PFAS and BIOSOLIDS and SEPTAGE on NORTHEAST FARMS

MAY 19, 2020 (updates & typos corrected, Aug. 5, 2020 & Dec. 28, 2021, shown in blue)

What are biosolids?

Biosolids – treated and regulated wastewater solids (sewage sludge) – are applied to many farms across North America to improve soil quality. Biosolids recycle the nutrients and organic matter captured at water resource recovery facilities (WRRFs, aka wastewater facilities). About 55% of the sludge from U. S. WRRFs is recycled to soil, the majority on farms. Septage – the solids from septic systems – are sometimes treated and recycled to soils in a similar way. Farmers use biosolids and septage because they work and are cost-effective, helping support local economies by recycling nutrients locally. In the Northeast, biosolids are applied mostly on fields growing feed – hay and corn – for cows.

What are PFAS?

PFAS is a group of manmade chemicals in widespread use since the mid-1900s. They are used in thousands of products to keep water and grease from soaking into materials (think Scotchguard fabric treatments, coatings on food packaging, impervious rain gear), as well as in many other consumer products. They are also in firefighting foam used on petroleum fires. PFAS are now found around the globe, measured in parts per trillion (ppt) in water and parts per billion (ppb) in soils, as well as in animals in the artic, in fish in many U. S. lakes and streams, and in human blood serum. Two of the original PFAS – PFOA and PFOS – are the most common and most studied and have been phased out of production and use in North America because of concerns about impacts on human health.

Are PFAS regulated?

PFAS risks to human health are debated and are still being researched. This has led to inconsistent regulatory actions. In May 2016, U. S. EPA set a protective drinking water health advisory value of 70 ppt for PFOA and PFOS combined. In December 2018, Canada set its public health drinking water limits at 200 ppt for PFOA and 600 ppt for PFOS. But several New England states have been pushed by concerned citizens to adopt some of the lowest PFAS standards anywhere: drinking water limits at 20 ppt or lower. The same states set groundwater limits at similar low levels. Many activities, such as daily cleaning of school floors, have been found to pollute drinking water wells at these low levels. Research on Cape Cod (Schaider et al., 2016) found that home septic systems polluted neighbors' wells with PFAS at levels approaching 20 ppt. NEBRA questions whether it is wise for states to regulate at what are, unfortunately, background levels – especially when U. S. EPA and most states rely on the 70 ppt limit.

What is a part per trillion?
1 ppt =
1 second in 31,700 years
1 part per billion (ppb)=
1 second in 31.7 years

What is the risk from PFAS in biosolids and septage?

Biosolids and septage contain traces of PFAS because they come from wastewater that comes from our daily living environments, where carpets, food packaging and food, cosmetics, cleaners, waxes, fabric treatments, and other products contain PFAS. All tests of wastewater, biosolids, and septage have found PFAS. The only likely risks from these traces is if they leach to groundwater and cause drinking water to be contaminated or if high levels in soils drive plant uptake (e.g. grass takes up some PFOS). For most people – except those drinking water with hundreds to thousands of ppt PFAS – exposures to PFAS are as much through food impacted by PFAS use in food packaging and using products (e.g. cosmetics, fabric treatments, waxes) that contain PFAS.

Are there other possible sources of PFAS on farms besides biosolids and septage?

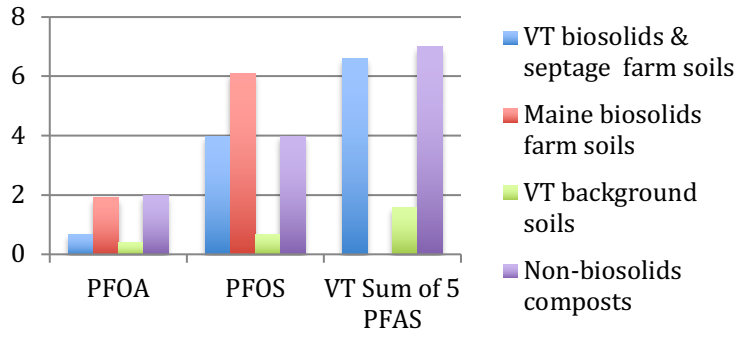
Yes. Many consumer products contain PFAS, and most farms use some such products around barns and processing areas, especially cleaning products, machine lubricants, paints, and surfactants. And, in the past, more PFAS may have been in use in agricultural chemicals, such as herbicides and pesticides. But there is less information about these sources on farms, because products do not have to be labeled for PFAS.

