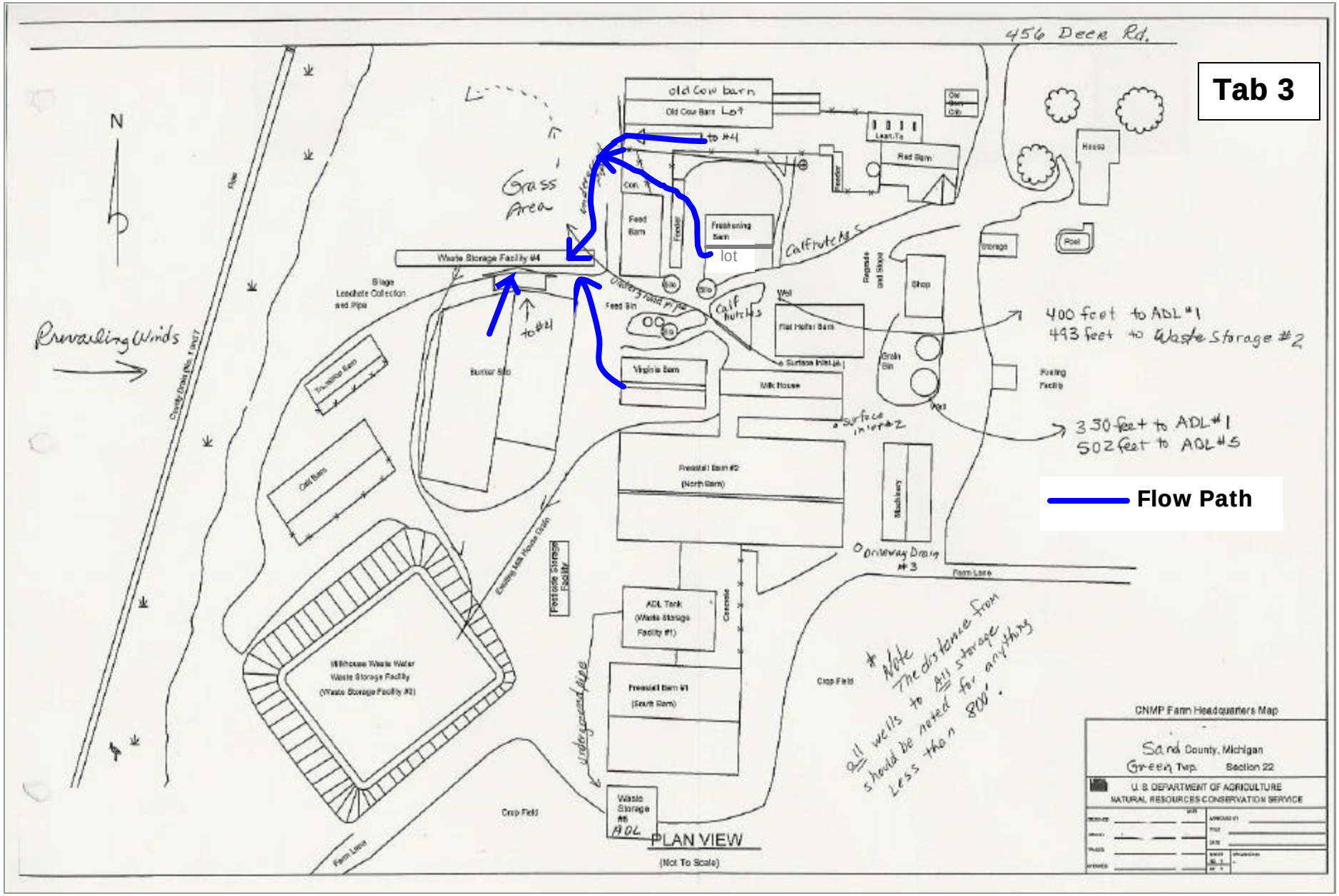

Tab 3
456 Deer Rd.
N
Prevailing Winds
Grass Area
old cow barn
Old Cow Barn Lot
to #4
Lean-To
Red Barn
House
Feed Barn
Freezer
Freshening Barn
Waste Storage Facility #4
Silage Leachate Collection and Pipe
to #2
Bunker Silo
Feed Bin
Calf Hutches
Flat Heifer Barn
Virginia Barn
Milk House
Shop
Storage
Pool
Grain Bin
Fueling Facility
Well
400 feet to ADL #1
493 feet to Waste Storage #2
330 feet to ADL #1
502 feet to ADL #5
Flow Path
Freestall Barn #2
(North Barn)
Machinery
Driveway Drain #3
Farm Lane
Old Barn
Pumphouse Barn
Existing Milk House Drain
Feedlot storage Facility
ADL Tank
(Waste Storage Facility #1)
Concrete
Milkhouse Waste Water
Waste Storage Facility
(Waste Storage Facility #2)
Freestall Barn #1
(South Barn)
Crop Field
Waste Storage #5
ADL
PLAN VIEW
(Not To Scale)
* Note
The distance from all wells to all storage should be noted for anything less than 800'.
CNMP Farm Headquarters Map
Sand County, Michigan
Green Twp. Section 22
U. S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

Comments on the inventory work for storage systems

Calculating the manure, wash water, rain and runoff at a farm is a very important task to conduct accurately. In this sample plan are examples of two methods of achieving this: one is by hand calculations and the other by using the Animal Waste Management (AWM) software. AWM is available at
http://www.wcc.nrcs.usda.gov/water/quality/common/wastemgmt/awm.html
Be sure to install the state specific databases.

AWM is developed to design facilities, and is a wonderful tool including area specific rainfall and evaporation data in the data base. It can estimate the critical months of storage and runoff volume based on these data banks. However, it takes some experience to learn how to use the program to evaluate existing structures for annual volume and capacity. Training sessions are periodically offered.

