PFAS ON MAINE FARMS: AN UPDATE ON GENERAL FINDINGS AND FUTURE CONSIDERATIONS

FOR THE NEWMOA SCIENCE OF PFAS CONFERENCE, APRIL 6TH, 2022:

BY

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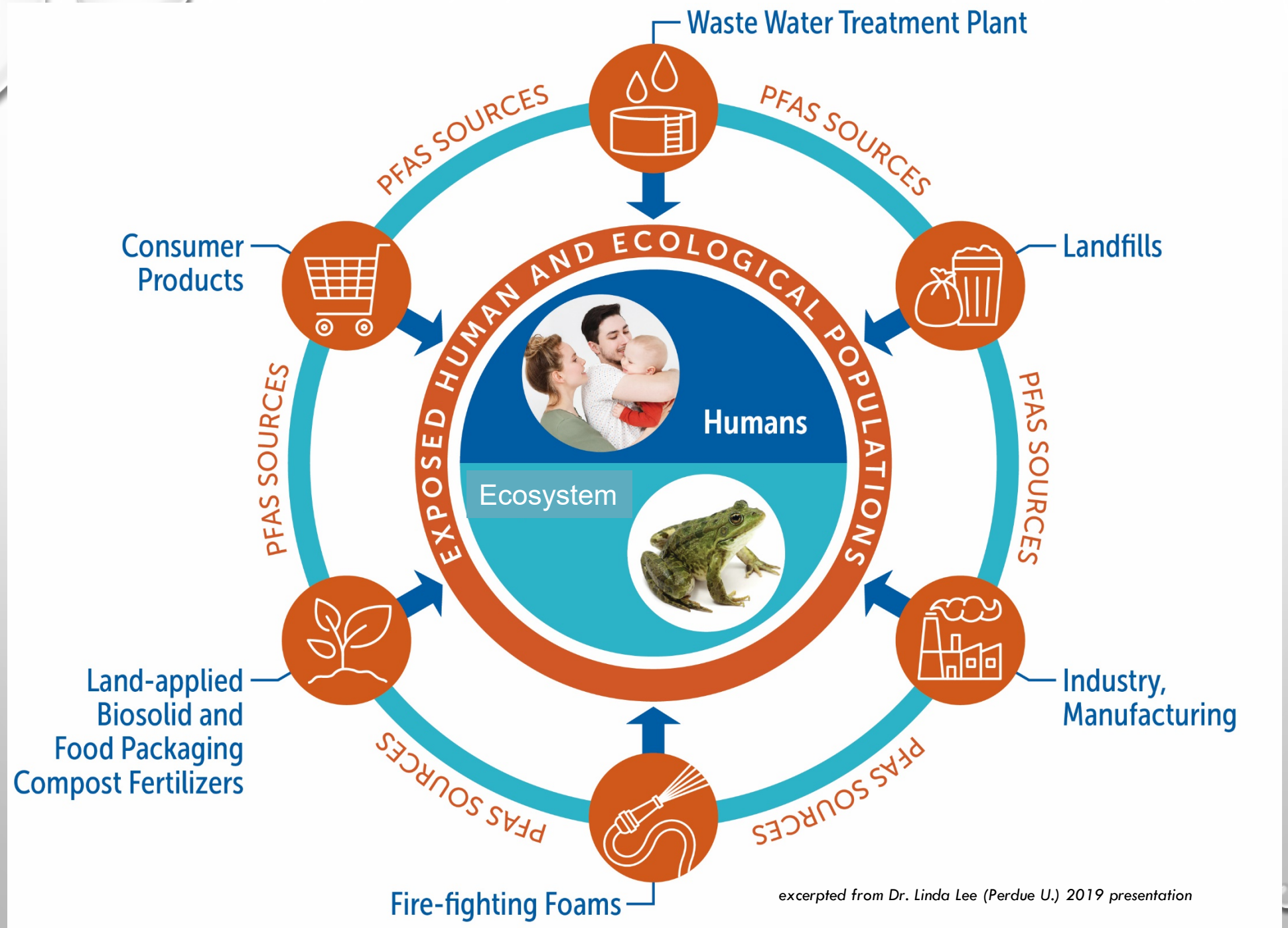
OF NORTHERN TILTH



