre
All crops	294,579,461	13,486,869	4.6	46.2	51.2				

* Farm-level yields below the 10th percentile yield within a land resource region were adjusted upward to equal the 10th percentile yield. Farm-level yields above the 95th percentile yield within a land resource region were adjusted downward to equal the 95th percentile yield.
** The percentage of manure nutrients applied is the amount applied on these farms divided by the total amount of recoverable manure nutrients for the after-CNMP scenario. The sum is the percentage of recoverable manure nutrients applied to manure-receiving farms. The column does not sum to 100 percent because additional manure was applied to manure-producing farms or is county-level excess manure.

Simulation results for acres with manure applied are generally supported by information from farmer surveys. Model simulation results for the baseline scenario are compared to the 1995 Cropping Practice Survey results (Padgitt et al., 2000) in table B–19 for crops and states that were included in the survey. For these crops and states, survey data show that, overall, 8.1 percent of the acres had manure applied in 1995. This compares to 4.9 percent for the same states and crops in the model simulation for the baseline scenario. The survey results overstate the number of acres with manure applied because the questionnaire only asked if manure was applied on the field, not what proportion of the field received manure. (In subsequent surveys, the question has been changed to obtain a more precise response.) Some of the survey results for specific crops are also suspect because the crop for which manure applications were intended was not always clear. For example, agronomists suspect that some soybean acres the survey shows receiving manure were probably for corn or other crops planted in rotation following the soybean harvest. Given the vagaries of the survey data, however, and the artificial nature of the model simulation, the correspondence between survey results and model simulation results is surprisingly close, indicating that the results of the simulation model are a reasonable representation of manure application rates for the baseline scenario.

Table B–19 Comparison of simulation model results for the baseline scenario to 1995 survey data for acres where manure was applied*

Crop	1995 survey results			Model simulation results for baseline scenario			
	Planted acres (1,000 acres)	Acres with livestock manure applied (1,000 ac)	Percent of planted acres with livestock manure applied	Total acres from the 1997 census (1,000 ac)	Acres with livestock manure applied on manure-producing farms (1,000 ac)	Acres with livestock manure applied on manure-receiving farms (1,000 ac)	Percent of acres with livestock manure applied
Corn (18 states)	64,105	9,562	14.9	67,511	3,942.40	2,928.16	10.2
Cotton (4 states)	9,395	337	3.5	7,556	4.61	321.40	4.3
Durum wheat (1 state)	2,950	102	3.4	2,541	0.98	0.00	0.0
Fall potatoes (10 states)	1,000	27	2.7	960	0.23	11.79	1.3
Spring wheat (3 states)	11,800	278	2.3	12,452	7.52	2.81	0.1
Soybeans (11 states)	47,790	2,408	5.0	39,675	135.05	374.91	1.3
Wheat (11 states)	30,745	853	2.7	28,413	53.03	557.63	2.1
All survey crops	167,785	13,567	8.1	168,933	4,149.23	4,196.70	4.9

* Model simulation results are for the specific states for which farmer survey results were available. Survey results were reported by Padgitt et al. (2000).

Appendix C Comparison of Size Class Categories Used in the Report to EPA Size Class Categories

Three size classes of farms were derived to summarize results of the cost assessment. Size class categories were based on the total amount of manure phosphorus produced on a farm, *as excreted*. This measure of farm size is more appropriate than a measure based on the number of animals or animal units on the farm because, as shown in appendix B, different animal types produce different amounts of manure and manure nutrients after adjusting for live weight. Manure nitrogen could also have been used to define size classes, but phosphorus was chosen because of its importance in determining CNMP land application criteria. Total manure phosphorus *as excreted* was used rather than recoverable manure phosphorus because recoverable manure does not include the amount produced when animals are not held in confinement, and would thus not be a reliable measure of the overall size of the livestock operation. In addition, the amount of recoverable manure can change with CNMP implementation as better management practices improve manure recoverability on the farm.

The three size classes were defined as follows:

- Large farms are operations that produce more than 10 tons (20,000 pounds) of manure phosphorus annually.
- Medium-size farms are operations that produce between 4 and 10 tons (8,000 to 20,000 pounds) of manure phosphorus annually.
- Small farms are operations that produce less than 4 tons (8,000 pounds) of manure phosphorus annually.

The number of farms by size class and the spatial distribution is presented in the main body of this publication (tables 6 and 7, and figures 12 and 13).

The large farm size class was derived to correspond roughly to concentrated animal feeding operations (CAFOs) with more than 1,000 EPA animal units since these operations present the greatest potential threat to environmental quality and require a National Pollutant Discharge Elimination System (NPDES) permit to operate. (See appendix A for a definition of CAFOs and the relationship between USDA animal units and EPA animal units.) Table C–1 presents estimates of the total pounds of manure phosphorus that would be produced on a farm annually at the 1,000 EPA animal unit threshold (column 7), assuming a farm had livestock at that level throughout the entire year. As shown in the table, the EPA CAFO criteria are not consistent with respect to phosphorus production across the various livestock types. Choosing a cutoff that would closely represent the number of fattened cattle or dairy CAFOs would account for too few swine CAFOs, for example. The EPA CAFO criteria also have the disadvantage of not accounting for multiple livestock types on an operation.

The 10-ton threshold (20,000 pounds) used to define large operations was selected to include the bulk of swine operations that would be classified as a CAFO with more than 1,000 EPA AU plus additional farms of an equivalent size in terms of manure production. Table C–2 shows that of the 11,398 potential CAFOs, 91 percent are included in the large farm size class. (See appendix A for definition of potential CAFOs as derived from the Census of Agriculture.) The 1,044 potential CAFOs not included were predominantly swine farms. An additional 9,392 livestock operations were also included that produced an equivalent amount of manure. The total number of farms in the large size class was 19,746, of which 59 percent were potential CAFOs with more than 1,000 EPA animal units.

A similar approach was used to derive the cutoff for medium size farms, where the 4-ton threshold corresponds roughly to the 300 EPA animal unit threshold. Table C–3 shows that of the 32,968 operations that would potentially have 300 to 1,000 EPA animal units, 64 percent are included in the medium farm size class, whereas 19 percent were included in the large farm size class and 17 percent were included in the small farm size class. An additional 18,365 farms that produced an equivalent amount of manure were also included in the medium farm size class including the 1,044 farms with more than 1,000 EPA animal units that were not included in the large farm size class. The total number of farms in the medium farm size class was 39,437, of which 53 percent have 300 to 1,000 EPA animal units.

Table C–1 Estimation of the pounds of phosphorus (*as excreted*) produced annually that corresponds to EPA head-count criteria for 1,000 EPA animal units, assuming a farm had livestock at that level throughout the entire year*

	Tons of manure as excreted per USDA AU (1)	Pounds of P per ton of manure (2)	Pounds of P per USDA AU (3)=(1)(2)	Number of animals per USDA AU (4)	Pounds of P per head (5)=(3)/(4)	Head count corresponding to 1,000 EPA AU (6)	Pounds of P corresponding to 1,000 EPA AU (7)=(5)(6)
Fattened cattle	10.59	3.37	35.69	1.14	31.3055	1,000	31,306
Milk cows	15.24	1.92	29.26	0.74	39.5416	700	27,679
Breeding hogs	6.11	4.28	26.15	2.67	9.7943	2,500	24,486
Hogs for slaughter	14.69	3.29	48.33	9.09	5.3168	2,500	13,292
Chicken layers	11.45	9.98	114.27	250.0	0.4571	100,000	45,710
Chicken broilers	14.97	7.80	116.77	455.0	0.2566	100,000	25,660
Pullets	8.32	10.53	87.61	250.0	0.3504	100,000	35,040
Turkeys for breeding	9.12	13.21	120.48	50.0	2.4095	55,000	132,523
Turkeys for slaughter	8.18	11.83	96.77	67.0	1.4443	55,000	79,437

* Parameters used to calculate manure phosphorus are taken from appendix B, table B–1.

Table C–2 Comparison of the number of potential CAFOs in the EPA 1,000 animal unit category to the number of farms in the large farm size class

Dominant livestock type	Potential CAFOs, 1,000 EPA AU*	Number of potential CAFOs in large farm size class	Number of potential CAFOs **not** in large farm size class	Number of additional farms in large farm size class	Total number of farms in large farm size class
Fattened cattle	1,766	1,562	204	810	2,372
Milk cows	1,450	1,450	0	1,348	2,798
Swine	3,924	3,096	828	464	3,560
Turkeys	388	388	0	2,297	2,685
Broilers	2,945	2,945	0	2,087	5,032
Layers/Pullets	671	671	0	705	1,376
Confined heifers/veal	254	242	12	75	317
Pastured livestock types	0	0	0	1,606	1,606
Total	11,398	10,354	1,044	9,392	19,746

* Taken from appendix A, table A–6.