Regardless of the method utilized, accuracy in estimating the total annual volume of manure, rain, evaporation and runoff from all areas that contribute to a storage system is very important.

Calculating the appropriate un-useable storage capacity (freeboard, plus 25/24 rain events) of each system is also critical to estimating the storage capacity and the number of days of storage.

The attached pages are examples to show the two methods. In this plan, the hand calculations were utilized throughout the plan. Examples of the AWM output are included to show the typical output that can be achieved from the software, but the data is not inclusive.

Natalie Rector
Nov. 2004

Supporting Calculations for Michigan Sample Dairy CNMP's
Manure Storage Systems

Calculating:
1) Unusable (freeboard) storage volume
2) The resulting capacity of a storage and
3) Annual volume that goes to storage.
4) Days, months of storage

Sand County Data:
Rain (32.5) – Evaporation (29.5) = 3 inches annually
25 year, 24 hour storm event = 4.3 inches

ADL #1: Summary

Unusable capacity to be maintained: 1.25 ft.
402,125 gallons useable capacity
1,080,182 gallons annually of manure, bedding, rain and runoff going to pit

ADL #1 Dimensions:
112 ft. x 80 ft. x 8 ft
with a 84 ft. x 20 ft. x 8' ramp (84 x 20 x 8 ÷ 2 = 6720 cu. ft)
with 5000 sq. ft. of flat concrete runoff directly to pit.

- Freeboard at all times = 6 inches

- 25/24 storm event = 4.3 inches

- 5000 sq. ft. of concrete adjacent to this manure storage needs to be accounted for.
- 25/24 storm event on 5000 sq. ft. =
  5000 sq. ft x (4.3'event ÷12") = 1792 cu. ft. x 7.48 gallons = 13,402 gallons.
  13,402 gal (ft^3 ÷ 7.48) (1÷5000 sq. ft) = 0.358 ft (12" per foot) = 4.3 inches of runoff from a 25/24 rain event onto 5000 sq. ft.

  or

  5000 sq. ft x (4.3 event ÷12 inches) = 1792 cu. ft ÷5000 sq. ft = 0.358 ft. ÷ 12 inches/ft = 4.3 inches of water

- Unused space to be maintained in this pit is: 6 + 4.3 + 4.3 = 14.6 inches, make it 15 inches and call it 1.25 feet.
- Resulting usable depth for storage is: 6.75 feet of an 8 ft. structure.

