



Information Update:

PFAS Contamination at Stoneridge Farm, Arundel, Maine

Ned Beecher, Executive Director

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This and future updated versions are at <https://www.nebiosolids.org/pfas-biosolids>.

Note: *Background information on biosolids and PFAS are provided toward the end of this document.*

SUMMARY OF KEY FINDINGS

- Investigations by Maine state agencies and an affected neighboring water utility identified two concerns related to PFAS contamination at and near the Stoneridge Farm in Arundel, Maine:
 - Elevated levels – not above EPA and Maine health standards – of PFAS chemicals – notably PFOA and PFOS¹ – were found in one drinking water well of the Kennebunk, Kennebunkport, and Wells Water District. Immediate actions were taken by the Water District to address any potential public health concern. Water from that well is now treated and shows non-detects for PFAS.
 - Elevated levels of concern of PFOS (one single chemical, not the group of PFAS) were found in Stoneridge Farm milk. This continues to be an issue, on and off, impacting the Farm’s core business. Maine Department of Environmental Protection (Maine DEP) hypothesizes that the cause of continued milk contamination today is the result of ongoing cycling of PFOS on the Farm.
- The original source of the anomalously high level of PFOS in the western field soil of the Farm is uncertain, but data from the Maine DEP investigation suggest it is likely something other than the municipal biosolids that were land applied on several Farm fields as fertilizer and soil amendment from the late 1980s to 2004. Evidence from the Stoneridge Farm and long-term municipal land application sites where just municipal biosolids (without large, ongoing industrial inputs) have been applied do not show impacts to ground or surface waters at or above the U. S. EPA public health advisory level of 70 parts per trillion (ppt).
- The Stoneridge Farm was also licensed to receive paper mill residuals, which it apparently did in the 1980s, according to Maine DEP records. Some industrial material of this sort is hypothesized to be the likely source of the anomalously high PFOS on the Farm’s western field.
- Confounding factors related to the Stoneridge Farm PFAS contamination make it difficult to draw firm conclusions:

¹ PFOA and PFOS are two of the more than 3,000 known PFAS chemicals. These two are the most well-researched PFAS chemicals, have been the most used in the past, and have been mostly phased out of use in the U. S. and Canada.

- Neither the municipal biosolids nor the paper mill residuals reportedly applied at the farm decades ago were tested for PFAS at the time of application. PFAS were not a known concern then.
- There were no known large industrial sources of PFAS discharging to the WRRFs at the time that they generated the biosolids applied at the Stoneridge Farm.
- Biosolids recently analyzed from southern Maine area water resource recovery facilities (WRRFs) show trace levels today, typical of modern municipal biosolids (which average ~5 parts per billion or ppb PFOA and ~11 ppb PFOS, according to data compiled by NEBRA; a part per billion is 1 second in 31.7 years).
- The paper mill residuals reportedly used at the Stoneridge Farm in the 1980s may have been from a mill known to manufacture coated paper.
- PFAS have been in use in many commercial products and commercial processes since the 1950s and are found in many places in the environment. Other activities and materials may have contributed PFAS at this Farm.

STONERIDGE FARM PFAS HISTORY AND CONCERNS

How were PFAS discovered at the Stoneridge Farm?

As part of ongoing efforts to ensure drinking water quality nationwide, U. S. EPA requires larger drinking water systems to test for emerging contaminants of concern under the Unmonitored Contaminant Monitoring Rule (UCMR). Under the [UCMR3](#) testing program, six PFAS chemicals were tested for, and the Kennebunk, Kennebunkport, and Wells Water District (KKW; <https://kkw.org>) found PFOA plus PFOS at 50 ng/L or parts per trillion (ppt) in its production well – not at or above the public health advisory level. (A ppt is 1 second in 31,700 years.) That well happens to be adjacent, and down gradient for groundwater flow, from Stoneridge Farm. The water utility, KKW, immediately began investigating the potential source of the PFAS in their well. That led to testing of water, soils, and other materials at Stoneridge Farm by KKW and Maine DEP.