Table C–3 Comparison of the number of farms in the 300 to 1,000 EPA animal unit category to the number of farms in the medium farm size class

Dominant livestock type	Farms with 300 to 1,000 EPA AU*	Farms with 300 to 1,000 EPA AU & in medium farm size class	Farms with 300 to 1,000 EPA AU & in large farm size class	Farms with 300 to 1,000 EPA AU and in small farm size class	Additional farms in medium farm size class		Total number of farms in medium farm size class
					Potential CAFOs, 1,000 EPA AU	Farms with less than 300 EPA AU	
Fattened cattle	2,682	1,423	465	794	204	1,621	3,248
Milk cows	5,780	4,552	1,227	1	0	3,098	7,650
Swine	9,901	5,568	317	4,016	828	2,258	8,654
Turkeys	1,615	0	1,615	0	0	460	460
Broilers	10,749	8,218	2,080	451	0	555	8,773
Layers/pullets	1,460	751	638	71	0	1,585	2,336
Confined heifers/veal	781	560	73	148	12	138	710
Small farms with confined livestock types	0	0	0	0	0	91	91
Pastured livestock types	0	0	0	0	0	7,515	7,515
Total	32,968	21,072	6,415	5,481	1,044	17,321	39,437

* Taken from appendix A, table A–6.

Appendix D Conservation Systems for Cropland in Land Resource Regions S, M, and R

Table D–1 Conservation systems for cropland in Land Resource Region S

Erosion class & conservation system number	Proportion of acres needing system	Practice code	Practice name	Unit	Amount per acre	Annualized cost per acre by state							
						DE	MA	MD	NJ	NY	PA	WV	VA
1–2T													
1	0.5	328	Conservation Crop Rotation	acre	1	8.83	8.83	5.00	8.83	6.00	19.32	8.83	9.20
		329B	Residue Management (Mulch-till)	acre	1	30.89	35.00	30.89	30.89	18.55	30.89	30.89	21.64
		340	Cover Crop	acre	1	1.04	4.47	1.94	1.84	2.95	3.05	2.95	2.98
		412	Grassed Waterway	acre	0.1	26.07	27.54	27.54	27.54	27.54	27.54	21.50	35.39
		585/586	Contour Stripcropping or Field Stripcropping	acre	1	5.50	6.71	2.98	4.38	4.69	1.90	5.50	0.37
			Total			72.33	82.55	68.35	73.47	59.74	82.69	69.68	69.59
2	0.5	328	Conservation Crop Rotation	acre	1	8.83	8.83	5.00	8.83	6.00	19.32	8.83	9.20
		329B	Residue Management (Mulch-till)	acre	1	30.89	35.00	30.89	30.89	18.55	30.89	30.89	21.64
		330	Contour Farming	acre	0.8	7.41	8.00	15.57	8.00	4.45	6.21	0.43	4.00
		332	Contour Buffer Strips	acre	0.2	4.08	11.92	4.56	3.54	5.16	3.30	3.49	1.19
		340	Cover Crop	acre	1	1.04	4.47	1.94	1.84	2.95	3.05	2.95	2.98
		412	Grassed Waterway	acre	0.1	26.07	27.54	27.54	27.54	27.54	27.54	21.50	35.39
			Total			78.31	95.76	85.49	80.64	64.65	90.30	68.09	74.41
			Weighted total			75.32	89.16	76.92	77.06	62.19	86.50	68.88	70.79
2–4T, >4T													
1	0.75	328	Conservation Crop Rotation	acre	1	8.83	8.83	5.00	8.83	6.00	19.32	8.83	9.20
		329A,B	Residue Management (No-till & Strip-till)	acre	1	16.57	35.00	12.18	23.88	19.00	18.32	23.88	15.00
		340	Cover Crop	acre	1	1.04	4.47	1.94	1.84	2.95	3.05	2.95	2.98
		412	Grassed Waterway	acre	0.1	26.07	27.54	27.54	27.54	27.54	27.54	21.50	70.79
		585/586	Contour Stripcropping or Field Stripcropping	acre	1	5.50	6.71	2.98	4.38	4.69	1.90	5.50	0.37
		600	Terrace	feet	200	102.66	119.22	80.48	74.51	111.77	153.80	102.66	34.28
			Total			160.67	201.77	130.11	140.98	171.96	223.92	165.33	132.62
2	0.25	328	Conservation Crop Rotation	acre	1	8.83	8.83	5.00	8.83	6.00	19.32	8.83	9.20
		329A,B	Residue Management (No-till & Strip-till)	acre	1	16.57	35.00	12.18	23.88	19.00	18.32	23.88	15.00
		330	Contour Farming	acre	1	9.26	10.00	19.46	10.00	5.56	7.76	0.54	5.00
		332	Contour Buffer Strips	acre	0.2	4.08	11.92	4.56	3.54	5.16	3.30	3.49	5.96
		340	Cover Crop	acre	1	1.04	4.47	1.94	1.84	2.95	3.05	2.95	2.98
		412	Grassed Waterway	acre	0.1	26.07	27.54	27.54	27.54	27.54	27.54	21.50	70.79
		600	Terrace	feet	200	102.66	119.22	80.48	74.51	111.77	153.80	102.66	34.28
			Total			168.50	216.99	151.15	150.14	177.98	233.08	163.85	143.21
			Weighted total			162.63	205.58	135.37	143.27	173.46	226.21	164.96	135.27

Table D–2 Conservation systems for cropland in Land Resource Region M

State and erosion class	Conservation system number	Proportion of acres needing system	Practice code	Practice name	Unit	Amount per acre	Annualized cost per acre
Indiana							
1–4T, >4T	1	1	328	Conservation Crop Rotation	acre	1	18.59
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	12.21
			410	Grade Stabilization Structure	each	0.005	2.93
			412	Grassed Waterway	acre	0.05	18.46
			620	Underground Outlet	feet	30	17.21
			638	Water & Sediment Control Basin	each	0.01	1.16
				Total			70.55
Illinois							
1–4T, >4T	1	1	328	Conservation Crop Rotation	acre	1	18.59
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	12.21
			330	Contour Farming	acre	0.5	5.38
			410	Grade Stabilization Structure	each	0.05	24.50
			412	Grassed Waterway	acre	0.05	20.86
			600	Terrace	feet	100	74.07
				Total			155.61
Iowa							
1–2T	1	1	328	Conservation Cropping System	acre	1	38.73
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	10.00
			412	Grassed Waterway	acre	0.05	18.46
				Total			67.19
2–4T	1	1	328	Conservation Crop Rotation	acre	1	38.73
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	10.00
			330	Contour Farming	acre	0.5	2.79
			332	Contour Buffer Strips	acre	0.1	2.27
			412	Grassed Waterway	acre	0.1	36.91
				Total			90.70
>4T	1	1	328	Conservation Crop Rotation	acre	1	38.73
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	10.00
			330	Contour Farming	acre	0.5	2.79
			412	Grassed Waterway	acre	0.1	36.91
			600	Terrace	feet	120	105.51
			620	Underground Outlet	feet	50	28.69
				Total			222.63

Table D–2 Conservation systems for cropland in Land Resource Region M—Continued

State and erosion class	Conservation system number	Proportion of acres needing system	Practice code	Practice name	Unit	Amount per acre	Annualized cost per acre
Minnesota							
1–2T	1	1	328	Conservation Crop Rotation	acre	1	19.95
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	16.94
			410	Grade Stabilization Structure	each	0.005	3.54
			412	Grassed Waterway	acre	0.05	18.46
			590	Nutrient Management	acre	1	7.50
			620	Underground Outlet	feet	30	12.34
			638	Water & Sediment Control Basin	each	0.1	35.25
				Total			113.98
2–4T	1	1	328	Conservation Crop Rotation	acre	1	19.95
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	16.94
			330	Contour Farming	acre	1	11.79
			412	Grassed Waterway	acre	0.05	18.46
			585	Contour Strip-cropping	acre	1	1.27
			620	Underground Outlet	feet	30	12.34
			638	Water & Sediment Control Basin	each	0.1	35.25
				Total			116.00
>4T	1	0.15	328	Conservation Crop Rotation	acre	1	19.95
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	16.94
			410	Grade Stabilization Structure	each	0.005	3.54
			412	Grassed Waterway	acre	0.05	18.46
			620	Underground Outlet	feet	30	12.34
			638	Water & Sediment Control Basin	each	0.01	3.52
				Total			74.75
	2	0.25	328	Conservation Crop Rotation	acre	1	19.95
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	16.94
			330	Contour Farming	acre	0.5	5.90
			410	Grade Stabilization Structure	each	0.05	35.44
			411	Grasses & Legumes in Rotation	acre	1	0.00
			412	Grassed Waterway	acre	0.1	36.91
			528A	Prescribed Grazing	acre	1	4.95
				Total			120.09