The usable capacity of ADL #1 is:

- 112 ft. x 80 ft. x 6.75 ft. = 60,480 cu. ft minus the ramp of 6720 cu. ft. = 53,760 cu. ft. x 7.48 gals. = **402,125 gallons of usable capacity**

Annual volume going to ADL #1:

As this pit becomes full, the liquids are pumped over to ADL #5.
For purposes of segregating the manure on an annual basis, it will be assumed that of the total, as excreted manure from the 500 milking cows: = 3,212,401
From Table 3, it calculated the values going to each pit as:
to ADL #1 = 778,764 gallons (498,409 + 280,355)
to ADL #5 = 2,433,637 gallons (1,557,528 + 876,109)

Sand Bedding:

- 292,521 gals. Of sand are used annually for 500 cows herd in the free stall barns:
  45 lbs. per day per cow (farmer knowledge) x 500 cows x 365 days = 8,212,500 lbs. sand x 50% deduction when mixed with manure = 4,106,250 lbs. sand ÷ sand at 105 lbs/cu.ft. = 39,107 cu. ft. of sand x 7.48 lbs. per gal, = 292,521 gals annually of sand.
- 80% assumed to stay in ADL #1 = 234,017 gal.
- 20% to ADL #5 = 58,504 gal.

Annual volume going to ADL #1:

- 234,017 gallons of sand bedding
- 778,764 as excreted manure (24% total)
- 16,755 gallons of rain.
  3 inches x 112 ft. x 80 ft. ÷ 12 = 2240 cu. ft. x 7.48 = 16,755 gallons
- 50,646 gallons of runoff from 5000 sq. ft.
  5000 sq. ft. x 32.5 inches annual rain, ÷12 x 50% x 7.48 = 50,646 gallons

---

1,080,182 gallons annually goes into ADL #1

ADL #5 Summary:
One foot unused portion of pit
2,326,460 gallon capacity
2,547,463 gallons est. annual volume of manure, bedding and rain to this system

Dimensions of ADL #5
Pre-fab, outdoor, concrete pit is
172 ft. x 172 ft x 12 ft.
Ramp = 20ft. x 120 ft. x 12 ft. ÷ 2 = 14,400 cu. ft.

Freeboard:

- 6 inches freeboard at all times
- 25/24 storm event + 4.3 inches
- 12 inches unused space (6 + 4.3 =10.3 inches, lets call it a foot (12 inches)

Capacity:
- 2,326,460 gallons
  172 ft. x 172 ft. x 11 ft. = 325,424 cu. ft – 14,400 cu. ft. (ramp) = 311,024 cu. ft. x 7.48 gallons per cubic foot

Annual volume to ADL #5

No manure directly goes to this system, it all passes through ADL #1, and the liquids are pumped off of #1 as needed, to ADL #5.

- 2,433,637 gals. As excreted manure
  Estimate that 75% of the 500 milking cow, as excreted manure goes here (1,557,528 + 876,109) = 2,433,637 gallons per year.
- 58,504 gals of sand
  Estimate 20% of total sand bedding transfers over in the pumping process
- 55,322 gals. of rain
  Rain into the storage: 3 inches (rain – evaporation) x 172 x 172 ÷ 12 = 7396 cu. ft. x 7.48 gal./cu. ft. = 55,322

- **2,547,463 total gal/yr to storage ADL #5**

When the total capacity of ADL #1 and ADL #5 are considered together, there is an estimated total capacity of 2,728,585 gallons
and
3,627,645 generated input per year, 302,303 per month, 9938 gallons per day for an estimated 9 months (274 days) of storage for the 500 head milking herd.

Runoff of collection and silage leachate #4:

Storage #4 is strictly for silage leachate and lot runoff. It was planned for one week of storage. As needed, the wastewater is pumped over to Earthen storage #2. Due to this, the total of #4 is dealt with in the total volume of #2.

Dimension of #4:
Concrete, outdoor pit
120 ft. x 20 ft. x 4 ft. (use one foot of freeboard) = 7200 cu. ft
ramp = 40 x 10 x 4 = 800 cu. ft.
leaves 6400 cu. ft. x 7.48 = 47,872 gallon capacity.

67,843 gallons of silage leachate plus first ½ rain = 67,843 gallons
(see Tab 2, following page, for silage leachate calculations
388,960 gallons of runoff from lot:
Runoff from open lot: 32.5 inches x 50% x 3200 cu. ft of concrete x 7.48

4,488 gallons rain
120 x 20 x 3 inches rain-evap ÷ 12 = 600 x 7.48 = 4488 gallons

461,320 gallons passes through #4 to #2. This volume is added to #2.

