Composting to Manage PFAS Contamination in Livestock

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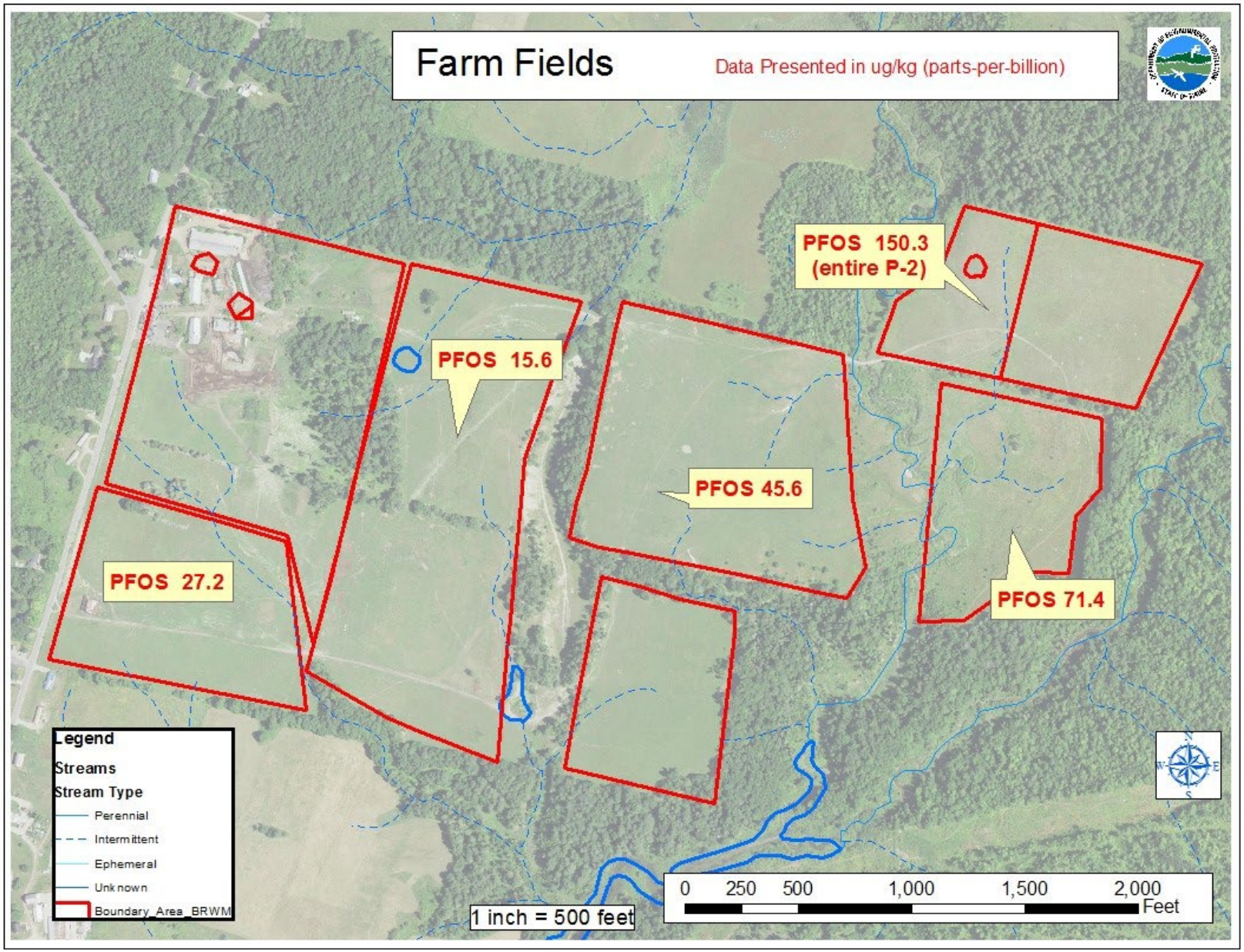
Background

- Central Maine Farm that used land-applied biosolids during the 1990's up until 2000.
- Site houses a Swine, Dairy and Beef operation.
- Milk tested during 2020 found to be excessively high in PFAS compounds [PFOS].
- Farmer in consultation with DACF Animal Welfare decided to euthanize animals as depuration was not practical due to animal age.
- Composting chosen as carcass management tool as landfills not keen on accepting whole carcasses.
- Plan: Compost animals—test compost—decide on next steps.


