APPENDIX C
DESIGN SPECIFICATIONS—FORMED MANURE STORAGE STRUCTURES

The following design specifications apply to a formed manure storage structure that is constructed belowground, is laterally braced and is not designed using MWPS-36 or by a PE or an NRCS engineer:

(1) The walls of a rectangular formed structure with a depth up to 12 feet shall be designed in accordance with the tables provided in this appendix.

(2) Consideration shall be given to internal and external loads including, but not limited to, lateral earth pressures, hydrostatic pressures, wind loads, and floor or cover, building and equipment loads.

(3) Each wall shall be braced laterally at the top of the wall.

(4) The walls shall be constructed above the groundwater table, or a drain tile shall be installed to artificially lower the groundwater table.

(5) Each wall that includes a pump out port shall be constructed under the design consideration that vehicles will be operating within 5 feet of the wall as provided in Tables D-2 and D-4.

(6) Minimum wall thickness and minimum vertical steel reinforcement shall be in accordance with one of the following:

(a) Table C-1, if **all** of the following conditions are met:

1. There will be NO VEHICLES operating within 5 feet of the wall.
2. Backfilling is performed with gravel, sand, silt, and clay mixtures (less than 50 percent fines), with coarse sand with silt or clay (less than 50 percent fines), or cleaner granular material (see NRCS Conservation Practice Standard, "Waste Storage Facility," Code 313, Table 2, for description and unified classification or ASTM D 2488 and D 653).

APPENDIX C, TABLE C-1
Minimum Wall Thickness and Vertical Steel Reinforcement

Wall height (feet)	Wall thickness (inches)	Steel Grade			
		Grade 40		Grade 60	
		Bar	Space o.c. (inches)	Bar	Space o.c. (inches)
4 or less	6	#4	16.5	#4	18.0
		#5	18.0	#5	18.0
4 or less	8	#4	12.0	#4	13.5
		#5	18.0	#5	18.0
6	6	#4	14.5	#4	18.0
		#5	18.0	#5	18.0
6	8	#4	12.0	#4	13.5
		#5	18.0	#5	18.0
8	8	#4	9.5	#4	13.5
		#5	14.5	#5	18.0
8	10	#4	9.5	#4	11.0
		#5	15.0	#5	17.0
10	8	#4	6.5	#4	9.5
		#5	10.0	#5	13.5
10	10	#4	6.5	#4	9.5
		#5	10.0	#5	15.0
12	10	#4	5.0	#4	7.5
		#5	7.5	#5	11.5

(b) Table C-2, if **all** of the following conditions are met:

1. There will be VEHICLES operating within 5 feet of the wall.
2. Backfilling is performed with gravel, sand, silt, and clay mixtures (less than 50 percent fines), with coarse sand with silt or clay (less than 50 percent fines), or cleaner granular material (see NRCS Conservation Practice Standard, "Waste Storage Facility," Code 313, Table 2, for description and unified classification or ASTM D 2488 and D 653).

APPENDIX C, TABLE C-2
Minimum Wall Thickness and Vertical Steel Reinforcement

Wall height (feet)	**Wall thickness (inches)**	**Steel Grade**			
		Grade 40		**Grade 60**	
		Bar	**Space o.c. (inches)**	**Bar**	**Space o.c. (inches)**
4 or less	6	#4	16.5	#4	18.0
		#5	18.0	#5	18.0
4 or less	8	#4	12.0	#4	13.5
		#5	18.0	#5	18.0
6	6	#4	10.5	#4	15.5
		#5	16.5	#5	18.0
6	8	#4	12.0	#4	13.5
		#5	18.0	#5	18.0
8	8	#4	6.5	#4	10.0
		#5	10.5	#5	16.0
8	10	#4	8.5	#4	11.0
		#5	13.5	#5	17.0
10	8	#4	4.5	#4	6.5
		#5	7.0	#5	10.5
10	10	#4	5.0	#4	7.5
		#5	8.0	#5	12.0
12	10	#4	3.5	#4	5.5
		#5	5.5	#5	8.5