Earthen storage #2 Summary:

1.4 ft. unused portion
1,212,067 gallons total capacity
1,955,356 gallons total annual volume
7 months estimated storage (226 days)

- Top dimensions = 230 ft. x 164 ft. x 8 ft. with 4:1 side slope
- Unused portion: 12 inches (one foot) for freeboard for an earthen, slope sided storage
- 25 yr. 24 hr. storm = 4.3 inches
- Total unused portion of storage = 1.4 foot or 6.6 ft. useable
- Capacity calculated using MMP to calculate this, comes to 1,212,067 gallons

Annual volume going to this storage:

- 1,423,500 gallons wash water
  5000 gal/day – wash water and plate cooler with 1100 gal recycled for watering
  leaves 3,900 gallons per day x 365 days = 1,423,500 gallons
- 70,536 gallons rain
  230 ft. x 164 ft. x 3 inches rain – evap ÷ 12 = 9430 cu. ft. x 7.48 = 70,536 gallons
- 461,320 gallons runoff and silage leachate pumped to Earthen #2, as needed

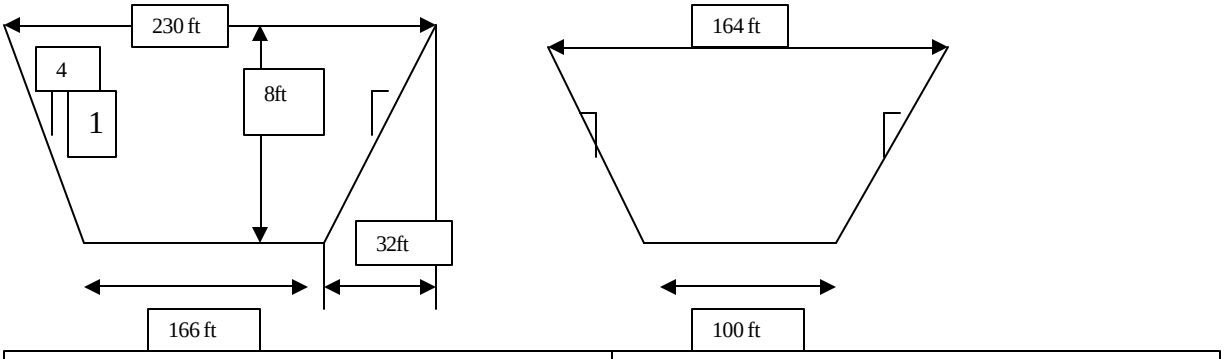
1,955,356 gallons per year annual volume

The above calculations were estimated using the calculator located in MMP, under the storage tab, by selecting F2 when your cursor is highlighting a cell under the “pumpable or spreadable capacity”.

Equations for calculating slope sided storage systems:

There are equations that can be utilized for calculating the volume of a slope sided storage system. An example of these equations are shown below. The calculations below will calculate the capacity at 1,307,133 gallons.

Top dimensions = 230 ft. x 164 ft. x 8 ft. with 4:1 side slope



Top dimensions: 230 ft x 164 ft Bottom dimensions: 166ft x 100 ft Total depth: 8 ft Side slopes: 4 horizontal : 1 vertical	Calculated bottom dimensions: 8ft x 4 = 32 ft x 2 = 64 ft 230 ft – 64 ft = 166 ft 164 ft – 64 ft = 100 ft

Volume equation: $V = \text{height} \times {}^{1}/_{6} (A_t + 4A_m + A_b)$
A_t = 230 ft x 164 ft = 37,720 sq.ft
$4A_m$ = 198ft x 132ft x 4 = 104,544 sq.ft.
A_b = 166ft x 100ft = 16,600 sq.ft.

Silage Leachate Calculations
For
Michigan Sample Dairy

Bunker dimensions:

195 ft. x 90 ft. x 12 ft. = 210,600 cu. ft.
+
165 ft. x 70 ft. x 12 ft. = 138,600 cu. ft.

349,200 cu. ft.
X 45 lbs./cu. ft. (density of silage)
15,714,000 lbs. ÷ 2000 lbs./ton = 7,857 tons

1 cu. ft. of leachate per ton of silage or 7.48 gal/cu. ft.

7,857 tons silage
X 7.48

= 58,770 Gal. Leachate Annual potential

Runoff, first 1/2"

195 ft. x 90 ft. = 17,550 sq. ft.
165 ft. x 70 ft. = 11,550 sq. ft.
29,100 sq. ft.
X 0.5 in.
÷ 12 in./ft.
= 1,213 cu. ft.
X 7.48
9,073 gallons for first ½ in. of rain

58,770
+ 9,073
= 67,843 gallons of potential annual leachate