Table D–2 Conservation systems for cropland in Land Resource Region M—Continued

State and erosion class	Conservation system number	Proportion of acres needing system	Practice code	Practice name	Unit	Amount per acre	Annualized cost per acre
Minnesota (continued)							
	3	0.15	328	Conservation Crop Rotation	acre	1	19.95
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	16.94
			330	Contour Farming	acre	0.5	5.90
			412	Grassed Waterway	acre	0.1	36.91
			600	Terrace	feet	120	66.17
			620	Underground Outlet	feet	50	20.57
				Total			166.43
	4	0.2	328	Conservation Crop Rotation	acre	1	19.95
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	16.94
			330	Contour Farming	acre	0.75	8.84
			412	Grassed Waterway	acre	0.05	18.46
			585	Contour Stripcropping	acre	0.75	0.96
				Total			65.14
	5	0.25	328	Conservation Crop Rotation	acre	1	19.95
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	16.94
			330	Contour Farming	acre	0.5	5.90
			412	Grassed Waterway	acre	0.1	36.91
			600	Terrace	feet	120	66.17
			620	Underground Outlet	feet	50	20.57
				Total			166.43
				Weighted total			120.84
Missouri							
1–2T	1	1	328	Conservation Crop Rotation	acre	1	18.59
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	12.21
			412	Grassed Waterway	acre	0.05	20.86
				Total			51.66
2–4T	1	1	328	Conservation Crop Rotation	acre	1	16.93
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	13.22
			330	Contour Farming	acre	0.5	8.47
			412	Grassed Waterway	acre	0.1	43.22
			600	Terrace	feet	100	17.59
				Total			99.42

Table D–2 Conservation systems for cropland in Land Resource Region M—Continued

State and erosion class	Conservation system number	Proportion of acres needing system	Practice code	Practice name	Unit	Amount per acre	Annualized cost per acre
Missouri (continued)							
> 4T	1	1	328	Conservation Crop Rotation	acre	1	16.93
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	13.22
			330	Contour Farming	acre	0.5	8.47
			412	Grassed Waterway	acre	0.1	43.22
			600	Terrace	feet	120	21.10
			620	Underground Outlet	feet	50	14.53
				Total			117.47
Ohio							
1–2T	1	1	328	Conservation Crop Rotation	acre	1	10.80
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	8.88
			410	Grade Stabilization Structure	dach	0.005	1.61
			412	Grassed Waterway	acre	0.05	14.08
				Total			35.37
2–4T	1	1	328	Conservation Crop Rotation	acre	1	10.80
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	8.88
			330	Contour Farming	acre	0.2	2.15
			332	Contour Buffer Strips	acre	0.1	1.04
			412	Grassed Waterway	acre	0.05	14.08
				Total			36.95
> 4T	1	1	328	Conservation Crop Rotation	acre	1	10.80
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	8.88
			330	Contour Farming	acre	0.75	8.07
			412	Grassed Waterway	acre	0.05	14.08
			585	Contour Strip-cropping	acre	0.75	3.02
				Total			44.85
Wisconsin							
1–2T	1	1	328	Conservation Crop Rotation	acre	1	18.59
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	12.21
			410	Grade Stabilization Structure	each	0.005	3.89
			412	Grassed Waterway	acre	0.05	17.10
				Total			51.78

Table D–2 Conservation systems for cropland in Land Resource Region M—Continued

State and erosion class	Conservation system number	Proportion of acres needing system	Practice code	Practice name	Unit	Amount per acre	Annualized cost per acre
Wisconsin (continued)							
2–4T	1	1	328	Conservation Crop Rotation	acre	1	18.59
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	12.21
			330	Contour Farming	acre	0.2	3.90
			332	Contour Buffer Strips	acre	0.1	1.04
			412	Grassed Waterway	acre	0.05	17.10
				Total			52.84
> 4T	1	1	328	Conservation Crop Rotation	acre	1	18.59
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	12.21
			330	Contour Farming	acre	0.75	14.64
			412	Grassed Waterway	acre	0.05	17.10
			585	Contour Strip-cropping	acre	0.75	2.07
				Total			64.60
Kansas							
1–2T	1	1	328	Conservation Crop Rotation	acre	1	4.83
			329C	Residue Management (Ridge-till)	acre	1	3.30
			412	Grassed Waterway	acre	0.01	3.41
				Total			11.54
2–4T	1	1	328	Conservation Crop Rotation	acre	1	4.83
			329A,B	Residue Management (No-till & Strip-till)	acre	1	10.00
			330	Contour Farming	acre	1	3.95
			332	Contour Buffer Strips	acre	0.2	6.00
			412	Grassed Waterway	acre	0.01	3.41
				Total			28.19
> 4T	1	1	328	Conservation Crop Rotation	acre	1	4.83
			329A,B	Residue Management (No-till & Strip-till)	acre	1	10.00
			330	Contour Farming	acre	1	3.95
			412	Grassed Waterway	acre	0.01	3.41
			600	Terrace	feet	150	15.20
			620	Underground Outlet	feet	50	40.91
				Total			78.30
Oklahoma							
1–2T	1	1	328	Conservation Cropping System	acre	1	5.00
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	0.3	2.40
			344	Residue Management (Seasonal)	acre	0.7	9.50
				Total			16.90

Table D–2 Conservation systems for cropland in Land Resource Region M—Continued

State and erosion class	Conservation system number	Proportion of acres needing system	Practice code	Practice name	Unit	Amount per acre	Annualized cost per acre
Oklahoma (continued)							
2–4T	1	1	328	Conservation Crop Rotation	acre	1	5.00
			329A,B	Residue Management (No-till & Strip-till)	acre	1	8.00
			412	Grassed Waterway	acre	0.05	4.10
			600	Terrace	feet	150	10.06
				Total			27.16
> 4T	1	1	328	Conservation Crop Rotation	acre	1	5.00
			329A,C	Residue Management (No-till & Strip-till, Ridge-till)	acre	1	8.00
			362	Diversion	feet	110	14.75
			412	Grassed Waterway	acre	0.05	4.10
			600	Terrace	feet	110	7.38
				Total			39.23
South Dakota							
1–2T	1	1	328	Conservation Crop Rotation	acre	1	3.85
			329C	Residue Management (Ridge-till)	acre	1	4.65
			412	Grassed Waterway	acre	0.01	4.02
				Total			12.52
2–4T	1	1	328	Conservation Crop Rotation	acre	1	3.85
			329A,B	Residue Management (No-till & Strip-till)	acre	1	10.78
			330	Contour Farming	acre	1	12.93
			332	Contour Buffer Strips	acre	0.2	6.00
			412	Grassed Waterway	acre	0.01	4.02
				Total			37.58
> 4T	1	1	328	Conservation Crop Rotation	acre	1	3.85
			329A,B	Residue Management (No-till & Strip-till)	acre	1	10.78
			330	Contour Farming	acre	1	12.93
			412	Grassed Waterway	acre	0.01	4.02
			600	Terrace	feet	150	31.30
			620	Underground Outlet	feet	50	25.36
				Total			88.23
Nebraska							
1–2T	1	1	328	Conservation Crop Rotation	acre	1	5.00
			329C	Residue Management (Ridge-till)	acre	1	4.65
			412	Grassed Waterway	acre	0.01	3.41
				Total			13.06