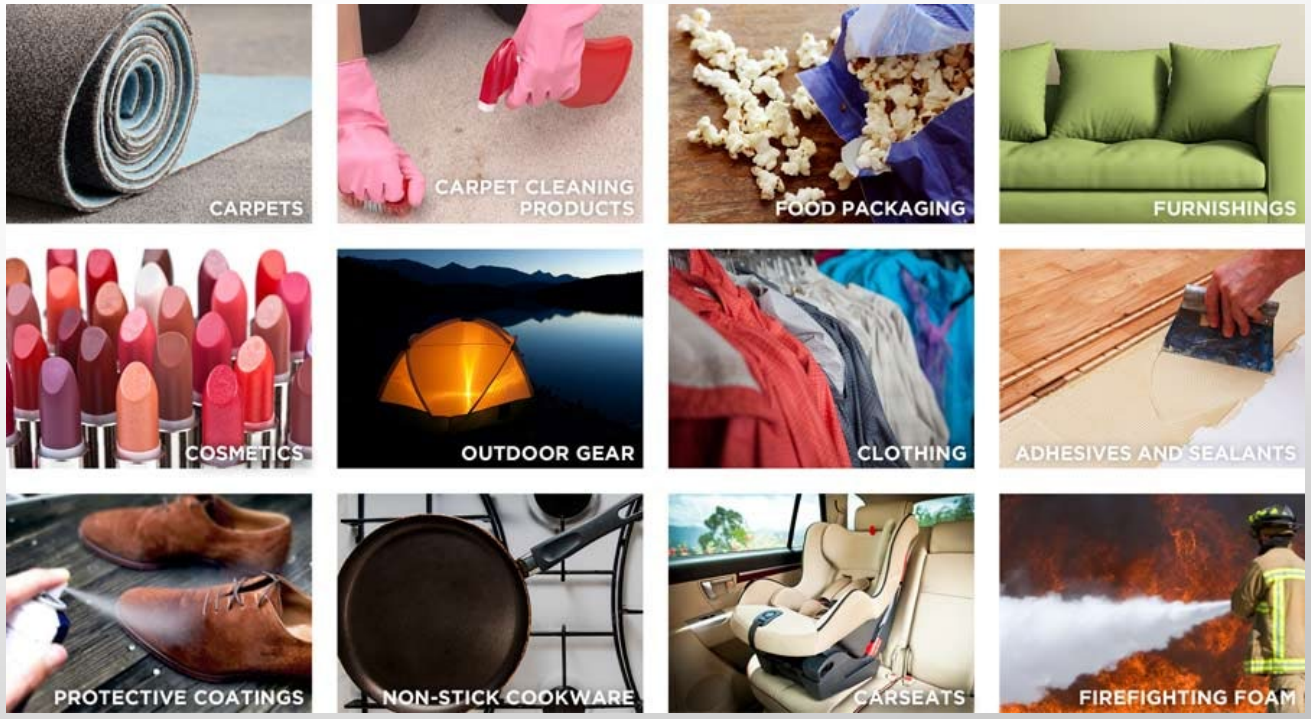
excerpted from Dr. Linda Lee (Perdue U.) 2019 presentation

PFAS SAMPLING

SOME PFAS SAMPLING NO-NO'S

(NOT AN EXHAUSTIVE LIST)

- WATERPROOF FABRICS; OUTDOOR GEAR
- MOST SUNSCREENS & INSECT REPELLANTS
- CLOTHES THAT HAVE BEEN WASHED FEWER THAN 6 TIMES SINCE PURCHASE
- CLOTHING LAUNDERED WITH FABRIC SOFTENER
- POST-IT NOTES
- PLASTIC CLIPBOARDS
- CHEMICAL (BLUE) ICE PACKS
- ALUMINUM FOIL



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MORE CHALLENGES OF SAMPLING FOR PFAS

- ON THE DAY OF SAMPLING YOU CAN'T:
  - SHOWER WITH SOAP
  - APPLY LOTION
  - FLOSS YOUR TEETH
  - WEAR HALF OF YOUR REGULAR OUTDOOR CLOTHING
  - EAT OR DRINK ANYTHING!