Data Quality Concern

The numerical data included here are from various sources, including Maine DEP, and may not be precise and are for screening purposes only. There are no EPA approved methods for analyzing PFAS in solids and non-potable waters (e.g. groundwater), and results can vary from lab to lab. Therefore, results from different studies may not be comparable. Data are presented here only to advance understanding.

What is known about the PFAS concerns at Stoneridge Farm is mostly due to Maine DEP investigations from late 2016 – early 2018. Further formal investigation by Maine DEP of the PFAS contamination at Stoneridge Farm ended in spring 2018.

In the meantime, KKW installed a granulated activated carbon (GAC) treatment system to treat the water from its well. Since June 2018, that one well has been back online, providing PFAS-free water at up to 1 million gallons per day to KKW customers. Other KKW sources of water were never of concern related to PFAS. KKW now continues to test for PFAS regularly.

Were municipal biosolids the major source of PFAS on the farm?

Maine DEP records indicate that municipal biosolids were used on the Farm. However, as expected based on research on land application, municipal biosolids seem to have contributed only relatively low levels of PFAS to the soils, similar to levels found at other municipal biosolids land application sites. This is what soil tests reveal. Other material(s) used in the western fields of the Farm – likely

directly from an industry using large amounts of PFOS – are hypothesized to be the most significant contributor(s) to the PFOS contamination that has raised concerns and harmed the Farm’s business.

When were biosolids/residuals applied at Stoneridge Farm?

According to a court filing, Maine Department of Environmental Protection (DEP) permits for use of Kennebunk Sewer District (KSD) biosolids at Stoneridge Farm were granted in October, 1986 and October, 1991. The KSD permit expired in February, 1997. In January, 1997, Ogunquit Sewer District began their involvement in providing biosolids to Stoneridge Farm. Between these permits, a total of about 50 acres of Stoneridge Farm was approved for land application. According to Maine DEP, a total of 2,643 cubic yards of biosolids (an estimated 400 dry tons) from the two water resource recovery facilities (WRRFs) was applied at Stoneridge Farm from 1992 to 2004.

Maine DEP records also show that there was a permit for Stoneridge Farm to receive residuals from a paper mill in the area, and “44.6 dry tons sludge and 26.8 dry tons bioash” from that mill’s waste management processes were applied at the Farm, apparently mostly on the western fields, in 1983 – 1985.

What do we know about the levels of PFAS in the biosolids/residuals applied at Stoneridge Farm?

Even back in the 1980s and 1990s, Maine DEP permits for land application required extensive testing and evaluation of materials that were to be land applied, and state and federal regulations oversaw the land application process. However, at that time, PFAS were not known to be a contaminant of concern, and the ability for analytical laboratories to measure them in low parts per billion (ppb) and parts per trillion (ppt) had not yet been developed.

Published research of archived biosolids samples from 2001 (around the time of the last uses of biosolids at Stoneridge Farm) from across the U. S. found average levels of PFOA at 34 ppb and PFOS at 403 ppb (Venkatesan and Halden, 2013). PFOA and PFOS were gradually phased out of use in the U. S. during the period ~2002 to 2015, resulting in lower levels today.

An August 2017 test of Kennebunk Sewer District biosolids found no detection of PFOA and 6 ppb PFOS. These recent test data correspond with data from other recent tests of biosolids around the country. NEBRA compilations indicate that, in modern biosolids, PFOA averages about 5 ppb and PFOS averages about 11 ppb (except in rare cases where there has been large industrial discharge of PFAS to the WRRF).

Even though there are no data about the levels of PFAS in the historic biosolids (and paper mill waste) used at the Stoneridge Farm, data on current soil levels at other farms provide understanding that the municipal biosolids were not likely any different from other biosolids used around the nation at that time and are unlikely to have created the relatively high PFOS levels in the Farm’s western field soil.

Data Units

- PFAS in water and liquids is reported in ng/L or parts per *trillion*, or *ppt*.
- PFAS in soils/solids is reported in ng/g or parts per *billion*, or *ppb*.

What can be understood from the data from testing at the Stoneridge Farm?