Farm Fields
Data Presented in ug/kg (parts-per-billion)
PFOS 150.3
(entire P-2)
PFOS 15.6
PFOS 45.6
PFOS 27.2
PFOS 71.4
Legend
Streams
Stream Type
Perennial
Intermittent
Ephemeral
Unknown
Boundary_Area_BRWM
1 inch = 500 feet
0 250 500 1,000 1,500 2,000
Feet

Summary of PFAS Contamination in Milk, Manure and Meat

Milk					
Sample ID	Sample Date	PFOS (ng/L)	Validation Qual	PFOA (ng/L)	Validation Qual
Fairfield Tank	6/24/20	12,700		31.9	
Fairfield Tank (re-test)	6/24/20	14,400		38.5	
Fairfield Tank (re-test)	6/24/20	14,900		52.9	J
Milk Tank	7/13/2020	32,200		46.5	J

Manure					
Sample ID	Sample Date	PFOS (ng/g Dry)	Validation Qual	PFOA (ng/g Dry)	Validation Qual
BEEF MANURE PAD	7/31/2020	113	J	22.1	J
DAIRY MANURE PIT	7/31/2020	35.1	J	4.48	J
HOG MANURE STACK	7/31/2020	39.9	J	5.81	J

Dairy Cow - Meat				
Sample ID	Sample Date	PFOS (ng/g)	PFOA (ng/g)	Beef Action Level*
Dairy Female (muscle) –USDA	11/25/2020	133	ND	3.4 ng/g
Stillborn calf (muscle) - USDA	6/15/2021	155	ND	
Stillborn calf (plasma) – USDA	6/15/2021	326	ND	