Table D–2 Conservation systems for cropland in Land Resource Region M—Continued

State and erosion class	Conservation system number	Proportion of acres needing system	Practice code	Practice name	Unit	Amount per acre	Annualized cost per acre
Nebraska (continued)							
2–4T	1	1	328	Conservation Crop Rotation	acre	1	5.00
			329A,B	Residue Management (No-till & Strip-till)	acre	1	10.78
			330	Contour Farming	acre	1	12.93
			332	Contour Buffer Strips	acre	0.2	6.00
			412	Grassed Waterway	acre	0.01	3.41
				Total			38.12
> 4T	1	1	328	Conservation Crop Rotation	acre	1	5.00
			329A,B	Residue Management (No-till & Strip-till)	acre	1	10.78
			330	Contour Farming	acre	1	12.93
			412	Grassed Waterway	acre	0.01	3.41
			600	Terrace	feet	150	12.07
			620	Underground Outlet	feet	50	24.29
				Total			68.48
Michigan							
1–2T	1	0.15	328	Conservation Crop Rotation	acre	1	6.52
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	12.00
			410	Grade Stabilization Structure	each	0.005	2.24
			412	Grassed Waterway	acre	0.05	18.63
			620	Underground Outlet	feet	30	22.35
			638	Water & Sediment Control Basin	each	0.1	17.88
				Total			79.62
	2	0.2	328	Conservation Cropping System	acre	1	6.52
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	12.00
			410	Grade Stabilization Structure	each	0.05	22.35
			412	Grassed Waterway	acre	0.1	37.26
			600	Terrace	feet	100	22.95
				Total			101.08
	3	0.1	328	Conservation Crop Rotation	acre	1	6.52
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	12.00
			410	Grade Stabilization Structure	each	0.005	2.24
			412	Grassed Waterway	acre	0.05	18.63
			590	Nutrient Management	acre	1	5.00
			620	Underground Outlet	feet	30	22.35
			638	Water & Sediment Control Basin	each	0.1	17.88
				Total			84.62

Table D–2 Conservation systems for cropland in Land Resource Region M—Continued

State and erosion class	Conservation system number	Proportion of acres needing system	Practice code	Practice name	Unit	Amount per acre	Annualized cost per acre
Michigan (continued)							
	4	0.35	328	Conservation Crop Rotation	acre	1	6.52
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	12.00
			412	Grassed Waterway	acre	0.05	18.63
				Total			37.15
	5	0.2	328	Conservation Crop Rotation	acre	1	6.52
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	12.00
			410	Grade Stabilization Structure	each	0.005	2.24
			412	Grassed Waterway	acre	0.05	18.63
				Total			39.38
				Weighted total			61.50
2–4T	1	0.15	328	Conservation Crop Rotation	acre	1	6.52
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	12.00
			410	Grade Stabilization Structure	each	0.005	2.24
			412	Grassed Waterway	acre	0.05	18.63
			620	Underground Outlet	feet	30	22.35
			638	Water & Sediment Control Basin	each	0.1	17.88
				Total			79.62
	2	0.2	328	Conservation Crop Rotation	acre	1	6.52
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	12.00
			330	Contour Farming	acre	0.5	5.38
			410	Grade Stabilization Structure	each	0.05	22.35
			412	Grassed Waterway	acre	0.05	18.63
			600	Terrace	feet	100	22.95
				Total			87.84
	3	0.1	328	Conservation Crop Rotation	acre	1	6.52
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	12.00
			330	Contour Farming	acre	1	10.77
			412	Grassed Waterway	acre	0.05	18.63
			585	Contour Strip-cropping	acre	1	1.58
			620	Underground Outlet	feet	30	22.35
			638	Water & Sediment Control Basin	each	0.1	17.88
				Total			89.73

Table D–2 Conservation systems for cropland in Land Resource Region M—Continued

State and erosion class	Conservation system number	Proportion of acres needing system	Practice code	Practice name	Unit	Amount per acre	Annualized cost per acre
Michigan (continued)							
	4	0.15	328	Conservation Crop Rotation	acre	1	6.52
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	12.00
			330	Contour Farming	acre	0.5	5.38
			412	Grassed Waterway	acre	0.1	37.26
			600	Terrace	feet	100	22.95
				Total			84.11
	5	0.1	328	Conservation Crop Rotation	acre	1	6.52
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	12.00
			330	Contour Farming	acre	0.2	2.15
			332	Contour Buffer Strips	acre	0.1	0.52
			412	Grassed Waterway	acre	0.05	18.63
				Total			39.82
	6	0.1	328	Conservation Crop Rotation	acre	1	6.52
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	12.00
			330	Contour Farming	acre	0.2	2.15
			332	Contour Buffer Strips	acre	0.1	0.52
			412	Grassed Waterway	acre	0.05	18.63
				Total			39.82
	7	0.2	328	Conservation Crop Rotation	acre	1	6.52
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	12.00
			330	Contour Farming	acre	0.5	5.38
			332	Contour Buffer Strips	acre	0.1	0.52
			412	Grassed Waterway	acre	0.1	37.26
				Total			61.68
				Weighted total			71.40
>4T	1	0.15	328	Conservation Crop Rotation	acre	1	6.52
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	12.00
			410	Grade Stabilization Structure	each	0.005	2.24
			412	Grassed Waterway	acre	0.05	18.63
			620	Underground Outlet	feet	30	22.35
			638	Water & Sediment Control Basin	each	0.01	1.79
				Total			63.53

Table D–2 Conservation systems for cropland in Land Resource Region M—Continued

SState and erosion class	Conservation system number	Proportion of acres needing system	Practice code	Practice name	Unit	Amount per acre	Annualized cost per acre
Michigan (continued)							
	2	0.25	328	Conservation Crop Rotation	acre	1	6.52
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	12.00
			330	Contour Farming	acre	0.5	5.38
			410	Grade Stabilization Structure	each	0.05	22.35
			411	Grasses & Legumes in Rotation	acre	1	0.00
			412	Grassed Waterway	acre	0.1	37.26
			528A	Prescribed Grazing	acre	1	0.37
				Total			83.88
	3	0.15	328	Conservation Crop Rotation	acre	1	6.52
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	12.00
			330	Contour Farming	acre	0.5	5.38
			412	Grassed Waterway	acre	0.1	37.26
			600	Terrace	feet	120	27.54
			620	Underground Outlet	feet	50	37.26
				Total			125.96
	4	0.2	328	Conservation Crop Rotation	acre	1	6.52
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	12.00
			330	Contour Farming	acre	0.75	8.07
			412	Grassed Waterway	acre	0.05	18.63
			585	Contour Strip-cropping	acre	0.75	1.18
				Total			46.41
	5	0.25	328	Conservation Crop Rotation	acre	1	6.52
			329A,B	Residue Management (No-till & Strip-till, Mulch-till)	acre	1	12.00
			330	Contour Farming	acre	0.5	5.38
			412	Grassed Waterway	acre	0.1	37.26
			600	Terrace	feet	120	27.54
			620	Underground Outlet	feet	50	37.26
				Total			125.96
				Weighted total			90.16

Table D–3 Conservation systems for cropland in Land Resource Region R

Erosion class & conservation sys. no.	Proportion of acres needing ststem	Practice code	Practice name	Unit	Amount per acre	Annualized cost per acre by state CT	MA	ME	NH	NY	NJ	PA	RI	VT	OH
1–2T															
1	0.5	328	Conservation Crop Rotation	acre	1	8.83	8.83	8.83	8.83	6.00	8.83	19.32	8.83	5.00	10.80
		329B	Residue Mgt (No-till & Strip-till, Mulch-till, Ridge-till)	acre	1	35.00	35.00	30.89	30.89	18.55	30.89	30.89	35.00	30.89	8.88
		330	Contour Farming	acre	0.8	8.00	8.00	8.00	7.41	4.45	8.00	6.21	8.00	7.41	8.61
		332	Contour Buffer Strips	acre	0.2	4.80	11.92	5.54	7.69	5.16	3.54	3.30	11.92	5.42	2.08
		412	Grassed Waterway	acre	0.1	27.54	27.54	27.54	40.49	27.54	27.54	27.54	27.54	22.10	28.15
		557	Row Arrangement	acre	1	1.49	1.49	1.12	0.30	2.01	0.43	1.09	0.54	0.48	0.37
			Total			85.66	92.78	81.92	95.60	63.71	79.23	88.34	91.83	71.30	58.89
2	0.5	328	Conservation Crop Rotation	acre	1	8.83	8.83	8.83	8.83	6.00	8.83	19.32	8.83	5.00	10.80
		329B	Residue Mgt (No-till & Strip-till, Mulch-till, Ridge-till)	acre	1	35.00	35.00	30.89	30.89	18.55	30.89	30.89	35.00	30.89	8.88
		412	Grassed Waterway	acre	0.1	27.54	27.54	27.54	40.49	27.54	27.54	27.54	27.54	22.10	28.15
		585	Contour Strip-cropping	acre	1	4.84	4.84	2.49	2.98	2.92	4.51	5.81	15.74	4.16	4.02
			Total			76.21	76.21	69.75	83.19	55.01	71.77	83.56	87.11	62.15	51.86
			Weighted total			80.93	84.50	75.84	89.40	59.36	75.50	85.95	89.47	66.73	55.37
2–4T															
1	0.4	328	Conservation Crop Rotation	acre	1	8.83	8.83	8.83	8.83	6.00	8.83	19.32	8.83	5.00	10.80
		329B	Residue Mgt (No-till & Strip-till, Mulch-till, Ridge-till)	acre	1	35.00	35.00	30.89	30.89	18.55	30.89	30.89	35.00	30.89	8.88
		330	Contour Farming	acre	0.8	8.00	8.00	8.00	7.41	4.45	8.00	6.21	8.00	7.41	8.61
		332	Contour Buffer Strips	acre	0.2	4.80	11.92	5.54	7.69	5.16	3.54	3.30	11.92	5.42	2.08
		362	Diversion	feet	200	119.22	119.22	186.58	312.96	102.83	117.44	79.88	119.22	77.50	136.81
		412	Grassed Waterway	acre	0.1	27.54	27.54	27.54	40.49	27.54	27.54	27.54	27.54	22.10	56.30
		557	Row Arrangement	acre	1	1.49	1.49	1.12	0.30	2.01	0.43	1.09	0.54	0.48	0.37

See footnote at end of table.