Upon learning of the PFAS contamination in well water adjacent to Stoneridge Farm, Maine DEP initiated an investigation, in association with the Maine Departments of Agriculture and Health. Testing and investigation in December 2016 through spring 2018 included samples of various waters,

the milk produced on the farm, soils, cow feed, hay, and manure. Test results are shown in Tables 1 and 2. The levels of PFOA and PFOS in the Farm’s pond water and drinking water, which comes from the Farm’s own well, was below drinking water health screening levels (70 ppt); however, out of caution, a treatment system was installed on the Farm’s drinking water system in May 2017, and, since then, PFAS have not been detected in the Farm’s drinking water.

The one significant concern was that PFOS was measured in late 2016 and early 2017 at up to 1420 ppt in the farm’s milk. The Farm had to stop shipping its milk to market, causing major disruptions to the Farm’s operations. In 2017 and 2018, the Farm brought in a herd of new cows, worked to remove any lingering contamination from its operations, and, at times, was able to sell milk that was below the Maine Department of Agriculture’s screening value for PFOS of 210 ppt for milk. Now, the milk buyer has stopped accepting milk from Stoneridge Farm because of ongoing PFOS levels occasionally above the Maine screening value.

Although further data (other than milk test data) have not been gathered by Maine DEP or other authorities since spring of 2018, PFOS contamination appears to be continuing on the farm, as milk test results continue to show PFOS. Maine DEP suggests this may be due to ongoing land application of the Farm’s PFOS-contaminated manure and the elevated levels of PFOS in soil in the western fields.

Table 1. Water and Milk Test Results

units: ng/L or parts per trillion/ppt; ND = not detected

Location	PFOA (ng/L, ppt)	PFOS (ng/L, ppt)	Sources/Notes
Drinking water - U. S. EPA public health advisory screening value	70 ppt for PFOA + PFOS combined		U. S. EPA, 2016
Drinking water of neighbors north and west of Stoneridge Farm	ND	ND	ME DEP, 2017
Drinking water well at Stoneridge Farm, before treatment was installed	5, 9, 13 (3 tests over 6 months)	30, 42, 43 (3 tests over 6 months)	ME DEP, 2017
Dug (shallow) well on at Stoneridge Farm; not used for human consumption	7	2.5 (uncertain data)	ME DEP, 2017
Groundwater monitoring wells at Stoneridge Farm	14 - 17	29 - 130	ME DEP, 2017
Pond water at Stoneridge Farm	ND – 8	2 – 33	ME DEP, 2017
Surface water, SW corner of Stoneridge Farm	249	476	ME DEP, 2017
Milk - Maine Dept. of Agriculture action level		210	
Milk - Stoneridge Farm	ND	176 - 1420	ME DEP, 2017

The soil test data collected at Stoneridge Farm by Maine DEP indicate moderate levels of PFOS and PFOA in soils of the eastern farm fields. These soil PFAS levels – in the single parts per billion – are comparable to soil test data from other farms where municipal biosolids have been used for several years or more. For example, as part of its investigation, Maine DEP tested another farm in the area that used the same Kennebunk Sewer District municipal biosolids and found soil levels of PFAS there to be in the same general range (Table 2).

These soil data from typical biosolids applications can be compared to “background levels.” PFAS are not naturally occurring, so “background levels” are from diverse, diffuse releases like aerial deposition and releases of small amounts from various commercial products like textiles, waxes, household chemicals, and personal care products. Soils in a wide variety of places that have *not* been impacted by significant industrial or fire-fighting activities show PFOA and PFOS levels from ~0.5 to ~10 ppb (Table 2). These levels are well below risk concern levels based on dermal contact or ingestion; the lowest such regulatory value is 300 ppb (ME and VT).

Research, risk assessments, and state regulatory actions indicate that the greatest concern regarding PFAS in soil is if it leaches and impacts drinking water. The data collected at the Stoneridge Farm indicate that the unusually high soil level of PFOS (up to 878 ppb) have caused some groundwater contamination of concern (up to 130 ppt), exceeding the drinking water health advisory level of 70 ppt in two groundwater monitoring wells. However, data showed that the Farm’s drinking water never exceeded the health advisory level (and treatment installed has reduced the PFAS to non-detect). And even the highest measured PFAS levels in the Farm’s groundwater and surface water – which is not drinking water – are not above, for example, Canada’s recently finalized drinking water standards of 200 ppt for PFOA and 600 ppt for PFOS. And, if Canada’s standard for PFOS for drinking water were applied to the milk from Stoneridge Farm, that milk would be considered safe to consume, based on more than a dozen test results taken since the initial three tests showed elevated PFOS levels and the Stone Farm initiated its remediation measures in February of 2017.