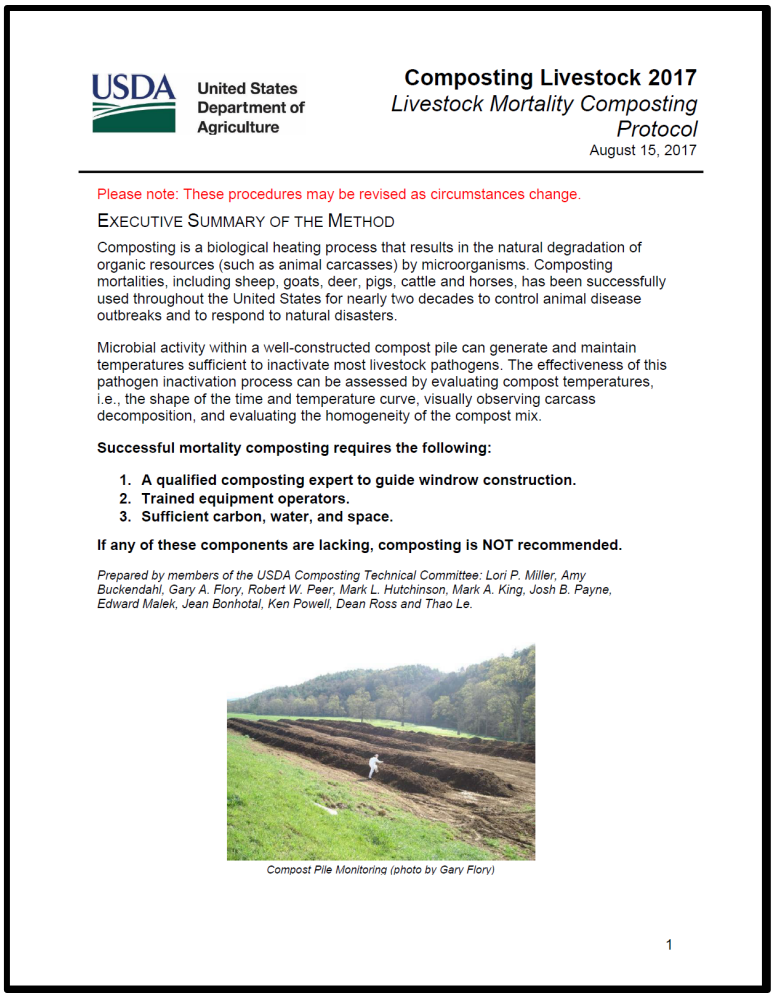
Summary of PFAS Contamination in Feed

Feed					
Sample ID	Sample Date	PFOS (ng/g Dry)	Validation Qual	PFOA (ng/g Dry)	Validation Qual
GREEN CHOP	7/8/2020	31.43		1.58	J
HAY SILOED 2019	7/8/2020	0.44	J	ND	
HAY-1 (haybale)	7/8/2020	50.61		7.64	
SILAGE-2019	7/8/2020	ND		ND	
GRASS-RIDGE-1	7/31/2020	399.10		39.82	
GRASS-RIDGE-3	7/31/2020	396.07		86.06	
GRASS-201-5	7/31/2020	352.90		49.96	
R3-FIRST-A	9/14/2020	121.46	D	6.08	
R3-FIRST-B	9/14/2020	83.54	D	4.2	
R3-2ND-A	9/14/2020	54.97	D	6.09	
R3-2ND-B	9/14/2020	81.72	D	3.28	
2011-CORN-1	9/25/2020	7.89		ND	
2011-CORN-2	9/25/2020	1.44		ND	
2011-CORN-3	9/25/2020	11.18		ND	
2011-CORN-4	9/25/2020	2.03		ND	
2011-CORN-5	9/25/2020	13.51		ND	
R6-CORN-1	9/25/2020	30.59		ND	
R6-CORN-2	9/25/2020	6.6		ND	
R6-CORN-3	9/25/2020	37.5		ND	
R6-CORN-4	9/25/2020	2.52		ND	
R6-CORN-5	9/25/2020	37.17		0.57	J

Average PFOS = 82.0 ng/g


Compost Area

Compost Plan for Carcasses



USDA United States Department of Agriculture

Composting Livestock 2017
Livestock Mortality Composting Protocol
August 15, 2017

Please note: These procedures may be revised as circumstances change.

EXECUTIVE SUMMARY OF THE METHOD

Composting is a biological heating process that results in the natural degradation of organic resources (such as animal carcasses) by microorganisms. Composting mortalities, including sheep, goats, deer, pigs, cattle and horses, has been successfully used throughout the United States for nearly two decades to control animal disease outbreaks and to respond to natural disasters.

Microbial activity within a well-constructed compost pile can generate and maintain temperatures sufficient to inactivate most livestock pathogens. The effectiveness of this pathogen inactivation process can be assessed by evaluating compost temperatures, i.e., the shape of the time and temperature curve, visually observing carcass decomposition, and evaluating the homogeneity of the compost mix.

Successful mortality composting requires the following:

1. **A qualified composting expert to guide windrow construction.**
2. **Trained equipment operators.**
3. **Sufficient carbon, water, and space.**

If any of these components are lacking, composting is NOT recommended.

Prepared by members of the USDA Composting Technical Committee: Lori P. Miller, Amy Buckendahl, Gary A. Flory, Robert W. Peer, Mark L. Hutchinson, Mark A. King, Josh B. Payne, Edward Malek, Jean Bonhotal, Ken Powell, Dean Ross and Thao Le.

Compost Pile Monitoring (photo by Gary Flory)

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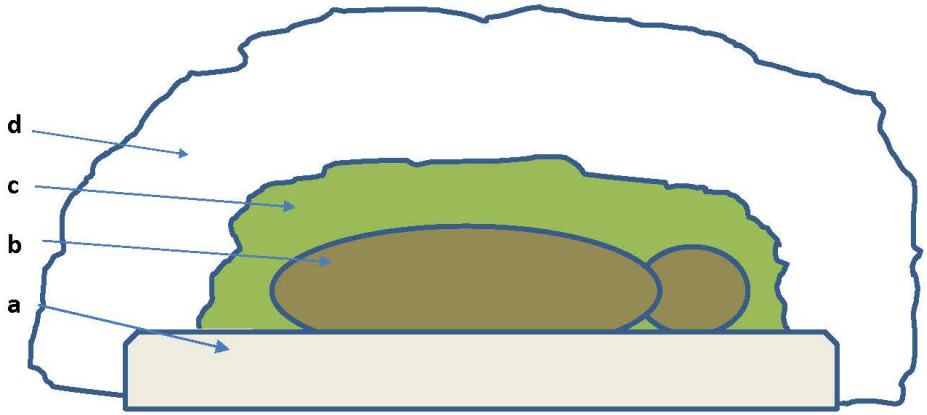
Pile Layer	Ingredient #1	Ingredient #2	Mix Ratio
Base/Bed	Shavings	Haylage	50:50
Carcass Layer	Manure	Haylage	50:50
Cap	Shavings	Haylage	50:50