Table D–3 Conservation systems for cropland in Land Resource Region R—Continued

Erosion class & conservation sys. no.	Proportion of acres needing ststem	Practice code	Practice name	Unit	Amount per acre	Annualized cost per acre by state									
						CT	MA	ME	NH	NY	NJ	PA	RI	VT	OH
2–4T (cont.)															
		638	Water & Sediment Control Basin	each	0.1	25.38	25.38	8.94	14.90	25.38	41.13	28.06	25.38	33.87	35.77
			Total			230.26	237.39	277.45	423.47	191.92	237.80	196.28	236.44	182.67	259.62
2	0.5	328	Conservation Crop Rotation	acre	1	8.83	8.83	8.83	8.83	6.00	8.83	19.32	8.83	5.00	10.80
		329B	Residue Mgt (No-till & Strip-till, Mulch-till, Ridge-till)	acre	1	35.00	35.00	30.89	30.89	18.55	30.89	30.89	35.00	30.89	8.88
		362	Diversion	feet	200	119.22	119.22	186.58	312.96	102.83	117.44	79.88	119.22	77.50	136.81
		412	Grassed Waterway	acre	0.1	27.54	27.54	27.54	40.49	27.54	27.54	27.54	27.54	22.10	56.30
		585/ 586	Contour Strip-cropping or Field Strip-cropping	acre	1	6.71	6.71	5.50	5.59	4.69	4.38	1.90	3.90	12.67	2.71
		638	Water & Sediment Control Basin	each	0.1	25.38	25.38	8.94	14.90	25.38	41.13	28.06	25.38	33.87	35.77
			Total			222.68	222.68	268.29	413.66	185.00	230.20	187.59	219.88	182.03	251.27
3*	0.05	382	Fence	feet	40	10.73	11.92	7.45	32.55	5.96	17.88	7.33	14.55	5.96	16.81
		512	Pastureland & Hayland Planting	acre	1	23.98	59.61	27.72	38.45	25.78	17.70	16.49	59.61	27.12	11.51
		516	Pipeline	feet	50	6.71	19.82	4.62	14.01	18.03	11.55	10.36	12.89	4.84	11.18
		528A	Prescribed Grazing	acre	1	1.49	1.49	1.12	0.30	2.01	0.43	1.09	0.54	0.48	0.37
		574	Spring Development	each	0.025	7.84	9.92	6.50	5.33	10.95	4.47	2.63	7.84	10.77	6.50
		575	Animal Trails & Walkways	feet	50	41.35	41.35	38.67	62.15	15.72	41.35	23.55	69.37	68.33	172.50
		580	Streambank & Shoreline Protection	feet	15	72.58	72.58	37.42	44.71	43.81	67.62	87.18	236.06	62.46	60.36
		614	Watering Facility	each	0.025	1.49	1.49	1.17	2.40	3.27	1.69	4.46	0.39	2.79	1.85
			Total			166.16	218.18	124.67	199.89	125.55	162.69	153.09	401.25	182.76	281.07

See footnote at end of table.

Table D–3 Conservation systems for cropland in Land Resource Region R—Continued

Erosion class & conservation sys. no.	Proportion of acres needing ststem	Practice code	Practice name	Unit	Amount per acre	Annualized cost per acre by state CT	MA	ME	NH	NY	NJ	PA	RI	VT	OH
2–4T (cont.)															
4*	0.05	378	Pond	each	0.025	16.73	16.86	10.50	10.99	34.65	6.11	26.89	16.73	13.86	19.63
		382	Fence	feet	40	10.73	11.92	7.45	32.55	5.96	17.88	7.33	14.55	5.96	16.81
		512	Pastureland & Hayland Planting	acre	1	23.98	59.61	27.72	38.45	25.78	17.70	16.49	59.61	27.12	11.51
		516	Pipeline	feet	50	6.71	19.82	4.62	14.01	18.03	11.55	10.36	12.89	4.84	11.18
		528A	Prescribed Grazing	acre	1	1.49	1.49	1.12	0.30	2.01	0.43	1.09	0.54	0.48	0.37
		575	Animal Trails & Walkways	feet	50	41.35	41.35	38.67	62.15	15.72	41.35	23.55	69.37	68.33	172.50
		580	Streambank & Shoreline Protection	feet	15	72.58	72.58	37.42	44.71	43.81	67.62	87.18	236.06	62.46	60.36
		614	Watering Facility	each	0.025	1.49	1.49	1.17	2.40	3.27	1.69	4.46	0.39	2.79	1.85
			Total			175.05	225.12	128.67	205.55	149.24	164.33	177.35	410.14	185.85	294.21
			Weighted total			220.51	228.46	257.79	396.49	183.01	226.57	188.83	245.08	182.51	258.25
>4T															
1	0.4	328	Conservation Crop Rotation	acre	1	8.83	8.83	8.83	8.83	6.00	8.83	19.32	8.83	5.00	10.80
		329B	Residue Mgt (No-till & Strip-till, Mulch-till, Ridge-till)	acre	1	35.00	35.00	30.89	30.89	18.55	30.89	30.89	35.00	30.89	8.88
		330	Contour Farming	acre	0.8	8.00	8.00	8.00	7.41	4.45	8.00	6.21	8.00	7.41	8.61
		332	Contour Buffer Strips	acre	0.2	4.80	11.92	5.54	7.69	5.16	3.54	3.30	11.92	5.42	2.08
		340	Cover Crop	acre	1	4.47	4.47	4.11	1.49	2.95	1.84	3.05	4.47	2.64	3.05
		362	Diversion	feet	200	119.22	119.22	186.58	312.96	102.83	117.44	79.88	119.22	77.50	136.81
		412	Grassed Waterway	acre	0.1	27.54	27.54	27.54	40.49	27.54	27.54	27.54	27.54	22.10	56.30
		468	Lined Waterway or Outlet	feet	25	86.33	85.69	120.94	25.48	47.80	60.43	39.38	47.54	55.74	428.37
		638	Water & Sediment Control Basin	each	0.1	25.38	25.38	8.94	14.90	25.38	41.13	28.06	25.38	33.87	35.77
			Total			319.57	326.06	401.37	450.14	240.66	299.64	237.62	287.91	240.56	690.68

See footnote at end of table.