From the data collected by Maine DEP, it is possible to back-calculate what the levels of PFAS would have been in the materials reportedly land applied. If the available data regarding how much was applied is correct, PFOS would have had to have been at more than 67,000 ppb in the land applied materials to result in the soil test levels observed. This level of PFOS in the Stoneridge Farm western field is an anomaly and must have had a large, industrial origin.

What are the next steps?

At the time of the March, 2019 publication of this Information Update, publicity about the Stoneridge Farm PFAS situation was in the news media (see links, below). Maine DEP has taken proactive steps to ensure the safety of current municipal biosolids use on soils by requiring, as a next step, PFAS testing of biosolids prior to their use in the state.

Conclusions about Stoneridge Farms from Maine DEP:

1. “Material applied to the surface of farm property, including some ongoing waste management practices, have led to long term contamination of soil;”
2. “Hay harvested from this property is contaminated and when fed to the dairy cows is a major source contributor to the PFOS measured in their milk;”² and
3. “There are likely several original sources of PFAS. Inability to analyze historical inputs interferes with final determination of specific source.”

However, for the reasons explained above, municipal biosolids are not likely the source of the anomalously high levels of PFOS at the Stoneridge Farm western field.

Table 2. Soil Test Results (*except where manure and biosolids are specified*) and comparison materials and screening standard

units: ng/g or parts per billion/ppb; ND = not detected

Location	PFOA	PFOS	Sources/Notes
Stoneridge Farm, western fields	ND - 23	ND to 878	ME DEP, 2017
Stoneridge Farm, eastern fields	ND – 0.6	0.6 - 5.4	ME DEP, 2017
Stoneridge Farm <i>manure pile</i>	3.2	20.3	ME DEP, 2017
Stoneridge Farm area forest control soil (background)	0.6	0.7	ME DEP, 2017
Nearby farm that also received Municipality A biosolids applied to Stoneridge Farm eastern fields	1, 1.4 (2 samples)	4.9, 6.0 (2 samples)	ME DEP, 2017
Municipality A biosolids, 2018 test	ND	6.2	Municipality A
Various soils, U.S, Mexico, Japan, not industrially impacted, not biosolids sites	0.8 – 31.7	0.4 – 10.1	Strynar et al, 2012
Lowest regulatory standard for soils, based on dermal contact and ingestion	300 (VT DEC)	400 (Denmark)	Accurate soil standards for leaching of PFAS from soils have not been determined.

² Note that how the hay is contaminated is uncertain. Limited research has indicated minimal crop uptake by other plants of PFOA and PFOS and other longer-chain PFAS compounds. Hay is not expected to absorb much PFOA and PFOS, although uptake has been shown to be correlated with the concentration in the soil. It is possible, however, that, when manure is cycled back onto hay fields, some will adhere to the outside of the hay, and some of the manure/soil mix at the base of the plants will be taken up into the hay when it is cut and processed. This is not uncommon. In addition, PFOS-tainted manure may be ingested accidentally by cows in other ways. The testing done to date at Stoneridge Farm is inadequate for drawing firm conclusions.

Litigation

On December 27, 2018, the owners of Stoneridge Farms, Inc., as plaintiffs, filed a complaint in York County, ME Superior Court. The defendants are 3M Company, Dyneon LLC, E. I. Dupont De Nemours and Co. LLC, The Chemours Co. LLC, Arkema Inc., Solvay Specialty Polymers USA LLC, Corning Inc., Kennebunk Sewer District, and Ogunquit Sewer District.