Cross section of windrow showing: (a) 24-inch thick compost bed 50:50 sawdust and fresh chopped grass, (b) mortality placement, (c) 50:50 mixture of haylage and wet cow manure and (d) final 24-inch thick cover of 50:50 mixture of sawdust and fresh chopped grass.


35 Adult Market Ready Swine 600 -700 lbs. each

Porcine Muscle Tissue Sampled by USDA FSIS November 2020 and June 2021

Meat				
Sample ID	Sample Date	PFOS (ng/g)	PFOA (ng/g)	Pork Action Level*
Porcine (muscle) – USDA	11/25/2020	7.32	ND	3.7
Porcine (muscle) – USDA	6/15/2021	12.2	1.4	3.7
Porcine (muscle) – USDA	6/15/2021	10.0	.89	3.7
Porcine (muscle) – USDA	6/15/2021	5.99	ND	3.7
Porcine (muscle) – USDA	6/15/2021	8.92	ND	3.7
Porcine (muscle) – USDA	6/15/2021	9.11	ND	3.7
Porcine (muscle) – USDA	6/15/2021	5.57	ND	3.7
Porcine (plasma) – USDA	6/15/2021	115	41.6	
Porcine (plasma) – USDA	6/15/2021	146	32.9	
Porcine (plasma) – USDA	6/15/2021	52	8.23	
Porcine (plasma) – USDA	6/15/2021	93.4	3.29	
Porcine (plasma) – USDA	6/15/2021	113	6.37	
Porcine (plasma) – USDA	6/15/2021	66	6.06	

Average Pork PFOS = 8.4 ng/g

ND" indicates that compound not detected in the sample *3.7 ng/g preliminary Maine Pork Action Threshold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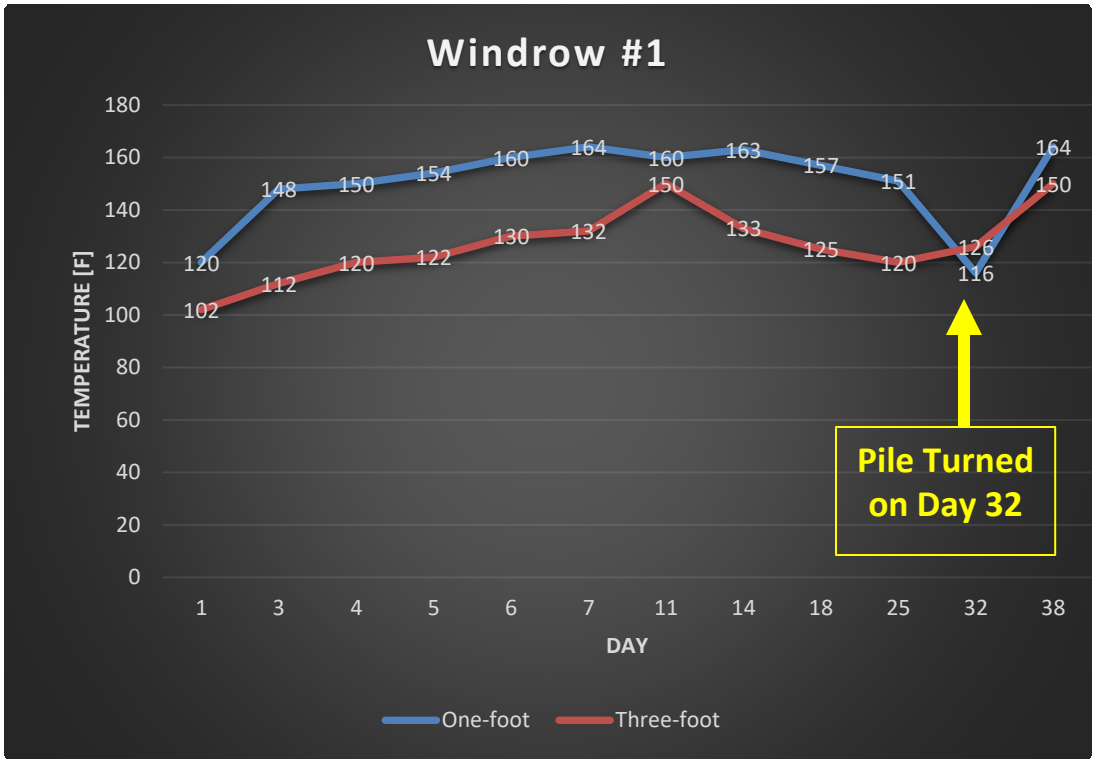
Temp Profile—Swine