(JUST KIDDING ABOUT THE EATING PART….SORT OF)

PFAS SAMPLING REQUIRES SOME PLANNING AHEAD

- IDEALLY, NEED AT LEAST 1 WEEK OF LEAD TIME TO:
  - IDENTIFY AN **APPROVED LAB** & ORDER SAMPLING SUPPLIES FROM THEM
  - DETERMINE FIELDS TO BE SAMPLED, OBTAIN **MAPS & LANDOWNER PERMISSION**
  - PICK A SAMPLING DAY WITH **GOOD WEATHER** AND COORDINATE A COURIER PICK-UP
  - **GATHER** SAMPLING SUPPLIES / **DECONTAMINATE** EQUIPMENT

SUPPLIES & EQUIPMENT

- STAINLESS STEEL BOWLS
- STAINLESS STEEL SPOONS
- TILE SHOVEL
- SAMPLE CONTAINERS & COC FROM LAB
- NITRILE GLOVES
- FIELD DECON KIT: TAP WATER, DISTILLED WATER, PFAS-FREE WATER, ALCANOX SOLUTION, BRUSH, SPONGE, ZIPLOC BAGS
- COOLERS WITH ICE
- A VEHICLE LARGE ENOUGH TO FIT ALL OF THIS CRAP

SAMPLING PROCEDURES FOR SOIL

- DIG A HOLE 10” DEEP
- USE THE “DIRTY” SPOON TO SCRAPE AWAY THE SOIL THAT CAME INTO CONTACT WITH SHOVEL
- USE THE “CLEAN” SPOON TO SCOOP A COLUMN OF SOIL FROM THE SIDE OF THE HOLE FROM 8” DEEP TO THE SURFACE
- REPEAT THIS 10-20 TIMES PER FIELD, DEPENDING ON FIELD SIZE! YAY!!

ME AND NH BIOSOLIDS AND SEPTAGE-BASED COMPOST RESULTS

			PFOA	PFOS
		ug/kg (ppb) dry wt. basis		
Median values	Biosolids Compost ME		3.1	5.2
	Septage Compost ME		18.2	35.7
	WRRF Solids ME		3.8	22.9
	Biosolids NH		1.6	13.0
Maximum values	Biosolids Compost ME		23.8	17.0
	Septage Compost ME		60	82
	WRRF Solids ME		46	120
	Biosolids NH		10	28
	Maine Screening Std.		2.5	5.2
	NEBRA data summary	Avg.	5	14
	2001 US biosolids *	Avg.	34	403

No clear trends in types of processing/size of WRRF v. PFAS concentrations, but it does appear that septage compost concentrations are typically higher than biosolids compost concentrations

Voluntary phase out of PFOA and PFOS use in US → lower levels in the environment

* Venkatesan, A.K., R.U. Halden. 2013. J. Hazard Mater. Based on analysis of archived samples from the 2001 national sewage sludge survey

SOIL RESULTS FROM FIELDS AMENDED WITH CLASS B BIOSOLIDS (AS OF 2019)

	PFOA	PFOS
Maine Data – Soil Concentrations from Agricultural Fields, n=29		
	ug/kg (ppb) dry wt. basis	
Median	1.9	6.1
Maximum	12.9	20.9
Minimum	1.1*	2.13
Maine Screening Std.	2.5	5.2

* six samples were below the LOD for PFOA

Current soil concentrations are reflective of higher concentrations from past applications

MILK AND FORAGE (AS OF 2019)

In the spring and summer of 2019 the Maine Dept. of Ag and NEBRA analyzed milk and forage from a combined four farms that have used biosolids on a regular basis as a soil amendment. All PFAS compounds analyzed (PFBS, PFOA and PFOS) were below analytical reporting limits in all samples. This in in contrast to detections in milk and forage results for one farm in southern Maine with significant levels of PFAS in milk and forage that which the Maine DEP has determined is not from biosolids land applied on that farm.

- Tested three commercial dairy farms across the tate.
  - All three farms **<**50 ng/L Reporting Limit
- Two with **long-term** histories of biosolid application from different waste water treatment plants and/or paper mill residual. Third close to the farm with a PFAS problem.
- Based on the survey and these three farm results, DACF has high confidence in the safety of Maine- produced milk.