Research and experience about PFAS in typical modern biosolids and septage shows:

- **There is no significant PFAS risk from handling, land applying, touching, ingesting, or inhaling biosolids and septage.** New Hampshire has the strictest standards for PFAS in soils for these kinds of *direct* human exposures: 100 and 200 ppb, depending on the site use (residential vs. commercial). Typical biosolids are in the range of 2 – 40 ppb – much lower. As always, when working with biosolids, follow good hygiene – washing hands, etc. (Good hygiene also reduces any potential PFAS risk.) As noted above, the two possible concerns with PFAS in soils is based on leaching and plant uptake, which are different pathways of exposure.

- **Most sites that have received typical biosolids applications for decades have measurable levels of PFAS in the soil - levels that are somewhat higher than background PFAS soil levels** (Figure 1, Table 1). Such levels do not appear to pose significant risk. In comparison, sites with industrial and fire-fighting PFAS concentrations are in the hundreds of ppb (e.g. soil at the Burlington, VT Air National Guard base, where firefighting foam was used, has 800 ppb PFOS in the soil, plus other PFAS; Parsons, 2020).

Figure 1: Median PFAS in Soils, ng/g (ppb)
with non-biosolids compost for comparison
(NEBRA data compilations and Zhu et al., 2019)



- **Limited data show some plant uptake and no impacts on the quality of farm products from PFAS at typical, multi-year biosolids application sites,** based on tests on farms in three New England states. Academic research has demonstrated some crop uptake in artificial laboratory studies and where industrially-impacted biosolids have caused high levels in soils, but nothing significant in field studies with typical biosolids (Blaine et al., 2013; Blaine et al., 2014; Gottschall et al., 2017). Some tests on New England farms have found no PFAS in high moisture corn, corn silage, and haylage grown on fields applied with biosolids or septage for many years. However, ongoing investigations in Maine are finding some uptake of PFOS in grass, resulting in measurable levels in hay that, when fed to animals, may lead to elevated levels in milk and beef. In fall 2021, Maine found elevated levels in wild deer meat and eggs near farms with very high PFAS levels in farm soils, and plant uptake is a likely route of exposure to these animals. Dairy products have not been impacted based on Maine's strict screening standard of 210 ppt for PFOS in milk (Smith, 2020) – unless in the rare cases where there has been major industrial PFAS impact.

I have heard news stories about PFAS contamination on farms in Maine, Michigan, New Mexico, and Vermont. What can you tell me about that?

There have been a few reports, including in farm journals, about PFAS on farms. These cases are unusual and not representative of the vast majority of biosolids recycling programs. Thousands of farms regularly use biosolids, and research suggests minimal potential for impacts to groundwater above the U. S. EPA drinking water advisory level of 70 ppt. Here are the facts about the most publicized farm PFAS stories:

1. **PFAS contamination causing harm at Stoneridge Farm in Arundel, ME, is likely not from municipal biosolids.** One chemical – PFOS – is the issue; it is likely from an industrial material placed on the farm, likely in the 1980s. See "Maine Farm PFAS Concern" at https://www.nebiosolids.org/pfas-biosolids.

2. **Two New Mexico dairies show PFAS from firefighting foam use at a nearby Air Force base.** One dairy's business has been significantly impacted. No biosolids or septage were involved in these cases. The levels in groundwater from this firefighting activity reached 14,320 ppt PFOA + PFOS in one irrigation well. The milk tested in the range of 1620 – 5680 ppt. That's what industrial and fire-fighting contamination looks like. For perspective, Maine's screening value is 210 ppt PFOS for milk (Maine CDC, 2020).