In the court filing, the plaintiffs focus on the major chemical companies that produce and market PFAS chemicals. Those companies and their facilities were/are located in other states, not in Maine. Their marketing of PFAS chemicals resulted in widespread uses that ultimately led to deposition of PFAS on the Stoneridge Farm. The plaintiffs allege that some of these companies had research evidence that some PFAS caused negative human health impacts, yet continued to market PFAS widely. The plaintiffs seek damages from PFAS manufacturers for negligence. The plaintiffs also seek damages from Kennebunk Sewer District and Ogunquit Sewer District for breach of contract, negligence, and breach of express warranty, claiming the biosolids from those facilities contaminated their soils with PFOA and PFOS. And the plaintiffs seek damages from all defendants for “trespass to real estate” and “common law trespass.”

Notably, the litigation does not include the paper mill (or any subsequent owner) as a defendant, and no mention of that potential source of PFAS contamination at Stoneridge Farm is included in the filed complaint.

NOTE: *This Information Update may be updated as new information becomes available. Any new version will be posted at <https://www.nebiosolids.org/pfas-biosolids>.*

BACKGROUND INFORMATION ON BIOSOLIDS AND PFAS

What are biosolids and residuals and why are they land applied on farms and other sites?

Biosolids are the solids separated from wastewater at water resource recovery facilities (WRRFs) that have been treated and tested and meet strict regulatory standards for recycling to soils. They provide nutrients (nitrogen, phosphorus) and organic matter, putting to use a local resource that has to be managed. By regulation, most biosolids are applied at the agronomic rate – meaning only the amount needed to meet crop nutrient needs. Biosolids have been widely used on farms and other lands across North America for decades. Sixty percent (60%) of U. S. wastewater solids are applied to soils. Seattle, San Francisco, Los Angeles, Denver, Chicago, Boston, Concord, Burlington, and hundreds of other communities recycle their biosolids – including dozens in Maine. Many major land grant universities have studied biosolids use on soils and accept the practice, finding little risk when used according to regulations. Every U. S. state and Canadian province regulates and allows biosolids use on soils. U. S. EPA, USDA, and U. S. FDA all support biosolids recycling. Thousands of research publications over 45+ years and two major reviews by the National Academy of Sciences have found biosolids use on soils presents “negligible risk” and that “there is no documented scientific evidence that the Part 503 rule [federal regulation] has failed to protect public health.” Biosolids recycling is considered an important part of sequestering carbon in soils, addressing climate change concerns, and helping communities reach sustainability goals.

What are PFAS?

PFAS are a family of 4000+ chemical compounds commonly used in many different products we encounter in our daily lives, which is one way we are exposed to them. Some have been in use since the 1940s. They are also sometimes called perfluorinated compounds (PFCs, a less precise term). Drinking water is considered an important route of human exposure, and most regulatory action related to PFAS has been focused on protecting drinking water. The two most prominent PFAS are PFOA and PFOS, which have been phased out of use in the U. S. over the past ~15 years.

PFAS Levels in various products & locations

(ng/g or parts per billion, ppb)

Foundation cosmetic: up to 2,370 ppb PFOA (1)
Pork liver in Taiwan: up to 283 ppb PFOA (2)
Dust in daycare center: 142 ppb PFOA median (3)
Household food waste: 6 ppb all PFAS mean (4)
U. S. human blood serum: 2 ppb PFOA mean (5)
Control garden soil: .36 ppb PFOA median (6)

(1) Danish study, Oct. 2018 (2) Chen et al., 2018 (3) Strynar and Lindstrom, 2008 (4) Brandli et al., 2006 (5) NHANES, 2012

Why are PFAS a concern? Modern humans have lived with traces of PFOA and PFOS in our blood for decades. But, in some epidemiological studies, PFOA and PFOS have been linked to several negative health effects. Other research has found some health impacts of PFAS in some lab animals, but not in others. Research has also ruled out correlations between PFAS and some other negative health impacts. But, out of caution – and because some PFAS are highly persistent, bioaccumulative, and do not degrade in the environment – regulatory agencies are urging reduced exposure.

Drinking water is the current focus of public health protection actions, and screening values for PFOA and PFOS vary widely. For example, in 2018, Health Canada finalized protective screening values of 200 and 600 ppt for PFOA and PFOS, respectively. Meanwhile, a few states are looking at values in the 20 ppt range. This wide divergence reflects the uncertainty and ongoing scientific debate about the health risks.