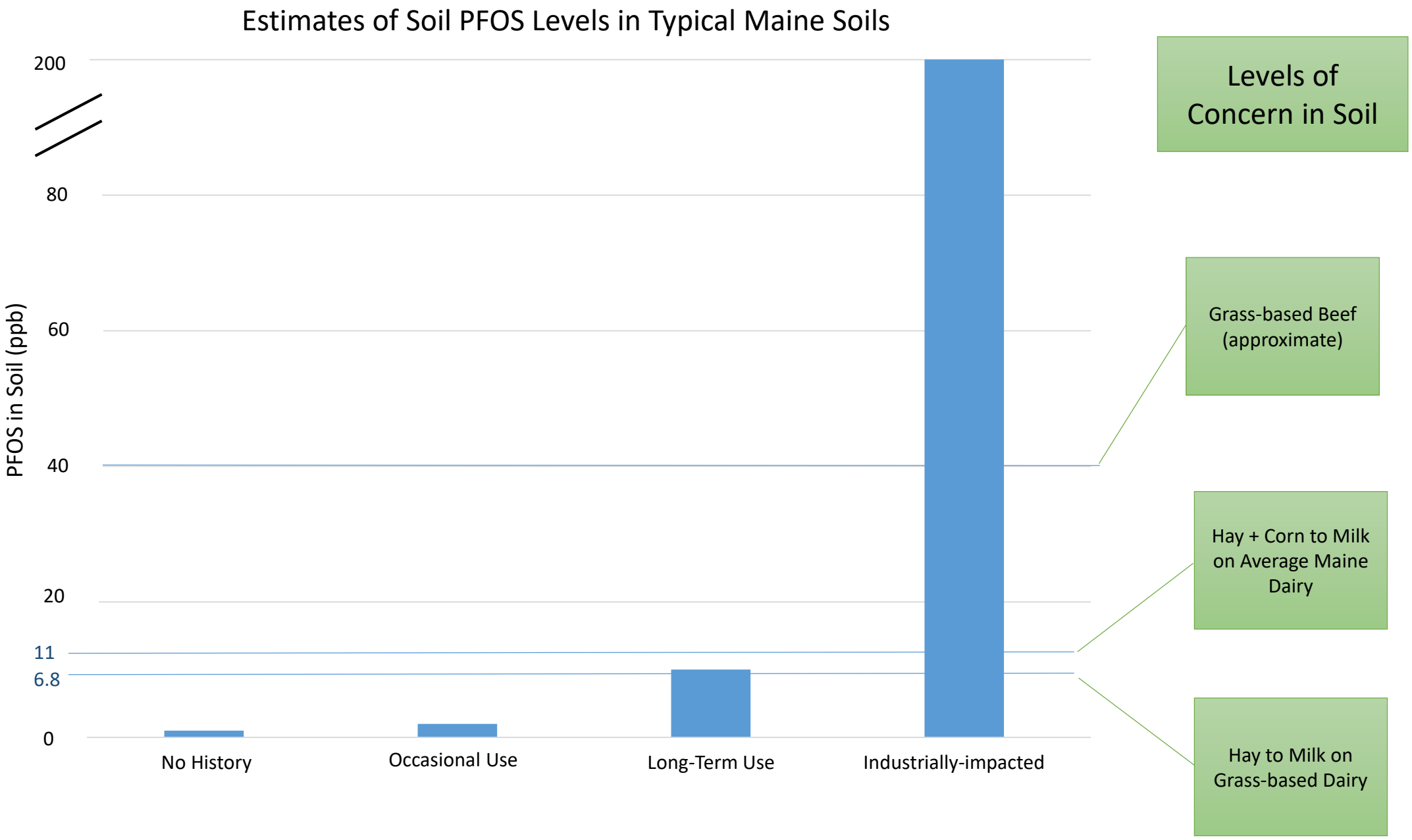
excerpted from McBrady ME DACF presentation Jan. 2020

SECOND AND THIRD FARMS WITH HIGH LEVELS

Farm in Center Fairfield with very high levels of PFAS in milk, in soil and in groundwater, including neighbor wells.

- Farm is cooperating with the Maine DEP and the Maine CDC which has allowed for the collection of data to help better define levels of concern in soil and forage
- Appears to be from an industrially impacted soil amendment
    - Levels are not typical of what are found on Maine farms that have used biosolids