Table D–3 Conservation systems for cropland in Land Resource Region R—Continued

Erosion class & conservation sys. no.	Proportion of acres needing ststem	Practice code	Practice name	Unit	Amount per acre	Annualized cost per acre by state									
						CT	MA	ME	NH	NY	NJ	PA	RI	VT	OH
>4T (cont.)															
2	0.4	328	Conservation Crop Rotation	acre	1	8.83	8.83	8.83	8.83	6.00	8.83	19.32	8.83	5.00	10.80
		329B	Residue Mgt (No-till & Strip-till, Mulch-till, Ridge-till)	acre	1	35.00	35.00	30.89	30.89	18.55	30.89	30.89	35.00	30.89	8.88
		330	Contour Farming	acre	0.8	8.00	8.00	8.00	7.41	4.45	8.00	6.21	8.00	7.41	8.61
		340	Cover Crop	acre	1	4.47	4.47	4.11	1.49	2.95	1.84	3.05	4.47	2.64	3.05
		600	Terrace	feet	210	125.18	125.18	107.79	107.79	117.36	78.24	161.49	62.59	107.79	108.24
		620	Underground Outlet	feet	100	155.09	78.54	370.49	295.08	55.44	151.26	222.50	133.83	87.33	34.57
		638	Water & Sediment Control Basin	each	0.1	25.38	25.38	8.94	14.90	25.38	41.13	28.06	25.38	33.87	35.77
			Total			361.96	285.41	539.05	466.39	230.13	320.20	471.51	278.10	274.93	209.93
3*	0.1	382	Fence	feet	40	10.73	11.92	7.45	32.55	5.96	17.88	7.33	14.55	5.96	16.81
		512	Pastureland & Hayland Planting	acre	1	23.98	59.61	27.72	38.45	25.78	17.70	16.49	59.61	27.12	11.51
		516	Pipeline	feet	50	6.71	19.82	4.62	14.01	18.03	11.55	10.36	12.89	4.84	11.18
		528A	Prescribed Grazing	acre	1	1.49	1.49	1.12	0.30	2.01	0.43	1.09	0.54	0.48	0.37
		574	Spring Development	each	0.025	7.84	9.92	6.50	5.33	10.95	4.47	2.63	7.84	10.77	6.50
		575	Animal Trails & Walkways	feet	50	41.35	41.35	38.67	62.15	15.72	41.35	23.55	69.37	68.33	172.50
		580	Streambank & Shoreline Protection	feet	15	72.58	72.58	37.42	44.71	43.81	67.62	87.18	236.06	62.46	60.36
		614	Watering Facility	each	0.025	1.49	1.49	1.17	2.40	3.27	1.69	4.46	0.39	2.79	1.85
			Total			166.16	218.18	124.67	199.89	125.55	162.69	153.09	401.25	182.76	281.07
4*	0.1	378	Pond	each	0.025	16.73	16.86	10.50	10.99	34.65	6.11	26.89	16.73	13.86	19.63
		382	Fence	feet	40	10.73	11.92	7.45	32.55	5.96	17.88	7.33	14.55	5.96	16.81
		512	Pastureland & Hayland Planting	acre	1	23.98	59.61	27.72	38.45	25.78	17.70	16.49	59.61	27.12	11.51
		516	Pipeline	feet	50	6.71	19.82	4.62	14.01	18.03	11.55	10.36	12.89	4.84	11.18
		528A	Prescribed Grazing	acre	1	1.49	1.49	1.12	0.30	2.01	0.43	1.09	0.54	0.48	0.37

See footnote at end of table.

Table D–3 Conservation systems for cropland in Land Resource Region R—Continued

Erosion class & conservation sys. no.	Proportion of acres needing ststem	Practice code	Practice name	Unit	Amount per acre	Annualized cost per acre by state CT	MA	ME	NH	NY	NJ	PA	RI	VT	OH
>4T (cont.)															
		575	Animal Trails & Walkways	feet	50	41.35	41.35	38.67	62.15	15.72	41.35	23.55	69.37	68.33	172.50
		580	Streambank & Shoreline Protection	feet	15	72.58	72.58	37.42	44.71	43.81	67.62	87.18	236.06	62.46	60.36
		614	Watering Facility	each	0.025	1.49	1.49	1.17	2.40	3.27	1.69	4.46	0.39	2.79	1.85
			Total			175.05	225.12	128.67	205.55	149.24	164.33	177.35	410.14	185.85	294.21
			Weighted total			306.73	288.92	401.50	407.16	215.80	280.64	316.70	307.54	243.06	417.77

* Conservation system represents a land use change from cropland to pastureland.

Appendix E CNMP Needs and Costs for Manure and Wastewater Storage and Handling

Table E–1 CNMP needs and costs for manure and wastewater handling and storage, by representative farm and component

Representative farm and component	Model farm region	Model farm size class (AU)	CNMP needs (%)	Cost unit	Capital cost per unit ($)	Operating cost per unit ($)
Fattened cattle #1: scrape and stack						
Lot upgrade	All	All	15	Head	5.09	0.00
Grassed waterway diversion	All	All	15	Head	.08–.20	0.00
Solids collection	All	All	10	Solids tons	6.20	5.70
Solids storage	Northeast	>35	25	Solids tons	3.50	0.00
	Southeast	>35	25	Solids tons	1.75	0.00
	Midwest	35–500	25	Solids tons	3.50	0.00
Contaminated runoff collection	Northeast	>35	40	Head	0.56–1.31	0.00
	Southeast	>35	55	Head	0.56–1.31	0.00
	Midwest	35–500	40	Head	0.56–1.31	0.00
Runoff storage pond	Northeast	>35	40	AU	25.92	0.00
	Southeast	>35	50	AU	26.23	0.00
	Midwest	35–500	40	AU	20.23	0.00
Liquid transfer	Northeast	>35	40	Liquid tons	0.20–0.40	0.06
	Southeast	>35	50	Liquid tons	0.20–0.40	0.06
	Midwest	35–500	40	Liquid tons	0.20–0.40	0.06
Settling basin	Northeast	>35	40	AU	2.01–5.49	0.00
	Southeast	>35	50	AU	2.01–5.49	0.00
	Midwest	35–500	40	AU	2.01–5.49	0.00
Fattened cattle #2: manure pack						
Lot upgrade	Southeast	>35	30	Head	5.09	0.00
	Midwest	35–500	30	Head	5.09	0.00
	Midwest	>500	5	Head	5.09	0.00
	Northern Plains	35–500	30	Head	5.09	0.00
	Northern Plains	>500	5	Head	5.09	0.00
	Central Plains	35–1,000	30	Head	5.09	0.00
	Central Plains	>1,000	5	Head	5.09	0.00
	West	35–500	30	Head	5.09	0.00
	West	>500	5	Head	5.09	0.00
Earth berm, undergound outlet	Southeast	>35	20	Head	3.58–5.07	0.00
	Midwest	35–500	20	Head	3.58–5.07	0.00
	Midwest	>500	10	Head	3.58–5.07	0.00
	Northern Plains	35–500	20	Head	3.58–5.07	0.00
	Northern Plains	>500	10	Head	3.58–5.07	0.00
	Central Plains	35–1,000	20	Head	3.58–5.07	0.00
	Central Plains	>1,000	10	Head	3.58–5.07	0.00
	West	35–500	20	Head	3.58–5.07	0.00
	West	>500	10	Head	3.58–5.07	0.00
Solids collection	All	All	10	Solids tons	6.20	5.70

Table E–1 CNMP needs and costs for manure and wastewater handling and storage, by representative farm and component —Continued

Representative farm and component	Model farm region	Model farm size class (AU)	CNMP needs (%)	Cost unit	Capital cost per unit ($)	Operating cost per unit ($)
Contaminated runoff collection	Southeast	>35	60	Head	0.56–1.31	0.00
	Midwest	35–500	60	Head	0.56–1.31	0.00
	Midwest	>500	50	Head	0.56–1.31	0.00
	Northern Plains	35–500	60	Head	0.56–1.31	0.00
	Northern Plains	>500	50	Head	0.56–1.31	0.00
	Central Plains	35–1,000	60	Head	0.56–1.31	0.00
	Central Plains	>1,000	50	Head	0.56–1.31	0.00
	West	35–500	60	Head	0.56–1.31	0.00
	West	>500	50	Head	0.56–1.31	0.00
Runoff storage pond	Southeast	>35	70	AU	17.56	0.00
	Midwest	35–500	70	AU	15.40	0.00
	Midwest	>500	70	AU	13.11	0.00
	Northern Plains	35–500	70	AU	7.41	0.00
	Northern Plains	>500	70	AU	5.75	0.00
	Central Plains	35–1,000	70	AU	5.99	0.00
	Central Plains	>1,000	70	AU	4.95	0.00
	West	35–500	70	AU	4.16	0.00
	West	>500	70	AU	4.07	0.00
Liquid transfer	All	All	70	Liquid tons	0.20–0.40	0.06
Settling basin	All	All	70	AU	2.01–5.49	0.00
Confined heifers # 1: Confinement barn						
Solids collection	All	>35	10	Solids tons	6.20	5.70
Solids storage	All	>35	40	Solids tons	3.50	0.00
Confined heifers # 2: Small lot, scraped						
Lot upgrade	All	All	30	Head	5.09	0.00
Grassed waterway diversion	All	All	15	Head	.08–.20	0.00
Solids collection	All	All	10	Solids tons	6.20	5.70
Solids storage	All but SE	All	25	Solids tons	3.50	0.00
	Southeast	All	25	Solids tons	1.75	0.00
Contaminated runoff collection	Northeast	>35	40	Head	0.56–1.31	0.00
	Midwest	>35	40	Head	0.56–1.31	0.00
	South, West	>35	55	Head	0.56–1.31	0.00
Runoff storage pond	Northeast	>35	40	AU	25.92	0.00
	Midwest	>35	40	AU	20.23	0.00
	Southeast	>35	50	AU	26.23	0.00
	West	>35	50	AU	4.16	0.00
Liquid transfer	Northeast	>35	40	Liquid tons	0.20–0.40	0.06
	Midwest	>35	40	Liquid tons	0.20–0.40	0.06
	South, West	>35	50	Liquid tons	0.20–0.40	0.06
Settling basin	Northeast	>35	40	AU	2.01–5.49	0.00
	Midwest	>35	40	AU	2.01–5.49	0.00
	South, West	>35	50	AU	2.01–5.49	0.00