(c) Table C-3, if **all** of the following conditions are met:

1. There will be NO VEHICLES operating within 5 feet of the wall.
2. Backfilling is performed with low plasticity silts and clays with some sand or gravel (50 percent or more fines); or fine sands with silt or clay (less than 50 percent fines); or low to medium plasticity silts and clays with little sand or gravel (50 percent or more fines); or high plasticity silts and clays (see NRCS Conservation Practice Standard, "Waste Storage Facility," Code 313, Table 2, for description and unified classification or ASTM D 2488 and D 653).

APPENDIX C, TABLE C-3
Minimum Wall Thickness and Vertical Steel Reinforcement

Wall height (feet)	Wall thickness (inches)	Steel Grade			
		Grade 40		Grade 60	
		Bar	Space o.c. (inches)	Bar	Space o.c. (inches)
4 or less	6	#4	16.5	#4	18.0
		#5	18.0	#5	18.0
4 or less	8	#4	12.0	#4	13.5
		#5	18.0	#5	18.0
6	6	#4	10.5	#4	15.5
		#5	16.5	#5	18.0
6	8	#4	12.0	#4	13.5
		#5	18.0	#5	18.0
8	8	#4	6.5	#4	10.0
		#5	10.5	#5	16.0
8	10	#4	9.0	#4	11.0
		#5	14.0	#5	17.0
10	8	#4	4.5	#4	6.5
		#5	7.0	#5	10.0
10	10	#4	5.0	#4	7.5
		#5	8.0	#5	12.0
12	10	#4	3.5	#4	5.0
		#5	5.5	#5	8.0

(d) Table C-4, if **all** of the following conditions are met:

1. There will be VEHICLES operating within 5 feet of the wall.
2. Backfilling is performed with low plasticity silts and clays with some sand or gravel (50 percent or more fines); or fine sands with silt or clay (less than 50 percent fines); or low to medium plasticity silts and clays with little sand or gravel (50 percent or more fines); or high plasticity silts and clays (see NRCS Conservation Practice Standard, "Waste Storage Facility," Code 313, Table 2, for description and unified classification or ASTM D 2488 and D 653).