4 Very Rough Groupings, meant to provide sense of scale; these are not precise numbers



Additional Farms with Elevated Levels

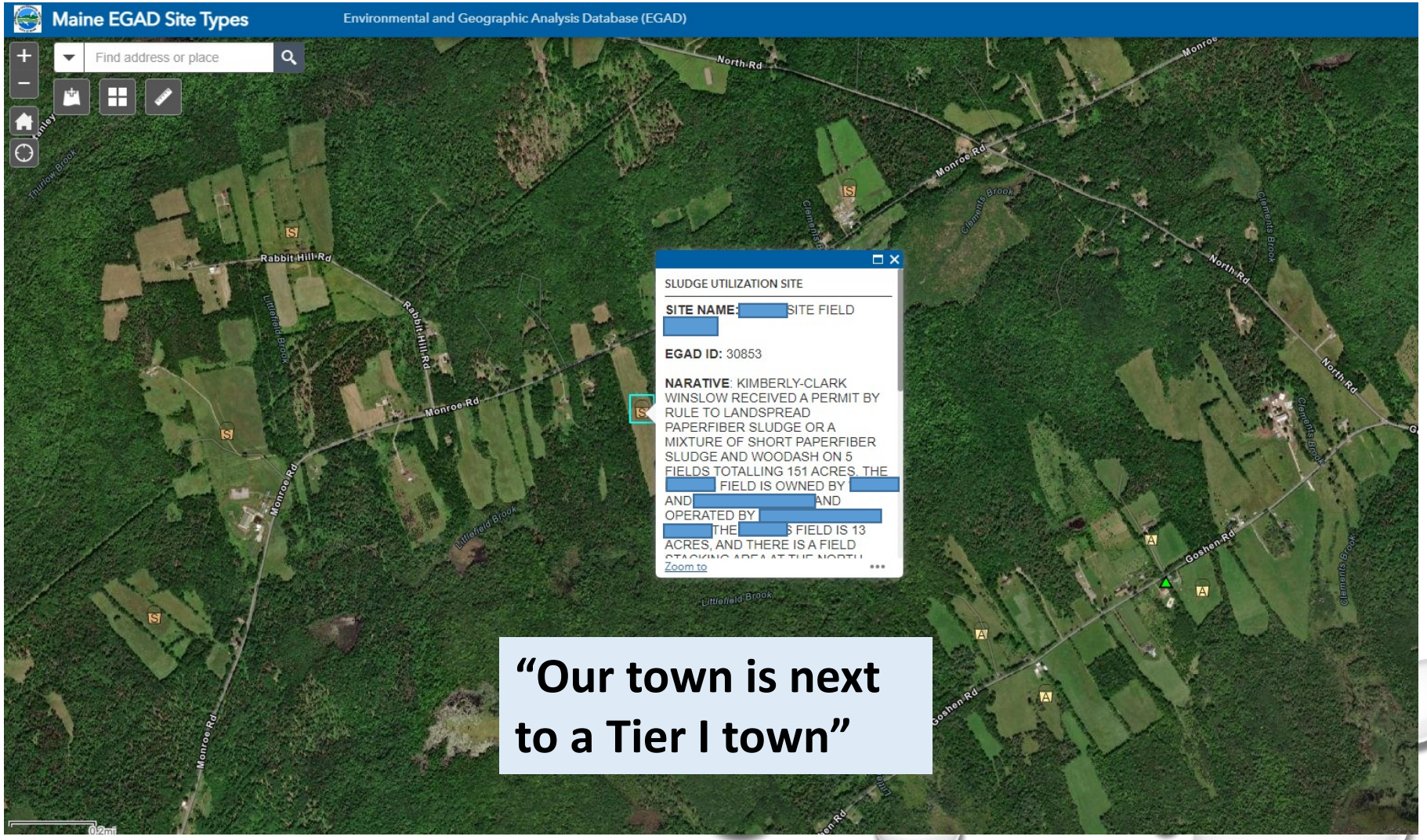
- Organic vegetable farm that purchased land from a farm that had used biosolids in the early 1990s
  - Extremely high soil and drinking water levels
- Organic diversified farm that purchased land from a farm that had used biosolids in the early 1990s
  - Extremely high milk levels
  - Milk had been tested randomly off-the-shelf by the MDACF one year earlier and it did not have a PFAS problem at that time
  - ***Further testing identified hay from another farm with very high levels of PFOS which at this point seems to be the source of high PFOS in milk***
- Organic vegetable farm adjacent to farm that applied biosolids in the early 1990s
  - Extremely high irrigation water levels and high drinking water levels
  - To date soils appear to only be impacted by recent use of irrigation water