Table E–1 CNMP needs and costs for manure and wastewater handling and storage, by representative farm and component —Continued

Representative farm and component	Model farm region	Model farm size class (AU)	CNMP needs (%)	Cost unit	Capital cost per unit ($)	Operating cost per unit ($)
Veal # 1: Confinement house						
Liquid storage	All	All	30	AU	7.12	0.00
Liquid transfer	All	All	30	Liquid tons	0.20–0.40	0.06
Swine # 1: Confinement, liquid system, lagoon						
Mortality management	All	All	70	Farm	1,248.00	0.00
			70	AU	2.20	1.40
Liquid collection	All	All	10	AU	16.50–20.70	8.46
Liquid storage	Southeast	35–100	20	AU	31.39	0.00
	Southeast	>100	20	AU	29.04	0.00
	Midwest, NE	35–500	20	AU	29.00	0.00
	Midwest, NE	>500	20	AU	28.45	0.00
	West	35–500	20	AU	35.43	0.00
	West	>500	20	AU	34.85	0.00
Liquid transfer	All	All	20	Liquid tons	0.20–0.40	0.06
Swine #2: Confinement, slurry system						
Mortality management	All	All	70	Farm	1,248.00	0.00
			70	AU	2.20	1.40
Slurry Storage	Southeast	35–100	60	AU	11.35	0.00
	Southeast	>100	60	AU	9.36	0.00
	Midwest, NE	35–500	60	AU	7.12	0.00
	Midwest, NE	>500	60	AU	5.65	0.00
	West	35–500	60	AU	6.91	0.00
	West	>500	60	AU	5.43	0.00
Liquid transfer	All	All	60	Liquid tons	0.20–0.40	0.06
Swine #3: Open building, slurry pit or flush gutter						
Mortality management	Midwest, NE	35–500	70	Farm	1,248.00	0.00
			70	AU	2.20	1.40
Earthen berm, surface outlet	Midwest, NE	35–500	20	AU	1.28	0.00
Roof runoff management	Midwest, NE	35–500	30	AU	0.85	0.00
Slurry storage	Midwest, NE	35–500	50	AU	10.67	0.00
Liquid transfer	Midwest, NE	35–500	50	Liquid tons	0.20–0.40	0.06
Swine #4: Open building, solids						
Mortality management	Midwest, NE	35–500	70	Farm	1,248.00	0.00
			70	AU	2.20	1.40
Earthen berm, surface outlet	Midwest, NE	35–500	20	AU	1.28	0.00
Roof runoff management	Midwest, NE	35–500	30	AU	0.85	0.00
Solids collection	Midwest, NE	35–500	10	Solids tons	6.20	5.70
Solids storage	Midwest, NE	35–500	60	Solids tons	3.50	0.00
Runoff storage pond	Midwest, NE	35–500	50	AU	8.34	0.00
Liquid transfer	Midwest, NE	35–500	50	Liquid tons	0.20–0.40	0.06
Settling basin	Midwest, NE	35–500	50	AU	2.01–5.49	0.00

Table E–1 CNMP needs and costs for manure and wastewater handling and storage, by representative farm and component —Continued

Representative farm and component	Model farm region	Model farm size class (AU)	CNMP needs (%)	Cost unit	Capital cost per unit ($)	Operating cost per unit ($)
Swine #5: Pasture or lot						
Mortality management	All	All	70	Farm	1,248.00	0.00
			70	AU	2.20	1.40
Earthen berm, surface outlet	All	All	50	AU	1.28	0.00
Solids collection	All	All	10	Solids tons	6.20	5.70
Contaminated runoff collection	Southeast	35–100	50	AU	1.28	0.00
	West	35–500	50	AU	1.28	0.00
Runoff storage pond	Southeast	35–100	50	AU	9.53	0.00
	West	35–500	50	AU	4.61	0.00
Liquid transfer	All	All	50	Liquid tons	0.20–0.40	0.06
Settling basin	All	All	50	AU	2.01–5.49	0.00
Layer #1: High rise and shallow pit						
Mortality management	All	35–400	45	House	82.00	371.00
	All	>400	15	House	82.00	371.00
Solids collection	All	All	10	House	0.00	1,272.00
Solids storage	All but NE	35–400	55	Solids tons	7.00	0.00
	All but NE	>400	30	Solids tons	7.00	0.00
	Northeast	35–400	40	Solids tons	7.00	0.00
	Northeast	>400	20	Solids tons	7.00	0.00
Layer #2: Flush system to lagoon						
Mortality management	All	35–400	45	House	82.00	371.00
	All	>400	15	House	82.00	371.00
Liquid collection	All	All	10	House	3,157.00	1,291.00
Liquid storage	Southeast	35–400	40	House	15,770.00	0.00
	Southeast	>400	20	House	14,818.00	0.00
	South Central	>400	20	House	14,188.00	0.00
Liquid transfer	All	<400	40	Liquid tons	0.20–0.40	0.06
	All	>400	20	Liquid tons	0.20–0.40	0.06
Layer #3: Manure belt or scraper system						
Mortality management	All	35–400	15	House	82.00	371.00
	All	>400	15	House	82.00	371.00
Solids collection	All	All	10	House	0.00	1,956.00
Solids storage	All but NE	35–400	55	Solids tons	7.00	0.00
	All but NE	>400	55	Solids tons	7.00	0.00
	Northeast	35–400	40	Solids tons	7.00	0.00
	Northeast	>400	20	Solids tons	7.00	0.00
Broilers #1: Broiler house						
Mortality management	All	<220	45	House	140.00	633.00
		>220	15	House	140.00	633.00
Solids collection	All	All	2	House	0.00	1,060.00

Table E–1 CNMP needs and costs for manure and wastewater handling and storage, by representative farm and component —Continued

Representative farm and component	Model farm region	Model farm size class (AU)	CNMP needs (%)	Cost unit	Capital cost per unit ($)	Operating cost per unit ($)
Solids storage	East	<440	30	Solids tons	7.00	0.00
	West	<440	50	Solids tons	7.00	0.00
	All	>440	25	Solids tons	7.00	0.00
Pullets #1: High rise or shallow pit						
Mortality management	All	<220	45	House	82.00	371.00
	All	>220	15	House	82.00	371.00
Solids collection	All	All	10	House	0.00	1,272.00
Solids storage	N. Central, NE	<440	40	Solids tons	7.00	0.00
	South, West	<440	55	Solids tons	7.00	0.00
	All	>440	25	Solids tons	7.00	0.00
Turkeys #1: Confinement house						
Mortality management	All	<220	60	House	96–187	433–846
		>220	30	House	96–187	433–846
Solids collection	All	All	15	House	0.00	1,060.00
Solids storage	All	<440	50	Solids tons	7.00	0.00
		>440	25	Solids tons	7.00	0.00
Turkeys #2: Turkey ranch						
Mortality management	All	<220	60	House	96–187	433–846
	All	>220	30	House	96–187	433–846
Solids collection	All	All	15	House	0.00	1,060.00
Solids storage	All	<440	50	Solids tons	7.00	0.00
		>440	2	Solids tons	7.00	0.00
Earthen berm, surface outlet	All	All	40	House	111.00	0.00
Roof runoff management	All	All	90	House	473.00	0.00
Contaminated runoff collection	All	All	90	House	111.00	0.00
Runoff storage pond	East	All	90	House	540.87	0.00
	Midwest	All	90	House	467.28	0.00
	CA	All	90	House	415.87	0.00
	West other than CA	All	90	House	458.50	0.00
Liquid transfer	All	All	90	Liquid tons	0.20–0.40	0.06
Settling basin	All	All	90	AU	2.01–5.49	0.00
Dairy #1: no storage						
Roof runoff management	Dairy Belt	All	80	Head	1.18	0.00
Earth berm, undergound outlet	Dairy Belt	All	50	Head	3.58–5.07	0.00
Solids collection	Dairy Belt	All	10	Solids tons	6.20	5.70
Solids storage	Dairy Belt	35–135	100	Solids tons	3.50	0.00
	Dairy Belt	135–270	100	Solids tons	3.50	0.00
Liquid treatment	Dairy Belt	35–135	65	Head	6.00	0.00
Runoff storage pond	Dairy Belt	135–270	80	Head	18.18	0.00
Liquid transfer	Dairy Belt	135–270	80	Liquid tons	0.20–0.40	0.06
Settling basin	Dairy Belt	135–270	80	AU	2.01–5.49	0.00