How do PFAS get into the environment and drinking water?

PFAS have recently gained more attention in the past decade because of high levels of contamination of drinking water by industries and the use of PFAS-containing aqueous film-forming foams (AFFF) used in firefighting, especially at military sites and airports. There are hundreds of these relatively high contamination sites around the U. S. Because of their extensive use and persistence, traces of PFAS are now found throughout the world, including in the most remote environments. However, mere presence does not mean there is risk.

On rare occasions, major releases from industrial production or industrial uses of PFAS have been into sewer systems, resulting in high levels (100s – 1000s+ ppt) in wastewater and biosolids/residuals. These industrially-impacted wastewaters and biosolids are rare. It seems the vast majority of the thousands of biosolids and residuals products are non-industrially or minimally-industrially-impacted and have levels in the single to low 10s parts per billion of PFAS, not much different from other diffuse releases from homes and businesses and consumer products. These many and varied releases create low background levels (single parts per billion) in many soils, sediments, and biosolids.

Research and recent data indicate that routine recycling of modern, non-industrially-impacted biosolids does not lead to groundwater impacts at levels greater than the U. S. EPA (and Maine) health advisory level of 70 ppt.

Resources:

- About biosolids: <https://www.nebiosolids.org/about-biosolids>
- See the many uses of PFAS here: <https://fluorocouncil.com/applications/>
- The U. S. Environmental Protection Agency (EPA) discusses PFAS here: <https://www.epa.gov/pfas/basic-information-pfas>
- Health information about PFAS is here:
 - U. S. Centers for Disease Control / ATSDR: <https://www.atsdr.cdc.gov/pfas/understanding-PFAS-exposure.html>
 - Australian Health: [http://www.health.gov.au/internet/main/publishing.nsf/Content/C9734ED6BE238EC0CA2581BD00052C03/\\$File/summary-panels-findings.pdf](http://www.health.gov.au/internet/main/publishing.nsf/Content/C9734ED6BE238EC0CA2581BD00052C03/$File/summary-panels-findings.pdf)

Sources:

- Malinowski, Kerri, 2018: “Maine’s Unique PFAS Site Investigation,” presentation to the AEHS Conference, October 2018, Amherst MA, but Kerri Malinowski, Safer Chemicals Program Manager, Maine DEP
- Maine DEP, 2017. Stone Farm, Arundel – Phase II Report, June 15, 2017
- Stone, Fred and Laura and Stoneridge Farms Inc, 2018. Complaint filed in York County, ME Superior Court, Dec. 27, 2018.
- Various state reports and data on file at NEBRA; available upon request.
- Personal communications: Norm Labbe, Superintendent, KKW; Carla Hopkins, Biosolids Program, Maine DEP; Kerri Malinowski, Safer Chemicals Program Manager, Maine DEP; Dave Madore, Communications, Maine DEP

Media coverage:

February 2018:

- NH Seacoast Online: <https://www.seacoastonline.com/news/20180201/dairy-farm-contaminated-kkwwds-kimball-lane-well>

March 2019:

- *Reuters*: <https://www.reuters.com/article/us-usa-dairy-chemicals-idUSKCN1R01AJ>
- *USA Today*: <https://www.usnews.com/news/us/articles/2019-03-19/the-curious-case-of-tainted-milk-from-a-maine-dairy-farm>
- *The Bullvine*: <http://www.thebullvine.com/news/the-curious-case-of-tainted-milk-from-a-maine-dairy-farm/>
- *Maine Public Radio*: <https://www.mainepublic.org/post/state-urged-prevent-exposure-harmful-chemicals-found-sewage-sludge>
- Portland Press Herald: <https://www.pressherald.com/2019/03/19/after-farm-contamination-health-advocates-urge-state-to-ban-sludge-spreading/> and <https://www.pressherald.com/2019/03/22/maine-dep-to-require-testing-of-sludge-for-forever-chemicals/>
- *NH Seacoast Online*: <https://www.seacoastonline.com/news/20190319/dairy-farm-ruined-by-pfas-contaminants>