Follow up on these farms

- All three of these farms pulled products from the shelves and notified customers, an extremely difficult choice.
  - This has been a nightmare to deal with for each of these farms
- This has made them eligible for support for additional testing by the DACF
  - There is legislation proposed that has support that, if passed, will provide funding for farms impacted by PFAS, as well as providing funding for further testing and research related to PFAS management and/or remediation in agriculture
- Additional testing, along with an increase in our understanding of the fate and transport of PFAS in agriculture in Maine, in some cases will provide a path forward for some of these impacted farms.
  - Clean feed reduces PFAS in milk within a matter of months
  - PFAS in meat appears to have a relatively short half life, so, again, a change in feed can reduce levels relatively quickly
  - Grains and fruiting vegetables tend to have lower PFAS transfer factors than grass and leafy greens

Publicly available records

- Maintained by Maine DEP
- Includes all sites that have ever been licensed for land application of sludge, septage, or ash – regardless of whether the license was ever utilized
- Does not include sites where class A biosolids may have been spread
- Is reliant on records dating back to the 1980s
- Includes names of individuals who owned/managed the fields at the time of licensing



Impact on Consumer Perception of the Food Supply

- Growers are concerned → huge uptick in farmers requesting PFAS testing services
  - PFAS Cohort of the USDA's FRSAN network
  - Maine Farmland Trust and MOFGA providing funding for farms requesting testing and consultation
    - Farms do not need to be participating with MOFGA nor the MFT to participate!
  - Unintentionally, Northern Tilth has become an agricultural PFAS testing ***and consulting*** company
    - Needing to perform triage on the phone, and limiting services to agriculture (for the most part)
- Consumers are concerned
  - Farmers that otherwise not test, and have no reason to suspect that their would be any source of contamination on their farms are being forced by their customers to test
  - Composters, likewise, are being forced by their customers to test their finished product
- Concern from our perspective on the concept of PFAS-free fields and PFAS-free products
  - By circumstance, Maine will become the testing ground for how to discuss the occurrence of PFAS in agricultural soils and products

The news isn’t all bad; It just seems that way

	Wells Sampled	Wells Exceeding 20 ppt Interim Standard	Percent
2020 Central Maine Sites	456	202	44
Initial Statewide Sampling	205	34	16.5

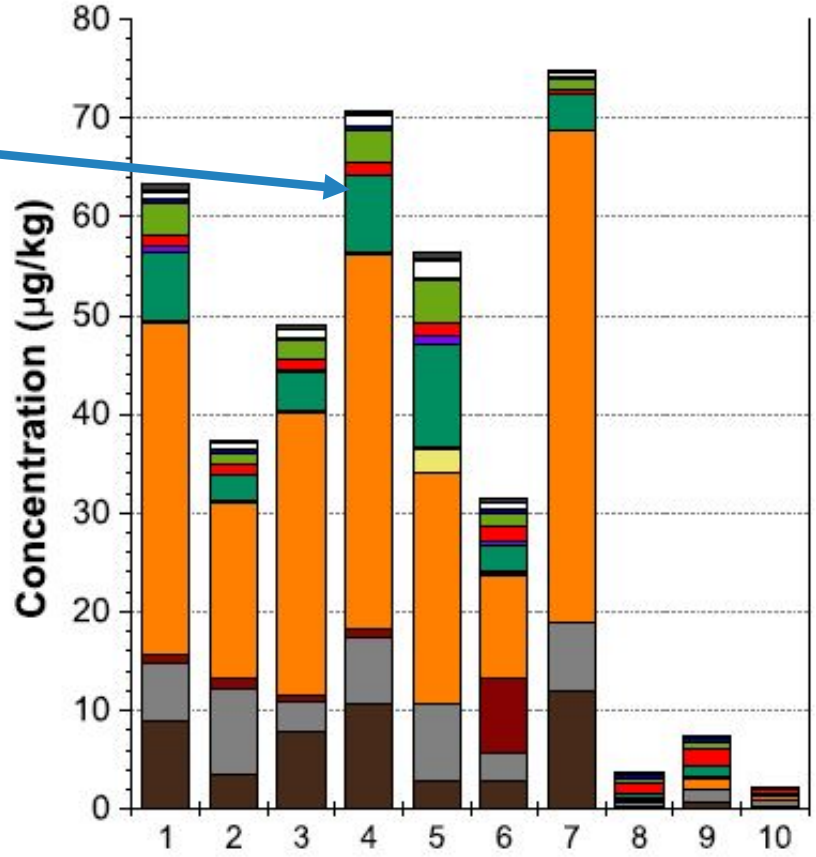
As a private PFAS testing company, we have the benefit of receiving results from a wider variety of agricultural sites, and the large majority do not have elevated PFAS levels in soils, water or farm products