Table E–1 CNMP needs and costs for manure and wastewater handling and storage, by representative farm and component —Continued

Representative farm and component	Model farm region	Model farm size class (AU)	CNMP needs (%)	Cost unit	Capital cost per unit ($)	Operating cost per unit ($)
Dairy#2: Solids storage						
Roof runoff management	Dairy Belt	<270	80	Head	1.18	0.00
	Dairy Belt	>270	45	Head	1.18	0.00
	Southeast	All	40	Head	3.77	0.00
	West	All	40	Head	1.18	0.00
Earth berm, undergound outlet	Dairy Belt	<270	50	Head	3.58–5.07	0.00
	Dairy Belt	>270	30	Head	3.58–5.07	0.00
	Southeast	All	20	Head	3.58–5.07	0.00
	West	All	20	Head	3.58–5.07	0.00
Solids collection	All	<270	10	Solids tons	6.20	5.70
Solids storage	Dairy Belt	35–135	20	Solids tons	3.50	0.00
	Dairy Belt	135–270	40	Solids tons	3.50	0.00
	Southeast	35–135	20	Solids tons	1.75	0.00
	Southeast	>135	10	Solids tons	1.75	0.00
	West	35–135	20	Solids tons	3.50	0.00
	West	135–270	20	Solids tons	3.50	0.00
Liquid treatment	All	35–135	75	head	6.00	0.00
Liquid storage	Dairy Belt	>270	100	Head	32.36	0.00
Liquid collection	Dairy Belt	>270	100	Head	23.10	11.84
Runoff storage pond	Dairy Belt	135–270	80	Head	18.18	0.00
	Southeast	>135	80	Head	17.94	0.00
	West	135–270	80	Head	12.00	0.00
Liquid transfer	Dairy Belt	135–270	80	Liquid tons	0.20–0.40	0.06
	Dairy Belt	>270	100	Liquid tons	0.20–0.40	0.06
	Southeast	>135	80	Liquid tons	0.20–0.40	0.06
	West	135–270	80	Liquid tons	0.20–0.40	0.06
Settling basin	Dairy Belt	135–270	80	AU	2.01–5.49	0.00
	Southeast	>135	80	AU	2.01–5.49	0.00
	West	135–270	80	AU	2.01–5.49	0.00
Dairy #3: Liquid/slurry storage in pit or tank						
Roof runoff management	Dairy Belt	All	40	Head	1.18	0.00
Earth berm, undergound outlet	Dairy Belt	All	30	Head	3.58–5.07	0.00
Slurry storage	Dairy Belt	35–135	20	Head	18.39	0.00
	Dairy Belt	135–270	30	Head	15.05	0.00
	Dairy Belt	>270	20	Head	15.05	0.00
Liquid transfer	Dairy Belt	35–135	30	Liquid tons	0.20–0.40	0.06
	Dairy Belt	135–270	30	Liquid tons	0.20–0.40	0.06
	Dairy Belt	>270	20	Liquid tons	0.20–0.40	0.06
Dairy #4: Liquid system, pond or lagoon						
Roof runoff management	Dairy Belt	All	40	Head	1.18	0.00
Earth berm, undergound outlet	Dairy Belt	All	40	Head	3.58–5.07	0.00

Table E–1 CNMP needs and costs for manure and wastewater handling and storage, by representative farm and component —Continued

Representative farm and component	Model farm region	Model farm size class (AU)	CNMP needs (%)	Cost unit	Capital cost per unit ($)	Operating cost per unit ($)
Liquid collection	Dairy Belt	35–135	30	Head	23.10–28.99	11.84
	Dairy Belt	135–270	30	Head	23.10–28.100	11.84
	Dairy Belt	>270	20	Head	23.10	11.84
Liquid storage	Dairy Belt	35–135	20	Head	35.46	0.00
	Dairy Belt	135–270	30	Head	38.81	0.00
	Dairy Belt	>270	40	Head	32.36	0.00
Liquid transfer	Dairy Belt	35–135	30	Liquid tons	0.20–0.40	0.06
	Dairy Belt	135–270	30	Liquid tons	0.20–0.40	0.06
	Dairy Belt	>270	20	Liquid tons	0.20–0.40	0.06
Dairy #5: Liquid or slurry system (West, Southeast)						
Roof runoff management	Southeast	All	40	Head	2.37	0.00
	West	All	40	Head	1.18	0.00
Earth berm, undergound outlet	Southeast	All	20	Head	3.58–5.07	0.00
	West	<270	20	Head	3.58–5.07	0.00
	West	>270	15	Head	3.58–5.07	0.00
Solids collection	All	All	10	Solids tons	6.20	5.70
Liquid collection	Southeast	All	40	Head	23.10–28.99	11.84
	West	35–135	40	Head	23.10–28.99	11.84
	West	135–270	40	Head	23.10–28.99	11.84
	West	>270	20	Head	23.10	11.84
Liquid storage	Southeast	35–135	30	Head	42.40	0.00
	Southeast	>135	30	Head	34.08	0.00
	West	35–135	30	Head	43.13	0.00
	West	135–270	30	Head	34.99	0.00
	West	>270	20	Head	38.87	0.00
Liquid transfer	Southeast	35–135	30	Liquid tons	0.20–0.40	0.06
	Southeast	>135	30	Liquid tons	0.20–0.40	0.06
	West	35–135	30	Liquid tons	0.20–0.40	0.06
	West	135–270	30	Liquid tons	0.20–0.40	0.06
	West	>270	20	Liquid tons	0.20–0.40	0.06
Pastured livestock #1: Pasture with heavy use protection						
Fence	South	All	30	AU	4.20	0.00
	Northeast	>70 AU	30	AU	4.20	0.00
Heavy Use Area Protection	South	All	50	AU	2.32–6.35	0.00
	Northeast	>70 AU	50	AU	2.32–6.35	0.00
Water Well	South	All	40	Farm	820.00	0.00
	Northeast	>70 AU	40	Farm	820.00	0.00
Watering Facility	South	All	40	AU	3.35	0.00
	Northeast	>70 AU	40	AU	3.35	0.00

Table E–1 CNMP needs and costs for manure and wastewater handling and storage, by representative farm and component —Continued

Representative farm and component	Model farm region	Model farm size class (AU)	CNMP needs (%)	Cost unit	Capital cost per unit ($)	Operating cost per unit ($)
Pastured livestock #2: Pasture with windbreak/shelter						
Fence	West Coast States	All	30	AU	4.20	0.00
	Northern Plains, Mountain States	All	30	AU	4.20	0.00
Water Well	West Coast States	All	40	Farm	820.00	0.00
	Northern Plains, Mountain States	All	40	Farm	820.00	0.00
Watering Facility	West Coast States	All	40	AU	3.35	0.00
Watering Facility, frost free	Northern Plains, Mountain States	All	40	AU	13.41	0.00
Windbreak/Shelterbelt	West Coast States	All	50	AU	4.51–7.51	0.00
	Northern Plains, Mountain States	All	50	AU	4.51–7.51	0.00
Pastured livestock #3: Pasture, lot and scrape–and–stack						
Fence	Midwest	All	30	AU	4.20	0.00
Filter strip	Midwest	All	30	AU	1.23	0.00
Solids storage	Midwest	All	50	Solids tons	1.85	0.00
Pastured livestock #4: Pasture with barn for shelter						
Fence	Lake States	All	30	AU	4.20	0.00
	Northeast	<70 AU	30	AU	4.20	0.00
Filter strip	Lake States	All	30	AU	1.23	0.00
	Northeast	<70 AU	30	AU	1.23	0.00
Solids storage	Lake States	All	50	Solids tons	1.85	0.00
	Northeast	<70 AU	50	Solids tons	1.85	0.00