On June 11, 2021, a single compost windrows measuring approximately 100 feet long by 15 feet wide was constructed at a Central Maine farm to help manage 35 adult swine averaging 650 lbs. each. A 24-inch-thick bed of a 50:50 mixture of sawdust shavings and fresh-chopped hay was laid down and mortalities were placed on the bed and immediately covered with a 50:50 blend of haylage and manure. This mixture was wet, dense, and especially hot and active. Finally, a 24-inch-thick cover consisting of a 50:50 mixture of sawdust shavings and fresh-chopped hay was placed on top of the mortalities to complete each windrow.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59 Adult Dairy Cows and 2 Still-born Calves
1,100-1,500 lbs. each

Dairy Muscle Tissue Sampled by USDA FSIS from 14 dairy cows and (3 beef cattle), September 2021.

USDA FSIS #	Cattle Sample #	Dairy (D) or Beef (B, BX)	Tissue PFOS (ppb)	PFHpA (ppb)	PFOA (ppb)	PFNA (ppb)	PFDA (ppb)	PFUnA (ppb)	PFDoA (ppb)
2441169	1	D	57.3	N/A	N/A	1.05	1.23	N/A	N/A
2441168	2	B	24	N/A	0.902	0.931	2.06	N/A	N/A
2441160	3	BX	22	N/A	N/A	1.17	1.12	N/A	N/A
2441159	4	D	113	N/A	N/A	0.984	2.62	N/A	N/A
2441167	5	D	96.3	N/A	N/A	1.06	2.15	N/A	N/A
2441166	6	D	83.1	N/A	0.538	0.993	2.82	N/A	N/A
2441165	7	D	37.5	N/A	N/A	N/A	0.634	N/A	N/A
2441164	8	D	35.6	N/A	N/A	N/A	0.708	N/A	N/A
2441163	9	D	67.2	N/A	N/A	1.42	1.71	N/A	N/A
2441162	10	D	26	N/A	N/A	N/A	0.526	N/A	N/A
2441161	11	D	20.7	N/A	N/A	N/A	N/A	N/A	N/A
2441158	12	D	82.8	N/A	N/A	1.38	2.11	N/A	N/A
2441156	13	D	46.5	N/A	N/A	0.514	1.16	N/A	N/A
2441155	14	D	56	N/A	N/A	0.762	1.17	N/A	N/A
2396250	15	D	36.1	N/A	N/A	0.563	5.11	1.33	
2396239	16	D	36.7	N/A	N/A	N/A	0.804	N/A	N/A
2395461	17	B	13.2	N/A	N/A	N/A	1.13	N/A	N/A