3. **At Vermont biosolids land application farm fields, PFAS have been found in groundwater where biosolids and/or septage have been applied for many years** (VT Digger, 2020). NEBRA has reviewed the data compiled by the Vermont Department of Environmental Conservation (VTDEC). PFOA was the PFAS most commonly detected in groundwater. Three out of two dozen sites were found to exceed Vermont's nearly-strictest-in-the-nation groundwater standard of 20 ppt for 5 PFAS combined (the "VT-5"). The median of those VT-5 groundwater data was 14 ppt, with a maximum of 176 ppt (Figure 2). However, at the three sites with high levels, testing to date shows nearby offsite groundwater is below the limit, and nearby drinking water sources were not impacted. For comparison, because PFAS are so ubiquitous, they show up in septic systems and contaminate wells in places; a school well in VT tested at 323 ppt for the VT-5 PFAS, likely due to decades of daily floor cleaning and waxing with PFAS-containing products. It is likely that further applications of biosolids and septage will not be allowed on the three sites with groundwater exceedances, but PFOA and PFOS have been phased out and the levels at these sites present minimal risk and will diminish with time. Because of the continent-wide phase-out, the levels of PFOA and PFOS in today's biosolids and septage are likely about 1/10th what they were in biosolids applied 20+ years ago.

4. **Several Michigan municipal biosolids land application programs were suspended when it was found that metal-finishing industries were discharging high levels of PFAS to several municipal wastewater treatment facilities. Biosolids were found to have as much as 2,100 ppb PFOS.** Since this industrial contamination was discovered in ~2017, Michigan has been proactive in reducing PFAS in wastewater and biosolids through industrial pretreatment and source reduction – halting the industrial discharge of PFAS to sewers, resulting in reductions of 90% or more in biosolids and wastewater effluent. Municipal biosolids land application programs that had been on hold are starting up again. Michigan's approach to PFAS in biosolids is a model; see links in references, below, for further information.

5. **In 2020 and 2021, continuing testing by the state of Maine at farms that have used biosolids has found measurable, but likely not concerning, levels of PFAS in soils, with a few detections in farm crops and products. But there is a notable exception in an area of central Maine – Fairfield and neighboring towns.** There, a small family dairy farm that had used municipal biosolids from the 1980s up to maybe 2003 was found to have elevated PFAS in milk and in soils, suggesting a large industrial input of PFAS to the municipal wastewater biosolids at that time. One test of the farm's milk found ~32,200 ppt PFOS – one of the highest levels ever found in milk. This was devastating news for the farmers, and it impacted their business. Testing of drinking water wells in the area found PFAS, mostly PFOS, exceeding the state's strictest-in-the nation standard, and more than 200 home treatment systems have been installed by the state, with more to come. "Out of an abundance of caution," the state has put in place a "do not eat" advisory for wild deer meat harvested in the Fairfield area, and tests have shown concerning levels of PFOS in eggs from home chickens raised in the area on PFOS-contaminated drinking water and free-range soils. State officials are concerned that soils with such high PFOS contamination may cause food safety issues because they seem to cause PFOS plant uptake into grasses and possibly leafy crops (but not corn). The Fairfield situation is very concerning and is severely impacting a farm community. But the contamination is a legacy of past industrial discharges to a wastewater treatment facility; today, Maine biosolids are tested for PFAS and have typical low levels. And, as the *Portland Press Herald* noted: "…McBrady, with the state agriculture department, said it is dangerous to paint all farms that used sludge with a broad brush because state testing has shown many do not have PFAS contamination issues." Investigations continue in Maine, and it is likely that some additional farm fields will be found with legacy PFAS (PFOS) contamination.

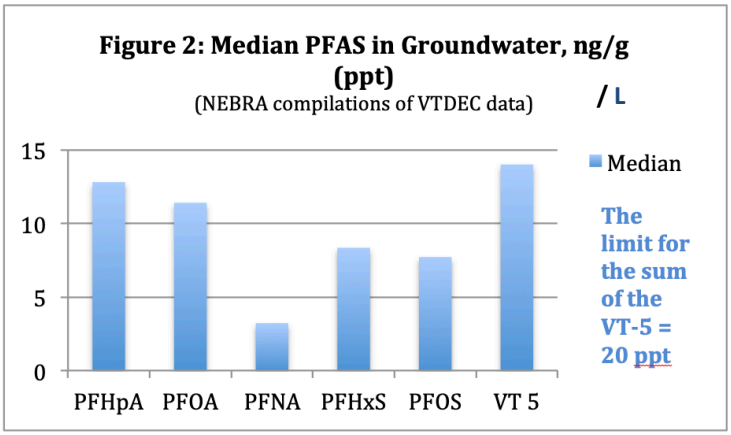
Table 1. PFAS in soils at long-term biosolids & septage land application sites, compared to other sites