APPENDIX C, TABLE C-4
Minimum Wall Thickness and Vertical Steel Reinforcement

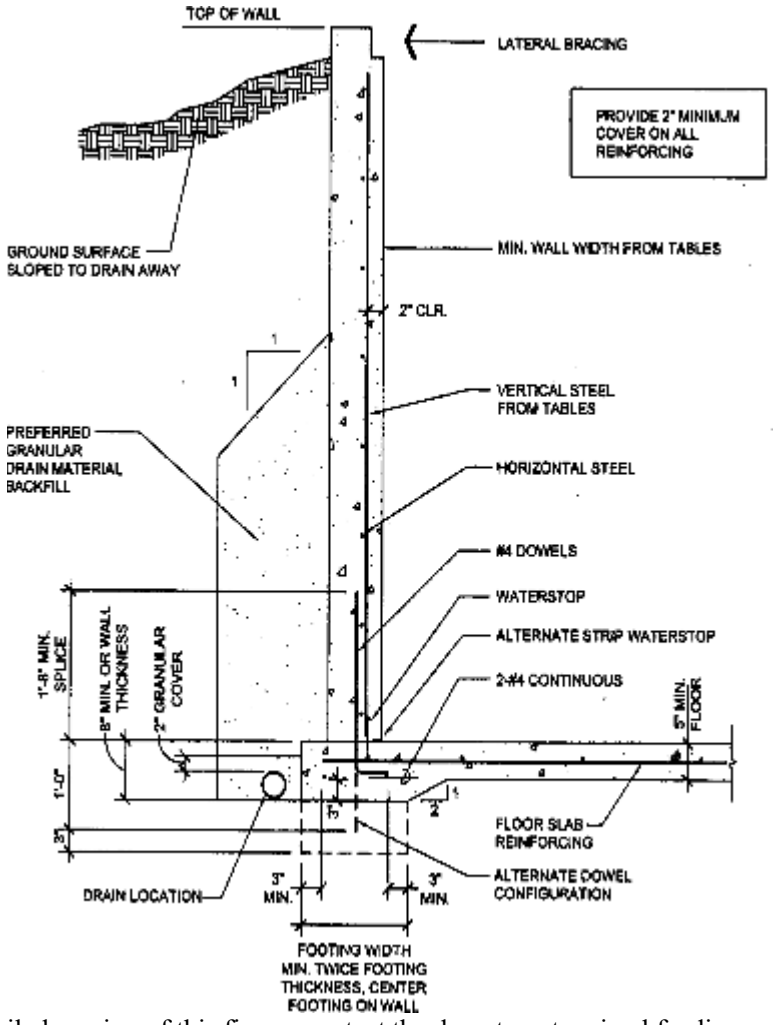
Wall height (feet)	Wall thickness (inches)	Steel Grade			
		Grade 40		Grade 60	
		Bar	Space o.c. (inches)	Bar	Space o.c. (inches)
4 or less	6	#4	16.5	#4	18.0
		#5	18.0	#5	18.0
4 or less	8	#4	12.0	#4	13.5
		#5	18.0	#5	18.0
6	6	#4	8.0	#4	12.0
		#5	12.5	#5	16.5
6	8	#4	9.5	#4	13.5
		#5	15.0	#5	18.0
8	8	#4	6.0	#4	9.0
		#5	9.0	#5	11.5
8	10	#4	6.0	#4	9.0
		#5	9.5	#5	14.0
10	8	#4	3.0	#4	4.5
		#5	4.5	#5	7.0
10	10	#4	4.5	#4	6.5
		#5	6.5	#5	10.0
12	10	#4	2.5	#4	4.0
		#5	4.0	#5	6.0

(7) Minimum horizontal steel for a rectangular tank shall be selected and placed according to Table C-5, regardless of wall height, and shall be tied to the soil side of vertical steel:

APPENDIX C, TABLE C-5
Minimum Wall Horizontal Steel Reinforcement

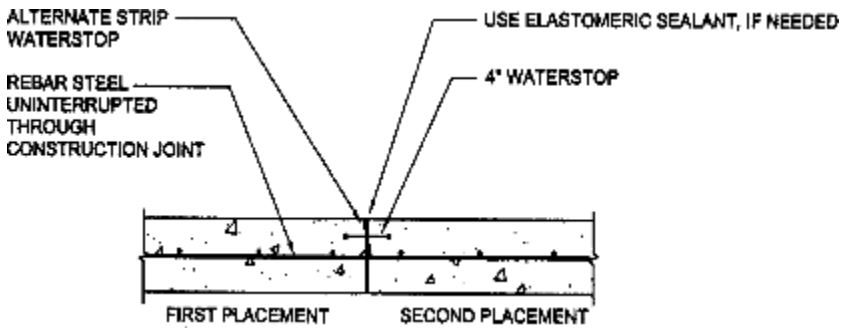
Wall thickness (inches)	Steel Grade			
	Grade 40		Grade 60	
	Bar	Space o.c. (inches)	Bar	Space o.c. (inches)
6	#4	16.5	#4	18.0
	#5	18.0	#5	18.0
8	#4	12.0	#4	13.5
	#5	18.0	#5	18.0
10	#4	9.5	#4	11.0
	#5	15.0	#5	17.0

APPENDIX C, FIGURE C-1 MONOLITHIC FOOTING FLOOR DETAIL



NOTE: For a more detailed version of this figure, contact the department, animal feeding operations.

APPENDIX C, FIGURE C-2 WALL AND FLOOR CONSTRUCTION JOINT



NOTE: For a more detailed version of this figure, contact the department, animal feeding operations.