RESULTS FROM OTHER MEDIA

From Choi et al. 2019. *Perfluoroalkyl acid characterization in U.S. municipal organic solid waste composts. – supporting data provided by Dr. Linda Lee, Purdue University*

Environmental Science & Technology Letters — Letter

Note that the PFOA level in several of these non-biosolids composts would be higher than the Maine screening standard of 2.5 ppb)



	Description
1	Municipal solid waste
2	Municipal solid waste and wood products
3	Residential and commercial food and yard waste, compostable food serviceware products
4	Residential and commercial food and year waste, compostable items
5	Mixed food waste (residential, local grocers, restaurants, and commercial food handling facilities) and yard waste
6	Residential food and yard waste, & compostable food serviceware
7	Food waste, horse manure, wood shavings, coffee grounds and lobster shells, &compostable food serviceware
8	Leaves and grass waste from municipalities
9	Residential back yard compost bin
10	Leaves

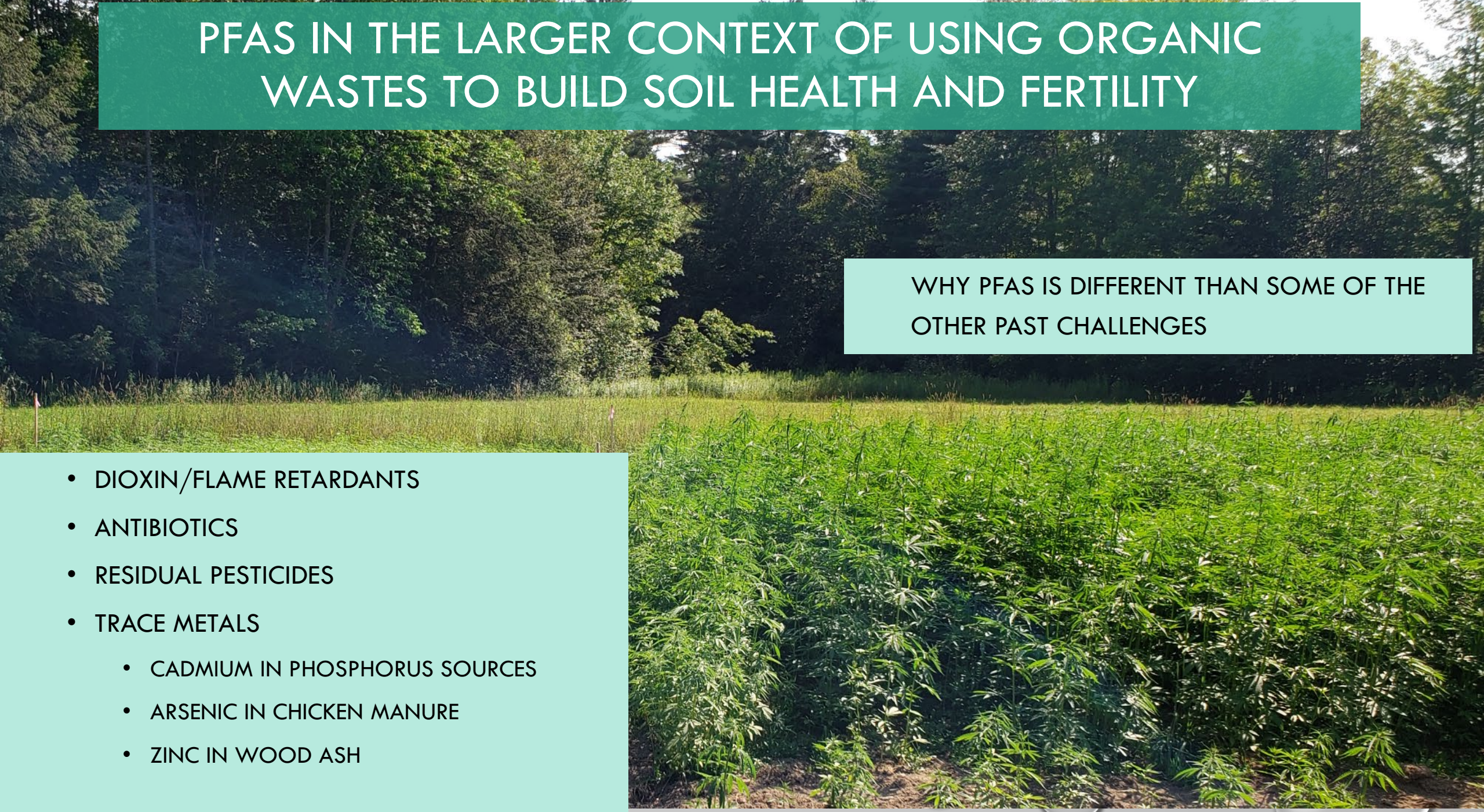
source	PFOA conc. (ug/kg dry wt)
1	6.88
2	2.54
3	3.58
4	7.85
5	10.31
6	2.73
7	3.64
8	0.48
9	1.05
10	0.47