Average PFOS = 50.2 ng/g


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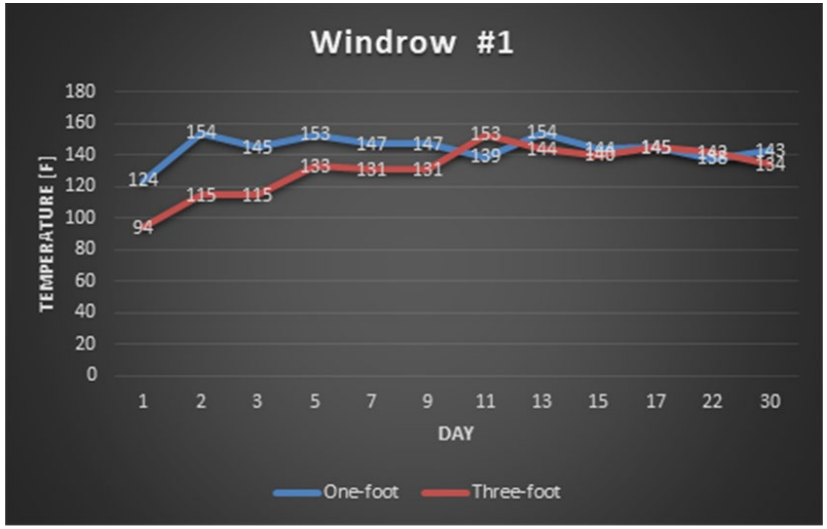
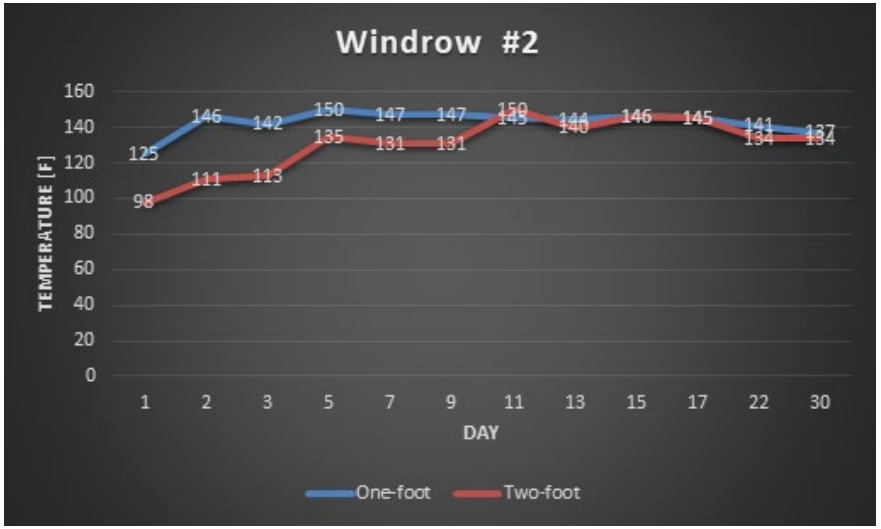
Temp Profile—Dairy Cows





On September 1, 2021, two compost windrows measuring approximately 100 feet long by 15 feet wide were constructed at a Central Maine farm to help manage a mixture of 59 adult and calve dairy cows and beef livestock mortalities. Each windrow consisted of a 24-inch-thick bed of a 50:50 mixture of sawdust shavings and fresh-chopped hay. The mortalities were placed on the bed and immediately covered with a 50:50 blend of haylage and manure. This mixture was wet, dense, and especially hot and active. Finally, a 24-inch-thick cover consisting of a 50:50 mixture of sawdust shavings and fresh-chopped hay was placed on top of the mortalities to complete each windrow.

PFOS Results for Hog and Dairy Cow Compost

Compost Type	PFOS Result ng/g
Hog Compost	97.5
Dairy Cow Compost	104

Benefits of Composting Carcasses

- Ties-up nutrients.
- Reduces/treats leachate generation.
- Reduces odors and possible vector attraction.
- Makes materials less bulky and easier to handle/manage.
- Possible reduction of PFAS levels??

Gallons of Potential Leachate Mitigated

Ave. weight of animals x %H20 x # of animals/8 lbs./gallon

- Hogs
  - 650 lbs. x 0.60 x 35/8 lbs./gallon = 1,706 gallons
- Dairy Cows
  - 1,300 lbs. x 0.60 x 59/8 lbs./gallon = 5,753 gallons

Future Research Directions

- Containerized Composting.
- Using Hyperaccumulators to remediate soils.
- Using Composted PFAS materials to amend and remediate contaminated soils.

Containerized Composting

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