Appendix to rule 901:10-2-05 Fabricated Structure.

Foundation.
Proportion the foundation of a fabricated structure to safely support all superimposed loads without excessive movement or settlement.

If a non-uniform foundation cannot be avoided or applied loads may create highly variable foundation loads, calculate the settlement from site-specific soil test data as ~~defined~~ required in rule 901:10-2-03 of the Administrative Code. The owner or operator may also utilize an appropriate design plan as defined rule 901:10-1-01 of the Administrative Code.

To eliminate potential uplift pressures, the designer should consider the design and ~~install~~ installation of a drainage system entirely around the foundation, discharged by gravity or a sump pump. Large structures may require additional drains at intermediate depths. The director may require monitoring or sampling, or both, of subsurface perimeter drains around manure storage or treatment facilities ~~at~~ as stated in rule 901:10-2-08-(D)(12). ~~(4)(l)(iv).~~

Structural Loading.
Design structures to withstand all anticipated internal and external loads, including: hydrostatic and uplift pressure, concentrated surface and impact loads, and any loading associated with water loads. Design the structure in compliance with the standard and applicable local building codes.

The lateral earth pressure should be calculated from soil strength values determined from the results of soil tests conducted in accordance with rule 901:10-2-03 of the Administrative Code. Lateral earth pressures can be calculated using the procedures in Technical Release 74.

Assign lateral earth pressures based upon equivalent fluid assumptions according to the structural stiffness or wall yielding as follows:

- Rigid frame or restrained wall: Use the values shown in Table 1 under the column “Frame Tanks”, which gives pressures comparable to the at-rest condition.
- Flexible or yielding wall: Use the values shown in Table 1 under the column “Freestanding Wall”, which gives pressures comparable to the active condition. Walls in this category are designed on the basis of gravity for stability or as a cantilever having a base wall thickness to height of backfill ratio not more than 0.085.

The designer shall determine the internal pressures of the stored manure. When the stored ~~by-products~~ manure ~~are~~ is not protected from precipitation or any other moisture that could potentially increase internal lateral pressures, design for a~~n~~ minimum internal lateral pressure of 65 lbs./sq.ft./ft. of depth. When the stored ~~by-products~~ ~~are~~ manure is protected from precipitation and will not otherwise become saturated, design for a minimum internal lateral pressure of 60 lbs./sq.ft./ft. of depth ~~internal lateral pressure~~. If the stored manure is sand laden, design for a minimum internal lateral pressure of 72 lbs./sq.ft./ft of depth. ~~Use lesser values if supported by actual pressure measurements of the by-products to be stored.~~ Roofed facilities designed to store~~d~~ dry materials such as sawdust, bedded horse stable manure, or well managed livestock mortality compost may be designed using a minimum lateral pressure of 35 lbs./sq.ft./ft. of depth. If heavy equipment will be operated within five feet of the wall, design for a minimum of 100 psf horizontal surcharge.

Design tank covers to withstand both dead and live loads. Use the minimum live load values for covers contained in ASAE EP378.3, Floor and Suspended Loads on Agricultural Structures Due to Use, and in ASAE EP393.2, Manure Storage. Use the actual axle load for tank wagons having more than 2,000 gallon capacity.

If the facility is to have a roof, snow and wind loads shall be as specified in ASCE ~~7-05~~7-22, using the "C" Exposure and Occupancy Category. If the facility is to serve as part of a foundation or support for a building, consider the total load in the structural design. The minimum wind and snow loading for Ohio is: wind load, basic velocity pressure = 20 psf and snow load = 20 psf. Note: The American Society of Civil Engineers has developed an online tool to evaluate hazards for different risk categories. The website link is: www.ascehazardtool.org.

Structural Design.
For structural design, consider all items that will influence the performance of the structure, including loading assumptions, material properties, and construction quality. Indicate the design assumptions and construction requirements on the plans.

Tanks may be designed with or without covers. Covers, beams, or braces that are integral to structure performance must be indicated on the construction drawings. Design openings in covered tanks to accommodate equipment for loading, agitating, and emptying. Equip these openings with grills or secure covers for safety. Consider solid covers if odor and vector control is necessary. Underlay all structures with free draining material or locate the footing below the anticipated frost depth.

Table 1 – Lateral Earth Pressure Values[1]:

Soil		**Equivalent fluid pressure (lb/ft^2/ft of depth)**			
Description[4]	**Unified Classification[4]**	**Above seasonal high water table[2]**		**Below seasonal high water table[3]**	
-Clean gravel, sand or sand-gravel mixtures (maximum 5% fines)[5]	GP, GW, SP, SW	Free-standing walls	Frame tanks	Free-standing walls	Frame tanks
		30	50	80	90
-Gravel, sand, silt and clay mixtures (< 50% fines) -Coarse sands with silt and/or clay (< 50% fines)	All gravel/sand dual symbol classifications and GM, GC, SC, SM, SC-SM	35	60	80	100
-Low-plasticity silts and clays with some sand and/or gravel (≥50% fines) -Fine sands with silt and/or clay (< 50% fines)	CL, ML, CL-ML SC, SM, SC-SM	45	75	90	105
-Low to medium plastic silts and clays with little sand and/or gravel (≥50% fines)	CL, ML, CL-ML	65	85	95	110
High plasticity silts and clays (liquid limit > 50)[6]	CH, MH	-	-	-	-

1 For lightly-compacted soils (85% to 90% maximum standard density.) Includes compaction by use of typical farm equipment.
2 Also below seasonal high water table if adequate drainage is provided.

3 Includes hydrostatic pressure.
4 All definitions and procedures in accordance with ASTM D 2488 and D 653.
5 Generally, only washed materials are in this category
6 Not recommended. Requires special design if used.

Other minimum requirements.
Structures must be designed and constructed to be watertight or leak proof and in accordance with an appropriate design plan as that term is defined in rule 901:10-1-01 of the Administrative Code.

Slabs on Grade.
Design slabs considering the required performance and the critical applied loads. The subgrade material must be evaluated as to the suitability and denseness. A 4-inch thick layer of crushed gravel or limestone may need to be provided as a uniform subbase. Where the subgrade is uniform and dense, a Type S-1 concrete slab is acceptable. Type S-2 concrete slabs shall be used where the subgrade material is non-uniform or has variable density, and it is not economical or feasible to improve the subgrade. The subgrade thickness in question is generally 12 inches, but could be more, depending on the soil profile. Type S-3 concrete slabs shall be used when the contraction joint spacing is to be more than 15 feet, when no contraction joints are wanted, when reduced seepage is required, or when a water - tight slab is required. Type S-3 concrete slabs without contraction joints, may be used under the following conditions:

- Slabs installed as a component of a liquid or slurry manure storage or treatment facility, where seepage that could occur with a Type S-1 or Type S-2 slab has potential of polluting groundwater and cannot be captured for treatment.

Design criteria for Type S-1, S-2 and S-3 concrete slabs are found in the NRCS Concrete Construction specification (210-VI-EFH, Exhibit OH 17-1. ~~September 2013~~April 2016).