*ND = non-detect	PFOA (ug/kg, ppb)	PFOS (ug/kg, ppb)	VT – 5 PFAS sum (ug/kg, ppb)
Vermont long-term biosolids & septage farm soils, 2019, NEBRA compilation (n = 107 soil tests at 28 sites)	Mean: 1.1 Median: 0.7 Range: 0.3 – 4.6 Detections: 34 of 107	Mean: 6.3 Median: 4.0 Range: 0.3 – 35.6 Detections: 64 / 107	Mean: 9.4 Median: 6.6 Range: 1.2 – 44.2 Detections: 75 of 107
Maine biosolids land application farm soils, 2019, Northern Tilth compilation, (n = 29 soil tests, 29 fields)	Mean: N/A Median: 1.9 Range: 1.1 – 12.9	Mean: N/A Median: 6.1 Range: 2.1 – 20.9	
Vermont background soils, Zhu et. al (Univ. VT, VT DEC), 2019 (n = 68 soil tests at 66 sites)	Mean: 0.5 Median: 0.4 Range: 0.05 – 4.9 Detections: 60 of 66	Mean: 1.1 Median: 0.7 Range: 0.1 – 9.7 Detections: 66 of 66	Mean: 2.4 Median: 1.6 Range (sum of all min – sum of max): 0.3 – 21.4
Non-biosolids composts, Choi et al., 2019	Median: ~2	Median: ~4	Median: ~7
Industrially-impacted farm soil, Stoneridge Farm, Arundel ME, 2017, ME DEP data	Range: ND* – 23	Range: ND* - 878	
Industrially-impacted biosolids land application farm soil, Decatur AL, 2009, U. S. EPA data	Range: 50 - 320	Range: 30 - 410	
Industrially-impacted soils by air emissions, 2016, Bennington College data	Mean: 5.3 Range: ND* - 23		

Public perception and consumer confidence are important.

Farms rely on consumer confidence, and issues like PFAS can be threats. Some suggestions:

- Learn more about PFAS. Ask your biosolids and septage providers. See https://www.nebiosolids.org/pfas-biosolids and contact NEBRA for info.
- Review biosolids PFAS test results from your supplier.
- Be aware of your state's PFAS standards.
- Consider private testing of your soils for PFAS. Knowing they have low levels of PFAS will provide peace of mind. If you find an issue, adaptations can be made.
- Review your use of consumer products that may contain PFAS: cleaning products, machine lubricants, paints, agricultural chemicals, and surfactants. Consider asking suppliers for PFAS-free products.



- Apply biosolids in accordance with regulations, at the required agronomic rate, which reduces potential nutrient pollution – and also minimizes PFAS addition to the soil. Apply to different fields to reduce build-up and aid natural attenuation.
- Be proactive in evaluating the PFAS issue in relation to your business, and get out ahead of regulatory actions and the public by addressing it head on and showing you are aware and acting proactively to ensure your systems and products are safe. NEBRA can help if needed.

Biosolids recycling to soils is common, backed by 45+ years of research and experience across the U. S. and Canada. Biosolids applied in accordance with regulations present "negligible risk" (as the National Academy of Sciences noted). The typical low levels of PFAS in biosolids and septage also present low risk – risk that is outweighed by the benefits of biosolids, such as soil health, economic, and climate benefits.

Further information about PFAS on farms:

NEBRA, PFAS & biosolids & residuals, https://www.nebiosolids.org/pfas-biosolids

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Michigan, 2021. Animal Health & Food Safety Workgroup: https://www.michigan.gov/pfasresponse/0,9038,7-365-86513_99807_99808-527975--,00.html

Michigan, 2021, Land application workgroup: https://www.michigan.gov/pfasresponse/0,9038,7-365-86513_99807_99808-527974--,00.html

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Parsons, 2020. Draft Final Expanded Site Investigation Report for PFAS at the Burlington ANG Base, March 2020.

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