Figure 1. PFAA concentrations quantified (micrograms per kilogram oven-dried, <2 mm) in the compost (left) and the relative contribution (percent) of each PFAA to the total PFAAs quantified for composts 1−10 (right).

WHY USE BIOSOLIDS ON FARMLAND?

- ENHANCES SOIL HEALTH
- RECYCLES NUTRIENTS
- SEQUESTERS CARBON (HELPS TO REDUCE OUR GREENHOUSE GAS EMISSIONS
- RESTORE DEGRADED LAND
- REDUCES THE NEED FOR PURCHASED COMMERCIAL FERTILIZER, WHICH IS OFTEN MINED OR PRODUCED THROUGH ENERGY-INTENSIVE PROCESSES
- IN LINE WITH THE PRIMARY TENETS OF SUSTAINABLE AGRICULTURE

PFAS IN THE LARGER CONTEXT OF USING ORGANIC WASTES TO BUILD SOIL HEALTH AND FERTILITY



WHY PFAS IS DIFFERENT THAN SOME OF THE OTHER PAST CHALLENGES

- DIOXIN/FLAME RETARDANTS
- ANTIBIOTICS
- RESIDUAL PESTICIDES
- TRACE METALS
  - CADMIUM IN PHOSPHORUS SOURCES
  - ARSENIC IN CHICKEN MANURE
  - ZINC IN WOOD ASH

Decreasing risk levels may make the additional PFAS added to soil from contemporary biosolids problematic

There is a need to distinguish between legacy PFAS issues from industrially contaminated biosolids and what we find in contemporary biosolids

THEN

Parameter of Interest*	PFOS	
Concentration in Soil Amendment	7,000	ug/kg
Solids content (%)	30%	
Bulk Density	1450	#/Y^3
Application Rate	176	wet tons/ac
Application Rate	52.8	dry tons/ac
soil bulk density	2,400	#/Y^3
soil moisture content	75%	
dry mass of soil	121	dry tons/acre-inch
Depth of plow layer (in)	8	
dry mass of plow layer	968	dry tons/acre
ratio of soil to soil amendment	18	dry weight
amount of PFOS added to soil	0.74	#/acre
Initial soil concentration*	0.00	ug/kg
amount of PFOS in soil	0.00	#/acre
amount of PFOS after 1 application	0.74	#/acre
Soil concentration after 1 application	382	ug/kg
change in soil conc. after 1 application	382	ug/kg

NOW

Parameter of Interest*	PFOS	
Concentration in Soil Amendment	30	ug/kg
Solids content (%)	25%	
Bulk Density	1450	#/Y^3
Application Rate	20	wet tons/ac
Application Rate	5.0	dry tons/ac
soil bulk density	2,400	#/Y^3
soil moisture content	75%	
dry mass of soil	121	dry tons/acre-inch
Depth of plow layer (in)	8	
dry mass of plow layer	968	dry tons/acre
ratio of soil to soil amendment	194	dry weight
amount of PFOS added to soil	0.00	#/acre
Initial soil concentration*	0.90	ug/kg
amount of PFOS in soil	0.00	#/acre
amount of PFOS after 1 application	0.00	#/acre
Soil concentration after 1 application	1.1	ug/kg
change in soil conc. after 1 application	0.155	ug/kg

5.2	ug/kg screening limit
28	years of application to get to screening limit

HOW TO MOVE FORWARD

- Don’t avoid the issue of PFAS in biosolids
- Support more testing and the type of research that the Maine CDC is completing on risk assessment in agricultural settings
- Work upstream to minimize PFAS inputs to the wastewater stream
- Don’t focus just on the PFAS compounds that we know about
  - Get ahead on understanding levels and fate and transport with other PFAS compounds and their replacements
  - Determine if there are other classes of chemicals that have similar physiochemical properties